BIODIVERSITY WATCH

BIODIVERSITY WATCH

April-June, 2014, Vol-4

Issue First Available : July 9, 2015

International Journal on Biodiversity Issues

www.biodiversity-watch.com

Editor in Chief
Dr. R.N. Pati

Guest Editor
Dr. Shailesh Shukla

About the Journal

International Journal on Biodiversity Watch is a peer reviewed journal developed to publish original, innovative, empirical and investigative research articles related to issues on Forest Law Enforcement, carrying capacity studies, research on ecosystem services, conservation and management of mangroves, maintenance of genetic diversity, conservation and management of wetland ecosystem, environmental and ecological issues relating to natural resource management, wild life conservation, climate change, mining and biodiversity conservation, execution of Corporate Social Responsibility initiatives, forest governance policy, programs and related issues.

This peer-reviewed scientific journal has been quarterly brought out by VRM Foundation International, Bhubaneswar, Odisha, India.

The Journal publishes investigative and empirical papers covering research findings across the sectors of forest governance, biodiversity conservation, issues relating to climate change, community based conservation, traditional medicine and medicinal plants conservation.

All theoretical and methodological perspectives are welcomed.

The Editorial Board of the journal also encourage the submission of, original manuscript translations, short papers/communications presenting various research based articles related to Biodiversity Conservation across different regions of India and world.

Aim and Scope

The main aim of the journal is to publish significant research findings focusing on Biodiversity Conservation and Forest Governance issues.

This journal aims at publishing investigative research articles covering policies, programs of Biodiversity Conservation, Challenges & threats to forest governance, conservation of medicinal plants and mainstreaming traditional knowledge into protection of biodiversity, community based conservation approach and so on.

Subjects covered in the journal

The International Journal publishes Reviews, Mini-Reviews, Original Papers, Notes, Rapid Communications, Natural Medicine Notes, Interview with policy makers and case studies on best practices of natural resource management. Three papers in each volume will be honored as Excellent Papers.

The Journal covers different dimensions of biodiversity conservation, sustainable development and environmental governances, best practices of Corporate Social Responsibility, Environmental Auditing, climate and ecosystem practices, sustainability management in corporate culture and corporate practices, substantive engineering in ecosystem functionality.

The International Journal on Biodiversity Watch is an open access journal that provides rapid publication (quarterly) of articles in all areas of the subject related to different issues of Biodiversity Conservation and Forest governance.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published approximately two months after acceptance.

Types of Paper

Regular Articles: The regular research based articles covering different dimensions of thematic area of the journal are invited from scientists, media experts and researchers working on different issues of biodiversity conservation..

The works should be original. The length of a full paper should be not less than 10 printed pages

Reviews: The journal accepts review of books by scientists and researchers published in India and abroad.

Reviews should be concise and no longer than 4-6 printed pages.

Reviews manuscripts are also peer-reviewed

Review Process : All manuscripts are reviewed by an editor and members of the Editorial Board or qualified outside reviewers.

Decisions will be made as rapidly as possible, and the journal strives to return reviewers comments to authors within 3 weeks.

The Editorial Board will re-review manuscripts that are accepted pending revision.

ISSN NO- 2436-4497

BIODIVERSITY WATCH

INERNATIONAL JOURNAL ON BIODIVERSITY ISSUES

Dr. Subha Mani
Associate Professor
Department of Economics
Fordham University
441 East Fordham Road
Dealy Hall, E 520
Bronx, New York 10458
Email: smani@fordham.edu

Dr. Robinson Mose Ocharo
Senior lecturer and Chairman
Department of Sociology and Social Work
The University of Nairobi
P.O. Box 30197 – 00100
Nairobi
KENYA
E-Mail. rocharo@uonbi.ac.ke

Dr. Prateep Kumar Nayak
Assistant Professor,
School of Environment
Enterprise and Development,
Environmental Change and
Governance Group, University of Waterloo,
Waterloo, Ontario,
Canada N2L3G1

William Armand Mala, PhD
Senior Lecturer
Department of Plant Biology
University of Yaoundé I
POBOX 337 Yaoundé, Cameroon
Email: williammala@yahoo.fr
warmand.mala@gmail.com

Dr. S.K. Tripathi
Associate Professor,
Department of forestry,
University of Mizoram,
Aizawl, Mizoram

Dr. Rabidyuti Biswas,
Associate Professor,
Department of Physical Planning,
School of Planning and Architecture, New Delhi
4 B. I.P. Estate, New Delhi - 110002

INTERNATIONAL REVIEW BOARD FOR THE SPECIAL ISSUE ON COMMUNITY FOOD SECURITY

PANEL OF PEER REVIEWERS

Dr. Tapas Kumar Sarangi
Senior Researcher,
Centre for Economic and Social Studies,
Nizamiah Observatory Campus, Begumpet,
Hyderabad-500016, Andhrapradesh, India
Email: sarangi.tapas@gmail.com

Dr. Ganesh Kawadia,
Professor and Head,
School of Economics,
Devi Ahilya University, Indore 452001
Madhya Pradesh, India,
Email: ganesh.kawadia@gmail.com

Dr. Amia Ekka
School of Life Sciences,
Pt. Ravishankar Shukla University,
Raipur – 492 010, Chhattisgarh
amia_tirkey@rediffmail.com

Dr.Parmod Kumar
Professor and Head,
Agricultural Development and Rural Transformation Centre
Institute for Social and Economic Change,
Nagarabhavi Post,
Bangalore - 560072
Mobile: 9035466781.
pkumar@isec.ac.in

Dr. P. Nayak
Professor of Economics
School of Economics, Management and Information Sciences,
North-Eastern Hill University, Shillong, Meghalaya - 793 022, INDIA.
Phone: +91-364-2723183 (O), 6183(R), 9436111308 (M)
Web Address: http://pnayak.webs.com
nehu_pnayak@yahoo.co.in

Dr. Pranab Pal
Wildlife Institute of India
Chandrabani ,
Dehradun , Uttaranchal

Ato Habtom Teklay
Department of Anthropology
Institute of Paleo environment and Heritage Conservation (IPHC)
Mekelle University, Post Box 231
Mekelle, Ethiopia, Africa
Website : **www.mu.edu.et**

Ato Hailaly G/Yesus
Department of Anthropology
Institute of Paleo environment and Heritage Conservation (IPHC)
Mekelle University, Post Box 231
Mekelle, Ethiopia, Africa
Website : **www.mu.edu.et**

Ato Mitiku Gabrehiwoti
Department of Anthropology
Institute of Paleo environment and Heritage Conservation (IPHC)
Mekelle University, Post Box 231
Mekelle, Ethiopia, Africa
Website : **www.mu.edu.et**

Dr. Shaik Yousuf Basha
Department of Anthropology
Institute of Paleo environment and Heritage Conservation (IPHC)
Mekelle University, Post Box 231
Mekelle, Ethiopia, Africa
Website : **www.mu.edu.et**

EDITORIAL ASSISTANT

Ms. Ruth-Anne Seaburn
Department of Indigenous Studies
University of Winnipeg,
515 Portage Ave, Winnipeg Manitoba, Canada, R3B 2E9

BIODIVERSITY WATCH

INERNATIONAL JOURNAL ON BIODIVERSITY ISSUES

Editor in Chief
Dr. Rabindra Nath Pati,
Department of Anthropology
Institute of Paleo environment and Heritage Conservation
(IPHC) Mekelle University, Post Box 231
Mekelle, Ethiopia, Africa

Publishers: **VRM Foundation International,**
HIG-101, Kanan Vihar, Phase-I,
Po: Patia, Bhubaneswar-751024
Tel: 0674-2725159

Special Issue on Community Food Security: Bumper volume

Price (single copy) Rs. 500.00

BIODIVERSITY WATCH

INERNATIONAL JOURNAL ON BIODIVERSITY ISSUES

www.biodiversity-watch.com

April-June, 2014, Vol-4

Community Food Security: Special Issue

Special Issue Editor
Dr. Shailesh Shukla

Editor in Chief
Dr. R.N. Pati

General Guidelines for Contributors/ Subscribers

A. GUIDELINES:

Scope

The themes of the submitted article should be on forest governance, policy and programson Biodiversity Conservation, conservation of medicinal plants and mainstreaming traditional knowledge into protection of biodiversity. Original research articles are invited on specific thematic area of forest governance and biodiversity conservation. The spectrum is very broad. It covers a wide range of issues relating to research on Biodiversity Conservation and forest governance.

Procedure for submission of article

The language of the article should be written in English. All portions of the manuscript must be typed **double-spaced** and all pages numbered starting from the title page.

The **Title** should be a brief phrase describing the contents of the paper. The Title Page should include the authors' full names and affiliations, the name of the corresponding author along with phone, fax and E-mail information. Present addresses of authors should appear as a footnote.

The **Abstract** should be informative and completely self-explanatory, briefly present the topic, state the scope of the experiments, indicate significant data, and point out major findings and conclusions. The abstract should be 300 to 500 words in length. Complete sentences, active verbs, and the third person should be used, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided.

Following the abstract, about 5 to 10 **key words** that will provide indexing references should be listed.

A list of non-standard **Abbreviations** should be added. In general, non-standard abbreviations should be used only when the full term is very long and used often. Each abbreviation should be spelt out and introduced in parentheses the first time it is used in the text. Authors should use the solidus presentation (mg/ml). Standard abbreviations need not be defined.

The **Introduction** should provide a clear statement of the problem, the relevant research done on the subject, and the proposed approach or solution. It should be understandable to colleagues from a broad range of scientific disciplines.

Materials and Methods should be complete enough to allow experiments to be reproduced. However, only truly new experiments should be described in detail; previously published experiment should be cited, and important modifications of published experiment should be mentioned briefly. Capitalize scientific terms and include the author’s name and year of

publication. Subheadings should be used. Methods in general use need not be described in detail.

Findings should be presented with clarity and precision. The results should be written in the past tense when describing findings in the author(s)' experiments. Previously published findings should be written in the present tense. Results should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the results but should be put into the discussion section.

The **Observations** should interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. The Results and Discussion sections can include subheadings, and when appropriate, both sections can be combined.

The gaps in policy and programmes must be highlighted along with suggestion for appropriate remedial measures. The findings of the research need to address deficiencies in implementation process and provide feed back for appropriate actionable strategic plan.

B. CONTACT ADDRESS:

Please send your papers to the following address:

EDITOR-IN-CHIEF
Dr. Rabindra Nath Pati,
Department of Anthropology
Institute of Paleo environment and Heritage Conservation (IPHC)
Mekelle University, Post Box 231
Mekelle, Ethiopia, Africa
Email : sainathpati2011@gmail.com
Website: www.biodiversity-watch.com

Contributors are requested to send their correct postal address (both official and residential) with pin codes, phone/mobile numbers, etc.

C. SUBSCRIPTION

Subscription Rates	India	Elsewhere
Per single copy	INR 500 (Individual) INR 600 (Institutional)	US $ 50 (Individual) US $ 80 (Institutional)
Annual (4 copies)	INR 2000 (Individual) INR 2500 (Institutional)	US $ 200 (Individual) US $ 320 (Institutional)
Two years (8 copies)	INR 4000 (Individual) INR 5000 (Institutional)	US $ 400 (Individual) US $ 650 (Institutional)
Five years (20 copies)	INR 10,000 (Individual) INR 12,500 (Institutional)	US $ 1000 (Individual) US $ 1600 (Institutional)

The subscription may be sent along with order in form of Demand Draft favouring VRM Foundation International, Bhubaneswar.

The office address of the publisher is;

VRM Foundation International,
HIG-101, Kanan Vihar, Phase-I,
Po: Patia, Bhubaneswar-751024
Tel: 0674-2725159
www.biodiversity-watch.com

CALL FOR PAPERS

The special issue of Biodiversity Watch on Biodiversity and Wild life will be published in next issue. The environmental scientist, conservationist and researchers are requested to contribute their research articles to the Editor.

Please note that the article should contain following components:

1) The article should cover the guidelines for the author
2) The length of the paper should be about 10-20 pages
3) The paper must be neatly typed
4) It must not be previously published
5) Please email your paper to Editor-in-Chief at following address:
6) A brief biodata of the author along with photograph must be forwarded
7) For further details, the editorial office may be contacted by email

EDITOR-IN-CHIEF
Rabindra Nath Pati, PhD
Department of Anthropology
Institute of Paleo environment and Heritage Conservation (IPHC)
Mekelle University, Post Box 231
Mekelle, Ethiopia, Africa
Website : **www.mu.edu.et** **Email : sainathpati2011@gmail.com**
Website: www.biodiversity-watch.com

Editor's Note

Food insecurity is a growing challenge for indigenous communities all over the world today. The main factors aggravating food insecurity are population growth, poor carrying capacity of agricultural land, limited off farm opportunities to generate cash for purchase of food drive. In countries of Asia and Africa, small land holders are worst sufferers. These households with limited option struggle to generate food and income for sustaining their livelihoods without alternative livelihood option. In this volume, the paper authors have discussed different dynamics of food security and food sovereignty with empirical evidences across different study regions and developed a more theoretical analysis of the issue.

The indigenous communities across different regions of the world have been threatened to safeguard their right to food sovereignty and food security. People have right to healthy and culturally appropriate food production through environmentally sound and sustainable indigenous technology. Since time immemorial, these communities have been culturally adopting sustainable mode of food production, distribution system and consumption pattern at the heart of food system. The liberalization of market forces and impact of globalization have eroded the indigenous mode of food production, distribution and consumption pattern apart from threatening right of people to food sovereignty. The current corporate trade and market strategies have dismantled indigenous food regime, indigenous mode of food production and distribution linked with farming, pastoral and fisheries systems. The indigenous food sovereignty revolves around local and national economies and market. These dynamics of food production and distribution empower small holder farmers and peasants to sustain indigenous mode of agriculture, artisanal fishing, pastoralised grazing and distribution and consumption driven by environmental, social and economic sustainability. The indigenous mechanism of food sovereignty contributes to transparent trade which ensures employment and income to all peoples and the right of consumers to control their food and nutrition. The empirical evidences have validated that community right to use and manage land resources, territories, water, seeds, livestock and biodiversity are controlled by the producers of food. Environmental sustainability and food sovereignty have been adopted as major policy goals of developed and developing countries of the world. But there are wide gaps and deficiencies in translating these goals at global, national and local level in terms of food supply and delivery and sustainability in exploring natural resources required for food production. These issues are numerous and complex. The policy framework of some Government fail sustenance activities of indigenous communities such as fishing hunting and good gathering which ensure collective right of community to food apart from nurturing local culture, identity and language. Land grabbing has become an instrument of globalised world. The foreign investors have grabbed mining and forest resources in indigenous territories across developing countries and dismantled indigenous mode of food production and right to food sovereignty. People have denied access to adequate food from their own natural resources and from market of their choice. The well being of indigenous communities depends on the universal right to quality of food for all. Indigenous food tradition of ancestors has significant impact in balancing between food sovereignty and food security.

The indigenous food traditions influence how they control food production, distribution and consumption. The policy makers have sidelined the indigenous food tradition of local communities. Food insecurity is a serious public health challenge among indigenous communities of Asia and Africa. These communities have become vulnerable to transformation of local culture and forced to shift from a subsistence way of life. The introduction of store based foods and change in traditional food acquisition pattern have severely affected their health and nutrition status. The frequent environmental degradation has affected indigenous coping mechanism to maintain food access among indigenous people of developed and developing countries of the world. A very little attention has been given on community level food security dynamics such as how traditions of sharing and reciprocity of food ensures the food security; how indigenous population cope internally with food inadequacies; how family members cope with food shortages differently; how they collectively cope with widespread food insecurity; and what micro strategies have been planned. The authors have critically examined these issues in their work and greatly focus on importance of traditional food acquisition and food sharing as well as community plan to cope food system change. It is empirically recognized that food sharing practice by indigenous communites is a key coping strategy to meet household food insecurity. Each indigenous community has own coping mechanism to address food insecurity and maintain food sovereignty. In globalised era, the indigenous communities have been influenced by income and food costs to exercise their choice on food. The findings and recommendations by different authors shall go a long way to encourage national governments to pay attention and work with indigenous communities mainstreaming greater food security and support an international agenda for food sovereignty.

October 25, 2014

Dr. Rabindra Nath Pati
Editor-in-Chief

Cultivating Community-based Food Security: Local Practices, Regional choices and Global perspectives : Guest Editorial

Shailesh Shukla, University of Winnipeg,
November 2014

Food –that sustains us- has transcended from the tables of families to big topic in scholarly debates, non-governmental organizations programs, government policies and funding priorities of International donors. The increasing focus on food is also seen in the changing dietary preferences among younger health-conscious and nutrion-savy generations and urban-based niche markets generating newer demands and opportunities to embrace traditional-food based recipes. The rhetoric of food and medicine as commonly expressed as 'Food for health and medicine for sick people' is now being rediscovered with 'food as medicine' – the commonly held wisdom and experiences of many Indigenous and local communities – in academia, among donors and many community-based organizations. . The global-level case studies FAO (Kuhnlein, Erasmus and Spigelski, 2009; FAO, 2013) of traditional foods and Indigenous community-based food systems have aptly established the nutritional, health, economic, educational, environmental and cultural benefits. The food-related discourses have been well echoed in policies, programs and publications on food security, food sovereignty and in recent times, Indigenous food sovereignty. The long-standing tensions and contested debates between the supporters of food security (seen as a neoliberal focus favoring supply side production) and practitioners of food sovereignty continue to compete amidst continued focus on food from all sectors and all walks of lives. International scholars such as Pimbert (2009) propose transformative concept of 'autonomous food systems' – a just and democratic food systems in which local community or a nation defines its own needs and limits and sets the course of its own food production and consumption. The transformative scope and hopes of autonomous food systems resonates very well with food sovereignty- a concept inspired from and as a movement with an explicit social justice and human rights commitment which empower people to grow, consume and distribute their own foods (V1´a Campesina 1996). Food sovereignty, challenged the dominant concept and intentions of food security, emerged as a 'big-tent' and multi-faceted concept with complex practical implications (Patel, 2009) To complicate the dialogue, Indigenous food sovereignty has recently registered its presence in support of food as a metaphor for Indigenous self-determination and reclamation of cultural identify for Indigenous communities from Canada (Morrison, 2012). The food sovereignty and Indigenous food sovereignty initiatives have been recently analyzed to reinforce their position as social justice and peasants movements (Kamal and Thompson, 2013) which counteracts the so-called top-drown supply-driven approaches promoted by the donor-driven and Government supported programs of food security.

The confusion between food security and food sovereignty still exists among academia and practitioners. In a recent international conference held the Yale University, papers were invited under a theme of 'Food Sovereignty: A Critical Dialogue' (see, http://www.yale.edu/agrarianstudies/foodsovereignty/.

One of the presenter and well-recognized scholar from Canada, Dr. Shirley Thompson, noted "The Yale conference was really about trade at the national and global level and did not provide much focus on the community level, peasant or Indigenous food sovereignty' (Thompson, Personal Communication, Dec 2014). Some of the well-recognized Journals from other disciplines also started to reflect the tensions between food security and food sovereignty. 'Dialogues of Human Geography' (Volume 4, Issue 2, 2014) has most recently published a special issue using multiple vantage points to understand food security and food sovereignty and reengage us in these debates. Murphy (2014) in this special issue suggests a rapprochement between these seemingly opposite terms in the spirit of feeding the future world. Someone with a pragmatist theoretical orientation like me welcome such reconciliation in hope to generate practical strategies based on local perspectives in order to meet the food and nutritional needs in a changing world. While drawing on an earlier definition of community food security by Hamm and Bellows (2003:37) and in the spirit of bridging food security and sovereignty, we define, community-based food security as local communities of a given region defining their own issues, priorities and needs for achieving and maintaining food security (both quality and quantity) and then using their own local knowledges, practices, and values (including belief systems) alongside scientific approaches in order to reflect, engage and govern the development of action which leads to achieving their own collective food security goals. The concept of 'community' is therefore central to any discourses and terminologies related to food. Community as a concept has always been contested with multiple meanings and dimensions (Hillery, 1955) and therefore, in community food security, community may be viewed as capable and empowered local inhabitants who can self-determine their own interest, needs, and priorities and creatively combine their Indigenous knowledges, perspectives and ways of knowing with science and formal knowledge systems to meet theirs and future generation's collective goals of securing adequate and nutritious foods. This is echoed by the nine research papers that are presented in this special issue.

The first three papers, reflect community perspectives and issues on the dimensions of production, consumption and sustenance of local food systems in Nepal. Naomi and Co-authors explored dietary diversity through a participatory case-study in the mountainous areas of Jumla, highlighted access and availability as major barriers to dietary diversity. In this study, local communities expressed that triggers in access and availabilitycaused shifts in consumption of local and traditional foods, causing newly acquired life styles. The production and consumption for the local traditional food (including traditional rice variety *Jumla Marsi)* are valued (by local communities and local community-based organizations) but also threatened due to a variety of local, regional and international factors reported by the Authors. The contributions of traditional foods and its consumption in community food security is reinforced by community voices and can be strengthened through (re)acquisition of taste for diversity of food including their own local traditional foods.

Like many countries of Global South, in Nepal too, one of the factors that is changing the context and meaning of community food security is migration (mostly by the male members) from rural regions to urban areas of Nepal and also to international places. Rural women farmers thus become prominent actors in ensuring community food security in recent times as reflected in the stats and facts presented in the second paper by Pudasaini and co-authors from LIBIRD (Local Initiatives for Biodiversity, Research and Development). *Ghar Bagaincha*- a community-based traditional home garden system with multiple species of medicinal and food plants (mainly native vegetables and fruits) and cattle primarily to meet family food and nutritional needs is examined through a survey of 769 households from 23

villages of 10 different districts in Nepal. This large survey demonstrates compelling evidence in support of the social (women empowerment), economic (overall increase in household income) and environmental (climate change adaptation) benefits of home gardens in women-dominated (due to high out-migration of male community members) small-scale farmers food systems in countries like Nepal. As shown, these home gardens are indeed serving as very valuable small community-crafted institutions and micro-habitats for production and consumption diversity of food and medicinal plants as per the wishes and interests of local women farmers and thus hold great promise for community food security. Once used as subsistence food production systems to feed own families such home-gardens, however, are now also being seen as an emerging avenue for commercial production by LIBIRD researchers for many small-scale women farmers in Nepal, which needs to be further examined from social-ecological resilience perspectives. In addition to Home gardens, community gardens as local institutional innovations for community food security were used by many communities in the past, including Indigenous communities from developing countries like Canada not just as food production systems but also as a means to cultural identity and community spirit of sharing (Beaudin et al 2013; and suggested as long-term approach to building skills, knowledge and values for community food security (Northern Healthy Food Initiative, Government of Manitoba, 2014; FAO and CINE, 2013;Council of Canadian Academies, 2014).

The sustainability of Community gardens or household gardens depend largely on the availability and use of seeds farmers or community levels. Our survival and nurturance must be credited to the generations of from generations seeds carry both genetic and cultural memory (Nazarea, 2006) - an essential ingredient for building and enhancing resilience of sustainable food systems of the local communities in various parts of the world. The seeds are often shared and exchanged among community members along with food many culturally-shared practices and beliefs. Such informal seed-sharing networks, however are least recognized and empowered and therefore are also on decline along with the seeds of many traditional food crops.

Through empirical and systematic social network analysis and tools in theKaski district from western mid-hiils of Nepa, the fourth paper by Gartaula and colleagues,shows that though weakened, an informal network of 95 farmers is still engaged in sharing and exchange of the seeds of finger millets, maize and rice. Many nodal farmers played a vital role not only in seed exchange but also contributing to conserve these seeds and cultural memory, which is now facing challenges due to variety of factors including preference to save seeds at the homes by network farmers, declining varietal diversity and most importantly local youth's loss of interest in agriculture and preference for wage Jobs than agriculture. The local (in-situ) conservation of traditional crops, cultural memory and informal institutions that sustain seed-diversity and cultural memory are valued in securing community food security at the local level but needs recognition and perhaps re-vitalization. Many place-based and self-organized native seed conservation initiatives and alliances such as RAFT (Renewing America's Food Seed Traditions, http://www.albc-usa.org/RAFT/) have recently emerged by well-known scholars like Gary Nabhan and gaining popularity in in North America to revitalize the valuable food and cultural heritage essential to feed and nurture future generations.

The next three papers from India, reflect, that local leadership and knowledge systems are capable to interact with science and formal institutions and promote community food security. Dyck's paper, explore the contributions of knowledge network often initiated by the

opinion leaders in dissemination of grassroots innovations that could strengthen community food security. As established by Gartaula's paper from Nepal, Dyck's in-depth empirical research emphasize that local leadership is very critical in inspiring, developing and sustaining such self-organized informal networks who can promote horizontal (within or across communities) diffusion of sustainable agricultural innovations. These informal networks are very important actors in building bridges with formal scientific and research institutions and non-governmental organizations to generate social learning for sustainable food systems.

Many traditional crops are regaining research and policy attention, albeit on smaller scale, in South Asia. The local communities are cultural carriers and custodians of traditional foods across many parts of the World. The research paper from Mishra and colleagues from the M.S. Swaminathan Research Foundation in India documents the Indigenous food systems of three tribal communities (Bhumia, Paroj and Penthia) from 26 villages of Odisha, India using a house-hold survey in addition to other multiple methods in order to measure food habits and consumption patterns. This study indicates that consumption in terms of dietary diversity is very high in all 15 food groups and notably Bhumia Indigenous communities reported to use 115 diverse food items. The nutrient intake, though varies among three study communities, found to be close to recommended dietary intake (RDI) values. In contrast to an earlier paper by Happychuk and co-researchers from Nepal, Indigenous communities do not have issues of access and availability in meeting their food needs, however, the availability of modern processed foods through markets and government schemes of public distribution systems led to increased use of refined sugar, oil and rice, which changed the consumption of traditional-food based recipes and cooking methods. Mishra and co-workers' paper also present some of the traditional recipes still used by these communities and underscores its significance in maintaining food and nutritional security in Indigenous communities. The Indigenous knowledges associated with traditional foods and its recipes should be organically transmitted in the younger generations order to retain the cultural memory. Through advent of policies and market, cultural memory may add new knowledges and insights keeping the nutrient-intake and core community values (such as sharing foods) intact. In the Revitalization of Small Millets project recently concluded in South Asia, recipe contests were used to recognize and renew the traditional recipes based on millets and were surprised by the richness of traditional knowledges demonstrated by study communities in South Asia- in many cases women farmers (Karthikeyan and Palani swamy, 2013; Shukla, 2009). While such community-based approaches can promote the value of traditional-food based recipes, understanding and enhancing the ways of organic intergenerational transmission to strengthen the cultural memory and encourage consumption of traditional foods among younger generations are emerging as important areas of community food security interventions and research.

The third paper from India by Ragupathy and co- researchers echoes the value of Indigenous knowledges of farmers using a DNA bar-coding approach in South Asia. The detailed taxonomic knowledge and understanding of farmers on 18 small millets land races (using 50 different morphological characters and choosing 18 different agricultural traits), and the use of these land races following the diachronic wisdom of habitat-adaptation and climate-compliance, portrays the significance and potential of ethnoecological knowledges of communities in future community food security and conservation initiatives. The wisdom of communities in selection of various variability-versatile varieties (in this case drought-tolerance) of small millets is worth mentioning. In many sub-tropical communities of Global South, where drought is a recurrent occurrence, this and many other farming communities

have developed similar systematic Indigenous genetics knowledges in selection and adaptation of place-based traditional crop cultivars of small millets. The differential perception and preferences of men (mostly utilitarian reasons) and women (mostly spiritual and family well-being reasons) in choosing and using local land races of millets illuminates the gendered nature of Indigenous knowledges, when it comes to selection of traits when feeding families. This paper clearly demonstrates how scientific tools such as DNA barcoding can work alongside, and synergistically with Indigenous knowledgesto enrich our overall understanding of contributions of traditional foods. The next step is to build on preferences and ingenuity of local communities in participatory breeding programs and policies of crop improvements.

Should the nature of and strategies for community food security differ in developed countries? A response to this question may be found in the three research papers from Canada. The research commentary by Cidro and Marten is a research commentary focussing on ensuring Indigenous food securities in cities through cultivating food skills. This paper, focuses on urban Indigenous population in Winnipeg (a city with highest Indigenous population in Canada) many of which are youth who lack the understanding and skills of their own cultural foods viz. hunting, trapping, fishing, growing, and gathering. Cultural foods for these groups are Indigenous foods- many of which are forgotten foods. The paper braves the idea of reviving the skills of production and consumption of cultural foods even in urban context within the legal and civic complexities of urban development. The role of civil society and non-governmental organizations in urban areas is considered critical in building these food skills for community food security. What is also important is to learn about and from is the cultural food skill-sets of immigrant and refugee people in cities like Winnipeg, where many people who may be originally Indigenous (in their countries of origin or birth) but officially not Indigenous from the Canadian context. Cities like Winnipeg thus weaves a multicultural tapestry of food-scape and resulting into multifaceted versions of community food security with cultural foods still being at the core.

The next two research papers from Canada speak to the value of cultural foods more so from an Indigenous perspective. The paper by Bolton and Davidson-hunt explores Anishinaabeg Perspectives of traditional fishing practices of Iskatewizaageg an Indigenous community from the Shoal Lake First Nations of Ontario, Canada. This paper achieves two purposes : i) it demonstrates a new direction of examining community food security using well-being as a competing theoretical and analytical framework' and ii) it focuses on 'wild' foods that conventionally skip the food security analysis which often focus on cultivated and domesticated foods. In a recently concluded report published by Council of Canadian Academies (2014) drawing on the expertise and experiences of high-profile Canadian experts and scholars (some of them are globally-recognized and well -cited experts on food security) noted that traditional or country foods are an important determinant of Canadian Northern Indigenous communities' food security. Therefore the ways of acquiring (for instance harvesting, gathering, fishing) and consuming (rather sharing) traditional foods and understanding various changes that affect the acquisition and consumption of these traditional foods is essential in understanding and implementing community food security interventions particularly among Indigenous communities. Echoed by several other Indigenous communities across the Globe, a detailed knowledge of fishing (for example) related practices by the study communities, the consideration that fishing is not just a food but also an act of community sharing, cultural identity and spiritual well-being is an important dimension of traditional and cultural foods. The community elders – who are the keepers of these valuable food traditions however are seriously concerned about the negative impacts of

government-supported development, policies and management of natural resources in and around Shoal Lake First Nations. Some interesting initiatives and recommendations indicated in this research including developing educational programs for local youths in schools and creating a congenial co-management partnership between local fishing communities and Government authorities is a welcome step towards community healing, empowerment, well-being and strengthening of existing and future community food security.

In order to generate alternative strategies and lessons for 'feeding the future' call by Government of United States to tackle Global hunger and food security, it would be useful to learn under what conditions and contexts various community food security initiatives work. The final paper in this special issue is one such example, which examines how the Boreal Gardening Program impacted community food security in O-Pipon-Na-Piwin Cree Nation (OPCN)a community in Leaf Rapids in Northern Manitoba, Canada. The rates of food insecurity among some remote Indigenous communities of Northern Manitoba are startling (in some cases 75 %) and demands urgent attention and intervention. The Boreal Gardening program could only make small impact, however it can be considered a complementary intervention to country food programs, which improve community food security in the harsh climatic region of Northern Manitoba. This intervention nevertheless provided some useful capacity building and creative engagement of local youths- who are the future custodians of community food security. The lessons learned in this innovative intervention are mixed but still hold good promise and create pathways for other agricultural and institutional interventions along with cultural food acquisition traditional activities. As noted in the program curricular innovations like Youth-Eco Action program needs to be replicated with active involvement of community elders to make Boreal Gardening a viable option for future community food security.

All nine papers present some common and unique features of community-based food security summarized as follows:

The concept of food is not just a factor or outcome of production or supply side intervention to be monitored and managed at the regional or national level. Food is viewed as multidimensional and multifaceted concept with different meanings in different communities. It ranges from nutrition, social sharing and bonding, community health and nutrition, food habits, community sharing and big harvests as a pride to community, eco-friendly modes of traditional food acquisition, preparation, consumption and disposal, intergenerational transmission of culture and skills, food as survival strategy to spiritual and ceremonial values, food is a medicine, food hunting as a fitness and recreational strategy and finally food as a way of life/ culture and identity. If voices of communities are counted, it is also useful to know whose voices in the communities are heard and taken into account in determining community food security. The voices, concerns and knowledges of food-insecure communities must be heard in shaping the meanings and interventions for community food security.

As mentioned earlier, community is not a homogenous and single entity but complex interplay of mix and multiple layers of knowledges-practices-beliefs generated by its constituents coming from varied class, gender and demographics. Desmarais and Whittmann (2013)'s analytical approach of discourse analysis to uncover various meanings of food sovereignty from the perspectives distinct actors (First nations, foodies and farmers) in Canada provides useful direction. Community food security should also be examined from multiple perspectives within same communities and among actors beyond defined

community, not just using discourse but also actual practices of community food security through place-based empirical research. Community food security as defined earlier, can reconcile food security and food sovereignty and suggests the way forward to action-agenda for feedings the future. As reflected in most papers, community food security is not just an ideological construct but a pragmatic strategy and invites both formal and informal knowledge systems to transform the food insecurity among communities. The role of new and digital technologies from sciences (DNA barcoding), social sciences (measuring extent of food insecurity) must collaborate with communities' own Indigenous knowledge systems (knowledge-practice-belief) complex. Community food security therefore calls for interdisciplinary approaches of research and development interventions that actively synergizes with Indigenous ways of knowing- communities' own knowledges, perspectives (beliefs and practices).

As underscored by many papers in this issue, traditional/cultural/local food shave been suggested to play a lead role in meeting existing and future community food security agendas, enhance intergenerational transmission and strengthen cultural memory. These traditional foods have also been confronting challenges including economic development activities, environmental changes, life style and dietary changes and career choices of existing and younger generation of farmers. In addition, Indigenous communities' food systems have been re-envisioned as sustainable food systems, which are sensitive to the needs of future generations and environment.

Some of the effective community-based food security interventions builds on existing educational and other relevant government programs (health, agriculture , environment, tribal development to name a few) than just being critical to government programs and policies. The joint decision making and management of food production and distribution have worked in some cases or have been envisaged as potential way forward to make community food security interventions work. Rather than measuring the success of isolated community-based food security interventions in a piece meal manner, it would be useful to examine the enabling conditions under which community-based food security nurtures, grows and inspires similar initiatives.

The women and youths are the most important constituents, custodians and carriers of community food security and their contributions in designing, implementing and evaluating community-based food security interventions should be sought actively. The lack of interest among existing small and marginal farmers to engage their youths in farming in South India (Agrawal, 2014), further accentuates the need to re-engage younger generations in securing their own community food security. As well, the role and potential of community leaders – who are seen as community champions of food security – are critical as seen in some effective community-based food security interventions. These leadership roles are often assumed based on demonstrated action and capabilities of these community food champions to self-organize the communities than hierarchical or political positions.

ACKNOWLEDGEMENT

I wish to thank Ms. Brielle Beaudin for her comments on initial draft. I would also like to express special gratitude to all the authors who contributed and all the reviewers for their feedback and constructive comments on the manuscripts. Ms. Ruth-Anne Seaburn provided commendable help and editorial support.

References:

Agarwal, Bina. 2014. Food sovereignty, food security and democratic choice: Critical contradictions, difficult conciliations, *The Journal of Peasant Studies, 41*(6), 1247-1268

Beaudin Brielle, Shukla Shailesh, Alfaro Jazmin, Hart Raven, BarkmanJanna and Evan Sinclair.2013 Indigenous Food SovereigntyCultivating Community Perspectives and Partnerships. Proceedings of the Workshop organized by the Department of Indigenous Studies, University of Winnipeg in collaboration with elders and teachers from three First Nations Communities and local groups from Manitoba, November 2013.

Council of Canadian Academies, 2014. Aboriginal FoodSecurity in Northern Canada: An Assessment of the State of Knowledge, Ottawa, ON. The ExpertPanel on the State of Knowledge of Food Security in Northern Canada, Council ofCanadian Academies.

Desmarais, A., &Whittman, H. (2013, September 14–15). Farmers, foodies & firstnations: Getting to food sovereignty in Canada. Paper presented at the proceedingsof the Food Sovereignty: A Critical Dialogue International Conference (The Journalof Peasant Studies), Yale University, New Haven, CT, Conference paper no. 3,pp. 1–28. Accessed December 2, 2014 from
http://www.yale.edu/agrarianstudies/foodsovereignty/pprs/3_Desmarais_Wittman_2013.pdf

Feed the Future: US Government Initiative. 2011.
http://www.feedthefuture.gov/sites/default/files/resource/files/FTF_research_strategy.pdf, Accessed Dec 5 2014

Food and Agriculture Organization (FAO) and Centre for Indigenous Peoples' Nutrition and Environment (CINE). 2009. Indigenous peoples' food systems: The many dimensions of culture, diversity and environment for nutrition and health. Available on-line
http://www.fao.org/docrep/012/i0370e/i0370e00.htm

Food and Agriculture Organization (FAO). 2013. Indigenous Peoples' food systems & well-being: Interventions & policies for healthy communities. Available on line
http://www.fao.org/docrep/018/i3144e/i3144e00.htm?utm_source=twitter&utm_medium=social+media&utm_campaign=faoknowledge

Hamm, M., & A. Bellows. 2003. Community food security and nutrition educators. *Journal of Nutrition Education and Behavior, 35*(1), 37–43

Hillery, G.A. 1955. Definitions of community: areas of agreement. *Rural Sociology, 20*(2),111-123.

Kamal, Asfia, G. and Thompson, S. 2013. Recipe for Recipe for decolonization and resurgence: The Story of O---‑Pipon---‑Na---‑Piwin CreeNation's indigenous food sovereignty movement. Paper presented at the International Conference on 'Food

Sovereignty:A Critical Dialogue' at the Yale University,USA September 14-15, 2003, Accessed on December 7 http://www.yale.edu/agrarianstudies/foodsovereignty/pprs/46_Kamal_Thompson_2013.pdf

Karthikeyan, M and Palaniswamy, S. 2013. Reviving Traditional Foods. *Development Matters, February 2013*, DHAN Foundation. Accessed on Nov 24, 2014, http://www.dhan.org/development-matters/2013/02/reviving-traditional-foods/

Kuhnlein, Harriet V., Bill Erasmus and Dana Spigelski, (Editors). 2009. Indigenous Peoples' FoodSystems: The Many Dimensions of Culture, Diversity and Environment for Nutrition andHealth. Rome, Italy: Food and Agriculture Organization of the United Nations.

Morrison, D. 2011. Indigenous Food Sovereignty: A model for social learning. In H. Wittman, A.A. Desmarais, and N. Wiebe (Eds.) Food Sovereignty in Canada: Creating Just andSustainable Food Systems. Halifax: Fernwood Publishing.

Nabhan, Gary Paul. 1989. Enduring Seeds: Native American Agriculture and Wild Plant Conservation. San Francisco: North Point Press.

Nazarea, V. 2006. Local Knowledge and Memory in Biodiversity Conservation. *Annual Review of Anthropology, 35*, 317-335.

Northern Health Food Initiatives. 2013. Food Matters Manitoba, http://foodmattersmanitoba.ca/content/fmm-northern-healthyfoods-Initiative, Accessed Dec 2, 2014

Patel, R. 2009. Grassroots voices: What does food sovereignty look like? *Journal of Peasant Studies,36*(3), 663–706.

Pimbert, Michael. 2009. towards Food Sovereignty: Reclaiming Autonomous Food Systems (International Institute for Environment and Development). [Available at: http://www.iied.org/pubs/pdfs/G02268.pdf

Renewing America's Food Traditions (RAFT) Alliance. 2014. http://www.albc-usa.org/RAFT/about.html, Accessed Dec 4, 2014

Shukla, Shailesh. 2009. Augmenting women's contributions in community-based conservation of medicinal plants: Lessons from biodiversity and recipe contests. In Pati, R.N. and D.N. Tewari (Eds.), Conservation of Medicinal Plants. New Delhi: APH Publishing, pp. 175-214

Vı´aCampesina 1996. The right to produce and access to land. Voice of the Turtle. Availablefrom: http://www.voiceoftheturtle.org/library/viacampesina.php, Accessed Dec 1, 2014

CONTRIBUTORS

1. Richard Bolton,
Natural Resources Institute,
University of Manitoba,
Canada.

2. Iain Davidson-Hunt,
Natural Resources Institute,
University of Manitoba,
Canada.
Email :Iain.Davidson-Hunt@umanitoba.ca

3. Jaime Cidro
Assistant Professor,
Department of Anthropology,
University of Winnipeg,
Canada
Email : j.cidro@uwinnipeg.ca

4. Tabitha Martens
Assistant Professor,
University of Manitoba,
Canada

5. Shirley Thompson,
Natural Resources Institute,
University of Manitoba,
Canada.
Email : s.thompson@umanitoba.ca

6. Asfia Gulrukh,
Natural Resources Institute,
University of Manitoba,
Canada.

7. Thomas Clahane,
Natural Resources Institute,
University of Manitoba,
Canada.

8. Uche Nwankwo,
Natural Resources Institute,
University of Manitoba,
Canada.

9. Subramanyam Ragupathy
Center for Biodiversity Genomics,
University of Guelph, Guelph, Ontario,
Canada. N1G 2W1.
Email: ragu@uoguelph.ca

10. Steven G. Newmaster
Center for Biodiversity Genomics,
University of Guelph, Guelph, Ontario,
Canada. N1G 2W1.
Email: snewmast@uoguelph.ca

11. Kathirvelu Sambandan
Post Graduate Department of Plant Science,
Avyaiyar Government College for Women,
Karaikal 609 602, U.T. of Puducherry, India.

12. Balasubramaniam C. Nirmala
Centre for Biocultural Diversity,
Chennai 600 091, India

13. Narasimhan Duvuru
Center for Floristic Research,
Department of Botany,
Madras Christian College,
East Tambaram, Chennai,
Tamil Nadu, INDIA-600 059

14. Kirit Patel
International Development Studies Program,
Menno Simons College,
Canadian Mennonite University,
Winnipeg, Manitoba,
Canada, R3C 0G2
Email: k.patel@uwinnipeg.ca

15. Rachana Devkota
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Pokhara, Nepal

16. Kamal Khadka
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Pokhara, Nepal

17. Hom Gartaula
International Development Studies
Program, Menno Simons College,
Canadian Mennonite University,
Winnipeg, Manitoba,
Canada, R3C 0G2
Email: hom.gartaula@gmail.com

18. Asis Shrestha
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Pokhara, Nepal

19. Deepak Upadhya
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Pokhara, Nepal

20. Pashupati Chaudhary
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324,
Pokhara, Nepal

21. Jason G Dyck
Independent Researcher,
Winnipeg, Manitoba, Canada
Email: jgdyck@gmail.com

22. Roshan Pudasaini,
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Pokhara, Nepal
Email :rpudasaini@libird.org.

23. Ram Bahadur Rana,
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Gairapatan,
Pokhara, Nepal

24. Suman Manandhar
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Gairapatan,
Pokhara, Nepal.

25. Naomi Happychuk,
University of Winnipeg Researcher,
Winnipeg, Canada
Email : naomihappychuk@hotmail.com

26. Epsha Palikhey,
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Pokhara, Nepal

27. Laxmi Lama,
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Pokhara, Nepal

28. Sajal Sthapit,
Local Initiatives for Biodiversity,
Research and Development (LI-BIRD),
PO Box 324, Pokhara, Nepal

29. Shailesh Shukla
Department of Indigenous Studies
University of Winnipeg,
515 Portage Ave, Winnipeg Manitoba,
Canada, R3B 2E9

30. Smita Mishra,
Pinciple scientist,
M.S.Swaminathan Research Foundation
3rd Cross Street, Institutional Area, Taramani
Chennai 600 113, India
Email: smita@mssrf.res.in or smitamishra_jp@yahoo.com.

31. V A Nambi,
M.S.Swaminathan Research Foundation
3rd Cross Street, Institutional Area, Taramani
Chennai 600 113, India

32. T.R.Prabhakaran,
M.S.Swaminathan Research Foundation
3rd Cross Street, Institutional Area, Taramani
Chennai 600 113, India

33. N. Kalaiselvan,
M.S.Swaminathan Research Foundation
3rd Cross Street, Institutional Area, Taramani
Chennai 600 113, India

34. R K Mahana
M.S.Swaminathan Research Foundation
3rd Cross Street, Institutional Area, Taramani
Chennai 600 113, India

Statement About Ownership

Biodiversity Watch

International Journal on Biodiversity Issues

FORM IV
(See Rule 8)

Name of the Journal	:	Biodiversity Watch
Periodicity of the	:	Quarterly
Publisher's Name	:	**VRM Foundation International**
Nationality	:	Indian
Address	:	**HIG-101, Kanan Vihar,** **Phase-I, Po: Patia** **Bhubaneswar-751024** **Odisha, India**
Printers's Name	:	**Prabhat Kumar Sharma**
Nationality	:	Indian
Address	:	4740-23, Ansari Road, Darya Ganj, New Delhi-110002
Editors's Name	:	**Dr. R.N. Pati**
Nationality	:	Indian
Address	:	**EDITOR-IN-CHIEF** Rabindra Nath Pati, PhD Department of Anthropology Institute of Paleo environment and Heritage Conservation (IPHC) Mekelle University, Post Box 231 Mekelle, Ethiopia, Africa Website : **www.mu.edu.et** **Email : sainathpati2011@gmail.com** **Website: www.biodiversity-watch.com**

I, Rabindranath Pati, hereby declare that the particulars given above are true as per my knowledge and belief.

Date: 17.07.2014 **Sd/-**

Rabindranath Pati
Publisher

Subscription form

Biodiversity Watch

International Journal on Biodiversity Issues

Biodiversity Watch is a quarterly journal on Biodiversity Conservation issues, climate change, community based conservation, traditional medicine and medicinal plants. published by VRM Foundation International, Bhubaneswar. Its primary aims to is to upgrade the scientific taste among the Scientists, media experts and researchers working on Biodiversity Conservation Issues. It invites research papers, book reviews, interview with policy makers, case studies on promising conservation practices or any other scientific writing on Biodiversity Conservation and Climate change.

1. ***Subscription (Institution)***
   Please accept our one year / two years/five years subscription to ***Biodiversity Watch***at the rate of Rs.2500/5000/12500/-

2. ***Subscription (Individual)***
   Please accept our one year/two years/ five years subscription to ***Biodiversity Watch*** at the rate of Rs.2000/4000/10,000/-

   (Please tick the desired option)

……

Please find enclosed the DD No…….. dated…… drawn on ……. and made payable at Bhubaneswar in favour of VRM Foundation International.
Name of the Subscriber……...
Name of the College/ University……
Postal Address for sending the journal (with pin code)…….

Signature

C O N T E N T S

1

"BEING OUT ON THE LAKE": ISKATEWIZAAGEGAN ANISHINAABEG PERSPECTIVES ON CONTEMPORARY FISHING PRACTICE AND WELL-BEING

Richard Bolton
Iain J. Davidson-Hunt

ABSTRACT

Shoal Lake, Ontario has a complex history of resource developments, policy and legislation that has impacted Iskatewizaagegan No. 39 Independent First Nation (IIFN) socially, economically and culturally. These factors continue to influence the community's contemporary fishing practices. The purpose of this paper is to explore the linkages between contemporary fishing practices and IIFN members' well-being. The study employs a mixed-method approach by utilizing a combination of household survey, semi-structured and open-ended interviews with expert IIFN fishers as well as participation in contemporary fishing practices. It presents both material and non-material benefits of contemporary IIFN fishing practices. Results indicate that IIFN members actively partake in fishing activities and continue to rely on fish as an essential part of their diet. Fishing practices also provide avenues for IIFN to convey cultural knowledge strengthen social cohesion and help articulate a sense of Iskatewizaagegan identity. As such, they are important to the community's physical and psychological health as well as Iskatewizaagegan culture and spirituality.

The Anishinaabeg people of Shoal Lake have relied on the forest, water and its resources to sustain a complex seasonal subsistence-based economy that has supported them since time immemorial. The Shoal Lake watershed offers a variety of ecosystem services that have been integral to their survival and well-being. Livelihood practices, such as fishing, have produced material benefits to the community by providing food and sustenance, and have contributed to their local economy through trade. The material benefits are often the focus of research regarding food security through the generally accepted framework that considers access, use, availability and stability in relation to food supply. As Power (2008) noted, this framework often leaves out issues of concern related to Aboriginal Peoples in Canada related to cultural practices and governance. A concern noted by others who have also suggested that food security has not fully considered the contribution of "wild" species in relation to providing food to communities nor the contribution of hunting, fishing and gathering to social and cultural practices (FAO 2014; IUCN 2013). Given these concerns we adopted the broader framework of well-being for this research so that we could include practices that supply many important non-material benefits. For example, they have been important vehicles for knowledge generation and learning for the Anishinaabeg and are also important conduits for defining and strengthening social institutions and their participation in the governance of the ecosystems that supply such benefits (Armitage et al. 2009; Davidson-Hunt and O'Flaherty 2007).

Presently, Iskatewizaagegan No. 39 Independent First Nation (IIFN) has limited participation in the governance of Shoal Lake and the management of its fisheries. The Ontario Ministry of Natural Resources (MNR) has the mandate to manage the Shoal Lake fisheries and currently does not incorporate IIFN's existing knowledge about fish and fish populations into their management approach. IIFN has practiced a variety of fishing methods - including both angling and netting techniques - for hundreds of years, and continue to today (Bosnich 1995). This suggests that there are community members that hold expert knowledge of the Shoal Lake fisheries, which could be usefully included to inform management. It also suggests that the practice of fishing is an important contributor to IIFN well-being.

IIFN's contemporary knowledge of fishing and fish populations on Shoal Lake has not been recently documented, with the last substantive community-based fisheries study carried out in 1995 (Bosnich 1995). Results presented in this paper support previous works by Berkes et al. (2001) that IIFN knowledge could potentially contribute to sustainable management of the Shoal Lake fisheries. In addition, it demonstrates that community fishing practices provide an analytical lens for articulating community-based natural resource management priorities and aspirations (Jones and Murphy 2010).

In many Anishinaabeg First Nations, there is a decline in the amount of "bush knowledge" that is being transmitted from one generation to the next through practices such as fishing (Davidson-Hunt and O'Flaherty 2007). This has recently motivated the IIFN community to record its existing knowledge of the fisheries for a variety of reasons, including cultural preservation, community sustainability and to fulfill governance objectives (Berkes 1998). Specifically, IIFN has expressed interest in exploring the existing knowledge relating to fish and fish populations to inform community-based land management approaches and to articulate management objectives of the Shoal Lake fisheries. The literature on community-based natural resource and environmental management highlights the fact that not enough attention has been paid to the restoration of indigenous land management institutions and organizations, and suggests that for this to occur, there is a need to deepen our understanding of social networks that exist within communities of practice (Armitage et al. 2009; Berkes 2009; Davidson-Hunt 2003). Social practices, such as fishing, provide a useful analytical lens to explore the ways by which communities embed knowledge, organize production activities, and interpret and derive meaning from the world (Jones and Murphy 2010). As such, they provide a framework to analyze both the material and symbolic ways that ecosystems contribute to human well-being.

"Well-being" in this context depends on the material resources, social relationships, and psychological state and subjective perceptions of people and is therefore contingent on the cultural context, agency and the social identities in question (White and Ellison 2007). To understand the present context of how Shoal Lake fisheries contribute to IIFN's well-being requires an understanding of the subjective, material and relational benefits that result from IIFN fishing practices (White 2008; 2010). As IIFN fishing practices are affected by fishery management decisions, various questions relating to the management of the Shoal Lake fisheries and the governance over the watershed arise within this context. For instance, who, how many, and why do community members in IIFN actively partake in fishing activities? How often to community members fish, and how important is this food source to the contemporary IIFN household diet? Are there contemporary barriers to IIFN fishing practices? If so, what are they? How have historical developments on Shoal Lake see to be affecting contemporary fishing practices and knowledge of these resources? Can existing indigenous knowledge about fish and fish populations on Shoal Lake contribute to more

sustainable management of these resources? We utilize these questions to organize our results and discussion and link our findings to the contemporary contribution of fishing practice to the well-being of Iskatewizaagegan people.

OVERVIEW OF SHOAL LAKE FISHERY

The Anishinaabeg of IIFN has relied on the fisheries at Shoal Lake for subsistence and to support local economies since time immemorial[1]. For several centuries prior to European settlement, the Iskatewizaagegan people have managed these resources without any imposed regulation or management regimes. In 1923, a commercial fishery was introduced on Shoal Lake and the Ontario Ministry of Natural Resources (OMNR) was given the mandate to manage it under the Natural Resources Transfer Act (OMNR 1977). This introduced commercial harvest of walleye (*ogaa*), Lake Whitefish (*atikamay*), white sucker (*namaybin*) and northern pike (*ginoozhe*) to Shoal Lake. At this time IIFN fishers adapted their fishing practices to this new resource-based industry in order to provide economic inputs for their families. This included fishing at higher frequencies and greater intensities, and adapting a host of new practices relating to the processing of fish and their transport to local markets.

For over 50 years commercial fishing was a main source of livelihood for IIFN. During this time, it contributed greatly to the well-being of the community (Manitoba Water Stewardship 2012). It supported families financially through the sale of fish to local markets and provided sustenance to fishing families and to the community as a whole. While many families relied on fishing as a "regular job", it was also an important source of leisure. In addition, fishing was important for conveying cultural knowledge and strengthening family connections.

[1] *'Time immemorial' in this context refers to a temporal scope that extends beyond the local oral history of IIFN peoples.*

In 1979, MNR introduced a commercial catch quota on walleye, which limited its annual harvest to 146,000 lbs (OMNR 1980). Throughout the following four years MNR continued to lower commercial catch quotas as Shoal Lake fisheries studies were revealing rapid decreases in walleye populations. Limiting the amount of fish that could be taken from Shoal Lake increased competition among local fishers and made it difficult for IIFN fishers to sustain a livelihood.

In May of 1983, MNR closed the commercial walleye fishery and quotas for whitefish were diminished (Mosindy 2008). At this time, the commercial walleye fishery was a main contributor to the local economy and a main source of livelihood for IIFN families. As a result, the community experienced various economic, social and cultural impacts.

When the commercial walleye fishery closed, IIFN fishers that had become dependent on the commercial fishing industry, attempted to adapt to the changing economic circumstances by seeking out resource-based employment outside of the community. This disrupted the dissemination of fishing knowledge to younger generations and put stresses on the social cohesion of family groups. With a depressed local economy and an overall low morale in the community, many fishing families were unable to adapt to the changing circumstances and were left with no choice but to support themselves and their families through social assistance payments from the Government of Ontario. In spite of these challenges, today fishing is still a widely practiced activity by IIFN members. Some members still partake in the commercial sale of Lake Whitefish; however, overall the community has adapted their fishing practices to subsistence and leisure-based activities, which offers a variety of material and non-material benefits to IIFN households.

METHODS

This research utilized a mixed-methods strategy of inquiry drawing upon both qualitative and quantitative data collection procedures to meet the goals of the research (Bernard 2006; Creswell 2009). Qualitative data collection procedures consisted of primary document review, participant observation and semi-structured (open-ended) interviews while quantitative data was collected using a household survey. Data collection occurred over a four-month period from August to November 2011, with several return trips throughout the winter of 2011/2012. During this time the following methods were utilized:

1) primary documentation research
2) participation in fishing activities
3) semi-structured and unstructured interviews
4) household survey

PRIMARY DOCUMENTATION RESEARCH

Primary documentation research was used to investigate information relating to the policy and legislation governing the management of natural resources within the Shoal Lake watershed. This included compiling and analyzing government policy documents relating to Shoal Lake fisheries management, watershed governance and resource developments (Hill 1993). It also included compiling and analyzing historical documents relating to resource developments on Shoal Lake; and, reviewing correspondence between MNR and IIFN that related to the Shoal Lake fisheries, from the period of the walleye closure to present.

PARTICIPATION IN FISHING ACTIVITIES

Through participation in fishing activities with community fishers Richard Bolton was able to observe IIFN fishers' knowledge of: fishing locations, fish movements, and population structures and species life cycles. The extensive and intimate engagement that was possible using this method was particularly useful for forging relationships with IIFN fishers and getting to know the lake. It was also particularly important for gaining an understanding of social, cultural and symbolic dimensions of contemporary fishing practices.

INTERVIEWS

Nine interviews were undertaken with active IIFN fishers. Semi-structured interviews were utilized to ensure that the research participants had a considerable amount of control over the interview process, and that they could decide what is relevant to discuss about a particular topic. The role of the interviewer was therefore to guide the discussion around the general topics of fishing practice and IIFN conceptions of well-being. In these interviews, community fishers were asked to reflect on how / if they feel resource developments have affected Shoal Lake fish and fish populations. This included asking them to reflect on how the opening of Ash Rapids, the City of Winnipeg intake / dyke, cottage developments, mining explorations, forestry operations and sports fishing lodges have impacted fish and fish populations on Shoal Lake. Community fishers were also asked about how they feel economic, political and policy processes influence their contemporary fishing practice. This included asking them about changes that may have occurred in the frequency, intensity or form of IIFN fishing practice due to financial costs associated with fishing; implementation of imposed fisheries legislation; contemporary fisheries management approaches; and, relationships with other resource users.

HOUSEHOLD SURVEY

The decision to use a household survey for this research project came out of collaborative discussions with IIFN, when they expressed their desire to document IIFN members' contemporary resource harvesting practices. Specifically, the research team was interested in collecting quantitative household-level data to get a representative picture of contemporary land-based practices and consumption of country foods by IIFN members. The purpose of collecting this data was to document how resources from the land and water contribute to IIFN's well-being. IIFN was also interested in creating a community database of contemporary land-based activities.

To administer the household survey, a questionnaire was developed in a collaborative process and in reference to livelihood survey methodology developed by the Poverty and Environment Network (Angelsen et al. 2011). The questionnaire was designed to take approximately 30 minutes to complete and was administered through face-to-face interviews. A systematic sampling strategy was employed that was applied to a randomly prepared list of the sample frame (Angelsen et al. 2011). We selected 50 households ($n = 50$) to produce generalizable information about the total population ($N=144$ households). Households were selected at random, using a household numbering system that was created for a previous community survey conducted in 2001. We selected every seventh household on the list until we reached our desired sample size. For each household selected, we interviewed the head of the household, as defined by household members.

This sampling strategy informed the design of the survey instrument. Knowing that we were not going to survey every household in the community allowed us to maximize the information that we gathered from each interview. Using this method we documented various aspects of contemporary fishing practices, by asking questions about the frequency of fishing activities, contemporary fishing techniques practiced by households members, gear utilized, type of fish taken, perceived access and barriers to fishing, and consumption of fish species. The survey was administered four times to the same households following each main season (winter, spring, summer, fall) over the course of year (2011-2012). This allowed us to obtain a sense of how harvest practice varied by season. Further details of the results of the survey, beyond those presented in this paper, can be found in Bolton (2012).

FINDINGS AND DISCUSSION

IIFN fishers perceived impacts on Shoal Lake

Interviews revealed that IIFN fishers have detailed knowledge of the changes that have occurred to the Shoal Lake ecosystem within their lifetime. Several IIFN fishers also hold detailed knowledge of what the condition of Shoal Lake's aquatic ecosystem was like before their lifetime, as stories of the lake have been passed down across generations. Table 1 highlights IIFN fishers perceived impacts on the health and integrity of Shoal Lake and their contemporary fishing practices. These include resource developments that have altered the hydrology of the lake, impacted fish spawning habitat and are having long-term adverse effects on the quality of water on Shoal Lake and its fish populations. It also includes government policies that have impacted their fishing practice. Such as, the closure of the walleye fishery and the Ontario Government's subdivision of land on Shoal Lake, which has since been purchased by urban residents primarily from Manitoba, who now reside on Shoal Lake and utilize its resources during summer vacation months.

Shoal Lake has a long history of resource developments, which include mining and forestry activities dating back to the late 1800s. The deepening and widening of Ash Rapids, which occurred at the turn of the 20th century; the construction and operation of the City of Winnipeg water intake / dyke; the closure of the commercial walleye fishery in the spring of 1983; and more recently, seasonal cottage developments for urban residents are all perceived have produced significant effects.

Table 1. IIFN Perceived Impacts on Contemporary IIFN Fishing Practices.

Perceived Impact	Time Period	Effect on IIFN Fishing Practices
Residential Schools	1800s - 1980s	1) social and psychological impacts 2) linguistic, cultural and spiritual impacts 3) effects on disseminating fishing knowledge across generations
Opening of Ash Rapids	1880s	1) long-term impacts on water quality 2) introduction of new fish species
City of Winnipeg Water Intake and Associated Dyke	1915 - present	1) reversed seasonal water flows 2) disrupted walleye spawning habitat
Falcon River	on-going	1) degrading water quality (pollution from upstream cottage developments)
Mining Developments	1892 - 1985	1) driver for the opening of Ash Rapids 2) future threats to water quality
Forestry Developments	1890s - present	1) effects on water quality 2) future threats to water quality
Cottage Developments	1970s - 80s	1) increased water traffic 2) degraded water quality 3) increased fishing activity
Closure of Commercial Walleye Fishery	1983	1) disrupted fish populations and age structures 2) resulted in too many fish in the lake 3) created an imbalance in the lake

IIFN fishers perceive that the inflow of water from outside sources such as Lake of the Woods and Falcon Lake is degrading the water quality on Shoal Lake. The combination of impacts that are being experienced from the water intake and associated dyke, the diversion of the Falcon River and the opening of Ash Rapids has reversed the hydrology of the lake during certain seasons and has drastically altered Shoal Lake's most productive spawning habitat. IIFN fishers are concerned about the potential long-term effects of these factors on the health and integrity of Shoal Lake. They believe that more scientific studies need to be conducted to understand these dynamics and how they might be impacting fish.

There is also considerable concern with the impacts from the closure of the walleye fishery. IIFN fishers perceive that too many walleye, and in particular, too many large walleye provide signs that the lake is 'out of balance'. This stems from their belief that, as an Iskategwizaagegan people, they have a custodial responsibility to the lake, and therefore have an obligation to interact with the aquatic ecosystem through harvesting of fish and sharing of country foods among the community (Davidson-Hunt 2003). Imbalances in fish populations are thus thought in part to be a result of decreasing in fish harvests, and IIFN fishers believe that re-introducing a commercial harvest of walleye could alleviate some of these effects. IIFN fishers are unsure of the ways that contemporary and future developments will impact Shoal Lake and their fishing practices and feel that more scientific studies need to be conducted to understand some of these potential impacts.

IIFN fishers are also concerned with the City of Winnipeg's proposal to increase its drinking water service to surrounding rural municipalities, which in turn would increase the amount of water that the City of Winnipeg is permitted to withdraw from Shoal Lake. Increasing the volume of water being withdrawn from Shoal Lake would increase the rate at which water from Lake of the Woods would enter into Shoal Lake. It is perceived that this may exacerbate the impacts that have been observed over the past century. In particular, IIFN believe that this would result in a more rapid deterioration of water quality on Shoal Lake, and would drastically impact future resource harvesting activities, including IIFN fishing practices.

CONTEMPORARY ISKATEWIZAAGEGAN FISHING PRACTICE

Fishing is still widely practiced by the majority of IIFN households. Most IIFN members continue to fish for a variety of purposes, which includes subsistence, leisure, sport and commercial activities.

Results from the *Iskatewizaagegan Land and Water Survey, Summer 2011* provide general characteristics of contemporary IIFN fishing practices and document the various material benefits of these practices.

Fishing is practiced in every season. Fishing is practiced by a greater number of households than any other resource harvesting activity (e.g. hunting, trapping, gathering plants & medicines) as shown through a comparison presented in Figures 1 and 2. Eighty-two percent (82%) of IIFN households partook in fishing activities in the summer and almost half of the community households are reported to take part in fishing activities in fall, winter, and spring. A substantial proportion of IIFN households partake in fishing activities in every season, while other resource harvesting practices, such as hunting, are practiced mainly during one season.

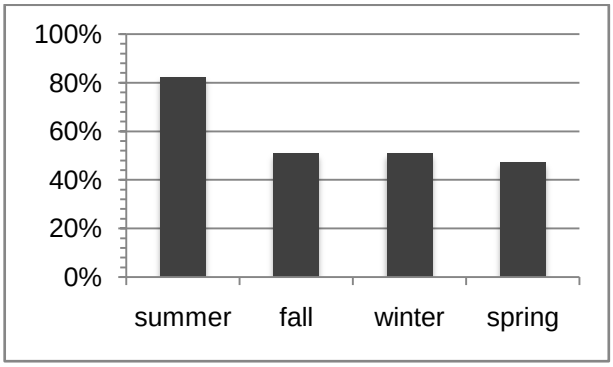


Figure 1. Seasonality of Fishing.

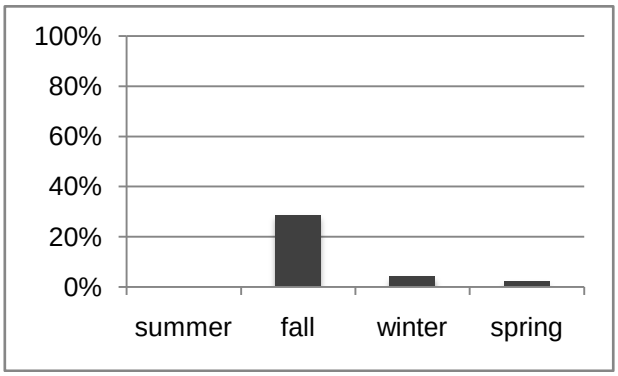


Figure 2. Seasonality of Hunting.

Fishing is practiced for subsistence and a variety of other purposes. Sixty-five percent (65%) of households characterized their fishing practice as a *"subsistence"* practice. The second most significant response was for "*leisure purposes" (39%).* Other important purposes of fishing were *"to share / gift" (29%)*, because fish are a *"traditional delicacy" (18%)* and for *"spiritual purposes" (14%).* The lowest response rate was *"to sell" (6%),* which points to the low participation in commercial fishing activities since the closure of the commercial walleye fishery.

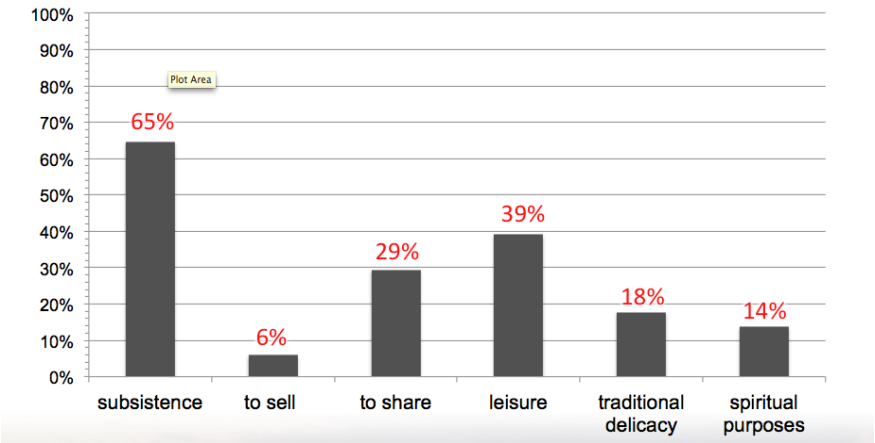


Figure 3. Reported purposes of fishing.

Walleye is most frequently consumed fish species and highly desired. Ninety-eight percent (98%) of IIFN households consumed walleye in the summer of 2011. Other species that were consumed include: lake whitefish (16%); northern pike 11%; and bass (9%) *(smallmouth and*

largemouth). These results indicate that during the summer of 2011 walleye was the preferred species for consumption, and that virtually every IIFN household that participated in the survey consumed this fish species.

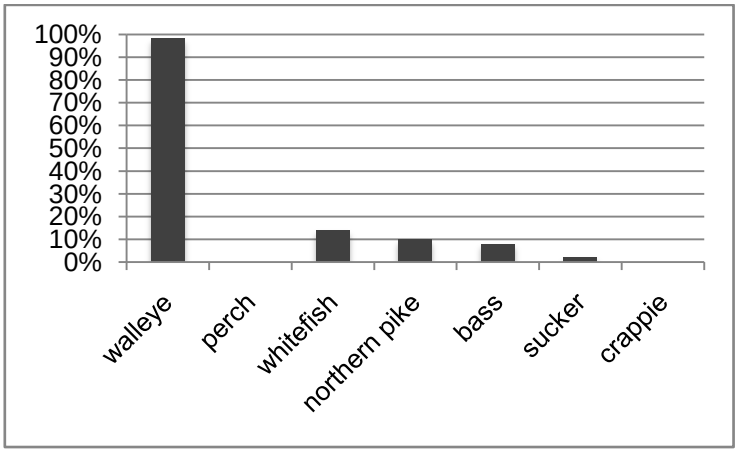


Figure 4. Preference of fish by species.

IIFN people do not perceive that there are many barriers to fishing. Overall, IIFN members do not perceive that there are significant barriers to contemporary fishing practices whereas perceived barriers, such as lack of knowledge and lack of interest, are present for other resource harvesting activities, such as trapping. Of the identified barriers to fishing, *"lack of equipment"* was the highest response at 13%, followed by *"costs"* (6%),*"access"* (4%) and *"time"* (2%).

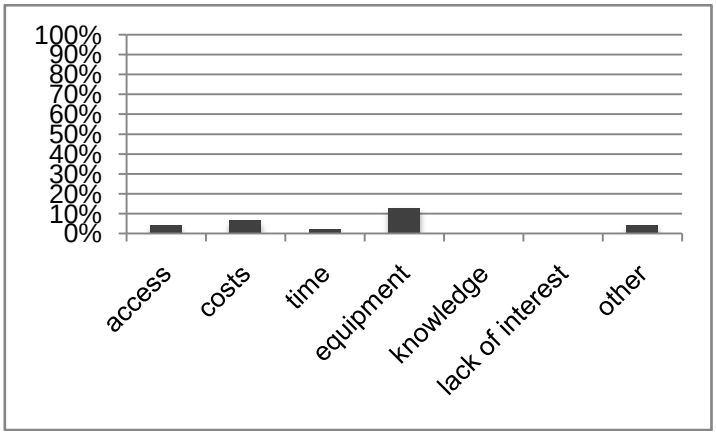


Figure 5. Perception of barriers to fishing.

Most IIFN households use fishing rods rather than gill nets. Seventy-nine percent (79%) of the IIFN households that participated in the household survey suggested that they primarily use fishing rods to harvest fish as opposed to seventeen percent (17%) that primarily use gill nets.

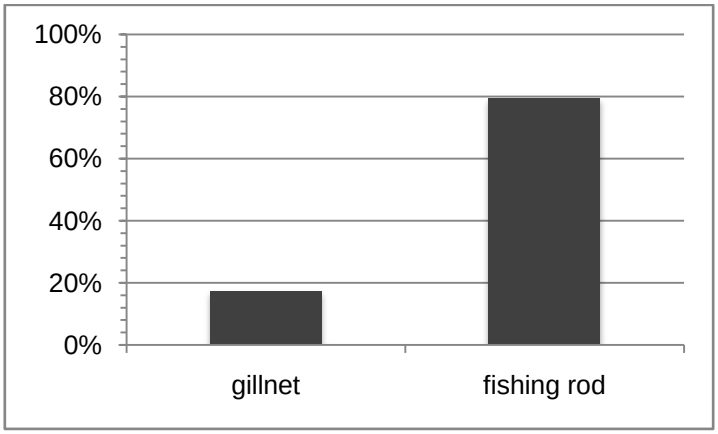


Figure 6. Gear utilized for fishing.

Acts of sharing are an important aspect of fishing. Sixty-three percent (63%) of IIFN households indicate that one of the ways that they obtain walleye for consumption is through it being *"shared"* or *"gifted"*. This represents the most common method for obtaining walleye for consumption in the summer of 2011. *"Harvesting"* is the second most common method for obtaining walleye for consumption at 59%. Another method of obtaining walleye for consumption is *"purchased"* (14%), however a relatively low percentage of respondents selected this option.

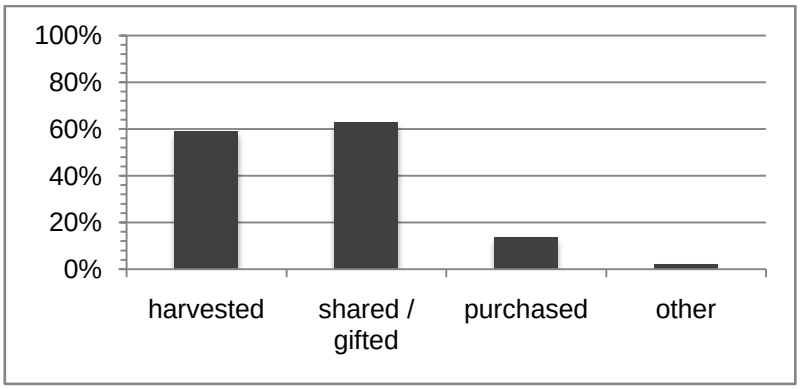


Figure 7. Means by which fish obtained for consumption.

Data obtained from participation in fishing activities and interviews with expert IIFN fishers highlights various non-material benefits that contemporary IIFN fishing practice provides to the community. Contemporary IIFN fishing practices provide an avenue for conveying cultural knowledge across generations and articulating a sense of Iskatewizaagegan identity. Acts of sharing are a significant way that IIFN members obtain fish for consumption. This practice is rooted in Iskatewizaagegan spirituality and connected to the importance of giving thanks to the Creator and the lake. Through contemporary acts of sharing fish and fish fry gatherings, social networks within the community are strengthened which contributes to social cohesion of family groups and the broader community. As described in an interview with one IIFN Elder,

"In the springtime we used to have our feasts to give thanks to the Creator and the lake for the gifts that enabled the community to survive the winter months...The people who go out and fish, they still give their thanks by sharing their fish with different people in the community."

Reflecting on the material and non-material benefits of IIFN's contemporary fishing practices it is clear that it continues to contribute greatly to the community's well-being.

MANAGING SHOAL LAKE FISHERY

IIFN are stewards of the Shoal Lake watershed and rely on detailed understandings of ecological systems and spirituality to inform sustainable ways of relating to the lake and surrounding landscape. Contemporary local knowledge of Shoal Lake is rooted in a long history and connection to this landscape. IIFN fishers could contribute greatly to the sustainable management of Shoal Lake's fisheries and the watershed as a whole; yet, they have had no success in having their management suggestions incorporated into Shoal Lake watershed management planning processes. IIFN has not signed onto the Shoal Lake Watershed Management Plan and currently do not participate in Shoal Lake Watershed Management Working Group (SLWMWG) meetings. This is, in part, due to IIFN's perception of the generally poor planning process in developing the document and that the SLWMWG would not formally recognize IIFN Treaty rights in the document. It is also rooted in a history of poor relations between the MNR and IIFN fishers that has resulted in a deeply ingrained lack of trust for this government agency by IIFN and differing perspectives on how to approach fisheries management.

MNR has implemented policies, such as catch quota systems and the closure of the commercial walleye fishery, which have drastically altered IIFN fishing practice and impacted the community's well-being. IIFN fishers' memories of the manner by which these policies were implemented highlight some of the root causes of IIFN's deeply ingrained mistrust of MNR. For example, during interviews with several IIFN fishers and community Elders, it was expressed that the closure of the walleye fishery was implemented without any prior consultation with IIFN or consideration of their knowledge of fish populations. As a result, IIFN fishers perceive that these and other Shoal Lake management decisions were not made for the benefit of the community.

Interviews with IIFN fishers revealed criticisms of the way MNR approaches fisheries management. IIFN fishers do not believe that MNR is capable of maintaining the health and integrity of the lake and its resources for future generations, as they perceive that MNR does not spend enough time on the lake interacting with its resources to truly understand its health. They also perceive that MNR does not have the capacity to properly enforce their fisheries policies and regulations. This is attributed to a lack of essential fisheries management capacity. IIFN fishers suggest that they have observed first-hand MNR's failure to enforce its management regulations when they shut down the commercial walleye fishery and they believe that this lack of enforcement capacity is one of the reasons that they have not re-opened the commercial walleye fishery. For example, MRN does not have the resources to have conservation officers on the lake at all times, which is what IIFN perceive as necessary to successfully enforce MNR's fisheries management policies.

Moving forward. The relationship between IIFN and MNR is clearly impacting the community's involvement in the management of the Shoal Lake watershed as well as their participation on the SLWMWG. Somewhat surprisingly, in spite of the history of poor relations between the two groups, several IIFN fishers value restoring the relationship with the government agency to ensure the sustainable management of the lake and its resources.

MNR must make a concerted effort at restoring the relationship with IIFN. In order to overcome the deeply ingrained mistrust of MNR by IIFN, it will be necessary for MNR to formally recognize the expert knowledge of IIFN with regards to the watershed and its resources. It will also require more transparency by MNR, specifically in the form of sharing unanalyzed fisheries data collected during fall walleye index netting projects, as well as more meaningful consultation about future management initiatives. Finally, MNR will need to recognize and respect that both parties have different worldviews and provide meaningful opportunity in their management approach for new ways of thinking about fisheries management. Thus, for Shoal Lake fisheries policies to be observed and potentially enforced by IIFN, they must be jointly discussed and formulated with MNR, which requires that the relationship between the two parties is be healed.

CONCLUSIONS

Analysis of contemporary IIFN fishing practices contribute to a better understanding of how ecosystems contribute to human well-being and highlight a variety of issues relating to local and indigenous peoples role in natural resource and environmental management. Sustaining IIFN's dynamic fishing traditions is an essential step for ensuring the well-being of the Iskatewizaagegan people. IIFN fishers insist that to ensure the health of the lake and its people, their community must take a leadership role in management decisions surrounding the lake and its fisheries. For IIFN to consider participating in MNR's models for Shoal Lake fisheries management would require a commitment of both parties to undergo a process of reconciliation and healing. Given the unequal power relations that exist within this context, the authors suggest this process should be initiated by MNR.

IIFN is presently building its capacity to manage its own resources, by undertaking a variety of research projects to generate baseline data about the lake and its resources. This initiative was generated in response to a history of poor relations and lack of trust with MNR and is a symbolic step for IIFN to exert its sovereignty and authority over the lake and its resources. Multiple avenues can be explored to re-establish a fishing economy for the IIFN community and their involvement in the management of the resources is essential to this process. While government imposed fisheries policies have drastically impacted IIFN, the community has shown ingenuity in culturally adapting their fishing practices within changing political, economic and environmental circumstances. The pride and integrity of the Iskatewizaagegan culture is exemplified through the resilience of its fishing practices over the past several hundred years. Whether MNR and IIFN will begin a process of reconciliation remains to be seen. Whether or not this occurs, IIFN has shown that it will continue to assume its custodial responsibilities over Shoal Lake and its resources in the future and will make its best efforts to ensure its territory remains healthy for future generations of Iskatewizaagegan people. While a food security framework would focus on fish as the primary outcome of a well-managed fishery for Iskatewizaagegan people this is to ignore that fish are emergent from a restored relationship with fish. Such a restored relationship can only occur in the context of new governance arrangements that consider the material benefits of fish, both for direct subsistence and as a commercial activity, as well as the cultural practice of fishing and the role of Iskatewizaagegan in governance of the fishery.

RECOMMENDATIONS

The central recommendation of this project is for the community to prioritize community-based initiatives as an essential step in building capacity to manage its own watershed and exerting its sovereignty over its traditional lands.

Initiatives to Implement Community-Based Fishery Management

Community-Based Fisheries Research. Some research has been undertaken to assess the effects of resource developments on fish populations and water quality (Borecky 1980; MNR 1980; Mosindy, 2008); however, IIFN fishers believe that up-to-date studies should be undertaken to evaluate contemporary effects of resource developments on Shoal Lake. The authors of this project recommend that multi-year studies that monitor these effects be undertaken. The design of such studies should emerge out of discussions with expert IIFN fishers, but could include:

1) a water quality monitoring study at the outlets of Ash Rapids and the Falcon River to determine how the inflow of these water bodies are affecting water quality on Shoal Lake;
2) a multi-year fish monitoring study at the water intake that quantifies the mortality of spawn, larval, and juvenile fish during relevant spawning seasons for lake whitefish, white sucker and walleye.

The specific design and methodology of these studies would require the skills and expertise of trained specialists in the areas of limnology and fisheries biology. IIFN could contract its own independent consultants to collaborate on the projects and securing funding for these studies may present an obstacle. However, for IIFN to have up-to-date data on the effects of these resource developments is seen as a priority to IIFN fishers.

Support Sustainable Fishing Practice: IIFN fishers have thought of various ways to re-establish an IIFN fishing economy. The following recommendations are made to support the proliferation of IIFN fishing practices in future generations, and explore avenues for future fishing economies.

1) Re-establish educational fishing programs (eg. “take a kid fishing day”) for students through the David Kejick School to learn survival skills and traditional resource harvesting practices
2) Establish a IIFN fishers advisory board

The first recommendation highlights the importance of ensuring the survival of IIFN fishing practices in future generations. Due to the tangible material benefits, combined with the myriad of ways that this practice helps strengthen IIFN culture and spirituality, re-establishing educational fishing programs should be considered a priority. This project acknowledges that programs, such as the fall harvest, are successful at conveying IIFN values and culture to younger generations. By engaging IIFN youth, these programs build stewardship of the Shoal Lake watershed. Contemporary IIFN fishers specifically reflected on the importance of “take a kid fishing day” for stimulating their interest in developing a fishing practice. This study recommends that the re-establishment of this program through the David Kejick Memorial School would be beneficial to sustaining IIFN fishing practices that are rooted in traditional teachings, which is an essential step for sustainable Shoal Lake watershed management.

The second recommendation is in response to IIFN fishers' desire to re-establish a fishing economy for IIFN. Due to the variety of options that could be explored, and a lack of knowledge of the feasibility of each option, this study recommends that an important first step in re-establishing a locally controlled fishing economy is for IIFN fishers to establish an organizational structure to help guide in future decision-making relating to fisheries. Interest has been expressed in finding creative ways to bring back a commercial walleye fishery. Those who are actively participating in these practices must decide the future of an IIFN fishing economy. This study suggests that organized discussions amongst expert IIFN fishers, Elders and Chief and Council will help determine the most suitable way to move forward.

Community-Based Enforcement of Fisheries Regulations. A final recommendation of this study is for IIFN and MNR to work together to explore avenues for involving IIFN fishers in the enforcement of fisheries regulations. As highlighted by Berkes et al. (2001) "fishers, the real day-to-day managers of the resource, must be equal and active participants in fishery management" (p.199). One option to achieve this could be to hire IIFN fishers to monitor Shoal Lake fishing activity to ensure that it is following their guidelines. This could be an essential symbolic step in recognizing IIFN's authority over Shoal Lake and its resources. This step would require reconciliation and forgiveness on the part of IIFN to be able to work for and alongside MNR. It would need to be determined whether there are individual IIFN fishers who would be interested or willing to bridge this gap.

References

Angelsen, A. et al. 2011. *Measuring Livelihoods and Environmental Dependence: Methods for Research and Fieldwork*. Bogor, Indonesia: Center for International Forestry Research.

Armitage, D.A., R. Plummer, F. Berkes, R.I. Arthur, A.T. Charles, I.J. Davidson-Hunt, A.P. Diduck, N. C. Doubleday, D.S. Johnson, M. Marschke, P. McConney, E.W. Pinkerton, and E. K. Wollenberg. 2009. Adaptive-Management for Social-Ecological Complexity. *Frontiers in Ecology and the Environment* 7(2):95-102.

Berkes, F. 1998. Indigenous Knowledge and Resource Management Systems in the Canadian Subarctic. In: *Linking Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge: Cambridge University Press.

Berkes, F. 2009. Evolution of co-management: Role of Knowledge Generation, Bridging Organizations and Social Learning. *Journal of Environmental Management* 90:1692-1702.

Berkes, F., R. Mahon, P. McConney, R. Pollnac and R. Pomeroy. 2001. *Managing Small-scale Fisheries: Alternative Directions and Methods.* International Development Research Centre. Ottawa, Ontario, Canada.

Bernard, H.R. 2006. *Research Methods in Anthropology: Qualitative and Quantitative Approaches.* Fourth Edition. Oxford: Altamira Press.

Bolton, R. 2012. *"Being out on the Lake": Iskatewizaagegan Anishinaabeg Perspectives on Contemporary Fishing Practice and Well-being*. M.N.R.M. Thesis. Winnipeg, MB: University of Manitoba. Available on-line at http://umanitoba.ca/institutes/natural_resources/canadaresearchchair/thesis/Bolton_Richard.MNRM.2012.pdf

Borecky, R.A. 1980. Summary of the Fishery Monitoring Program, Shoal Lake, 1979. Lake of the Woods-Rainy Lake Assessment. Unit Report 1980-1. Ontario Ministry of Natural Resources. Ontario.

Bosnich, D. 1995. Assessing Traditional and Contemporary Fisheries Knowledge

within the Shoal Lake Watershed: Possibilities for Partnerships with Shoal Lake First Nation #40. Practicum: Natural Resources Institute, University of Manitoba.
Creswell, J.W. 2009. *Qualitative, Quantitative, and Mixed Methods Approaches*. Third Edition. Sage Publications Inc. Thousand Oakes, California.
Coulthard, S., D. Johnson, and J. A. McGregor. 2011. Poverty, Sustainability and Human Wellbeing: A Social Wellbeing Approach to the Global Fisheries Crisis. *Global Environmental Change* 21(2):453-463.
Davidson-Hunt, I.J. 2003. Indigenous Lands Management, Cultural Landscapes and Anishinaabeg People of Shoal Lake, Northwestern Ontario, Canada. *Environments* 30(1):21-41.
Davidson-Hunt, I.J., R.M. Flaherty. 2007. Researchers, Indigenous Peoples, and Place-Based Learning Communities. S*ociety and Natural Resources* 20: 291-305.
FAO (Food and Agriculture Organization). 2014. Forsts for food security and nutrition, accessed at : http://www.fao.org/forestry/food-security/en/, 22/09/14
Hill, M.R. 1993. *Archival Strategies and Techniques*. Qualitative Research Methods Series. Sage Publications Ltd. Printed in the United Stated of America.
IUCN (International Union for the Conservation of Nature). 2013. *Food Security Policies: Making the Ecosystem Connections*. Gland, Switzerland: IUCN.
Jones, A. and J.T. Murphy. 2011. Theorizing Practice in Economic Geography: Foundations, Challenges, and Possibilities. *Progress in Human Geography* 35:366-392.
Koenig, E. C. 2005. *Cultures and Ecologies: Native Fishing Conflict on the Saugeen-Bruce Peninsula*. University of Toronto Press. Toronto Buffalo London.
Manitoba Water Stewardship. 2012. Shoal Lake Watershed Management Plan Page. Accessed from http://www.gov.mb.ca/waterstewardship/water_quality/quality/shoal_lake_wsmp.html on May 25, 2012. Government of Manitoba.
Mosindy, T. 2008. Shoal Lake Fall Walleye Index Netting: 2006. Aquatics Update 2008(2). Ontario Ministry of Natural Resources.
Ontario Ministry of Natural Resources. 1977. Lake of the Woods General Land Use Plan. Government of Ontario.
Ontario Ministry of Natural Resources. 1980. *An Evaluation of the Shoal Lake Fishery*. Lake of the Woods – Rainy Lake Fisheries Assessment Unit Report. Government of Ontario.
Power, E. 2008. Conceptualizing Food Security for Aboriginal People in Canada. Canadian Journal of Public Health 99(2): 95-97
White, S. C. 2008. But What is Wellbeing? A Framework for Analysis in Social And Development Policy and Practice. Paper for Regeneration and Wellbeing: Research into Practice. ESRC Research Group on Wellbeing in Developing Countries.
White, S. C. 2010. Analyzing Wellbeing: A Framework for Development Practice. *Development in Practice* 20(2): 158-172.
White, S. C., and M. Ellison. 2007. Wellbeing, Livelihoods and Resources in Social Practice. In *Wellbeing in Developing Countries: New Approaches and Research Strategies*. Eds. I. Gough and J. A. McGregor Cambridge: Cambridge University Press.

2

EATING INDIGENOUS FOOD IN THE CITY: THE LIMITATIONS OF FOOD SECURITY FOR INDIGENOUS PEOPLES IN URBAN CONTEXTS

Jaime Cidro
Tabitha Martens

ABSTRACT

Urban Indigenous communities in Canada face marked economic disparities. Winnipeg, Manitoba has the largest population of urban Indigenous people in Canada. Winnipeg's inner city community, where the majority of Indigenous people reside, has faced challenges in recent years with the shutdown of the majority of discount grocery stores, resulting in large areas without access to grocery stores, otherwise known as food deserts. Undoubtedly Winnipeg's inner city faces food insecurity, and swift action is needed in order to address this pressing social and health issue. Addressing food insecurity for Indigenous people is however insufficient to properly address the fundamental shifts that have taken place in response to the larger ongoing colonial pressures facing Indigenous communities, both in rural, remote and reserve communities, but also in an urban context. Indigenous food sovereignty is a much more useful concept and approach to addressing food security. It is described as the increased control over food systems and has emerged in the literature as a means of addressing food insecurity. Food sovereignty places control over how, what, and when food is eaten and encourages a close relationship between production and consumption. Indigenous food sovereignty (IFS) goes even further to call on Indigenous people to reconnect to their food systems, including cultural food. An essential component to this is food skills. Urban Indigenous organizations that are attempting to reduce food insecurity amongst their community members should consider placing emphasis on food skill building, with a focus on cultural food, as one way not only to improve food security, but reclaim culture and build community.

Keywords: Indigenous, food security, food sovereignty, food skills, cultural food, inner city

Canadians, in general, experience a relatively high standard of living given the stable national economy, with few experiencing the day to day physical hunger associated with poverty. Despite this, pockets of marginalized populations in Canada face not only physical hunger but a lack of quality food that meets their cultural and social needs. Food insecurity, which includes accessibility, availability, and utilization of culturally adequate and acceptable foods, has been recorded and is a major concern among the economically vulnerable groups (McIntyre et al., 2000, Che & Chen, 2001). Access to safe, affordable, and nutritious food is an obstacle facing many urban Indigenous people, particularly in the inner city of Winnipeg, Manitoba. Undoubtedly food security is a pressing issue for urban Indigenous people, especially those living in inner city areas, but there are also some important and unique elements to food insecurity related to cultural food that have received little attention.

Indigenous people and food are often explored within a deficit based construct, and, most often, in a traditional environment or rural and/or remote community. Food security for Indigenous urban people has received some attention in academic literature with a marked limited focus on cultural foods (Baskin et al., 2009; Brown et al., 2008; Sinclaire, 1997).

Urban Indigenous food security requires an examination of several important theoretical areas including culture and food consumption, Indigenous food security, Winnipeg's Indigenous population and food, Indigenous food sovereignty and food skill building. This brief paper will explore the insufficiency of using the concept of food security to understand issues of access to cultural foods for Canada's largest Indigenous urban population. We argue that a more sound approach is to reconceptualize food security for Indigenous people in the context of Indigenous food sovereignty (IFS). Looking at cultural food skill building at a much more pragmatic level works towards the larger goals of IFS.

LITERATURE REVIEW:

Culture and food consumption

The relationship between culture and food consumption is not well understood in academic literature beyond a small number of research projects (Adekunle et al. 2010, 2011, 2012; Abdel-Ghany & Sharpe, 1997; Wang &Lo, 2007). Some literature has emerged in recent years attempting to examine the complex relationships between ethnicity, consumption and acculturation in Canada (Abdel-Ghany & Sharpe, 1997; Adekunle, et al. 2010). What is known is that food plays a central cultural role for Indigenous people. Cultural foods, country foods, and traditional foods are all terms that are used to describe the diets of Indigenous peoples historically (or pre-contact). While these terms are frequently used inter-changeably, the term traditional is to be considered with caution. As Luppens (2009) noted the term traditional food is not flexible and excludes store-bought foods (salmon or berries, for example) despite their historic use. Similarly, foods that have been used since European contact, such as flour, are also not considered traditional despite the hundreds of years of use. While the term traditional is used widely in literature, for the purposes of this paper we will use the term cultural food which refers to local food and includes food obtained through gathering, hunting, fishing, trapping, and agriculture, or a combination of these methods (Willows, 2005). Cultural food is considered to be culturally, spiritually, socially, and economically important to Indigenous people. It reflects the link between culture and the environment, and the link between the environment and human health (Paci et al., 2004). Yukon First Nations people interviewed about their consumption of cultural food indicated that eating cultural food supported basic cultural values including keeping people "in tune" with nature, facilitating sharing, and was a way for adults to display responsibility for their children and to practice spirituality (Receveur et al., 1998, p. 118). Wilson (2003) noted that there was a strong link between food and medicine for Anishinabek people in Ontario and describes "certain plants, berries, and animals…are not only consumed for nutritional reasons but can also be used in the production of medicines" (p. 88).Lambden et al.'s (2007) work with the Yukon First Nations, Dene/ Metis and Inuit women found that they considered cultural foods to be culturally beneficial. In Toronto, work by Baskin et al. (2009) describes young Aboriginal women's lack of access to cultural foods as a challenge because they "tied their Aboriginal cultures to such foods and wanted to be able to pass this knowledge on to their children" (p. 8). To date, though, there has been almost no substantial body of work on urban Indigenous people's preferences and attitudes toward cultural foods especially in an urban context.

INDIGENOUS FOOD SECURITY

Canada has expressed its commitment to the achievement of food security for all Canadians, with a particular recognition of Indigenous people through the International Labor Organization (ILO) Convention 169 (1989) recognizing the role of both traditional and market food as essential in addressing food insecurity in Indigenous communities. Food security discussions tend to focus on cultural foods in the context of rural, remote and reserve communities, not urban Indigenous populations (Cuthand, 2012).

According to Willows et al., (2011) 33% of Indigenous households are food insecure compared to 9% of the non-Indigenous households resulting in rapid changes in eating patterns, reduced food intake and increased anxiety over food among many Indigenous families. Furthermore, the findings of Oliver De Schutter, United Nations Special Rapporteur of his 2012 visit to the poor inner-city neighbourhoods and remote Indigenous communities in Manitoba and Alberta showed that 2.5 million Canadians were food insecure and that many lived in desperate conditions (Cuthand, 2012), while Mercille (2012) reported more prevailing food insecurity among the geographically isolated Indigenous communities. Urban Indigenous food insecurity data has depended on small national samples obtained from food bank users (Tambay & Catlin, 1995) and provides little insights into the complexity of this issue.

Food insecurity amongst Indigenous people is common with many being forced to compromise in the types of food they would normally consume which are inaccessible due to availability or price (Sinclaire, 1997). The financial burden of providing for family requires many Indigenous people in the city to reduce their food budgets resulting in less nutritious food. In their study based on the 1990/99 Canadian National Population Health Survey data, Che and Chen (2001, p. 18) found that the prevalence of food insecurity was high among Indigenous people living off reserves with more than one-quarter (27%) reporting at least some food insecurity, and 24% experiencing a compromised diet. Indigenous people were about one and a half times as likely to live in a food insecure household as non-Indigenous people. Food insecurity is inextricably linked to poverty and related issues such as lack of affordable housing.

Power (2008) argues that cultural food security is an additional level of food security and suggests that additional research is required to understand Indigenous perspectives on food security. She suggests, for example, that "in terms of access, food security may be affected by access to traditional/country food, as well as access to market food" (p. 96). National food guides are often based on the mainstream categorization of food and do not reflect Indigenous realities. Canada's Food Guide was revised in 2007 to include versions specific to First Nations, Inuit and Metis populations, with translated copies available in Anishnawbe, Plains Cree, Woods Cree, English and Inuktitut (Health Canada, 2007). Little evidence exists on the success of these food guides in changing dietary behavior in Indigenous populations. Johnson-Down and Egeland (2010) found that Inuit children still met basic nutrient consumption even without following this guide. They also noted that foods recommended in Canada's Food Guide were inappropriate for the population such as milk due to the early onset of lactose intolerance in Inuit populations (Johnson-Down & Egeland, 2010). Work done by Gates et al (2012) on healthy food eating and change making behavior in the remote community of Kasheshewan, Ontario found that despite students participating in a program to promote healthy eating, the "nutrition environment in the greater community

was not conducive to behaviour change" given the remote location and the flying in of groceries to the remote community (Gates et al., 2012, pg. 4).

WINNIPEG'S INDIGENOUS POPULATION AND FOOD

Indigenous people in Canada experience high population growth rates and in 2006 surpassed the one million mark. The census indicates that Indigenous people represented 3.8% of the Canadian population. Of this population, 60% identified themselves as First Nations, 33% Metis and 4% Inuit (Statistics Canada, 2008). The census also revealed that more than 50% of this population was urban dwellers, an increase of 4% from the 1996 figure. Winnipeg has one of the largest urban Indigenous populations in Canada. In 2006, 10% of Winnipeg's population was comprised of Indigenous people (Statistics Canada, 2010). The National Household Survey identified a total of 86,600 First Nations, Metis and Inuit people living in Winnipeg (total single and multiple Aboriginal ancestry responses) (Statistics Canada, 2011). The inner city of Winnipeg has the highest portion of urban Indigenous people and has shown marked economic and social disparities compared to other parts of the city. This area is comprised of 17.4% Aboriginal people compared to 10% of the rest of Winnipeg (Statistics Canada, 2006). This area has lower rental rates compared to other parts of the city, and is the location of many urban Indigenous social service organizations such as the Friendship Centre.Socio-economic problems "which are dynamic, inter-related and often not easily determined in terms of cause and effect" are a challenge in Winnipeg's North End (Zurba et al. 2012, p. 285). The North End of Winnipeg is in an impoverished area and experiences "food deserts" as many grocery stores have moved out of the area resulting in the experience of food insecurity for residents (Zurba et al. 2012). It is well documented that inner cities or areas with low-income populations often have less access to supermarkets and affordable foods (Cummins & Macintyre, 2005) forcing residents to rely on smaller food and convenience stores with typically higher prices, and less nutritious food (Donkin et al., 2000). When there is a limited amount of affordable places to purchase healthy food people are forced to make unhealthy dietary choices (Wrigley et al., 2003). This situation has not gone unnoticed in Winnipeg. Food Matters Manitoba in 2014 published a Downtown Winnipeg Community Food Assessment; urban Indigenous people identified cost of food, availability of food and the ease of processed food as the top factors shaping their shopping and consumption habits. Cultural food was also discussed in this document, and the authors acknowledge that access to such food is a challenge in the inner city of Winnipeg (Food Matters Manitoba, 2014). In 2014, Food Matter Manitoba released a resource guide which lists 37 locations across the city which sell a variety of food such as large animals (bison, elk, venison), small animals (turkey, rabbit and duck), fish (pickerel, goldeye, trout, pike, whitefish and cod), berries and/or jams (wild blueberries, wild saskatoons), and wild rice (Food Matters Manitoba, 2014b). This guide refers to cultural food which is farmed, and thus legislated by the province of Manitoba. In most cases, these cultural foods are prohibitively expensive for many urban Indigenous people living on fixed incomes.

INDIGENOUS FOOD SOVEREIGNTY

Food sovereignty is about the increased control over food systems and has emerged in the literature as a means of addressing food insecurity. Food sovereignty places control over how, what, and when food is eaten and encourages a close relationship between production and consumption. Indigenous food sovereignty (IFS) is not a new concept, and in fact can be described as a "living reality" for thousands of years. IFS has been impacted by the larger process of colonialism as well as environmental changes which have threatened local food

systems. The result is an increased dependence on market foods and higher levels of food insecurity. Morrison (2011) describes IFS as a call for people to reconnect to their food systems. IFS are guided by four main principles: the recognition that food is sacred; participation in food systems; self-determination; and supportive legislation and policy. These principles recognize that food has a historical element for Indigenous people; indeed, many IFS initiatives are centered on cultural food practices (Morrison, 2011). Kamal and Thompson (2013), for example, have documented an Indigenous land-based food movement in O-Pipon-Na-Piwin, Manitoba whereby community members gather on the land for food harvesting activities and youth education. Rudolph and McLachlan (2013) have also documented IFS initiatives in northern Manitoba where community gardens and the procurement of country foods have been important. Beyond this, little information exists with regards to IFS in an urban context. The Urban Aboriginal Garden Project at the University of British Columbia, one urban example, found the garden to be a decolonizing experience for participants because it helped reduce dependence (Mundel & Chapman, 2010). These principles recognize the direction that IFS must take to move forward in Canada, however, they also highlight the need for protective legislation around land. Numerous communities face challenges regarding contamination and climate change, for example, that threaten their way of life (Thompson et al. 2011; People's Food Policy Project 2011; Lougheed 2010).

FOOD SKILL BUILDING

Jaffe and Gertler (2006) have referred to the loss of consumer knowledge and food skills as deskilling. These include practical skills such as preparing food from scratch, knowledge-based skills that guide consumers to make better food choices, and importantly, cultural food skills that "go beyond sustenance, as medicinal products, as carriers of culture and heritage, as focus for social intercourse and celebration" (p. 6). Food deskilling adds a further layer to the complexity of Indigenous food security, and may look different in an urban context. To date, little research has been done around understanding deskilling for Indigenous people, and yet the need for cultural food skills is great. Indeed, the 2012 report propagating the Food Movement: Provincial Networks and Social Mobilization in Canada, found that a loss of cultural knowledge and food skills can result in reduced community food security (Levkoe et al. 2012). Re-focusing education to include participation in food and survival skills has been documented as a way to pass on Indigenous food knowledge, ensuring these important skills are transmitted from one generation to the next (Morrison, 2008). Elliot et al. (2012) also found a loss of food related skills were seen in direct relation to access to cultural foods.

REFLECTION AND COMMENTARY

Numerous studies speak to the disproportionately high levels of food insecurity for Indigenous people in Canada. And yet, as a concept, Indigenous food security has also been criticized for failing to address the issue of power in market-based food systems and for failing to consider cultural food and other cultural elements, in particular for the urban Indigenous population(Power, 2008; Loppie Reading &Wien, 2009; Levkoe, 2012).And so, what do these findings mean? Do they tell the story of the power *in* food and the power *of* food? The issue of power in food systems has special resonance for Indigenous people in Canada, whose rights continue to be eroded despite the presence of treaties and the confirmation of such rights through the court systems. There is a long history of power imbalances around food embedded in Canada's colonial story. Daschuk (2013) recently

documented a history of government negligence and cruelty around food rations for Indigenous people in the 1800's; often bands were provided with rancid flour and meat with deadly consequences. Today, the power imbalances continue with cultural food systems facing threats ranging from contamination to climate change and large-scale impacts such as hydro development. Food security, for many Indigenous communities, cannot be achieved without cultural food, and security measures need to acknowledge this element of Indigenous culture (Lambden et al., 2007; Power, 2008). According to Power (2008) experiences around cultural foods, in traditional languages, are critical to understanding a household or community's food security. These findings point to a need to examine food through another lens, one that considers history, power, and healing. It is at this juncture that we turn to food sovereignty. Through food sovereignty, the protection and redistribution of land is key, along with the recognition that "people of the land" should have the right to be on the land to produce food (Desmarais, 2008). However, food sovereignty, and in particular, IFS needs to be self-determining. Individuals, households, and communities must create their own vision for re-connecting with their food systems, and indeed, for deciding what those food systems entail. Agriculture provides us with an important example. Not all communities have a history of agriculture due to their climate and access to other resources. In fact some communities have experienced trauma related to agricultural work during their time at residential school. In such cases, gardening is not a one-size-fits-all approach to IFS. From an Indigenous perspective, food is more than sustenance. Food is land, it is life, and it is love. Food is part of healing, and contains cultural values (Hill 2008). Cultural foods contribute to and create wellness through their production, by being on the land, and consumption, as being healthy food sources (Simpson, 2003). This relationship considers food as impacting all parts of being- mental, physical, spiritual, and emotional. In an urban context, these issues take on other important considerations. If cultural food is tied to a connection with land, and a person or a family has no home community then access to cultural foods becomes even more difficult. More than access to the food itself, without that homeland, there is also a loss of access to cultural food skills. These are skills that are learned from family and friends who take us in the bush or into the kitchen. Cultural food skills such as hunting, trapping, fishing, growing, and gathering look different in an urban setting than a rural or reserve setting. There are differences in land-base, with few urban spaces dedicated to these practices (that are often prohibited in the city), and backyards or personal property being expensive. However, urban centres are also places of hope. Brown et al. (2008) found that in moving to the city from reserve, some participants found that they had greater trust in the land of the city and perceived it easier to grow food than in more northern reserves. Access to cultural food skills will look different in the city, but can be achieved through the vision and guidance of our Elders, mentors, and teachers. The abundance of community centres, community gardens, and food organizations in the city can help create spaces and places for this learning.

CONCLUSIONS AND RECOMMENDATIONS

Many of the larger Canadian urban centres, especially those in the Prairies, have many Indigenous organizations providing a range of services. It is in these centres, such as Friendship Centres that urban Indigenous people can seek out and practice their culture. Urban community members gather to participate in cultural activities, gather for feasts, and access services and programs in these organizations. Urban Indigenous people often rely on these organizations to have opportunities to visit with Elders, who are an essential link in food sovereignty. As Indigenous scholars, we have learned experientially through our Elders the importance of blood knowledge, or ancestral knowledge, in helping us know what we

know or not know what we don't know. Looking to our history, and our ancestors we know that these food skills were, at one point in history, present. There is the hope, and belief, that when faced with the opportunity to practice these skills again, that ancestral knowledge will help our hands remembers what to do. It may take time, but with increased access to practicing food, we will slowly find our way. Urban Indigenous organizations have a critical role to play in facilitating IFS by providing access to food skilling, specifically with a focus on cultural food. Programs such as the Aboriginal Diabetes Initiative and Healthy Babies, Healthy Children are operated out of local Indigenous organizations like the Friendship Centre, there is a captured audience who may have an interest in enhancing or learning food skills to address deficiencies in their diets. In the meantime, more research is needed to better understand urban IFS. As a means for addressing hunger and as an element of well-being, food security should not be considered alone.

References:

Abdel-Ghany, M., and Sharpe, D. L. (1997). Consumption patterns among ethnic groups in Canada. *Journal ofConsumer Studies and Home Economics, 21*(2), 215–223.

Adekunle, B., Filson, G., &Sethuratnam, S. (2010). Preferences for ethno-cultural foods in the Greater TorontoArea (GTA): A market research. Unpublished manuscript, OMIF/FarmStart/GTAAAC, Guelph, Ontario: University of Guelph.

Adekunle, B., Filson, G., Sethuratnam, S., and Cidro, D. 2011. Acculturation and consumption: Examining the consumption behavior of people of Afro-Caribbean descent in Canada. *Journal of Agriculture, Food Systems, and Community Development, 2*(1), 297–313.

Adekunle, D., Filson, G., and Sethuratnam, S. (2012). Culturally appropriate vegetables and economic development. A contextual analysis. *Appetite, 59*(12), 148-154.

Baskin, C.A., Guarisco, B., Koleszar-Green, R., Melanson, N., and C. Osawamick. (2009). Struggles, Strengths and Solutions: Exploring Food Security with Young Aboriginal Moms. *Esurio: Journal of Hunger and Poverty, 1*(1), Article 3.

Brown, J., Isaak, C., Lengyel, C., Hanning, R., and Friel, J. (2008). Moving to the city from the reserve: Perceived changes in food choices. *Pimatiziwin: A Journal of Aboriginal and Community Health, 6,* 1-16.

Che, J. and Chen J. (2001). Food insecurity in Canadian households.*Health Report, 12,* 11-22.

Cummins, S. C. J., and Macintyre, S. (2005). Food environments and obesity: Neighbourhood or nation? *International Journal of Epidemiology, 35,* 100-104.

Cuthand, D. (2012). Government response to rapporteur disappointing. *The Star Phoenix*. Published: Friday, May 18, 2012. www2.canada.com/saskatoonstarphoenix/news/forum/story.html?id=04a49618-3248-47c5-bbdb-1a295840e61e.

Daschuk, J. (2013).*Clearing the Plains*. Regina: University of Regina Press.

Desmarais, A.A. (2008). The power of peasants: Reflections on the meaning of La Vía Campesina. *Journal of Rural Studies 24*, 138-149.

Donkin, A. J. M., Dowler, E. A., Stevenson, S. J., and Turner, S. A. (2000). Mapping access to food in a deprived area: The development of price and availability indices. *Public Health Nutrition,3*, 31-38.

Elliot, B., Jayatilaka, D., Brown, C., Varley, L., and Corbett, K.C. (2012). We are not being heard: Aboriginal perspectives on traditional foods access and food security.*Journal of Environmental and Public Health*.

Food Matters Manitoba. (2014). *Downtown Winnipeg Community Food Assessment*. Food Matters Manitoba: Winnipeg.

Food Matters Manitoba. (2014b*). Traditional Food Guide*. Food Matters Manitoba: Winnipeg. Retrieved from www.foodmattersmanitoba.ca/2014/04/traditional-food-guide-winnipeg/

Gates, A., Hanning, R., Gates, M., McCarthy, D., Tsuji, L.J.S. Inadequate Nutrient Intakes in Youth of a RemoteFirst Nation Community: Challenges and the Need forSustainable Changes in Programand Policy.*International Scholarly Research Network Public Health*, 2012, 1-5.

Health Canada. (2007). *Eating Well with Canada's Food Guide – First Nations, Inuit and Metis*. Ottawa: Health Canada. Catalogue Number H34-159/2007E-PDF.

Hill, G.L.P. (2008).*Understanding Indigenous Canadian traditional health and healing*. Theses and dissertations. Wilfrid Laurier University.

Jaffe, J. and Gertler, M. (2006). Victual vicissitudes: Consumer deskilling and the (gendered) transformation of food systems. *Agriculture and Human Values, 23,* 143-162

Johnson-Down, L. &Egeland, GM. (2010). Adequate Nutrient Intakes Are Associated with Traditional Food Consumption in Nunavut Inuit Children Aged 3–5 Years. *Journal of Nutrition, 140* (7), 1311-1316.

Kamal, A.G. and Thompson, S. (2013). Recipe for decolonization and resurgence: Story of O-Pipon-Na-Piwin Cree Nation's indigenous food sovereignty movement. Conference Paper #46, Food Sovereignty: Critical Dialogue. Yale University, September 14-15. Retrieved http://biowww2.biology.yale.edu/agrarianstudies/foodsovereignty/pprs/46_Kamal_Thompson_2013.pdf

Lambden J., Receveur O., and Kuhnlein, H.V. (2007). Traditional food attributes must be included in studies of food security in the Canadian Arctic. *International Journal of Circumpolar Health, 66,* 308-19.

Levkoe, C. (2012). Food sovereignty in Canada: Creating just and sustainable food systems. *The Journal of Peasant Studies First Book Review*.

Levkoe, C. Z., Bebee, M., Wakefield, S., Castel, E., and Davila, C. (2012) Propogating the food movement: Provincial networks and social mobilization in Canada. Retrieved www.foodmattersmanitoba.ca/sites/default/files/Propagating%20the%20Food%20Movement-MB.pdf

Loppie Reading, C. and Wein, F. (2009). Health Inequalities and Social Determinants of Aboriginal Peoples Health. Prince George, BC: National Collaborating Centre for Aboriginal Health.

Lougheed, T. (2010). The Changing Landscape of Arctic Traditional Food. *Environmental Health Perspectives*, 118: 386-393.

Luppens, L. R.A. (2009). "Today Indian food:" Perspectives of Aboriginal peoples on the foods in their contemporary diets. [Unpublished Master's thesis] Queen's University.

McIntyre L, Connor S.K and J. Warren. (2000). Child hunger in Canada: results of the 1994 National Longitudinal Survey of Children and Youth. *Canadian Medical Association Journal, 163,* 961–965.

Mercille G, Receveur O and Potvin L. (2012). Household food insecurity and Canadian Aboriginal women's self-efficacy in food preparation.*Canadian Journal of Dietetic Practice and Research, 73*(3), 134-140.

Morrison, D. (2008). Final Activity Report. Working Group on Indigenous Food Sovereignty. B.C. Food Systems Network.

Morrison, D. (2011). Indigenous food sovereignty: a model for social learning. In H. Wittman, A. Desmarais and N. Wiebe (Eds.),*Food sovereignty in Canada: creating just and sustainable foodsystems (*pp.97–113). Halifax, Nova Scotia: Fernwood Publishing,

Mundel, E. and Chapman, G.E. (2010). A decolonizing approach to health promotion in Canada: the case of the urban Aboriginal Community Kitchen Garden Project. *Health Promotion International, 25*,166-173.

Paci, J.C.D., Dickson, C., Nickels, S., Chan, L. and C. Furgal. (2004). Food security in northern Indigenous peoples in a time of uncertainty. *Northern Research Forum*, 1-15.

People's Food Policy Project. (2011). Resetting the Table: A People's Food Policy Project. Retrievedhttp://peoplesfoodpolicy.ca/policy/resetting-table-peoples-food-policy-canada

Power, E.M. (2008). Conceptualizing food security for Aboriginal people in Canada. *Canadian Journal of Public Health, 99,* 95-97.

Receveur, O., N. Kassi, H.M. Chan, P.R. Berti, and H.V. Kuhnien. 1998. *Yukon First Nations' Assessment of Dietary Benefits/Risks.* Montreal: Centre for Indigenous People's Nutrition and Environment, McGill University.

Rudolph, K.R. and McLachlan, S.M. (2013). Seeking Indigenous food sovereignty: origins of and responses to the food crisis in northern Manitoba, Canada. *Local Environment, 18,* 1079- 1098.

Simpson, L. (2003). Toxic contamination undermining Indigenous food systems and Indigenous sovereignty. *Pimatiziwin: A Journal of Aboriginal and Community Health, 1*: 129- 134.

Sinclaire, M. B. (1997). Barriers to food procurement: The experience of urban Aboriginal women in Winnipeg. Dissertation. Winnipeg, MB: University of Winnipeg.

Socha, T., Mehdi Z., Chambers, L., Abraham, R. and Teri Fiddler. (2012). Food security in a northern First Nations community**:** An exploratory study on food availability and accessibility. *Journal of Aboriginal Health, 8*,5-14.

Statistics Canada. (2006). 2006 Aboriginal population profile for Winnipeg. (89-638-X).

Statistics Canada. (2008). Aboriginal peoples in Canada in 2006: Inuit, Metis and First Nations, 2006 Census (97 – 558 - XIE).

Statistics Canada. (2010). 2006 Census dictionary. Catalogue no. 92-556-X. Ottawa: Statistics Canada.

Statistics Canada. (2011). National Household Survey, Statistics Canada Catalogue no. 99-011-X2011029.

Tambay J.L., Catlin G. (1995). Sample design of the National Population Health Survey. Health Reports,Statistics Canada, Catalogue no. 82-003.

Thompson, S., Lozeznik, V., Gulrukh, A., Ballard, M., Islam, D., Beardy, B., and Wong, K. (2011). Is community economic development putting healthy food on the table? Food sovereignty in northern Manitoba's Aboriginal communities. *Journal of Aboriginal Economic Development,7*: 33-45.

Wang, L., and Lo, L. (2007). Immigrant grocery-shopping behavior: Ethnic identity versus accessibility. *Environment and Planning A, 39(*3)684–699.

Willows, N., Veugelers, P., Raine, K., and S. Kuhle. (2011). Associations between household and Food Insecurity and Health Outcomes in the Aboriginal Population (Excluding Reserves). Statistics Canada Catalogue no. 82-003-X.

Wilson, K. (2003). Therapeutic landscapes and First Nations peoples: An exploration of culture, health and place. *Health and Place, 9,* 83-93.

Wrigley, N., Warm, D., and Margetts, B. (2003). Deprivation, diet, and food-retail access: Findings from the Leeds 'food desert' study. *Environment and Planning A, 35,* 151–88.

Zurba, M., Islam, D. Smith, D. and Thompson, S. (2012). Food and healing: an urban community food security assessment for the North End of Winnipeg. *Urban Research and Practice, 5*(2), 284-289.

ACKNOWLEDGEMENTS

We would like to gratefully acknowledge the Indian and Metis Friendship Centre of Winnipeg (Jim Sinclair) as well as University of Winnipeg Anthropology students Janaya Rieger, David Syvitski, and Kacey Fields. This project was generously funded by the Urban Aboriginal Knowledge Network (SSHRC), Manitoba Research Alliance (SSHRC), Government of Manitoba Ministry of Indigenous Affairs, University of Winnipeg Major Research Award, University of Winnipeg Partnership Development Grant, and the University of Winnipeg Discretionary Grant.

In Canada, Section 35 of the Constitution recognizes Aboriginal people as three distinctive peoples: First Nations, Inuit and Metis. First Nation began to be used in Canada in the 1970s to replace the term Indian. This term typically applies to both Status and non-Status Indians. Inuit refers to a cultural group of people living in far northern regions in territories such as Nunavut, parts of Labrador, Quebec and the Northwest Territories. Inuit people are not a part of the Indian Act, and have Inuit beneficiary cards instead of Indian Status cards.Metis is a more problematic term. It refers both to historically created communities along the Red River in Manitoba and Saskatchewan created by mixed unions between French and Scottish fur traders and Native people and in some cases, to contemporary unions between non-Native and Native people. Metis organizations grant people membership cards if they can prove an ancestral link to a historical Metis community. The term "Indigenous" is now increasingly used in the literature, and when used in a Canadian context, refers to First Nations and Inuit people. However for the purposes of this paper, Indigenous and Aboriginal will be used synonymously. Many people live "off reserve", which may refer to people living in urban centres or in rural areas. The term rural refers to areas that are non-reserve, and are either "remote or wilderness areas and agricultural lands, small towns and villages with populations of less than 1000 people and population densities of less than 400 people per square kilometer" (Statistics Canada, 2003: 18).

It is important to note that we do not see Indigenous people as an ethnic group. However some of the literature on ethnicity and food preferences may be useful in providing a background for this paper.

3

GROWING GARDENS, YOUTH AND FOOD SECURITY IN CANADA'S BOREAL FOREST

Shirley Thompson,
Asfia Gulrukh,
Thomas Clahane
Uche Nwankwo

ABSTRACT

The Boreal Gardening Program in Leaf Rapids, Canada involves straining youth in gardening and seed-breeding through school programming and summer internships. Community development participatory research methods, involving ethnographic methods, were used to analyze the programs impact on youth development, sustainable livelihoods and community food security.

The program built assets for sustainable livelihoods, particularly human, social and natural assets and to lesser degree financial and physical assets. Youth interns gained mastery of many job skills, established social networks, enhanced their access to food resources and gave back to the community and region through training, seeds and plants. The market garden and seed-breeding program engaged youth in a global movement of food sovereignty, while assisting their basic needs for healthy food and youth development. Working in the north using mainly conventional agriculture is a difficult process with the harsh climate, short growing season and the lack of organic matter and nutrients in the soil. Adopting indigenous agriculture methods, like permaculture and hugelkultur, would work with nature to reduce the effort required. To increase community food security requires producing high calorie crops such as potatoes, sweet potatoes and onions, as well as livestock. Considering the cultural and caloric importance of hunting and fishing for Cree people, whose territory Leaf Rapids occupies, a country food program should be considered as well.

INTRODUCTION

How far north can a garden provide community food security for the local community as well as develop job skills and youth empowerment? In the discontinuous permafrost at Leaf Rapids in Manitoba, Canada, gardening is being done at the northern tip of the boreal forest. Leaf Rapids is an unlikely place to become the centre for youth programming on gardening in northern Manitoba, and a seed saving centre. This community experiences poor soils, cold temperatures below -40 degrees Celsius in winter, and a short growing season. However, the Boreal Gardening Program was established in this far northern climate to provide local, healthy food and train youth in food production and seed saving in northern Manitoba. The Boreal Gardening Program endeavours to grow sustainable livelihoods, community food security and youth empowerment, in addition to berries and vegetables.

This paper analyzes the Boreal Gardening Program for its impact on community food security, sustainable livelihoods and youth development, considering the impact at three levels: individual level, the Leaf Rapids community and the Boreal region. The objective of this paper is to determine the benefits of the program and identify areas that could improve the outcomes. This program provides some plants and training for programs in other northern communities including the country foods program inO-Pipon-Na-Piwin Cree Nation (OPCN).This article focuses on the Boreal Gardening Program but also discusses OPCN's programming to compare it to this and other models for food and youth development.

Food Security in Northern Manitoba

Food security occurs "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996, p. 1). Food security has five universal pillars including adequacy, availability, acceptability, and action, but for indigenous peoples there is a sixth pillar, country food harvesting and sharing (Power, 2008). The drop in country food harvesting by indigenous peoples in Canada has resulted in higher rates of anemia, obesity, diabetes, lowered immune function and dental caries (Szathmary, Ritenbaugh, & Goodby, 1987; Thouez, Rannou, &Foggin, 1989; Willows, Veugelers, Raine, &Kuhle 2011; Willows et al. 2012).

In northern Manitoba only one quarter (25%) of all households are considered food secure, according to a survey (n=533) of 14 rural and remote communities (Thompson et al, 2012). High-impact food programs are needed to prevent the dire consequences of food insecurity. The 75% food insecurity rate in northern Manitoba is roughly ten times the Canadian rate of food insecurity, which is 7.7% (Health Canada, 2011).Food insecurity varied by both severity and rate of incidence, across communities with OPCN having the highest rate of food insecurity at 100% of any of the 14 communities. The food insecurity rate at Leaf Rapids, although high for Canada at 69%, was slightly better than most northern communities. Nelson House First Nation had the lowest food insecurity rates of the 14 communities, which community members attributed to its country food program provisioning. In the remote communities of northern Manitoba, many families are too poor to afford healthy food, as retail food is very costly with limited selection of healthy foods and a scarcity of any employment opportunities. These communities currently lack the quality and quantity of food required for community members to thrive.

Community Food Security

Community food security requires that we consider food security at a local level, both for its adequacy, production and decision-making. Hamm and Bellows (2003:37) describe community food security as, "a situation in which all community residents obtain a safe, culturally acceptable, nutritionally adequate diet through a sustainable food system that maximizes community self-reliance and social justice". Unlike food sovereignty, community food security considers household food security as key, but concentrates interventions at the local level of community infrastructure and local food systems rather than through food security initiatives (e.g., nutrient supplementation or food assistance programs).

Food sovereignty

Food sovereignty, according to the Declaration of Nyéléni, is "the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems" (International Planning Committee for Food Sovereignty, 2007, p. 1).Food sovereignty, often used interchangeably with food security, has similarities but is a different concept. Food security does not require the community to be directly involved to produce and distribute that food (e.g., disaster situations provide food from outside sources), whereas food sovereignty requires that the ownership of food systems be in the control of the community members.

Food sovereignty requires a sustainable, long-term process by which a community or country establishes its own food systems and produces local products independent of external sources for the acquisition of seeds and being vulnerable to external markets. Food sovereignty incorporates the geographical, cultural, environmental and social context of the community in the development of a culturally appropriate action plan. This is done with local food, as much as possible, that addresses the community's particular problems and needs.

Indigenous organizations and peasants are the leaders of the food sovereignty movement (Altieri, 2008; Holt-Giménez, Patel, & Shattuck, 2009). Their struggle is for territory, access to natural resources, and land redistribution (Torrez, 2011) as settlers have usurped land for their own development with policies favoring private property over commons. Settler development, when environmentally destructive or proprietary, reduces indigenous people's intergenerational, small-scale economic usufruct practices on ancestral territories (LaDuke, 2002) including environmentally damaging development, such as hydroelectric damning and mining (Ballard, 2012). Food sovereignty considers that people, living and feeding off the land, have a deep and reciprocal relationship to a land that is considered to be alive, rather than dead matter (Gulrukh &Thompson, 2013).

Country food programs to build food security

Indigenous people's food sovereignty is based on controlling and managing the resources in their traditional territory, indigenous agriculture methods and being able to share local food. Country food programs support people that hunt, fish and gather from the local land to feed their local community with food from the land (Thompson et al., 2011; 2012). Country food is a term that refers to the fish, mammals, plants, birds and berries, harvested locally. Country foods program are associated with better food security (Thompson et al, 2012). For example, Nelson House First Nation had the highest food security and attributed this to their country foods program. Sharing country foods was discovered to have a higher impact on food security than the five conventional pillars for food security (OR 20.64, 95% CI 2.41–176.08, $P<0.01$) (Thompson et al, 2012) or gardening. The country foods program pays for some of the prohibitively expensive costs of hunting and fishing if people share some of food with the country foods programs. Many households in northern Manitoba cannot actively hunt and fish due to the high price of gas, materials, and equipment (e.g., skidoos and boats), and the long distances they must travel to get to trap lines or inland lakes (requiring a float plane to get to). The people who can afford to hunt and fish (i.e., who have sufficient income) prize the time they get to spend engaging with traditional activities and food, however they do not see hunting as a cost-saving activity.

Despite OPCN being close by to Nelson House FN no country food program existed there at the time of the 2009 food security survey. The country food program, called Ithinto Mechisowin (food from the land), was created in 2012 after they found out from the 2009 survey that many households did not have access to country foods and that the community had 100% food insecurity. Ithinto Mechisowinis creating community food security, through programming that includes land-based workshops involving youth learning from elders, youth internships, Frontier School Division education credit courses, supports to facilitate getting country foods and delivery of country foods regularly to, on average, approximately 110 households including elders, single mothers and other people need (Gulrukh & Thompson, 2013).Ithinto Mechisowin has employed a full-time country foods program person since 2012 and in 2014 a youth co-ordinator was hired to supervise four students as gardening interns (Gulrukh& Thompson, 2013).Ithinto Mechisowin is governed by a board of directors with representation by Frontier School Division First Nation teachers at the local school, a University of Manitoba doctoral student and the director of the Community Health Centre, as well as by OPCN First Nation elders. Although quantitative data is not available, the OPCN Ithinto Mechisowinappears to be having a highly positive impact on community food security from qualitative data.

Local food production allows for self-sufficiency (LaDuke, 2002) and would provide the region with a higher degree of food sovereignty. To be based on indigenous values, according to LaDuke (2002), food-production should be decentralized, and cognizant of the carrying capacity of that ecosystem. This would be similar to the mixed subsistence-based economy that occurred with First Nations until recently, which included indigenous agriculture, where the climate allowed it, as well as hunting, fishing and gathering.

Gardening programs for food security

Gardens offer agency to produce fresh, healthy food (Fulford & Thompson, 2013), to bring about community food security. Gardeners both have a healthier diet and save money on their shopping bill by supplying their own fruits and vegetables (Twiss et al, 2003). As a physical labour, gardening increases fitness and reduces obesity (Twiss et al., 2003).School gardens provide living laboratories for children, youth and people of all ages to interact with nature firsthand. Examining bugs and observing plants allow a better understanding of nature (Wakefield et al., 2007), which helps people become better environmental stewards (Chawla, 1998). Youth gardening programs can result in transformative learning, stimulating involvement in food–based community development (Levkoe, 2006). For example, a Hawaiian gardening program with indigenous youth created a local food movement that jumpstarted a sustainable local food system plan (Trinidad, 2009).

In a survey of 14 northern Manitoba communities, gardening was found to have a small but positive and significant relationship to food security (OR 1.41, 95% CI 1.01–1.81, $P<0.01$). The impact is small as only a few families of the 534 interviewed were able to harvest and preserve sufficient vegetables to be a regular part of their diet year-round. This lack of large impact of gardening is a result of these northern locations having a short growing season and poor soil conditions and a general lack of farming equipment and greenhouses in the north.

Community Development for Youth and Community Food Security

Some positive evidence is emerging from recent studies of youth gardening's role in community food security and youth development (Trinidad, 2009; Fulford & Thompson,

2013) but requires more documentation. Food-based programs have youth getting their hands dirty planting, harvesting, and preparing diverse foods with participation in these activities being linked to a higher dietary ingestion of vegetables and fruits (Fulford & Thompson, 2013; Robinson-O'Brien, 2009; Story et al, 2002).

Youth food-based programs provide other benefits worth documenting. These benefits can include skills development, improved academic performance, enhanced self-esteem, and increased employability (Hoffman et al., 2007; Robinson-O'Brien, 2009). The promotion of physical activity, gardening and harvesting bolster efforts to improve youth wellbeing, combat obesity and public health. Also, training youth on food production builds livelihood assets, self-esteem and local capacity as well as an opportunity to reassess their lives (Lawson & McNally, 1995). This positive youth activity appears to reduce the attraction of gangs and vandalism activities (Trinidad, 2009).

The circle of courage model has recently been used to document impacts on youth development of gardening programs (Fulford & Thompson, 2013). The Youth Eco Action (YEA) program in corporate this philosophy and trained workers with this model (Fulford & Thompson, 2013). By incorporating ways to foster the four basic needs of belonging, mastery, independence, as well as generosity (Brendtro et al., 1991; 2005), they felt they could help complete and heal at-risk youth for positive development. This circle of courage model came out of an anthropological study of Amerindian child rearing compared with western child rearing (Brendtro et al., 1991; 2005) and positive psychology. In youth development, the four needs are often not met in Western society, particularly in homes and communities disrupted by residential school abuse, in which children of previous generations were taken away from families to schools. The authors of this model propose that unmet needs create 'broken circles', which place youth at risk (Brendtro& Mitchell, 2010; Brendtro et al., 1991; 2005).Negative youth behaviours are both harmful to the youth and to society, resulting in absent or distorted behaviours being manifested (Brendtro & Mitchell, 2010). The circle of courage was not consciously applied in the Boreal Youth Garden Project but only its indicators are measured to see if the programming results in these positive aspects of youth development.

The Boreal Garden Program

The majority of the education outreach programming and the internship program of the Boreal Gardening Program is based out of Leaf Rapids. This program recently subdivided into the Grow North program and Frontier School Division (hereafter called Frontier) program. However, to consider both parts and the history of the program the Boreal Gardening Program will be the focus of and term used this paper. OPCN is another Frontier community with its own community gardening program and a country foods program to share vegetables, fish and wild meat to Elders and single mothers but receives some youth training, plants, seeds and vegetables from the Boreal Gardening Program.

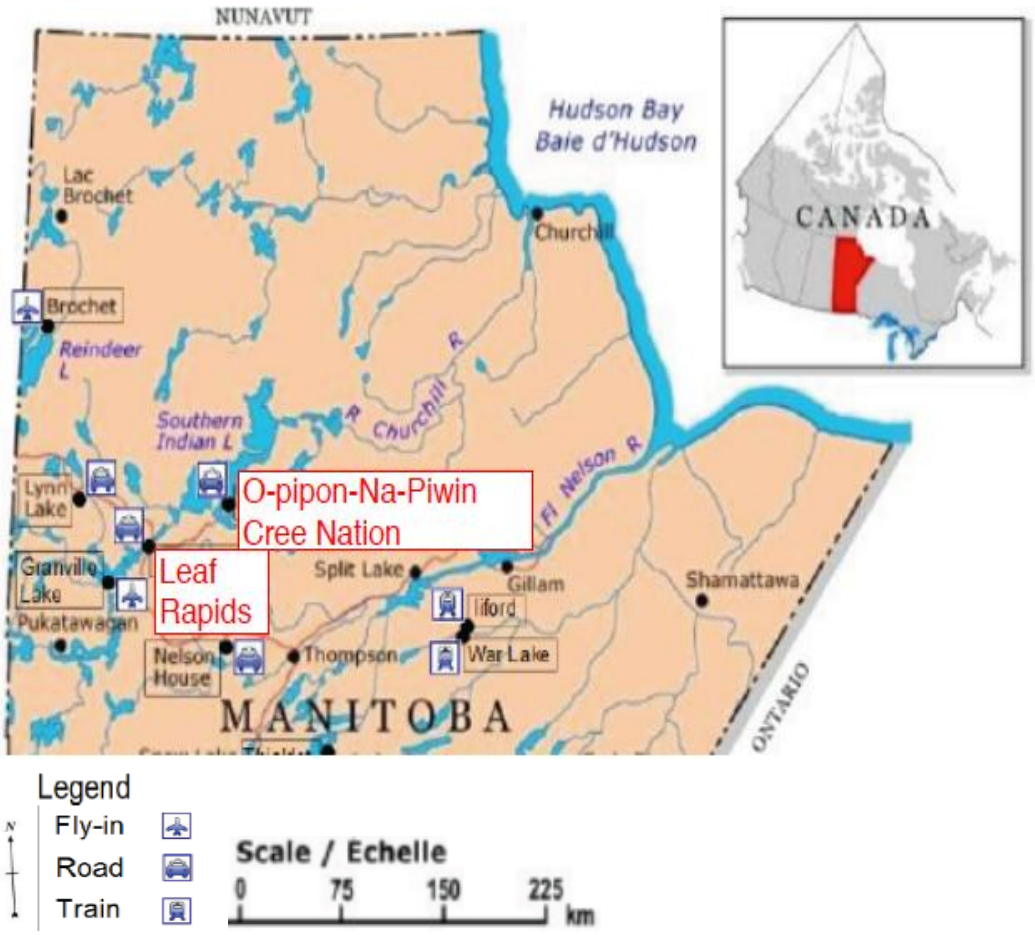
Both Leaf Rapids and OPCN communities are comprised mainly of indigenous people, which include First Nation and Metis peoples there. Indigenous people in Canada have higher levels of many diseases, lower attainment in formal education system, and face systemic racism and discrimination (Thompson, et al, 2013). As such, indigenous youth in Canada are at higher risk than Canadian youth. Living in northern Manitoba, communities,

they are challenged with high levels of structural unemployment, poverty, lack of youth programming, and substance abuse, (Thompson et al, 2012), which undermine community food security, youth development and sustainable livelihoods.

Communities of Leaf Rapids and O-Pipon-Na-Piwin Cree Nation (OPCN)

Leaf Rapids and OPCN are located more than 1,000 km north of Winnipeg along the Churchill River in northwestern Manitoba. Leaf Rapids was an intentionally designed, purposely created community designed to support the Ruttan Mine project in the early 1970s. The design is unique, and won the Vincent Massey Award for Urban Design. With a peak population of over 2000 in 1982, with the closure of the mine the population shrank to around 350 in the early 2000suntil today. Since the closure, this town has many empty homes, which is unique to northern Manitoba which has severe housing shortages in every other community. Leaf Rapids provides some residences for people from displaced and other communities suffering from housing shortages, such as Granville Lake and OPCN. However, the lack of population growth in Leaf Rapids, is in contrast to the very high population growth in every other northern community and indicates a need for jobs, educational opportunities and dealing with the historical and present-day tendencies of racism in settler and mining cultures that are noticeable in Leaf Rapids.

Map 1: Location of Leaf Rapids and O-Pipon-Na-Piwin Cree Nation (OPCN)



From Leaf Rapids an all-weather road provides year round access to the community of OPCN, which is located on South Indian Lake. The OPCN was displaced due to Manitoba Hydro's Churchill River Diversion, which reversed the flow of the lake and river system, and relocated the community. When water was diverted to flow south to the Rat River into the Burnt wood River and the Nelson River more water flowed to make Hydropower on the lower Nelson River. See the location on map 1.

Sustainable Livelihoods at Leaf Rapids and OPCN

A sustainable livelihood encompasses the assets, access and policies that together decide the living obtained by an individual, community or region (Ellis, 2000). Although a sustainable livelihoods analysis of the five assets is typically not part of community development plans or community food security analysis (Brocklesbury & Fisher, 2003, Thompson et al, 2012) this concept has been deemed highly useful for this application (Thompson et al., 2012).

The status of the five sustainable livelihood assets in OPCN and Leaf Rapids are: 1) Human capital (considers the education, health and skills of the people which then determine the labour productivity and the capacity for managing land) is reduced, given the relatively poor state of education, chronic unemployment rates, and higher disease rates compared to most areas in Canada (Statistics Canada, 2011). OPCN had 100% food insecurity in 2009 compared to 7% in the Canadian population (Thompson et al, 2012) and Leaf Rapids was slightly better at 69%; 2) Social capital (considers how cooperative action, sharing, bonding and social bridging is facilitated by trust and close bonds), once robust, was eroded by reserve settlements, the *Indian Act* and the residential school system, which has resulted in gang activity and crime in northern Manitoba communities (LaDuke, 2002). Aboriginal peoples' ability to determine their own policies, programs, and development has been limited by settler racism and jurisdictional barriers (Ballard, 2012); 3) Natural capital (also known as the practices for land management natural resource use) is rich in northern Manitoba's First Nation territories for minerals, forests, fisheries, hydroelectricity and non-timber forest products. That First Nations (FNs) are not recognized as having regulatory and ownership rights to resources in their territories means this natural capital is often not accessible to FNs (Ballard, 2012); 4) Physical capital is the infrastructure and equipment, which is inadequate with severe housing shortages, unpaved roads and lack of piped safe drinking water to households at OPCN. Leaf Rapid's infrastructure stands in stark contrast to the poor infrastructure in OPCN. Leaf Rapids was a rich mining town, which depopulated after the mine closed although it retained its state-of-the-art town infrastructure; 5) financial capital, represents the savings and access to credit, which is low on FN reserves. First Nation housing and land is Crown property and is not considered as their capital (Ballard, 2012). Without this property as collateral, FN peoples often cannot finance business development as accessing credit is more difficult. The median individual income in OPCN was $11,359 in 2010 (Statistics Canada, 2011), which is markedly lower than Winnipeg's rate for the same year of $30,804 (Statistics Canada, 2011).

Food-based community development can transform assets. Gardening internships and other food-based activities are a purposeful intervention in the communities' welfare (Douglas, 1994). Natural capital can be changed by economic activity into physical capital and/or financial capital, for example through a market garden or community-shared

agriculture generating capital. As well, other capital can be transformed into human capital if they support training and education (Khan et al. 2009). Resource use is manipulated by rules, customs, land tenure and other institutional arrangements as well as laws, policies, societal norms incentives and other processes (Scones, 1998; Carney, 1998; Ellis, 2000).

METHODS

In this participatory community development research project, students and faculty at the University of Manitoba partnered with Frontier School Division on youth gardening. These community development research methods involved graduate and undergraduate students and faculty assisting and advising the coordinator in different endeavours over a number of years. University of Manitoba students were important in assisting with the seed, plants, training and then strawberry distribution since 2011in the spring before the interns started. They were also involved in training programs for youth internships and the Boreal Garden Programming as well as planting, digging and harvesting. The observations over time from this participatory research study, over several years, provide much of the data, as well as the findings and notes from a workshop. A workshop was held in 2013 with ten interns over 18 years of age, as well as a community co-ordinator and university student to explore the impact of the gardening internship programs on the individual, community and regional level. Based on the views of the twelve adults in the workshop the program was analyzed for its impact.

To consider the total impact on participants the benefits at the individual level were considered for their application to one of the basic needs for youth development identified by the circle of courage, namely: belonging, mastery, independence and generosity (Brendtro et al., 1991; 2005) as well as for the five different sustainable livelihoods, specifically: social, cultural, natural, financial and physical assets. Benefits of the Boreal Gardening Program that were identified were grouped into three frames of reference: 1) impact on the youth interns, 2) impact on their community, and 3) impact on boreal agriculture and northern Manitoba communities, as a whole. The contribution of the entire program was analyzed for its impact on sustainable livelihoods considering its contribution to five assets. Benefits are given either a strong positive notation if reported by all interns or, if multiple accounts resulted but without consensus weak rating was assigned (Fulford & Thompson, 2013).

RESULTS AND DISCUSSION

The findings first document the history of the program to study some of the critical stages of development. See table 1 for a brief summary of the timeline.

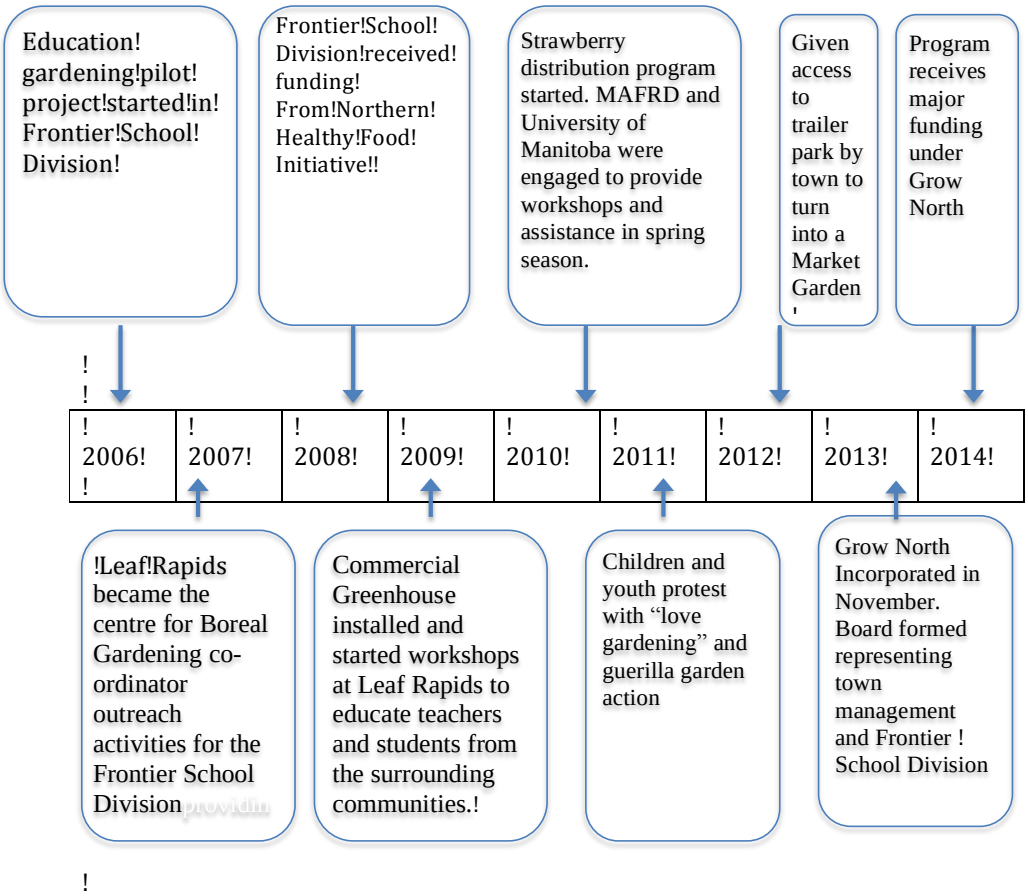


Figure 1: Timeline of the Boreal Gardening Program

The Boreal Gardening Program started by involving local school children in local gardening projects and expanded both within Leaf Rapids, by offering internships, and outside of Leaf Rapids, by delivering materials and education programs. Gardening programs started as a Frontier School Division education pilot program in 2006.In 2007 Leaf Rapids became the centre for the Boreal Gardening Program co-ordinator activities for the Frontier School Division outreaching to all the schools in the northeast. In 2009 the co-ordinator started organizing annual workshops at Leaf Rapids to educate teachers and students from the surrounding communities. The coordinator had a strong sense of place and was committed to building the assets and gardening program in his community. In 2009 a commercial greenhouse was installed.

Photo Credit: Kamal, A., 2010.

Youth organizing was a critical aspect of the development of gardening in Leaf Rapids. Only when school children held a peaceful protest in 2011 shouting slogans in the streets of Leaf Rapids did the town start to listen. The children held signs saying “Gardening is Cool” and a big banner stating “We love gardening. A call for care. Better health and food for all” as well as “Grow Gardens. Eat Healthy” and others. Then, in 2011, youth gardeners with the community coordinator started to guerrilla garden in a tiny section of an empty, large (six acre) trailer park. These events led to the town’s mayor and council approving of gardening in this ideal place for a market garden with its electricity, road way and free water access on most lots in late 2012 for growing season of 2013.

Partnering was essential for the growth of the program. In 2010, it joined the Northern Healthy Food Initiative and started to partner with Manitoba Agriculture and Food Rural Development (MAFRD) and the Natural Resources Institute (NRI), University of Manitoba. As a result, the Boreal Gardening Program was able to include more training, education and skills-building opportunities. That year, the strawberry project started, which allowed each child who signed a contract to receive 10 strawberry plants. The number of participants in the “Sweet Taste of Success” strawberry project grew from under 50 in 2010 to more than 300 students in 2013 from 14 schools. As well, 12,000 berry plants (strawberry, raspberry, blueberry, etc.), provided by MAFRD, were planted in the Leaf Rapids gardens and area for people to harvest.

Youth internships shifted the program to allow a market garden and local food production. In 2011 youth internships started with a summer hire program through a $5000 contribution from Dr. Thompson's research funds for this purpose, which was supplemented by Frontier School Division to allow three part-time youth internships. Before that Frontier School Division had hired a greenhouse technician but had not applied for the Green Team or other government funded research programs, or engaged the town's economic development officer. In many northern communities there is not a community economic development officer, expertise or eligibility for provincial programs (federal reserves are often not eligible for Green Team or other programs funded by the province) but that was not the case in Leaf Rapids. At Leaf Rapids, the problems were not resources but the lack of communication to ask the community economic development officer to undertake the applications. Since 2012 the internships have steadily expanded by accessing government youth funding programs through the town's community economic development officer.

Another expansion occurred with the Boreal Gardening Program incorporating into a not-for-profit organization called Grow North Corporation in 2013. Prior to this arrangement the coordinator ran the program through Frontier School Division without a formal structure for the community to input. However, the town and Frontier School Division saw the need to work together more formally and formed Grow North, having representation on its board from both Frontier School Division and town employees. This not for profit volunteer organization is focused on bringing economic development opportunities to the Town of Leaf Rapids and neighboring communities. The internship program at Leaf Rapids, formerly administered by the Frontier School Division, was turned over to Grow North Inc. for administration and management after being incorporated. Frontier School Division continues to provide research facilities in the school and the greenhouse and the coordinator for the gardening project still works for Frontier, but his work is now managed by Grow North Inc.

POSITIVE IMPACTS

The Boreal Garden Program builds assets for sustainable livelihoods, particularly human, social and natural assets, and to small degree financial and physical assets. Youth interns in the program gained mastery of many job skills, established social networks and access to food resources (Brendtro et al., 1991; 2005). The community and region benefited as well. The program provided participating communities in northwest Manitoba with plants, including strawberries as well as seeds, seedlings and vegetables, which provided some natural assets and some garden training, which together could be turned into food and financial resources. The seed saving research and the training of interns from multiple northern Manitoba communities (The Pas, Thompson, OPCN, Leaf Rapids) extends the impact of this project to the regional level. The benefits were divided into the four Circle of Courage areas noting the sustainable livelihoods assets and different levels (individual, community and region) gained in Table 2.

Table 2: Impact of the Boreal Gardening Program to Participants, Community and Region

Positive Impact of the Boreal Gardening Program	Impact on Youth Interns	Impact on Community	Impact on Region	Asset related to Sustainable livelihood
Mastery				
Gardening skills	√	+ (33%0	+ (25%)	Human& Natural
Job preparation & training	√	+ (25%)	+ (17%)	Human
Communication Skills	√	n/a	n/a	Human &Social
Sense of personal accomplishment	√	n/a	n/a	Human
Marketing of produce	√	+ (25%)	n/a	Human & financial
Belonging				
Connection or pride in community	√	+ (67%)	n/a	Social
Community Building	√	+ (50%)	n/a	Social
Networks within and diverse networks outside of community	√	+ (33%)	n/a	Social
Independence				
Leadership Development	√	n/a	n/a	Human
Healthy Eating	+ (58%)	+ (25%)	+ (17%)	Human
Knowledge of Food System	√	+ (25%)	n/a	Human
Food Security	+ (42%)	+ (17%)	+ (13%)	Natural
Generosity				
Environmental knowledge	√	25%	n/a	Natural & human
Environmental Behaviour	√	+ (17%)	+ (13%)	Natural
Gifting plants & produce to community members & other communities	√	+ (33%)	+ (17%)	Natural & physical

√ = unanimously identified by interns+ = positive responses from multiple interns
% = percent of respondents with positive response n/a = not applicable

<u>Human Assets for Mastery and Independence youth development</u>

Human assets increased when students mastered a wide variety of gardening and agriculture skills, as well as general competencies. Interns engaged in vegetable production, berry production and basic greenhouse training. Interns indicated that they developed skills along the full cycle of crop production from starting seeds, watering, weeding and harvesting. As well, many gained a complex understanding of companion planting, intercropping and seed saving. One youth wrote a list of many of the skills he learned which included: dealing with bug infestations, weather/seasons for different plants, plant hardiness, gardening skills, communication and composting. Another intern talked about how she had learned a lot and was planning to share it: "I have learned a lot from being here over a month and I can go teach other people some stuff I have learned." Most of the youth after this program wanted to start their own garden and felt they could succeed.

Most of the interns discussed how the job made them more self-disciplined, confident and stronger leaders (Carter, 2009). In the workshop most interns referred to themselves as leaders, with one stating they were learning: "how to be great leaders and to teach others to be greater leaders." The youth co-ordinator mentioned that he was "helping potential leaders learn to be great leaders." Confidence building seemed to be a key output for the program, with one youth intern explaining: "I feel it gave me more confidence". As much of the gardening work was independent many felt that they had the opportunity to decide for themselves what to do.

The interns in 2013 included youth from four different communities who wanted to go back to their home communities and plant gardens and create similar programs in their home communities. For example, one youth intern from OPCN believed he has the skills to work in home community to manage and expand the OPCN Country Foods Program to include a greenhouse and berry production in 2013, which he then did successfully in 2014. This intern was not the only one who felt that they had learned skills and knowledge that would benefit their community.

Youth also learned general competences, management skills and a good work ethic, as well as getting stronger from the physical workout of gardening. One youth from OPCN felt he had learned not only how to do the work but management skills to work in any job: "[This] gave me the opportunity to go back home and possibly be in a management position." The gardening program helped youth grow strong muscles and pride as illustrated in the photo below.

The gardening program was described as a gardening boot camp. This gardening boot camp required five days of physical labour outside each week. The NRI university students reported being exhausted after working outside digging and planting rain or shine, sometimes in a field full of mosquitoes and black flies to get the market garden growing day after day. This focus on gardening prevented these graduate students doing other jobs, like designing the curriculum for a credit course with Frontier or organizational development. The community may have been better served by employing local people at these labourers job as it would have provided employment, which was badly needed in this community. The overload of work in the early spring preparing the soil and planting, before the interns came on board, resulted in a boot camp for gardening and prevented graduate students from focusing on completing the long term goals of the project.

Photo credit: Thompson, 2013.

Human assets could be further built through a gardening credit course or country food program. Although the Boreal Garden Program has been involved in gardening for many years it had not resulted in a gardening credit course in their local school or any Frontier school. The development of human assets is limited to adhoc programming in gardening in school and the summer internships but could be broadened by a gardening or country food credit course in the curriculum. Oppositely, OPCN was able to introduce a 55 hour credit course on country food in their Frontier school in 2012 in the first year of its country food program. As a result, youth at OPCN gained a high school credit, where secondary students go out on the land in four seasons to learn how to trap rabbits, ice fish and hunt caribou, as well as garden.

Courses that include elders and traditional activities on the land, are a recipe for decolonization. Land based programs with First Nation elders provide a counterbalance to colonization. Simpson (2004: 380) describes the aspects education program needs to decolonize First Nation youth: "They must be land-based, and provide opportunities for youth to interact with Elders and Traditional Knowledge holders on Indigenous terms." More efforts are required to counter colonization, particularly for this group of interns and the northern populations largely made up of First Nation families who suffer from the intergenerational impacts of displacement, residential school legacy and internment on reserves, to ensure holistic youth development occurs. Simpson (2004: 373) postulates: "Recovering and maintaining Indigenous worldviews, philosophies and ways of knowing and applying those teachings in a contemporary context represents a web of liberation strategies."

Social Assets and Belonging

Social assets are about belonging and feeling a connection with others, which facilitate cooperative action, sharing, bonding and social bridging, which facilitates trust and close bonds (Brendtro et al., 1991; 2005).The youth developed a positive sense of community belonging and pride in their community feeling that their garden work was making the community more beautiful; one intern stated: "People come by the nursery to see the plants and say the garden is beautiful". Community people appreciated the school garden and nursery, according to one intern: "People appreciate what we're doing for the community." All youth reported positive interactions with community members around the gardens and with other youth, children and teachers in their visits to communities to provide workshops on gardens and plants. By being involved in the Boreal Garden Program and the community gardens, the interns noticed a positive change in community members' attitudes towards them and an upsurge in appreciation that their garden could produce sufficient vegetables for trading, selling and sharing.

The interns built both bonds to provide supports in the community and bridges that would expand their resources. The interns supported and bonded with each other with one intern stating that, as part of this job, she: "enjoyed the outdoors and hanging out with friends". One of the older interns in his twenties, who had a partner and owned a residence, housed several other interns who were having difficulties at home. One intern wrote about how the program helped him develop social skills, in that he: "Learned to be socially better with others." The interns that came from different northern communities stated that they were sharing knowledge with other communities with one intern stating: "The other communities should have gardens so the people will have jobs and learn a new life skill. I want to teach others what I learned to make this happen." Other communities in the region were planting gardens and berries to some extent, although few to the same degree as OPCN and Leaf Rapids. Interns built social assets by creating bridges and networks with University of Manitoba students, college students and staff as well as personnel from government and funding agencies.

Natural Assets and Independence

Natural assets include seeds, plants, soil, water, land access and other aspects of food production and supply. The decentralization of food supply, which is part of indigenous values, is part of the Boreal Gardening Program, with Leaf Rapids acting as a regional centre providing seeds and materials, as well as gardening training, to many northern Manitoba communities. For example, some seeds, plants and vegetables were given to the OPCN country foods program in 2013. Generosity with seeds and plants allows youth to take joy in giving and sharing (Brendtro et al., 2005), which helps form healthier relationships, and a greater sense of purpose. The gardening interns all signed the "Northern Gardeners Creed", which describes how they will build natural assets, share and protect the land:

I, _____ will,
Prepare the soil and place the plants,
Weed and water, And watch them grow,
And write what I learn and pass it on,
So everyone will know.
Then I will harvest
And make next year's plan,
To grow again and protect the land,
That puts the food into our hands. (Frontier School Division, nd)

Natural assets have increased by saving local seeds. Seed saving is occurring in the Boreal Garden Program and is reported to have resulted in hardier plants with "northern vigour" whereby they are "creating their own strain of seeds". Plants with certain preferred characteristics, such as the size of the plant, size of fruits, taste, yield and ability to withstand cold were observed and marked with ribbons. During the harvest, the seeds of plants with preferred characteristics were reserved for growing the next crop to slowly improve the quality of his variety.

The results of seed saving in the intercropped gardens have been a learning process. The coordinator and students in the Boreal Garden Program have saved seeds for years, which have saved a great deal of money. Although heirloom vegetables keep their traits through careful open pollination, at Leaf Rapids the lack of ensuring parent seeds were heritage or non-hybrid seeds and the absence of enforcing isolation distances resulted in seeds that were high risk to be a hybrid. As a hybrid the seeds saved over these years will not grow "true to type" to the original parent and are unpredictable in overall type, quality and flavour. In 2014, a University of Manitoba graduate student sowed heirloom seeds with isolation distances for a few species, namely beans (*Phaseolus vulgaris*), tomatoes (*Lycoperisiconspp*), radishes (*Rapnanussativas*) and squash (*Cucubitaspp*). Tomatoes and beans, as well as lettuce (*Lactuca sativa),* peas *(P. sativum)*, etc., are self-pollinated and relatively easy to keep these seeds pure, as they typically do not cross-pollinate and so do not require large isolation areas.However, crops, which are cross-pollinated by insects and plants, like radishes and squash, require an isolation distance of more than one km to minimize the risk of cross-pollination, as (*Brassica oleracea*), for example, can interbreed with all varieties of the same species (the oleraceas family) including broccoli, brussel sprouts, cabbage and cauliflower. The careful saving of these heirloom seeds in the long term will build community food security, through increasing yields and biodiversity of plants in the northern boreal region, and in the short term will save on seed costs.

Growing and eating local food is a way that youth build a local food system that expands natural assets. By increasing their local food provisioning, youth increase their independence from agricultural systems. Many interns changed their diet to include the fresh produce they grew. Many of the interns had, prior to their internship, limited exposure to diverse vegetables and herbs but as a result of growing bokchoy (*Brassica chinensis*), stevia (*Stevia rebaudiana*), basil (*Ocimumbasilicum*), and many other "exotic" foods grew to like them. For example, one intern stated: "I like trying new fruits and vegetables. I eat all my vegetables and fruits fresh." In the picture below they are acting like their favourite vegetable, with some people being kale, others loved corn (*Zea Mays*), and others prefer bokchoy.

Photocredit: Z.S.R. Assing, 2013.

Natural assets are improving but slowly with setbacks around seed saving, due to hybridization, the limited efforts given to amending the sandy soil and the lack of water conservation. With sandy soils and mainly conventional gardening techniques, gardening is very labour intensive and requires large amounts of water. The treated water from the town pipe is continually running, often into the pavement, with the view that the town pays their water bill and they get it for free but not seeing the waste of natural capital this represents. Working carefully with nature will yield more natural capital.

Physical assets

The Boreal Gardening Program has established both gardens and infrastructure, which represent physical assets. The Boreal Gardening Program has free access to a six acre land base in the trailer park to grow food as well as having access to a number of greenhouses in Leaf Rapids. The trailer park is an ideal place for a nursery with its electricity, road way and free water access on most lots. In 2014 the nursery area was enclosed in a large fence to protect their investment from wildlife and also community members vandalism and sampling. One person explained the need for this fence as being protection against the henny-penny syndrome described in the little red hen story, whereby people expect to benefit from other people's hard work but refuse to help. Although the market garden does generously provide some food for select events, the priority is on research first, market garden second and food for the poor and hungry third. This approach helps to build financial assets and may build community food security in the long term, while limiting it in short term by preventing locals to share in the harvest.

Financial assets

Natural and human capital has been changed into financial capital, through some market garden sales and through grants provided to recognize their work on seeds and education. Since the program was incorporated into Grow North Inc., it is eligible for more programs and has gained more access to the town's resources. Since establishing Grow NorthInc, the Board has garnered funding from the following sources: Bauta Family Initiative on Canadian Seed Security, Federal Government, Green Team, Canada Summer Students Program, Frontier School Division, Province of Manitoba, Community Places North, Northern Healthy Food Initiative, Northern Youth Empowerment Initiative, Tides Canada Foundation and Walmart/Evergreen. In 2014 Organic Alberta and the Bauta Family Initiative on Canadian Seed Security chose Leaf Rapids as one of two organizations in Canada to host seed internships for the summer. These internships are cost-effective programs compared to reacting after at-risk youth are in trouble and incarcerated at 100,000/year (John Howard Society of Manitoba, 2011).

Community Food Security

Food adequacy, production and decision-making in Leaf Rapids is relatively low compared to the youth development and livelihood assets obtained. Up until 2014, the program did not have a community board but was basically run by the Frontier gardening coordinator. Only with its incorporation into Grow North Inc. in November 2013 has a board made up of town employees and Frontier employees been put in place. This board currently lacks First Nation representation and a vision that incorporates community food security directly. The only stated purpose of Grow North Inc. is economic development, which can help food security but does not guarantee it. Without seeing community food security as a goal Grow North Inc. cannot plan to reach that goal. Grow North Inc. should develop an overall mission, vision and plan, considering the need for community food security as 69% of community members in Leaf Rapids were food insecure in 2009 (Thompson et al, 2012).

Community food security dictates that food sources should be multiple, resilient and varied. In these northern Manitoba communities, gardening can only play a small part in community food security. Conventional agriculture in the north has a limited role in food security due to northern Manitoba's harsh climate, short growing season and the lack of organic matter and nutrients in the soil. Conventional agriculture at Leaf Rapids has been able to produce vegetables, due to the use of greenhouses, free water resources, very hard work by free labour (government funded and graduate student internships) and access to cleared land. However, this focus on conventional gardening ignores First Nation hunting, fishing, gathering and indigenous agriculture, which were the traditional methods to achieve community food security.

Conventional gardening should be seen as a small but important piece of the community food security puzzle. Incorporated with country food sharing, livestock production, permaculture and hugelkultur, the Boreal Gardening Program could work with nature and uphold local cultural traditional to build community food security. Both Nelson House FN and OPCN have a country foods program and have found that it is improving food access and building social bonds. Knowing country food programs are more effective in this

boreal region and culture than gardening at improving food security rates (Thompson et al, 2012), a sole focus on gardening, is counter to community food security. Recognizing the abundance of fish and wildlife in the area, the Boreal Garden Program should learn from the successes at OPCN and incorporate its community outreach, food distribution and country foods.

The Boreal Gardening Program provides the potential for building food security in the future through training and seed saving but presently has a low impact on food security. To provide community food security the Boreal Gardening Program requires a serious focus on growing enough calories, protein and calcium to meet the dietary needs of their population or even the interns, in addition to their current focus on youth development and seed research. Rather than aiming to provide community food security the approach to date has focused on improving the town's economic development, training youth and exploring the diversity of plants and seeds that can be grown and saved in the northern boreal region.

To better feed the community gardening has to be done differently to better deal with the climate and soil challenges, as well as better meeting the dietary needs of the population. Permaculture, which means "permanent agriculture", is a system that works with nature to care for earth and people through an ethic of giving back (Connor, 2014). Permaculture is based on indigenous agriculture and culture, rather than European conventional gardening techniques. The permaculture approach is based on observing sites, climate and culture and building relationships for a healthy diverse ecosystem, considering the multiple functions of elements, synergies, succession, edges, and the need for redundancy in nature. Country foods are most culturally appropriate for the climate and culture but to create synergies, edges and redundancy there is a need for gardening and livestock. By identifying leverage points to mobilize change, such as hugelkultur, green manure and livestock production, small-scale biointensive permaculture systems can be created to bring about community food security. To be effective, the program has to put food on the table, both in the short and long term, and build in evaluation and learning from mistakes into management and designing the food systems.

Livestock, including chicken and/or rabbit production, could improve community food security by providing meat and also manure to improve the soil. However, although the Boreal Garden Program was offered free chickens with a chicken trailer many times as well as a veterinary student to oversee different medium scale livestock production (e.g., 200 broiler chickens over a summer in two or three batches of 100 or 70) different people in the Boreal Garden Program and Grow North said no. Instead of building chicken tractors they opted to build a bat box to try to increase the bat population with the idea that bat guana would provide some organic matter to the soil. This idea has not yet resulted in any sustainable supply of manure to build the organic matter in the soil and will never result in eggs or meat.

While there have been some advances in terms of growing methods in Leaf Rapids, there is still a lot of work to do. If the sandy soil is to be improved, the soil needs organic matter and nutrients, which requires widespread hugelkultur, livestock manure, green manure and/or composting efforts. With the abundance of trees in this boreal forest area and the lack of organic matter in soil, hugelkultur seems an appropriate method to build organic matter, allow conservation tillage, and reduce workload dramatically. To create hugelkultur soil bed,

branches, logs and/or brush a foot or two deep in a mound with peat and compostable materials are placed into a pile with an inch or so of soil. The decomposing woodland other organic matter in hugelkultur beds increase the soil temperature boosting plant growth. It is not necessary to fertilize or irrigate hugelkultur beds very often as they release nutrients slowly as the organic matter rots, and hold quite a bit of water. Many elders discussed that using branches and logs is the way their parents and grandparents built garden beds. Despite having abundant tree material readily available, Leaf Rapids is exploring but not committing to hugelkultur, demolishing one bed of hugelkultur in the spring of 2014, but then created four small windrows later that summer.

Composting and green manure are other ways to improve the soil, with small steps being taken in these directions in 2014. The garden at that time gained five composters, to take garden and other compost from the grocery store and households, who are encouraged to drop it off. However, without any town collection system in place only a small amount of food waste is being composted. Also a tiny bit of green manure crop was started in 2014for a particularly bad patch of soil. However, all the annual garden beds need it for sustainable cropping. This green manure crop, includes legumes to fix atmospheric nitrogen in their root nodules to make it available to plants, and will be plowed under to incorporate organic matter and nutrients into the soil (Connor, 2014).

CONCLUSIONS

Community food security considers the process, product and decision making of growing sufficient food in the community. Leaf Rapids food programs have work to do in terms of organizational development and process before community food security is achieved. As a first step towards deciding a community food plan, the governance of its food program has shifted from being run by one person, the Boreal Garden Program coordinator, to a board with representatives from the school and the town, all of who are recent settlers to the community. It would make sense for the board to include someone from the community health centre, to consider health outcomes, and include First Nation peoples, given the high population of Aboriginal people, as well as local people. The Boreal Garden Program is shifting from a training program for youth development to include economic development aspects of the community with its incorporation into Grow North. Given the high food insecurity in the town of 69%, it would be natural for a food program run by the town to mandate community food security.

Despite sandy soil and a short cold growing season, conventional agriculture has provided good results for vegetables. This productivity has been largely due to using greenhouses, abundant water resources, cheap labour (government and university funded internships) and free access to cleared land. With its focus on youth training as well as seed and plant research, the garden has not been designed to grow calories, nutrients and protein required by the local population or even the interns in the program for community food security. Although the garden does not provide community food security presently it is building capacity for food security in the future by engaging youth in garden and seed-breeding programs. This has allowed the garden program to amass financial and physical assets for building social, natural and human assets. These are good seeds for tomorrow to feed the future.

But what about feeding the community in the next few years? With permaculture this gardening could scale up food production by incorporating hugelkultur, green manure and livestock but also bio intensive small-scale methods of high calorie crops. By working with nature, the work would be less labour intensive but more biointensive.

For remote northern communities that have high food insecurity and structural unemployment, youth internships in gardening programs can be an effective strategy for developing sustainable livelihoods and holistic youth development and potentially with changes to the approach, community food security. According to the indicators in the Circle of Courage model and sustainable livelihoods, the Frontier gardening program resulted in positive youth development and grew community assets. Youth experienced the benefits of: mastery in job training and skill building; independence by gaining leadership and self-esteem, as well as improved nutrition and food security; generosity through teaching gardening skills and increased belonging by community building. However, a formal adoption of this model by the School Division or the Boreal Garden Program has not occurred, unlike in the Youth Eco Action (YEA) program, which did incorporate this philosophy and train coordinators and workers with this model (Fulford & Thompson, 2013).

To expand the knowledge exchange to more than a few interns, a credit course(s) should be developed that brings gardening, potentially along with country foods, into the curriculum and to more students. An excellent model for this course is the secondary school credit course at OPCN where youth with elders have to go out on the land in four seasons to learn the traditional activities of trapping rabbits, ice fishing and hunting caribou, as well as gardening. Land based programs with First Nation elders provide the solution to colonization. Considering this school boards and government should explore how to build indigenous land based programs and food programs, that include gardening, in their work in Leaf Rapids and other indigenous communities in northern Manitoba, based on the example at OPCN.

References:

Altieri, M.A. (2008). *Small farms as a planetary ecological asset: Five key reasons why we should support the revitalization of small farms in the global South: Institute for Food and Development Policy.* URL: http://www.foodfirst.org/en/ node/2115 [December 10, 2011].

Ballard, M. (2012). *Flooding sustainable livelihoods of the Lake St Martin First Nation: The need to enhance the role of gender and language in Anishinaabe knowledge systems* (Doctoral thesis). Natural Resources Institute, University of Manitoba, Winnipeg, Manitoba.

Benveniste, P., Fournier, E., Haynor, L. and Mason, A. (2008), Small Is Beautiful: Youth Garden Programs. In Kirby, P. and Peters, E. (eds.), *Community Gardening*. Brooklyn: Brooklyn Botanic Garden.

Bery, R. (2003). Participatory video that empowers. In White, S (ed.), *Participatory Video: Images that Transform and Empower*. London: Sage.

Brendtro L., Brokenleg, M. and Van Bockern, S. (1991). The Circle of Courage.*Beyond Behavior*,(2), 5-12.

Brendtro L., Brokenleg, M. and Van Bockern, S. (2005). The Circle of Courage and Positive Psychology.*Reclaiming Children and Youth*, (14), 130-136.

Brendtro, L. K., & Mitchell, M. L. (2010). Weighing the evidence: From chaos to consilience. *Reclaiming Children and Youth*, *19*(2), 3-9.

Briand, L., Sauve, N. and Frechette, L. (2011). The Benefits and Economic Value of Community Recreation: Proposal for an Analytical Framework Based on an Exploratory Study. *Canadian Journal of Nonprofit and Social Economy Research,* (2), 24-44.

Brown, K. and Carter, A. (2003). *Urban Agriculture and Community Food Security in the United States: Farming from the City Center to the Urban Fringe.* Venice: Community Food Security Coalition.

Cammack, C., Waliczek, T. and J. Zajicek. (2002). The Green Brigade: The Educational Effects of a Community-based Horticultural Program on the Horticultural Knowledge and Environmental Attitude of Juvenile Offenders. *Hortechnology,* (12), 77-81.

Carney, D. (1998). *Sustainable rural livelihoods: What contribution can we make?* London: Department for International Development, University of Sussex.

Carter, T. (2009). Housing and Neighbourhood Challenges of Refugee Resettlement in Declining Inner City Neighbourhoods: A Winnipeg Case Study. *Journal of Immigrant & Refugee Studies,* 7(3), 308-327.

CCPA-MB. 2012. State of the Inner City 2012: Breaking Barriers Building Bridges. Winnipeg: CCPA. http://www.policyalternatives.ca/publications/reports/state-inner-city-2012#sthash.o6kofpOb.dpuf

Chambers, R., & Conway, G. R. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century* (IDS Discussion Paper No. 296). Brighton, UK: Institute of Development Studies. Retrieved from https://www.ids.ac.uk/publication/sustainable-rural-livelihoods-practical-concepts-for-the-21st-century

Chawla, L. (1998). Significant life experiences revisited. *Journal of Environmental Education,* 29(3), 11-21.

Connor, C. (2014). *Grow a Sustainable Diet: Planning and growing to feed ourselves and the earth.*Gabriola Island: New Society Publishers.

Department for International Development [DFID]. (2001). *Sustainable livelihoods guidance sheets.* London: Author. Retrieved from http://www.efls.ca/webresources/DFID_Sustainable_livelihoods_guidance_sheet.pdf

Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford, UK: Oxford University Press.

Fieldhouse, P. & Thompson, S. (2012). Tackling Food Security Issues in Indigenous Communities in Canada: The Manitoba Experience. *Nutrition and Dietetics*, 69 (3), 217–221, DOI: 10.1111/j.1747-0080.2012.01619.

Ford, E. S., &Mokdad, A. H. (2008). Epidemiology of obesity in the Western Hemisphere. *Journal of Clinical Endocrinology and Metabolism, 93*(11, Supp. 1), 1–8. http://dx.doi.org/10.1210/jc.2008-1356

Garfat, T., & Van Bockern, S. (2010). Families and the Circle of Courage.*Reclaiming Children and Youth,* 18(4), 37-39.

Hamm, M., & A. Bellows.(2003). Community food security and nutrition educators. *Journal of Nutrition Education and Behavior,* 35(1), 37–43. doi:10.1016/s1499-4046(06)60325-4

Health Canada. (2007). *Community Health Survey, Cycle 2.2, Nutrition (2004)—Income-Related Household Food Security in Canada.* Ottawa: Health Canada.

Hemenway, T. (2009). *Gaia's Garden: A Guide to Home-Scale Permaculture.* White River Junction: Chelsea Green Publishing Company.

Hoffman, J., Knight, L. & J. Wallach, (2007). Gardening Activities, Education, and Self-Esteem: Learning Outside the Classroom. *Urban Education,* (42), 403-411.

Holt-Giménez, E., Patel, R., & Shattuck, A. (2009). *Food rebellions! Crisis and the hunger for justice*. Boston, MA: FahumuBooks and Grassroots International.

International Planning Committee for Food Sovereignty (2007). *Declaration of Nyelini*. URL: http://www.foodsovereignty.org/Portals/0/documenti%20sito/Resources/Archive/Forum/2007/2007-En-Declaration_of _Nyeleni.pdf [July 1, 2012].

John Howard Society of Manitoba (2011). *Winnipeg Centre residents vote for getting smart on crime.* [Press release].http://www.johnhoward.mb.ca

Kirkpatrick, S. I., &Tarasuk, V. (2008). Food insecurity in Canada: Considerations for monitoring. *Canadian Journal of Public Health, 99*(4), 324–327. http://www.cpha.ca/en/cjph.aspx

LaDuke, W. (2002). *The Winona LaDuke reader: A collection of essential writings*. Penticton Indian Reserve, B.C.: Theytus Books.

Ledrou, I., & Gervais, J. (2005). Food insecurity. *Health Reports, 16*(3), 47–50. http://www.statcan.gc.ca/pub/82-003-x/4060784-eng.htm

Levkoe, C. (2006). Learning democracy through food justice movements. *Agriculture and Human Values,* (23) 89-98.

Markey, S., J.T. Pierce, K. Vodden, & M. Roseland. (2005).*Second Growth: Community Economic Development in Rural British Columbia*, Vancouver: University of British Columbia.

Patel, I. (1991). Gardening's Socioeconomic Impacts.*Journal of Extension*, 29(4), 7-8.

Patel, R. (2009). What would food sovereignty look like? *The Journal of Peasant Studies, 36*(3), 663–706.

Power, E. (1999). Combining social justice and sustainability for food security. In Koc, M., MacRae, R., Mougeot, L. and J. Welsh, (eds.), *For Hunger Proof Cities: Sustainable Urban Food Systems*. Ottawa: International Development Research Centre.

Power, E. M. (2008). Conceptualizing food security for Aboriginal people in Canada [Commentary]. *Canadian Journal of Public Health, 99*(2), 95–97.http://www.cpha.ca/en/cjph.aspx

Power, E. M., & Tarasuk, V. (2006, March). The impact of income on healthy eating in Canada. *Health Canada Policy Forum*, 60.

Robinson-O'Brien, R., Story, M. and Heim, S. (2009). Impact of Garden-Based Youth Nutrition Intervention Programs: A Review. *Journal of the American Dietetic Association*,(109), 273-280.

Scheier, L. M. (2005). What is the hunger-obesity paradox? *Journal of the American Dietetic Association, 105*(6), 883–885. http://dx.doi.org/10.1016/j.jada.2005.04.013

Scoones, I. (1998). *Sustainable rural livelihoods: A framework for analysis* (IDS Working Paper No. 72). Brighton, UK: Institute of Development Studies, University ofSussex. Retrieved from https://www.ids.ac.uk/publication/sustainable-rural-livelihoods-a-framework-for-analysis

Simpson, L. (2004) "Anticolonial Strategies for the Recovery and Maintenance of Indigenous Knowledge," *The American Indian Quarterly*, (28), 373-384.

Skinner, E. and Masuda, J. 2013. Right to a healthy city? Examining the relationship between urban space and health inequity by Aboriginal youth artist-activists in Winnipeg. *Social Science & Medicine*, (91), 210-218.

Statistics Canada. (2006). *City of Winnipeg Neighbourhood Profiles.*http://winnipeg.ca/census/2006/.

Szathmary, E. J. E., Ritenbaugh, C., & Goodby, C.S. M. (1987). Dietary change and plasma glucose levels in an Amerindian population undergoing cultural transition. *Social Science and Medicine,* 24(10), 791–804. http://dx.doi.org/10.1016/0277-9536(87)90181-X

Thompson, S. (2005). Sustainability and vulnerability: Aboriginal Arctic food security in a toxic world. In F. Berkes, R. Huebert, H. Fast, M. Manseau, & A. Diduck (Eds.),

Breaking ice: Renewable resource and ocean management in the Canadian North (pp. 47–69). Calgary, Alberta: University of Calgary Press.

Thompson, S., Gulrukh, A., Ballard, M., Beardy, B., Islam, D., Lozeznik, V., & Wong, K. (2011). Is community economic development putting healthy food on the table? Food sovereignty in northern Manitoba's Aboriginal communities. *Journal of AboriginalEconomic Development,* 7(2), 14–39. http://www.edo.ca/edo-tools/jaed

Thouez, J. P., Rannou, A., & Foggin, P. (1989). The other face of development: Native population, health status and indicators of malnutrition — The case of the Cree and Inuit of northern Quebec. *Social Science and Medicine, 29*(8), 965–974. http://dx.doi.org/10.1016/0277-9536(89)90052-X

Torjman, S. (2004).*Culture and Recreation: Links to Well-Being.* Ottawa: The Caledon Institute of Social Policy.

Torrez, F. (2011). La Via Campesina: Peasant-led agrarian reform and food sovereignty. *Journal of Development, 54*(1), 49–54.

Twiss, J., Dickinson, J., Duma, S., Kleinman, T., Paulsen, H., and Rilveria, L. (2003). Community Gardens: Lessons Learned from California Healthy Cities and Communities. *American Journal of Public Health,* 98(9), 1435-38.

Wakefield, S., Yeudell, F, Taron, C., Reynolds, J. and Skinner, A. (2007). Growing urban health: Community gardening in South-East Toronto. *Health Promotion International,* 22(2), 92-101.

Wansink, B. (2006), Nutritional Gatekeepers and the 72% Solution.*Journal of the American Dietetic Association* (106), 1324-6.

Whittington, A. and Nixon Mack, E. (2010). Inspiring Courage in Girls: An Evaluation of Practices and Outcomes. *Journal of Experiential Education* 33(2), 166- 180

Willows, N. D., Hanley, A. J. G., &Delormier, T. (2012). A socioecological framework to understand weight-related issues in Aboriginal children in Canada. *Applied Physiology, Nutrition, and Metabolism*, 37(1), 1–13. http://dx.doi.org/10.1139/h11-128

Willows, N., Veugelers, P., Raine, K., &Kuhle, S. (2011) Associations between household food insecurity and health outcomes in the Aboriginal population (excluding reserves). *Health Reports, 22*(2), 15-20.http://www.statcan.gc.ca/pub/82-003-x/2011002/article/11435-eng.htm

Zimmerman, M., Stewart, S. Morrel-Samuels, S., Franzen, S. and Reischl, T. (2010). Youth Empowerment Solutions for Peaceful Communities: Combining Theory and Practice in a Community-Level Violence Prevention Curriculum.*Health Promotion Practice*, (12), 425-439.

4

SECURING BIOCULTURAL DIVERSITY OF THE LOST ANCIENT SMALL MILLETS

Subramanyam Ragupathy
Steven G. Newmaster
Kathirvelu Sambandan
Balasubramaniam C. Nirmala
Narasimhan Duvuru
Kirit Patel

ABSTRACT

Traditional land races of small millets were once an important part of ancient commerce in SE Asia; they were served to royalty and provided sustenance to locals living in harsh, impoverished environments. Historical records list over 4000 landraces, which were selected and developed by indigenous peoples for specific uses in their day-to-day lives; today only seven species of several landraces are used in commercial agriculture as recorded at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Our research seeks to explore the diversity and associated local farmer traditional knowledge (TK) of small millets in order to assist in conservation and food security of indigenous landraces. Our case study focuses on18 landraces of small millets that are still used by indigenous farmers in rural India. Our results indicate that local knowledge systems consist of a complex classification of small millets diversity that considers the role of small millets in the farming system. This fine-scaled indigenous classification system gives rise to five times the number scientific taxa based on scientific knowledge (SK). There is a unique biocultural and economic role for each millet landrace including its place in the ecosystem and utility within these communities; including medicine (e.g., treating stomach bloating, diabetes, heart conditions, morning sickness, veterinary use and more), food (nutritious grains), fertilizer, pathogenic resistance and feed for livestock. The primary characteristics used by the indigenous farmers to identify small millets include three general categories; morphology, experience and ecology. Morphological characters are used most often to recognize specific landraces of which vegetative features are more commonly used than floral features. These vegetative and floral characteristics are recognized at the macro-scale and include several salient features such as shape, color and size of grains. Personal experience with small millets accounts for a significant portion of the skills used by the farmers to identify small millets landraces. These sensory experiences are hierarchical in usage and respectively comprised of olfaction (smell), palpation (touch) and gustation (taste). Our most novel discovery is the extensive use of traditional ecological knowledge to classify landraces; this includes drought tolerance, and the habitats and range where specific landraces will thrive. Many landraces are grown in special ecological niches, and indigenous knowledge system provides in-depth understanding of these spatial niches. The paper argues that indigenous knowledge has potential to provide new framework and approach for conservation initiatives. We used an Ethnobotany genomic tool called DNA barcoding to discriminate all small millets landraces included in the study. We propose that DNA barcodingis a quick and reliable tool to identify any landrace of millet, which will further legitimize the validity of TK, rendering it testable

and ultimately generalizable, mobile and globally meaningful. Local communities are concerned about the loss of small millets diversity and their indigenous knowledge system relating usage and conservation of small millets. This interdisciplinary approach responds to the increasing urgent global imperatives to conserve both cultural and biological diversity as urged by the Convention of Biological Diversity (CBD 1992), UNESCO's 'Man and Biosphere Programme' and the Declaration on the Rights of Indigenous People (2007).Our research has revealed that there is considerable generic diversity exists among landraces of small millets used within subsistence farming system in our areas of study. This is important to food security as many of these case study sites rely on rain fed agriculture and the diversity of millets utilized allow the farmers to adapt to difficult and variable farming conditions. We suggest that this diversity should be recognized and supported through policy so that both the genetic diversity and traditional knowledge of the local farmers does not disappear.

Keywords: Millets, Biocultural diversity, Landraces, DNA barcoding, Food security

INTRODUCTION

Securing Traditional Knowledge of Ancient Land races of Small Millet

Though small millet are rich in micro nutrients they are overlooked by research and development institutions. This is partly because most research efforts have focused on breeding high yielding wheat and rice. Such high yielding varieties require irrigation, and are therefore not useful to people who depend upon rainfed crops. This is a common theme across the globe as much of the current human population has ignored the diversity of wild medicines and foods that existed in the past and have over exploited the current species used in food production (Gyulai, 2000). The demands for large quantities of grains through inexpensive and easy processing have focused on only a few cereal crops and disregarded the many ancient grains such as the landraces of small millets throughout most of Asia. Interest in food security of traditional foods is in conflict with the "Green Revolution" that seeks to cleanse the landscape of traditional foods. In rural India, traditional wild food and landraces such as millet are starting to become more popular as they once were in the past. Unfortunately, much of the knowledge concerning these ancient landraces of millet is about to be lost in the current generation. Immediate action is needed to preserve TK and genomic diversity of landraces that may serve impoverished areas that experience drought.

Rain fed areas of India are a perfect example of a place where local communities have been sustain by ancient drought tolerant grains such as some of the landraces of small millet. Despite India's impressive technological, economic, and political achievements, the gains of the green revolution have not trickled down to much of the country's rainfed regions. For example, data from an anthropometric survey conducted by the National Institute of Nutrition, Hyderabad, indicate that the problem of malnutrition among rural women and children is worse than in most of sub-Saharan Africa (Dheaton & Dreze, 2009). India has the largest group of undernourished people in the world (Ziegler, 2006) of which most of them are among caste and tribes living in rainfed regions that are poorly integrated with public infrastructure and markets (Gill et al., 2003). Cereals provided the cheapest source of calories for this population, but unfortunately the Indian Green Revolution has only focused on wheat and rice. This strategy of breeding high yielding crop varieties through conventional plant breeding or biotechnology has failed to increase food production in these rainfed regions. Research programs need to focus on revitalizing small millets.

Small farming and tribal communities cultivate small millets under rainfed conditions throughout South Asia. These largely ignored crops include kodo millet (*Paspalum scrobiculatum*), little millet (*Panicumsumatrense),* ragi (*Eleusinecoracana),* foxtail millet *(Setariaitalica),* proso millet (*Panicummiliaceum*) and barnyard millet (*Echinochloacolona*). Several studies have highlighted the excellent agronomical, economical, ecological, cultural, nutritional and gastronomical traits of these food grains in terms of oil content, protein, minerals, crude fiber, and iron (Arunachalam et al., 2005; Baghel et al., 1985; Hegde & Chandra, 2005; Maloles et al., 2011; Newmaster et al., 2013; Seetharam et al., 1983; Upadhyaya et al., 2009). These millets are well suited for people suffering from anaemia, diabetes and gastric problems. Many tribal communities across the Indian subcontinent use traditional millets as special foods for nursing mothers, young children, and working bullocks during the planting season (Maloles et al., 2011). Despite knowledge of the nutritional value of these food grains, both in formal sciences as well as in indigenous knowledge systems, the total cultivated area for small millets has declined by more than 40 per cent as compared to the area allocated at the beginning of the green revolution in 1967. The overall consumption of these coarse grains has declined by almost half in last 50 years(Dheaton & Dreze, 2009). This is more pronounced among lower income groups where the consumption of small millets has declined by almost 70 per cent of the consumption level reported in 1983 (Kumar et al., 2007). Traditional millet farmer's indigenous knowledge has increasingly attracted attention in global scientific community as there is concern for the increasing loss of this indigenous knowledge. This has inspired the desire to preserve the genetic diversity and TK concerning landraces of millet within India (Ohmagari & Berkes, 1997).

Securing Biocultural Diversity of Local Landraces of Small Millet

Researchers have discovered only a small fraction of earth's biodiversity. Approximately 1.7 million species of plants and animals have been described and named under the Linnaean system (Hawksworth & Kalin-Arroyo, 1995), the total number of species on earth remains unknown, and estimates vary widely ranging from 10 million to more than 100 million (Hammond, 1992; Hawksworth & Kalin-Arroyo, 1995; May, 2014). Since agriculture began about 1200 years ago, over 7000 wild plants species have been collected and cultivated, but only 15 plant and 8 animal species are used to supply 90% of the world's food (Lal & Lal, 2004; Oldfield, 1990).

Indigenous knowledge of plants or crops is responsible for most of the medicine and food used in modern society(Franco & Narasimhan, 2012). The traditional knowledge (TK) of small millet is foundational towards understanding the role of this food and medicinal plant for local communities and how this may serve society at large. For example, previous research (Maloles et al., 2011) has shown that by considering several different mechanisms, indigenous millet farming cultures have found several sub-taxa ("cryptic landraces ") not apparent to a Linnaean approach based mainly on morphologic characteristics. This multi-mechanistic approach for classifying plant genetic diversity, described by Newmaster et al., (2006, 2007)is supported by findings of several studies(Arunachalam et al., 2005; Balakrishnan et al., 2003; Maloles et al., 2011; Newmaster et al., 2013).

Millet landraces are classified by TK following theories of ethno-classification. The assemblage of traditional and scientific knowledge concerning millet landrace classification has advanced knowledge of ethno-classification. Utilitarian classification theory states that all human societies responded to the diversity of plants and animals in their local environment by grouping them into categories of greater or lesser inclusiveness (Brown, 1984). People created categories in order to make sense of the diversity and grouped things based on similarities and differences (Ellen, 2006). F**olk classification and ethnotaxonomy were examples of** indigenous **knowledge** (Newmaster et al. 2006)**.** Folk classification is defined by the way in which members of a language community named and categorized plants and animals, whereas ethno taxonomy is a term referring to the hierarchical structure, organic content, and cultural function of biological classification that ethnobiologists appeared to find in every society around the world (Atran et al., 2004; Brown, 2000).Malayali tribal farmers in South India have classified the landraces of millet into folk species and folk varieties. Their categorization structured in a hierarchical system based on morphological similarities and also by the way in which the plants were used. Rengalakshmi (2005) and Maloles et al. (2011) suggested that the 'Malayali' farmers used two dimensions of categorizations. The first was based on morphological and gastronomic characters, while the second classification was a functional classification based on multiple use values, harvesting method, and maturation and landscape characters. The morphological characteristics used were: plant height, hairiness, ear head shape and structure, seed colour, shape and lustre, and stem colour. The functional classification was a special purpose taxonomy that utilized the practical knowledge of the landraces (Arunachalam et al., 2005; Maloles et al., 2011). Similarly the morphological characteristics, such as stem juiciness, midrib colour, grain shape, plumpness, covering and size, as well as glume colour and hairiness, are used to classify the sorghum landraces in Ethiopia (Teshome et al., 1997).

Our research program - the assemblage of biodiversity concept states that TK recognizes fine-scale morphological and genomic variation in biological organisms. The fine-scaled classification of millets has been documented both morphology(Maloles et al., 2011)and genetically (Newmaster et al.,2013). Classic Linnaean taxonomy assumes that inter specific genetic variation is a proxy for morphological variation. This would lead us to predict thatsmall millet landraces would form similar classification clusters using either genetic or morphology characters. Alternatively, the interpretation of this variation may not be congruent among different classification systems. A classic Linnaean phenotypic classification based on plant morphology may not be congruent with a classification based on DNA loci; the limited genetic divergence between the small millet landraces provides limited clustering using molecular analysis in contrast with conventional taxonomy. Furthermore, a multi-mechanistic hypothesis (Newmaster et al., 2007)suggested that Aboriginal classifications may use more characters leading to a finer classification than a Linnaean classification system. This may lead to different clusters of small millets based on an alternative interpretation of biological variation from a different knowledge source i.e., "Indigenous Knowledge".

Our research here seeks to investigate the genetic and morphological diversity of small millets within the context of the landraces recognized and utilized by local farmers in rain fed areas of India. More specifically we seek to explore;1)Variation among 18 landraces of small millet using both scientific (morphology and genetic) and traditional classification systems, 2) Traditional knowledge (TK) of the agricultural traits and utility of 18 small millet landraces, and 3) discuss approaches for food security and the conservation of biocultural diversity of small millet landraces in rain fed areas of India.

BACKGROUND AND METHODOLOGY

Study Sites:

The study was conducted in three sites located in Southern Indian states of Tamil Nadu. The sites selected for this research project were rainfed areas, which have high incidence of poverty, food and nutritional insecurity. They are remote, underdeveloped and have a considerable tribal population. These are areas where traditional millet landrace based cropping systems still exist. The local farmers in these areas have a vast TK about the biodiversity of these underutilized species, their agronomic practices and associated indigenous practices. Study sites are: 1) Plains of Peraiyur (Madurai district),that fall in the moderately food secure category; poorer and more food insecure than their respective state's performance, 2) Eastern Ghats of Anchetty (Krishnagiri district), which is a predominately subsistence based food among small and marginal rainfed farmers, due to the drought prone nature of the area, high levels of poverty, remoteness and the need to conserve the millet based subsistence cropping system in the area, and 3) Jamnamarudur (Vellur district), which is also predominately subsistence based small millets are regularly grown and consumed. However, there is evidence that traditional varieties are in threat of being lost due to the decline in use (Rengalakshmi (2005) and Maloles et al. (2011). In this area there are high levels of poverty, due to the remote nature of the community it is desirable to conserve traditional millet based subsistence cropping system in the area.

Generally, these millet-farming communities have small acreages of land that are typically considered economically marginalized due to limited income-earning opportunities. Other than millet farming, the next major source of agriculture is the flower industry, which includes: cut flowers, ornamental flowers, spiritual pooja flowers, death ceremony flowers and a few cosmetic flowers. 20 years ago these communities used to grow many traditional landraces of small millets, which were the main source of staple food for them and neighboring communities. Now it is restricted to a few varieties based on their purpose again where utilitarian category plays a major role. This has been replaced by the recent advent of modern agriculture and prepared foods. In particular, a considerable portion of Jamnamarudur people worked with forest/public works department as daily labourers (under re-vegetation, restoration and rehabilitation programs) harvesting wild forest produce for small markets. The typical diet included rice, which was received from the Public Distribution System (PDS) operated by the local government. The highest quality food came from their traditional millets and food plants that were harvested in their landscape.

DATA COLLECTION

Sampling occurred within three marginal farming communities (Lingayats, Vanniyars, Vokaligas, Malaiyali and Scheduled Tribes) that focused on growing small millets in rural India. The farmers helped to collect accessions for 18 landraces. Field work was conducted between April 2011 and July 2012 with 66 research participants (called informants). 32 male and 34 female informants that were interviewed including three age groups: Age group 1 - Young people between, 5-25 years old (n=20); Age group 2 - Middle age people between 26-50 years old (n=26); Age group 3: Elders between 51-75 years old (n=20). Initially, a 4^{th} age group (>76 years old) was considered for knowledge stratification, but this was excluded because the sample size of participants was too small and had no consistency to be included in this study. The knowledge of these (4^{th} category) elders was

considerable and notes were made of this elderly knowledge where appropriate within the discussion.

Millet-specific information was collected using the following methods: 1) Knowledge holders were requested to accompany us to the field and identify the plants used, 2) Specimens were brought to the village and shown to knowledge holders for sharing information, 3) Photographs taken from the field crops in the vicinity were also used as interview probes and 4) Suitable participatory rural appraisal techniques were followed in eliciting information from the community for a number of community resources and knowledge –related issues. Researchers used participant observation method for recording qualitative information about information conservation, cultivation and usage of small millets. With the help of project partner organization (Development of Humane Action (DHAN) Foundation) community meetings were organized before and at the end of field research. Field researchers explained objectives and outcome of the study in local language and their suggestions were incorporated in executing research plan. The prior informed consent from the concerned village councils were obtained verbally by field researchers. In addition, the individual respondent's prior informed consent was obtained. Most of the women were interviewed at their home. Both qualitative and quantitative data gathering and analysis tools were used. Research instruments included semi-structured interviews, photo identification of selected varieties, and informal key informant interviews (Etkin, 1993; Pelto & Pelto, 1990; Stepp & Thomas, 2005; Vogl, Vogl-Lukasser, & Puri, 2004). Effort was taken to attend all festivals and ceremonies happening in the village, which helped in developing a better understanding of their culture, the role played by millets and also helped in strengthening the relationship with the community. All semi and fully structured data collection instruments were pretested with informants that were not later represented in the sample, in order to determine whether the questions generated the desired information (Bernard, 1994). The photo identification of millets investigated the ability of informants to identify few randomly selected millet crops from the pool of 125landraces/ethnotaxa. This was verified as consumed by the three socio-cultural groups – through photographs, providing a 'correct' vernacular name for the plants that informants could identify (secondary materials were used for identification of species names).

Voucher specimens were collected and tagged except from millet farmer's landscape and deposited at the Center for Biocultural Diversity Herbarium (http://www.cbdindia.org/) and seed samples were deposited in "All India Coordinated Small Millet Integrated Project" (AICSMIP), in Bangalore, India. Information was recorded in field notebooks and electronic recorder. The specimens were identified and they were brought to the CBD head office herbarium at Chennai, with the help of the Floras such as Flora of British India (Hooker, 1894), Flora of the Madras Presidency (Gamble, 1915), and Flora of Tamil Nadu (Henry, Chithra, & Balakrishnan, 1987, 1989; Nair & Henry, 1983).Millet crop names were updated by referring to http://www.kew.org/data/grasses-db.html and as well as appropriate revisions and monographs.

Millet TK include three categories including 1) Morphological traits (plant height, size, shape, strength, panicle size, shape, length, color, grain size, grain color), 2) agricultural traits (grain yield, drought tolerance, salt tolerance, maturing variety (late or early) seed production, length of growing season, germination requirements, site conditions, broadcasting, storage process and domestic drudgery advantage, grain size, feeding livestock), 3) culturally important traits(nutrition, gastronomic taste, type of flour produced from grain, customary, medicinal value (treating circulatory, respiratory, digestive and

rheumatic ailments), veterinary medicine and wine production, and 4) economic traits (profitability) specific to farmers. These traits were correlated (Pearson Correlation) for each landrace and identified on the Neighbour Joining (NJ) tree based on significant ($p<0.05$) correlations where the Pearson Correlation was greater than 80%.

DNA isolation, PCR amplification and sequencing were described in detail in Newmaster et al (2013).Nuclear (*ITS, ITS2, ITS2*) and plastid regions (*rbcL, matK, trnH-psbA*) were used to assess sequence variation. DNA was isolated from the fresh leaf samples using the modified CTAB method (Khanuja, Shasany, Darokar, & Kumar, 1999). Isolated DNA was used as the template for Polymerase chain reaction. The sequences were then aligned using Clustal W (Thompson, Higgins, & Gibson, 1994). The genetic distances were calculated using the Kimura2Parameter (K2P) model in Mega5 (Tamura et al., 2011).Sequences were submitted to Genbank and BOLD (Barcode of Life Database).

PHYLOGENETIC ANALYSIS

Optimal trees were obtained by using two phylogenetic inference methods, Maximum Parsimony and Bayesian Inference. The parsimony analyses were analysed with the heuristic search options in PAUP*4.0b8 (Swofford, 1998). Internal branch support was assessed by bootstrap analyses (Felsenstein, 1985). For Bayesian phylogenetic inference, models of DNA evolution were selected by using the AIC (Akaike's information criterion) information decision criterion as implemented in the APE library (Paradis et al., 2004) of the R package version 2.7.1 (www.r-project.org). Bayesian analyses were performed under the corresponding models using MrBayes 3.04b (Ronquist & Huelsenbeck, 2003).

LINNAEAN TAXONOMY ANALYSIS

The 96 phenotypic characters for the morphometric analysis are listed in Table 1. These characters were obtained using digital imagining of landrace populations taken during the field survey. The 96 morphological variables (Table 1) were recorded from 125 specimens from the herbarium (CBD) collections. A matrix of 125 specimens and 96 morphological characters were used in a multivariate analysis. Canonical ordination was used to detect groups of specimens and to estimate the contribution of each variable to the ordination. A principal component analysis (PCA) (ter Braak & Smilauer, 1998) was used to identify the length of the ordination axis and the need for either a linear or unimodal ordination technique.

Table 1. List of the 96 characters and criteria for morphometric analysis.

Phenotypic Characters	Criteria
Culm	Stature, straightness, height
Culm Node	Number of nodes, rooting, constriction, colour, indumentum
Culm Internode	Diameter of lower internode, length, hollowness, length of base internode, colour, variegation, surface relief, indumentum
Culm Sheath	Persistence, length at base, length at top, as a fraction of internode, colour when fresh, variegation, surface indumentum, hair location, hair inclination, hair colour, presence of marginal hairs, apex shape
Culm Sheath Blade	Outline, basal constriction, persistence, width, indumentums, shape of apex
Ligule	Height, colour, apical ornament, structure, consistency, apex incision, shape of apex
Collar	Colour, length of hairs
Leaves	Basal or cauline, heterphylly
Leaf Sheaths	Involute margins, length, presence of keel, venation, roughness, surface indumentums, hair type, hair colour, presence of marginal hairs,
Leaf Blades	Shape of base, base symmetry, carriage, straightness, direction of taper, vernation, length, width, consistency, stiffness, colour, midrib distinctness, midrib lower emergence, clarity of venation, surface roughness, surface indumentums, surface hair density, surface location of hairs, surface hair type, marginal thickening, marginal roughness, marginal hairiness, location of marginal hairs, apex shape, apex pungency
Oral Hairs	Presence, shape, carriage, length, colour
Caryopsis	Outline, compression, transverse section, length, colour, roughness, shape of apex, presence of apical appendage
Embryo	As a fraction of caryopsis

Detrended Correspondence Analysis (DCA) was used to explore variation in species scores in this study. A cluster analysis was used to classify the specimens, as it is better in representing distances among similar specimens, whereas DCA is better in representing distances among groups of specimens(Sneath & Sokal, 1973). Cluster analysis was performed with NTSYS (Rohlf, 2000). A distance matrix was generated using an arithmetic average (UPGMA) clustering algorithm and standardized data based on average taxonomic distance subjected to the unweighted pair-group method. A discriminant function analysis (DFA; SPSS 1999) was used to rigorously test the classification of specimens provided in the cluster analysis. The object of DFA is to predict multivariate responses that best discriminate subjects among different groups (Ramsey & Schafer, 1997). A total of 96 morphological characters for each of the 125 specimens were used as input for a DFA. The 125 specimens used as input for a DFA were each coded as belonging to one group as designated a priori groups which 1) determined if the classification was accurate, 2) provided discriminant functions for the classification of the taxa and, 3) indicated if there are important morphological characters for each of the canonical discriminate functions.

Farmer's Taxonomy and Traditional Knowledge (TK): The farmer's classification of millet crops was complex and had been largely influenced by agronomic traits.Many millet farming communities in India, such as the Lingayats, Vanniyars, Vokaligas, Malaiyali and Scheduled Tribesare still considered in the pre-agricultural stage of development. Their

taxonomy analyses are listed in Table 2 and their traditional millets traits knowledge associated with the millets are listed in Table 3.

Table 2. List of the farmer's characters and criteria for taxonomic analysis (in parenthesis farmers character terms in Tamil).

Farmers phenotypic characters	**Criteria**
Plant duration (paiyer kalam)	Long or short
Plant habit (paiyer vakku)	Erect or not erect
Stem (thandu)	Thickness, length, color, sap taste, hollow or solid.
Stem Internode (thandu edai kanu)	Thickness, length, color, sap taste, hollow or solid.
Stem sheath(thandu orai)	Structure, length, color
Ligule(illai innuku)	Structure, length, color
Collar color (illai kathu pattai)	Green, light green, yellow, pale, brown, purple, orange)
Leaves position (illai)	Mostly basal, basal and cauline, cauline (comment if herbaceous without but sheaths)
Leaf sheaths(illai orai)	Structure, collar
Panicles (kathir)	Size, length, firmness, color, branches arrangements (closed or open), seed arrangements (tight or loose), seed rows (1, 2, 3 or many),
Seed coat (glumes)(vithai umi)	Number, shape, size, colour, apex
Seed(vithai)	Shape, colour, thickness, apex shape
Rice/grain (mani)	Compression, transverse section, length, color, shape of apex
Embryo(karu)	Embryo position, size, shape

Table 3. List of the farmer's Traditional Traits Knowledge associated with recognizing their millet landraces (in parenthesis farmers character terms in Tamil).

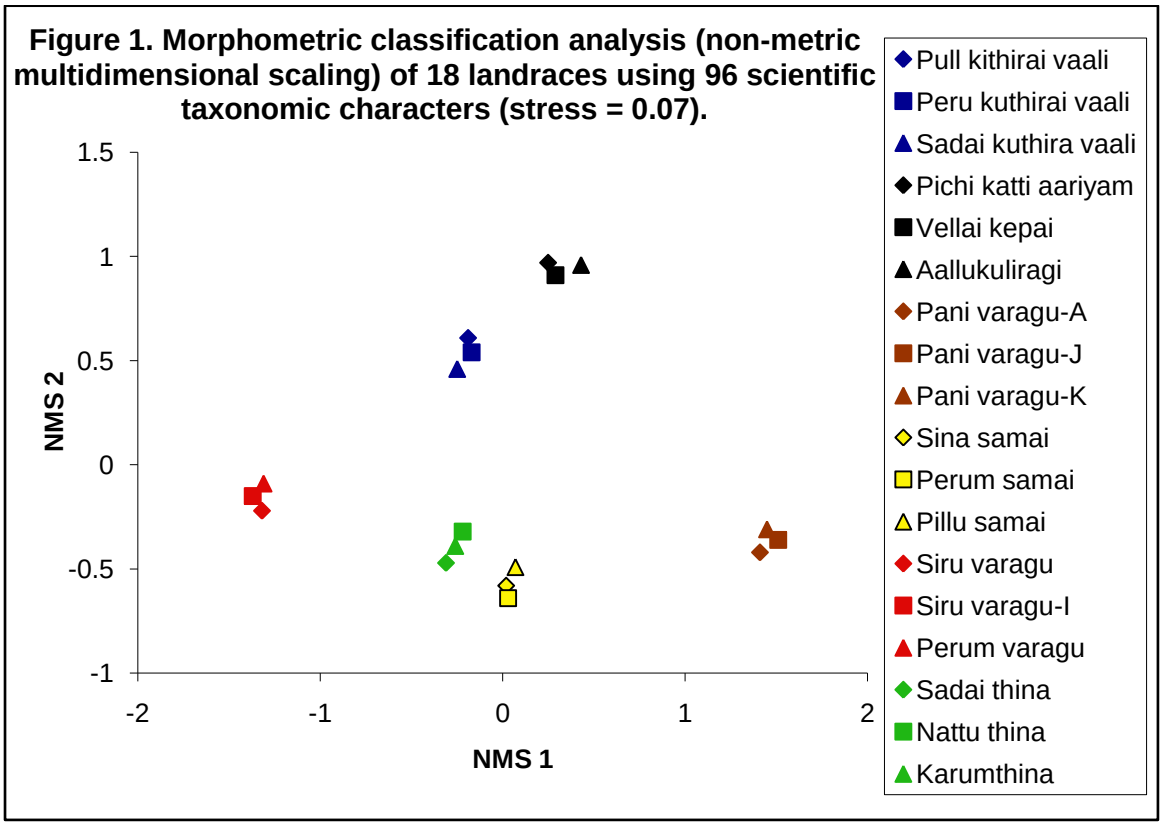
Farmers TKfeatures	Criteria
Seed storage endurance (vithai seamippu thiran)	Longer duration or less duration
Seed storage with treatment (pakkuvapaduthal)	With treatment (>10 yrs, <5yrs, <3 yrs), without treatment (up to 10, 5, <5, 2 yrs)
Kind of treatment for sowing(padapaduthum vidham)	Soaking, water spraying, ash mixing, shade drying, sun drying, overnight exposing on dark or moon light
Productive tillers(paiyer kilithal)	Increasing plant let count (more, medium, less)
Plant count(paiyer ennikkai)	After sowing germination rate (more, medium, less), growth establishment (more, medium, less) success close to (more, medium, less)
Plant physique (paiyer thandu thadippu)	Thin, profuse (undersized)
Flowering time(kathir kallam)	Late or early or uniform flowering
Panicle count(kathir ennikkkai)	Number of panicles for the tillers (more, medium, less)
Plant height (paiyer uaram)	Plants - tall, medium and short
Plant biomass (paiyer valam)	Plant mass- high, medium, low
Panicle yield (kathir valam)	Panicle mass - high, medium, low
Grain yield (mani ganam)	Grain mass - high, medium, low
Straw yield(vaikol ganam)	Straw mass: high, medium, low
Grain yield by season(paruva kala mani valam)	Grain mass –variable
Plant grazing (paier maipu)	Palatable or not palatable
Plant suitable habitat(paier vashidam)	Sandy, Red, black cotton, rocky terrain, mountain/slop terrain, mud, rain fed, irrigated soils
Plant duration(paier kalam)	Long or short duration
Plant water needs(neer pasanam)	Water needs - high, medium, less
Plant growth (paier valarvidham)	Good, V good, not good
Ploughing needs(neer pasanam)	High, medium, low
Hay utility(vaikol payan)	Commercial or non-commercial; high, medium, low
Plant disease resistant (Noi ethirppu thanmai)	Maintenance- High, medium, low

RESULTS & DISCUSSIONS

Morphometric Variation among Millet Landraces

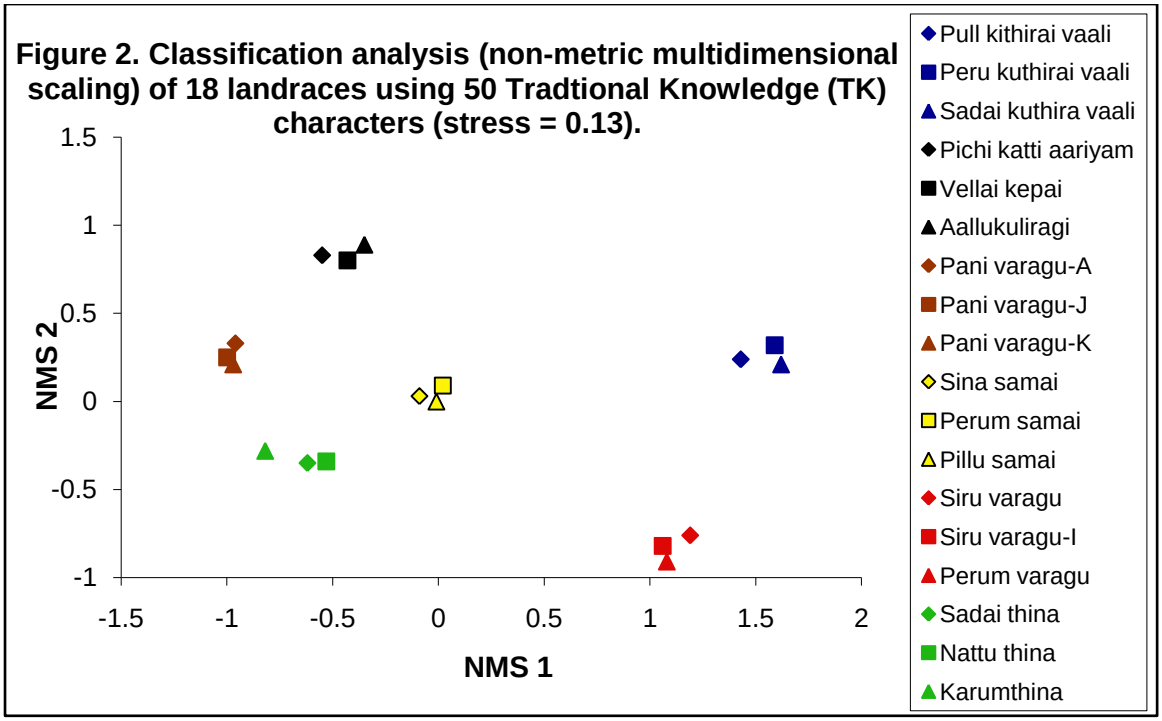
There is considerable morphological variation among the 18 landraces of small millet, which was classified by the farmers using TK. Variation in the data matrix was substantial (>2.5 standard deviations) on two axes suggesting that these 18 landraces are morphologically distinct as perceived by the farmers. The ordination below (Figure 1) clearly shows that all 18 landraces are classified into morphologically distinct clusters; note that any

two symbols in the ordination that are close share similar morphological characters, whereas those symbols that are distant are also less morphologically similar. The traditional landraces cluster within Linnaean "Species" of which similar genera are clustered together. This classification is hierarchical in which landraces are the finest scale of the classification; genera-species-landraces. This result supports that of Maloles et al. (2011) for a different suite of landraces.



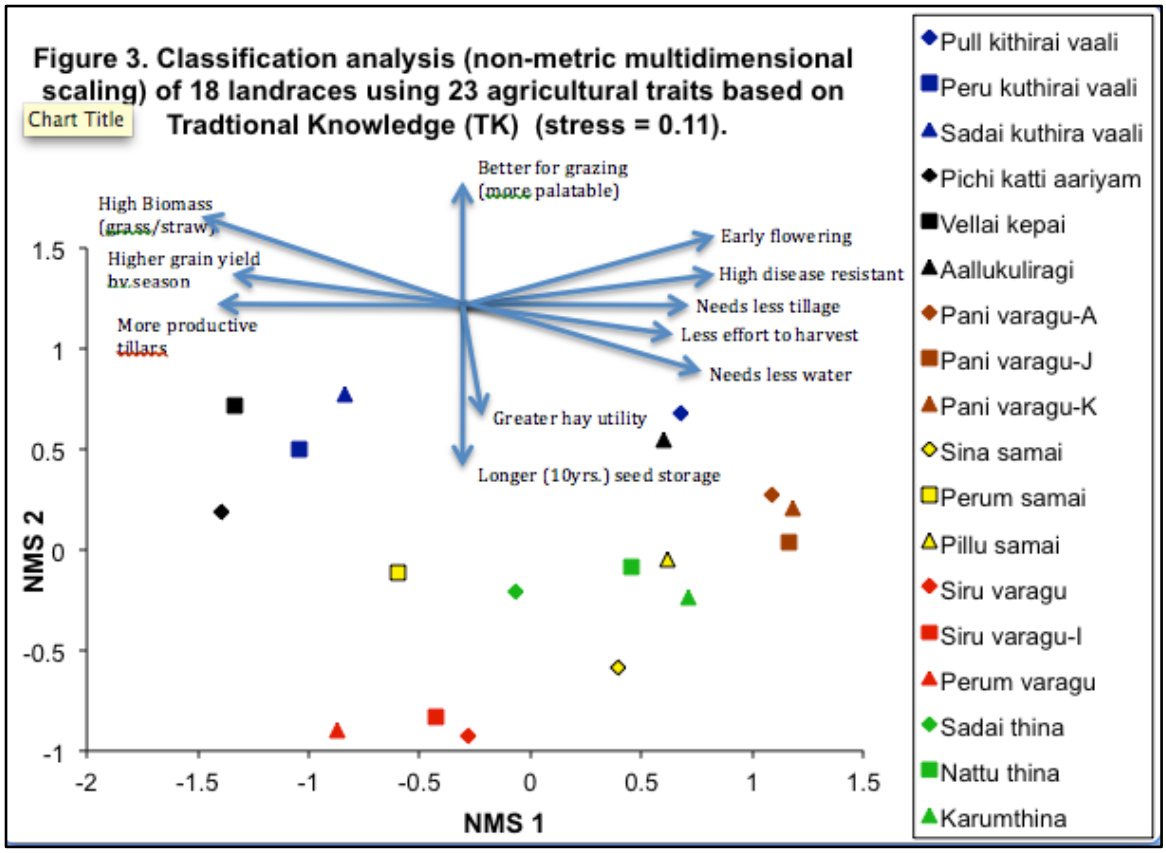
Farmer's Landrace Classification based on Traditional Knowledge

The famer's TK was rich and classified all landraces most efficiently. Farmers used 50 phenotypic characters to classify the 18 landraces in our study (see table 2 for a list of characters). The ordination in figure 2 clearly separates all landraces based on farmers TK; note that once again landraces where classified within Linnaean species. Farmers were able to identify all specimens of landraces with 97.2% accuracy. This knowledge is acquired by famers in an apprenticeship type pedagogy that has been in places for thousands of years within their culture. Their classification is not as technical as the scientific morphometric classification in figure 1 above. However, the classification of landraces using TK is a specialized skill that is not easy to acquire and this knowledge is threatened as less youth are trained in this TK; many youth are being trained in modern urban facilities.



Farmer's Landrace Classification based on Traditional Knowledge of agricultural Traits

Farmers have selected landraces based on desirable agricultural traits that provide a robust classification system. This classification utilizes 23 agricultural traits that differentiate all 18 landraces (Figure 3). The variation among the landraces is greater than that of either the morphometric (Figure 1) or TK phenotypic characters (Figure 2). A bi-plot of the most significantly ($P<0.05$) correlated (Pearson correlates) agricultural traits identify the most important traits; the longer the arrow the more influence (PCorr.) it has in classifying the landraces. The direction of the arrow is related to increases for a specific direction in reference to the landrace classification. For example, *Vellai Kepai* and *Pichi katti aariyam* are associated with higher biomas, tiller production and grain yield; *Pani varagu* is associated with less biomas, tiller production and grain yield. *Siru varagu* is associated with longer seed storage and great yield of hay, whereas *Sadai kuthira vaal i*is associated with shorter seed storage and smaller yield of hay. There is clustering of different landraces associated with agricultural traits, which is not associated with the respective Linnaean species classification. There is great utility in recognizing and preserving this TK, as it is closely associated with biocultural diversity and food security that has sustained these cultures for thousands of years.



Genomic Variation Among Millet Landraces

This study documents genomic sequence variation of millet landraces utilized by marginal farmers who possessed detailed TK of intraspecific variation. It has been found that there was a considerable amount of interspecific (p-distance = 0.1821) and intraspecific variation (p-distance = 0.0426) in the nuclear regions (ITS, *ITS1*, and *ITS2*) among 15 landraces, which represented 6 species of small millets (*Panicum sumatrense, P. miliaceum, Paspalum scrobiculatum, Setaria italica, Echinochloa frumentacea and Eleusine coracana*). *ITS2* alone can be used to resolve all six species with considerable intraspecific variation (p-distance 0.0348) among the 15 landraces (Figure 1). All the 18 individual landraces fell into distinct clades with high bootstrap support values corresponding to the six species. The plastid regions (*rbcL, matK, &trnH-psbA* intergenic spacer) exhibited much less sequence diversity (p-distance interspecific = 0.0298; intraspecific = 0.00) than the nuclear (*ITS, ITS1* and *ITS2*) regions (p-distance interspecific = 0.1821; intraspecific = 0.0426). Some of the *trnH-psbA* region sequences exhibited small repeat units of various length or insertions and deletions of base pairs that served to distinguish some of the landraces of small millet.

Millet Traditional Knowledge Stratification within the Farming Community

There is a decline in TK concerning small millet landraces utilized by aboriginal communities in India and Nepal (Ragupathy et al. 2014 in preparation). This is disturbing given that only a small portion of this knowledge is preserved. Little is known regarding how this knowledge is stratified across cultural groups or the means by which it is transferred from generation to generation. Our study also focused on how TK of millet landraces is stratified among the farming communities. This explored how agronomic traits are stratified by gender and kinship roles. Exploration in this knowledge was conducted through two years

of participant observation and unstructured interviews. Multivariate analysis was used to explore variation in TK of 66 informants concerning 125 ethnotaxa (125 landraces of millets) constrained by 6 explanatory variables and 9 covariates. Results showed that millet farmers TK of millet utility is significantly gender based with women holding the majority of TK regarding medicinal use for children, food and spiritual millet use, whereas men hold the majority of TK regarding the technical and general agronomic practices, characterization and traits of millets. Maloles et al. (2011) during their ethnobotanical survey of the millets farmers in the Eastern Ghats, rainfed area – Kolli hills of Tamil Nadu recorded the food and medicinal use of several millet landraces/ ethnotaxa of small millets. In these surveys, all of the informants were familiar with millets as a food and many (35%) could identify different millet land races used for various utilities. The grains of these millets were regularly used to make regular staple food. Surveys from non-millet farming communities indicated that some people (20%) were still familiar with some of the basic TK concerning the utility of millets. Surprisingly, it was also noted that many (75%) people in modern urban centres used millets to treat/food for diabetics, but few (<5%) were not familiar with the TK of millets and millet-derived foods.

Conservation of millet landrace genomic biocultural diversity

Landraces are associated with highly valued TK that have sustained biocultural diversity for thousands of years. Through ancient breeding programs, famers have selected landraces based on specific suites of traits that are desirable. These are the traits that elders have chosen because they are of great value to their communities. In ancient times this would be a critical decision that sustained communities through drought, floods, high heat or cold spells. This is a delicate balance between high yielding landraces on fertile soils and those low yielding landraces that could tolerate marginal lands. There is a great diversity in the traits such as morphological traits related to grain size and plant height that are important to crop yield. A current list of the different types of cultural traits of millet landraces can be found within Maloles et al. (2011) and Newmaster et al. (2013). Perhaps the biggest discovery was the existence of several landraces that the farmers claimed are resilient to severe drought. Agricultural traits such as drought tolerance, length of the growing season, salt tolerance, germination requirements etc., are highly variable among the different landraces. Farmers have selected for these traits over many generations and the variety of traits reflected the different needs of farmers that grew a particular landrace of millet in different types of sites. Millet farms were at low and very high elevations (1000 to 1500 m) in harsh conditions were observed during the visit. There was also considerable variation in millet landrace traits associated with cultural utility. This category of TK included traits such as nutrition, taste, amount and type of flour produced from grain, medicinal value, veterinary use and social status; some millet landraces are used to produce cakes for royalty. We have investigated less than 1% of the proposed number of landraces suggesting we have merely inched forward towards a goal of protecting the biocultural diversity of millet landraces in support of food security for a large population throughout Asia.

The conservation of millet landraces and the associated TK are in the hands of local communities. Although millet is currently undervalued as an agricultural crop, it has been historically recognized as one of the most important agricultural commodities as evidenced from numerous archaeological sites throughout the globe (Weber & Fuller, 2008). There is a potential danger of losing the current TK of millet landraces if there is no immediate action taken to recognize farmer's TK in small millet crop breeding and on farm conservation programs. Surveys of marginal farmers who grew millet indicated that these rural men and

women are the custodians of millet genetic resources and TK; they have retained seeds and TK for over 4000 landraces (Dida et al., 2008; Seetharam et al., 2006). Women played a key role in millet based food production systems and insisted that a diversity of landraces needed to be maintained in order to deal with the complex environmental and health issues. The Protection of Plant Varieties and Farmer's Rights (PPVFR) Act, 2001 has set the tone for farmer's ownership over plant genetic resources. The implementation of PPVFR Act has led to creation of the authority that registered local landraces of different cultivated species conserved by farmers and communities and facilitates their claims for benefit sharing and recognition. The important next step in this process is to document genetic diversity using a common method and archival system such as the Barcode of Life database (BOLD; Fazekas et al. 2012). It should be suggested that DNA barcoding (*ITS2*) would provide a measure of diversity while delivering a commodity identification tool to ensure authentication and traceability of millet landraces. This could provide a DNA based model for conservation of genetic diversity and the associated biocultural diversity (TK) of millet landraces still used and shared among rural communities.

Small millets are an important crop throughout Asia and Africa as recognized by CIDA, IDRC and UNESCO. There is a tremendous amount of variability in the number of landraces that existed on the landscape in many different environments. Marginal farmers have developed many of these landraces over many generations and these landraces are associated with considerable TK and biocultural diversity. In order to conserve this cultural heritage there has been a recent effort to collect a large number of landrace accessions by the combined efforts of the All India Small Millets Coordinated Project (AISMCP) and ICRISAT. The International Development Research Center (IDRC) has recently funded several projects in South Asia, under its Canadian International Food Security Research Fund (CIFSRF), to document landraces of small millets and associated TK. Many of these accessions have been evaluated in the country and some were released as commercial cultivars for the highlands and lowlands. Still others have been used in supplementing the germplasm base of the international and national agricultural systems around the globe. Maloles et al. (2011) and Rengalakshmi et al. (2005) illuminated the importance of the Indian Small Millets germplasm in the world collection as it related to conservation of biocultural diversity as urged by the Convention of Biological Diversity and UNESCO's 'Man and Biosphere Programme' and the Declaration on the Rights of Indigenous People. However, in recent years, the diversity of landraces is decreasing due to reduced value within the Indian agricultural system and vulnerability due to adverse climate conditions such as recurrent drought (FAO, 2010). A changing climate has resulted in low yield of millet or even crop failure as the rain ended early in the season before flowering could occur. For these areas, it is desirable to conserve local germplasm that can mature within the range of the rainy season. Over the years, a large number of early/late-maturing millet landraces with various desirable traits have to be introduced and evaluated.

CONCLUSION

This research is part of a long-term goal for conservation and molecular characterization of millet landraces and the associated TK used in agriculture throughout Asia and Africa. Our research has revealed that considerable generic and morphological diversity exists among the landraces of small millets used within subsistence farming system in our areas of study. Local farmers have highly valuable traditional knowledge of agricultural, nutritional and ecological traits for each landrace that has sustained their communities for many generations. This is important to food security as many of these case study sites rely on

rain fed agriculture and the diversity of millets utilized allow the farmers to adapt to difficult and variable farming conditions. We suggest that this diversity should be recognized and supported through policy so that both the genetic diversity and traditional knowledge of the local farmers does not disappear.

Competing interests

The authors declare that they have no competing interests.

ACKNOWLEDGEMENTS

This research was supported by Canadian International Food Security Research Fund (CIFSRF) from the International Development Research Centre (IDRC) and the Canadian International Development Agency (CIDA), the Social Sciences and Humanities Research Council of Canada, Genome Canada through the Ontario Genomics Institute, the Canadian Foundation for Innovation. We acknowledge and give special thanks to all the indigenous small millet farmers who shared their knowledge with us. We would like to thank Drs. MVC Gowda, Manish Raizada, late Koushik Seetharan for their time-to-time and critical comments of this work.We thank Kawa Cheng for editing and journal formatting the manuscript. We are grateful to the staff members of the DHAN Foundation and AISMCP for field research, ongoing interviews with farmer's and facilitating access to plant samples are.

References:

Arunachalam, V., Rengalakshmi, R., & Kubera Raj, M. S. (2005). Ecological stability of genetic diversity among landraces of little millet (Panicum sumatrense) in south India. Genetic Resources and Crop Evolution, 52, 15–19.

Atran, S., Medin, D., & Ross, N. (2004). Evolution and devolution of knowledge: a tale of two biologies. Journal of the Royal Anthropological Institute, 10(2), 395–420.

Baghel, R. P. S., Netke, S. P., & Bajpai, L. D. (1985). Nutritive value of kangni. Poultry Guide, 22, 28–29.

Balakrishnan, V., Narayanan, M. K. R., & Kumar, N. A. (2003). Ethnotaxonomy of Dioscorea among the Kattunaikka people of Wayanad District, Kerala, India. Plant Genetic Resources Newsletter, 135, 24–32.

Bernard, H. R. (1994). Research methods in anthropology: qualitative and quantitative approaches (2nd ed.). Newbury Park: Sage Press.

Brown, C. H. (1984). Language and living things, uniformities in folk classification and naming. New Brunswick: Rutgers University Press.

Brown, C. H. (2000). Folk classification: an introduction. In Ethnobotany: a Reader (pp. 65–68). Norman: University of Oklahoma Press.

Dheaton, A., & Dreze, J. (2009). Food and nutrition facts in India: facts and interpretations. Economic & Political Weekly, 44(7), 42–65.

Dida, M. M., Wanyera, N., Harrison Dunn, M. L., Bennetzen, J. L., & Devos, K. M. (2008). Population structure and diversity in finger millet (Eleusine coracana) germplasm. Tropical Plant Biology, 1(2), 131–141.

Ellen, R. F. (2006). The categorical impulse: essays in the anthropology of classifying behaviour. New York: Berghahn Books.

Etkin, N. L. (1993). Anthropological methods in ethnopharmacology. Journal of Ethnopharmacology, 38(2-3), 93–104.

FAO. (2010). http://www.fao.org/docrep/012/k7930e/k7930e00.pdf (p. 98). Rome. Retrieved from http://www.fao.org/docrep/012/k7930e/k7930e00.pdf

Fazekas, A. J., Kuzmina, M., Newmaster, S. G., & Hollingsworth, P. . (2012). DNA barcoding methods for land plants. In W. . Kress & D. . Erickson (Eds.), DNA barcodes: methods and protocols (pp. 223–252). New York: Springer.

Felsenstein, J. (1985). Confidence limits on phylogenies : an approach using the bootstrap. Evolution, 39(4), 783–791.

Franco, M. F., & Narasimhan, D. (2012). Ethnobotany of the Kondh, Poraja, Gadaba and Bonda of the Koraput region of Odisha, India (p. 254). D.K. Printworld (P) Ltd.

Gamble, J. S. (1915). Flora of the Madras Presidency. London: West, Newman and Adlard.

Gill, G. J., Farrington, J., Anderson, E., Luttrell, C., Conway, T., Saxena, N. C., & Slater, R. (2003). Working paper 231: food security and the millennium development goal on hunger in Asia.

Gyulai, F. (2000). Preservation and use of agrobiodiversity. In A lecture dedicated to A. Jánossy (1908-1975), the founder of the Hungarian Agrobotanical Institute and Genebank, Agricultural Museum (Budapest) and the Institute of Agrobotany (tapioszele).

Hammond, P. (1992). Species inventory. In B. Groombridge (Ed.), Global biodiversity: status of the earth's living resources (pp. 17–39). London: Chapman & Hall.

Hawksworth, D. L., & Kalin-Arroyo, M. T. (1995). Magnitude and distribution of biodiversity. In Global Biodiversity Assessment (pp. 107–191). Cambridge University Press.

Hegde, P. S., & Chandra, T. S. (2005). ESR spectroscopic study reveals higher free radical quenching potential in kodo millet () compared to other millets. Food Chemistry, 92(1), 177–182.

Henry, A. N., Chithra, V., & Balakrishnan, N. P. (1987). Flora of the Tamil Nadu, India series II. Botanical Survey of India.

Henry, A. N., Chithra, V., & Balakrishnan, N. P. (1989). Flora of the Tamil Nadu, India series II. Botanical Survey of India.

Hooker, J. D. (1894). The flora of British India volume 6. Ashford, England: L. Reeve & Co. Ltd.

Khanuja, S. P., Shasany, A. K., Darokar, M. P., & Kumar, S. (1999). Rapid isolation of DNA from dry and fresh samples of plants producing large amounts of secondary metabolites and essential oils. Plant Molecular Biology Reporter, 17, 74.

Kumar, P., Mruthyunjaya, M. M., & Dey, M. M. (2007). Long-term changes in Indian food basket and nutrition. Economic and Political Weekly, 42(35), 3567–3572.

Lal, L., & Lal, R. (2004). Sustainable agriculture and the international rice-wheat system. Sustainable Agriculture and the International Rice-Wheat System (p. 450). New York: Marcel Dekker.

Maloles, J. R., Berg, K., Ragupathy, S., Nirmala, B. C., Althaf, K. A., Palanisamy, V. C., & Newmaster, S. G. (2011). The fine scale ethnotaxa classification of millets in southern India. Journal of Ethnobiology, 31(2), 262–287.

May, R. M. (2014). Many Species Are There on Earth ? Science, 241(4872), 1441–1449.

Nair, N. C., & Henry, A. N. (1983). Flora of the Tamil Nadu, India series I. Botanical Survey of India.

Newmaster, S. G., Fazekas, A. J., & Ragupathy, S. (2006). DNA barcoding in land plants: evaluation of rbcL in a multigene tiered approach. Canadian Journal Of Botany-Revue Canadienne De Botanique, 84(3), 335–341.

Newmaster, S. G., Ragupathy, S., Dhivya, S., Jijo, C. J., Sathishkumar, R., & Patel, K. (2013). Genomic valorization of the fine scale classification of small millet landraces in southern India. Genome / National Research Council Canada = Génome / Conseil National de Recherches Canada, 56(2), 123–7.

Newmaster, S. G., Ragupathy, S., Ivanoff, R. F., & Nirmala, C. B. (2006). Mechanisms of ethnobiological classifications. Ethnobotany, 18, 4–26.

Newmaster, S. G., Subramanyam, R., Balasubramaniyam, N. C., & Ivanoff, R. F. (2007). The multi-mechanistic taxonomy of the Irulas in Tamil Nadu, South India. Journal of Ethnobiology, 27(2), 233–255.

Ohmagari, K., & Berkes, F. (1997). Transmission of indigenous knowledge and bush skills among the Western James Bay Cree women of subarctic Canada. Human Ecology, 25(2), 197–222.

Oldfield, M. (1990). Summary of the discussion. In G. H. Orians, G. M. Brown, W. E. Kunin, & J. E. Swierzbinski (Eds.), The Preservation and Valuation of Biological Resources (pp. 89–94). Seattle: University of Washington Press.

Paradis, E., Claude, J., & Strimmer, K. (2004). APE: Analyses of phylogenetics and evolution in R language. Bioinformatics, 20(2), 289–290.

Pelto, P. J., & Pelto, G. H. (1990). Field methods in medical anthropology. In T. Johnson & C. Sargent (Eds.), Medical Anthropology: A Handbook of Theory and Methods (pp. 269–297). New York: Greenwood Press.

Ragupathy, S., S. Dhivya, A. Sritharan, K. Sambandan, R. Sathishkumar, A. Nirmalakumari, K. Khadka, H. Gartaula, K. Pateland S. G. Newmaster. 2014. DNA Barcoding of Traditional Minor Millet Landraces for the Protection of Plant Varieties and Farmer's Rights (PPVFR) in India & Nepal, Southeast Asia. Journal Ethnobiology and Ethnomedicine (in preparation)

Ramsey, F. ., & Schafer, D. . (1997). The statistical sleuth: a course in methods of data analysis. Belmont, NY: Duxbury Press.

Rohlf, F. (2000). NTSYS. Numerical taxonomy and multivariate analysis system. New York: Exeter Software.

Ronquist, F., & Huelsenbeck, J. P. (2003). MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics, 19(12), 1572–1574.

Seetharam, A., Patel, D. ., & Halaswamy, B. . (2006). Small millets. In B. . Dhillon, S. Saxena, A. Agrawal, & R. . Tyagi (Eds.), Plant genetic resources: foodgrain crops (pp. 204–222). New Delhi: Narosa Publishing House.

Seetharam, B., Bakke, J. E., & Alpers, D. H. (1983). Binding of intrinsic factor to ileal brush border membrane in the rat. Biochemical and Biophysical Research Communications, 115(1), 238–244.

Sneath, P. H. ., & Sokal, R. . (1973). Numerical taxonomy: the principles and practice of numerical classification (p. 588). San Francisco: W.H. Freeman & Co.

SPSS. (1999). Professional base system software for statistical analysis. Chicago: SPSS Inc.

Stepp, J. R., & Thomas, M. (2005). Managing ethnopharmacological data: herbaria, relational database, literature. In N. L. Etkin & E. E (Eds.), Ethnopharmacology: Encyclopedia of Life Support (pp. 96–102). Oxford: UNESCO.

Swofford, D. L. (1998). PAUP: Phylogenetic analysis using parsimony (and other methods). Sunderland, Massachusetts: Sinauer Associates.

Tamura, K., Peterson, D., Peterson, N., Stecher, G., Nei, M., & Kumar, S. (2011). MEGA5: molecular evolutionary genetics analysis using maximum likelihood, evolutionary distance, and maximum parsimony methods. Molecular Biology and Evolution, 28(10), 2731–2739.

Ter Braak, C., & Smilauer, P. (1998). CANOCO reference manual and user's guide to Canoco for Windows – software for canonical community ordination. Ithaca, NY: Microcomputer Power.

Teshome, A., Baum, B. R., Fahrig, L., Torrance, J. K., Arnason, T. J., & Lambert, J. D. (1997). Sorghum [Sorghum bicolor (L .) Moench] landrace variation and classification in North Shewa and South Welo , Ethiopia. *Euphytica*, *97*, 255–263.

Thompson, J. D., Higgins, D. G., & Gibson, T. J. (1994). CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research*, *22*(22), 4673–4680.

Upadhyaya, H. D., Pundir, R. P. S., Gowda, C. L. L., Gopal Reddy, V., & Singh, S. (2009). Establishing a core collection of foxtail millet to enhance the utilization of germplasm of an underutilized crop. *Plant Genetic Resources*, *7*(2), 177–184.

Vogl, C. R., Vogl-Lukasser, B., & Puri, R. K. (2004). Tools and methods for data collection in ethnobotanical studies of homegardens. *Field Methods*, *16*(3), 285–306.

Weber, S. A., & Fuller, D. Q. (2008). Millets and their role in early agriculture. *Pragdhara*, *18*, 69–90.

Ziegler, J. (2006). *Report of the special rapporteur on the right to food*. *United Nations Human Rights* (p. 24). Retrieved from http://www.righttofood.org/new/PDF/India PDF.pdf

5

FARMERS' SEED NETWORKS AND AGRO BIODIVERSITY CONSERVATION FOR SUSTAINABLE FOOD SECURITY: A CASE FROM THE MID-HILLS OF NEPAL

Rachana Devkota
Kamal Khadka
Hom Gartaula
Asis Shrestha
Deepak Upadhya
Pashupati Chaudhary
Kirit Patel

ABSTRACT

This paper evaluates the nature and functioning of seed networks for rice, maize and finger millet, and explores the effect of such networks on agrobiodiversity conservation and food security. Using snowball sampling, ninety-five farmers from the Dhikurpokhari Village Development Committee in Kaski district, a representative site for western mid-hills of Nepal, were interviewed. Data were collected through semi-structured interviews, focus group discussions and field observations. Social network analysis tools and maps, with the help of Net Draw software, were used to examine the status of the network and identify the key nodal and connector farmers. It was revealed that there is a loose network of seed exchange in the community, varying according to crop. While nodal farmers play a more pivotal role than other farmers in seed exchange, only marginal differences were found in the characteristics of nodal and non-nodal farmers, apart from their age and education. More than 90% of farmers had saved seeds of maize and finger millet on their own, mainly local varieties, while only 70% of farmers had saved rice seed. Farmers' practices of saving seed at home, limited varietal options in locality, a declining interest in agriculture, rural-to-urban migration and thence scarcity of labour have all contributed to a reduction in the exchange of seed. This in turn has affected the on-farm conservation of agrobiodiversity and food security at the local level.

Keywords: **Seed network, Connectors, Nodal farmers, Agrobiodiversity, Conservation and Food security**

The world's population is expected to exceed nine billion after 2050. In order to feed this growing population and attain sustainable food security, the conservation and management of agrobiodiversity is crucial (Pautasso et al., 2013). Despite a number of conservation efforts, in many regions agrobiodiversity is under severe threat (Lotti, 2010; Shen et al., 2010; Engels et al., 2011). The world relies on only 82 crop species for 90% of the energy needed for human consumption (Prescott-Allen and Prescott-Allen, 1990). From the perspective of agrobiodiversity management, the sustainability of in situ conservation is critically dependant on the nature of seed systems, which influences the adaptability of crops (Thomas et al., 2011). The farmers in Nepal have maintained a system of seed flow within and between communities, which constitutes the informal seed system (Subedi et al., 2004; Baniya et al., 2005; Baniya et al., 1999). Such an informal seed system is created through the

interpersonal relationships of individuals in the community, a process shaped by the wider social, cultural and economic structures (Subedi et al., 2003). Farmers' seed supply is a complex and dynamic system of interrelated activities and components, which can be compared to the principal components of a formal seed system: breeding, seed production and distribution (Almekinders et al., 1994). The degree of access to seed and plant materials indicates the seed system of a community and gives a broad picture of the conservation threats or opportunities of local crop biodiversity.

In developing countries like Nepal, a large spectrum of traditional farming practices related to the exchange of seeds still exists, shaping the varietal and genetic diversity in a dynamic way. Nepalese farmers mainly depend on informal seed systems to meet their seed demand and farmers in remote regions likely save seeds, as they do not have access to other seed sources. They exchange seeds among themselves and form networks based on the type of crop, socio cultural setting, economic context and individual preference. These farmers' seed networks can be considered a building block of an informal or a local seed system, play a significant role in the flow of seeds and other planting materials, which consequently contributes to on-farm agrobiodiversity, food security and evolutionary change in the agroecosystems (Subedi et al., 2003). In other words, farmers' seed networks lead to a greater crop diversity, which not only contributes to their economic resilience and control over genetic materials, but also offers a sustainable solution to food and nutrition security through creation of dietary diversity (Pellegrini and Tasciotti, 2014).

It is clear that the actors and methods as well as the degree, nature and process of seed exchange are entirely crop-specific; however, to date the research associated with these issues has been limited to major crops such as rice, wheat and maize (LI-BIRD, 2012). Despite playing an important role in biodiversity conservation and people's food and nutrition security, traditional crops like finger millet have not received enough attention in the research and policy arena (Padulosi et al., 2009). Based on a study carried out in the mid-hills of Nepal, this paper identifies seed networks for finger millet, rice and maize; analyses the farmers' seed system using social network analysis tools and maps; identifies the nodal farmers, assessing their key characteristics along with their contribution to maintaining balance in the local seed system, and identifies the link between seed exchange and agrobiodiversity conservation for sustainable food security. The findings offer researchers and policymakers an improved understanding of the importance of seed and its networks for identifying areas for seed sovereignty, maintaining agrobiodiversity, and contributing to a sustainable solution for food security in the area.

LITERATURE REVIEW

Agrobiodiversity refers to the diversity of agricultural systems, from genes to varieties and species and from farming practices to landscape composition. This diversity is maintained through a range of formal and informal networks of seed and planting materials, and is governed by the social, cultural, political, economic and technological factors of a particular geographical territory (Pautasso et al., 2013). Calvet et al. (2012) report that informal networks of seed exchange can play an important role in maintaining agrobiodiversity, underlining the link between seed exchange and the in situ agrobiodiversity conservation of home gardens. Another assertion is that seeds and knowledge are transmitted together (Vogl and Vogl-Lukasser, 2003; cf. Calvet et al., 2012), which directly contributes to the conservation of genetic material along with the associated knowledge.

While farmers preserve agrobiodiversity both by saving seeds and exchanging them with neighbours, friends and relatives, conservation is not necessarily their intended goal (Pautasso et al., 2012). They often do this as part of their usual livelihood practice, through their social networks – the interpersonal relationships among a set of persons connected through the flow of information or goods and materials, or through joint activities or other social bonds (Subedi et al., 2003). Thus, the exchange of seeds and planting materials is an element of the social networks that are part of peoples' everyday practices.

However, the knowledge possessed by the farmers through their years of experience is not well valued or acknowledged. Studying the contribution of seed networks to the maintenance of local crop varieties only makes sense if the scientific community recognizes the conservation of agrobiodiversity as one of its fundamental goals.

INFORMAL SEED SYSTEMS AND FARMERS' SEED NETWORKS

Seed is the carrier of genetic diversity and one of the most important inputs for agriculture. It is critical for agricultural change, technology transfer and technological development (Louwaars and Engels, 2008; Neate and Guei, 2010). The access and availability of seed determines the food security for a country (McGuire and Sperling, 2011). Thus, studying seed systems is important not only to understand farmers' access to planting materials, but also to understand the overall state of agriculture and agricultural biodiversity in a particular region. Generally, there are two types of seed systems: formal and informal. In a formal seed system the components, including breeding, management, replacement and distribution of seed, are regulated by public sector; in an informal seed system (also called a traditional seed system) these components are managed by farmers using their own knowledge and capacity (Almekinders, 2001; Thiele, 1999).

In classical terms, formal seed supply systems are characterized by a vertically organized production and distribution of tested seed and released varieties through public and private organizations, using strict quality control. Even though these are operated in the developing countries, but basically copied from seed companies of the developed countries. In the case of an informal seed system, however, the use of seed is integrated within the agronomic and socio cultural practices of the farming community. In most developing countries, the informal seed system is the major source of seed for farming communities (Almekinders et al., 1994; Thiele, 1999; Baniya et al., 2005; Pray et al., 2001), with smallholders relying on it for 75 to 90% of their food crop cultivation (Gill et al., 2013). Informal seed systems form an integral part of diversity management for farmers in developing countries where farmers get seed materials from diverse sources, including their own farm-saved seed, and through exchanges with their relatives and neighbours (Shrestha, 1998; Louwaars and Engels, 2008). Informal seed systems are flexible, dynamic and managed by farmers themselves (Ravinder et al. 2007). They are usually made up of multiple components such as farmers' self-saved seed, farmer-to-farmer seed exchange, informal seed storage and the conservation of knowledge base surrounding the local seed system (Gill et al., 2013).

In an informal system, farmers maintain and conserve crop varieties through their own selection process, based on environmental suitability and preferences. Their knowledge and cultural practices are crucial for decision-making, which in turn provides space for maintaining farmers' networks of seed exchange (Balemie and Singh, 2012). In Nepal, the informal seed system is the most prevalent system, utilizing and managing both landraces and

modern varieties with better information on local production environments, user needs and preferences as compared to formal seed systems (Joshi, 2001). The small farmers have established a pattern of seed saving and exchange based on the availability of and access to seed and planting materials of various crops. Seed exchange is more frequent and important between poor households; while it is less significant between poor and rich households (Gill et al., 2013; Almekinders et al., 1994), indicating the critical role of social ties in seed saving and exchange (McGuire, 2008). Exchange of seeds among farmers provides them with the opportunity to connect to different networks. The networks of seed exchange often differ based on the type of crop, sociocultural settings, economic contexts and personal preferences.

THE FARMER'S ROLE IN AGROBIODIVERSITY CONSERVATION

Numerous crop species in the world are underutilized or overlooked by the mainstream research and development initiatives, yet individual farmers save diverse and useful varieties informally for their own use. Farmers use the diversity of seeds and other resources available from their surroundings for home consumption, medicinal purposes, income generation, landscape management and so on (Kahane et al., 2013; Uniyal and Vandana, 2005), which directly or indirectly contributes to conservation of the crop species. Jarvis et al. (2011) state possible reasons and options for agrobiodiversity conservation, while Shen et al. (2010) indicate a significant threat to the loss of agrobiodiversity in China despite a number of efforts already in place.

Farmers and farming communities play a significant role in the preservation and conservation of agrobiodiversity and ecosystem (UNEP, 2008; FAO, 2011); thus, discussions on sustainable livelihoods mostly revolve around farmers, agrobiodiversity and agroecosystem management. Most of the agricultural crops and varieties have been conserved as a result of farmers' efforts and could have been lost if farmers did not cultivate, save or exchange seeds. The practice of seed saving or exchange adopted by farmers over the years is likely to be the key to management of crop diversity, which is now at a point of being lost from the agroecosystem (Serpolay et al., 2011). However, farmers' knowledge and practices related to seed materials can be useful for formulating strategies for conservation of agrobiodiversity (Baniya et al., 2005).

The adoption and cultivation of the varieties of various crops differ based on household characteristics, endowments and ease of access to agricultural extension, which directly affect farmers' valuations of crop variety traits (Asrat et al., 2009). In the majority of developing countries, the public sector is more inclined towards establishing and strengthening the formal system of seed production and distribution (Louwaars, 2013). In this context, empowering farmers to maintain genetic integrity for improved seed systems through farmer-harvested seeds in local areas needs to be emphasized, in order to promote sustainable agrobiodiversity conservation.

AGROBIODIVERSITY CONSERVATION AND FOOD SECURITY

The biological components that constitute agrobiodiversity – crops, livestock, fish, and the interacting species of pollinators, predators and competitors – are also the basis for food and nutrition security. Both cultivated and wild relatives of crops provide human beings with genetic resources for food and agriculture (Jackson and Ford-Lloyd, 1990). In fact, the global food supply rests essentially on the biological diversity developed and nurtured by indigenous communities and farming communities located in the centres of origin and

diversity of genetic resources (Sundar, 2011). Food and nutrition security exists when all people at all times have physical, social and economic access to food that is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life (FAO, 2011). However, this definition lacks a discussion on the social control of the food system where producers' freedom to choose own crop and seed, maintaining (agro)biodiversity for sustainable production and empowerment of producers to control the local food market are the necessary condition for a long-term food security as envisioned by the food sovereignty movement (Patel, 2009). In this perspective, agrobiodiversity and locally controlled seed system (also called seed sovereignty) are the important components of food and nutrition security (Kloppenburg, 2010). Agrobiodiversity contributes to farming system resilience, maintaining nutritional balance, improving income and balancing ecosystem services in farms such as pollination, fertility and nutrient enhancement, insect and disease management and water retention (Thrupp, 2000).

Food security is influenced by a number of socioeconomic variables such as income, gathering of wild foods, community support, assets and migration (Sen, 1981). It is also negatively influenced by pest and disease infestation causing significant declines in crop yields. Pimental et al. (1997) report that pests reduce global crop yields by about 40% each year. Due to the homogenization of crops, species, landscapes and farming systems encouraged by green revolution technologies, crops are increasingly vulnerable to pest and diseases (Oerke, 2006). Frison et al. (2011) reveal that the use of both inter- and intra-species diversity enhances resistance to outbreaks of pest and diseases and thus is an effective mechanism for increasing yield and food security.

In this context, agrobiodiversity is valuable for scientific and technological advancements in crop production. Starting in the late nineteenth and early twentieth centuries, scientists who recognized the value of diverse crop varieties discovered plant breeding methods that boosted crop productivity. The innovative use of plant genetic resources has continued to be important for scientific advances in plant and livestock breeding and seed improvements up to the present day (Thrupp, 2000). Thus, increase in crop productivity is directly or indirectly linked to crop diversity. Frison et al. (2011) report that adopting diversity could increase productivity more effectively than only stressing a higher management intensity. A study by Zhang and Li (2003) reveals that wheat shows a 74% yield increase when intercropped with maize and a 53% increased when intercropped with soybean, which relates to the diversity of crops at the species level.

RESEARCH METHODOLOGY

This study was part of an action research project named "Revalorizing Small Millets in Rainfed Regions of South Asia (RESMISA)," implemented between 2011 and 2014 by Local Initiatives for Biodiversity, Research and Development (LI-BIRD), Nepal, together with other Canadian and South Asian partners[2]. Data for the seed network study were collected from the Dhikurpokhari Village Development Committee (VDC),[3] one of the

[2] Financial support for the project came from the International Development Research Centre (IDRC) and the Department of Foreign Affairs, Trade and Development (DFATD) of Canada, under the Canadian International Food Security Research Fund (CIFSRF) program.

[3] A village development committee (VDC) in Nepal is the lower administrative part of the local development ministry. Each district has several VDCs, similar to municipalities but with greater public-government

working sites of the RESMISA project. This VDC is located in the Western Development Region, about 25 kilometres west of Pokhara city in Nepal (Figure 1).

Figure 1: Map of Nepal showing the research location.

The altitude of the research area ranges from 841 to 2,074 meters above sea level. It is densely populated, with a total population of 8,081 and average household size of 4.8. The literacy rate in Dhikurpokhari is 64% (DDC Kaski, 2010). This VDC area is characterized by rain-fed farming with a maize-millet cropping system at the higher elevations, and a rice-based cropping system at the lower elevations made possible by irrigation water from small streams during the rainy season. The VDC is located in the western mid-hills of Nepal. The community is characterized by ethnic diversity, and rural-urban migration is an integral part of people's livelihood. While traditional agriculture is the common practice in the area, this is changing over time due to increased road access, market infrastructure and other developments in the area. The study team assumed that these changes have influenced the traditional (or informal) seed system used by farmers, and that in the long run this will affect food security and agrobiodiversity conservation in the area. The site was selected for the seed network study with the objective of identifying the key nodal farmers and the primary seed flow system, and introducing the project's major intervention of strengthening the local seed

interaction and administration. There are 3,915 village development committees in Nepal. A VDC is further divided into wards; the number depends on the population of the district: the average is nine wards.

system. Based on their geographic and socioeconomic similarities, three adjoining villages within the VDC were selected for the study.

RESEARCH DESIGN, DATA COLLECTION AND ANALYSIS

This study was conducted from August to December of 2012. Two major cereal crops, rice and maize, and a minor cereal crop, finger millet, were used to compare farmer networks for major and minor cereals. The research team used semi-structured interviews, focus group discussions and field observations to collect primary data. Using snowball sampling, a total of 95 respondents (36% male, 64% female) were selected from the three villages, using information collected for baseline survey for the RESMISA project. At the first stage, 90 respondents – 30 from each village – were selected for the study. The first round of data analysis showed that five key connectors, or nodal farmers, were missing in the earlier data collection list. To include them, a second round of data were collected from these purposively selected additional five respondents. All respondents were stratified on the basis of a well-being ranking, defined by the farmer groups who participated in a focus group discussion organized for this purpose (Table 1). Productive landholding, total household income and food sufficiency month per household were used to classify respondents into rich, medium and poor groups.

Table 1: Distribution of sample respondents

Village	Number of respondents			Total
	A	B	C	
Dhikurpokhari-5	12	15	16	43
Dhikurpokhari-6	10	11	10	31
Dhikurpokhari-7	7	10	4	21

A = rich well-being; B = medium well-being; C = poor well-being

Data was entered and coded in a spreadsheet and into VNA format, and the data analysed using NetDraw (version 2.087) computer software. For purposes of the analysis, farmers were considered as node data and their characteristics such as sex, ethnicity, occupation and wealth category as node properties. The means of seed flow such as exchange, gift, purchase among farmers and the crop varieties in transaction were used as tie data. Degree and betweenness centrality were computed for identification of nodal farmers and their networking. Centrality values were used to generate the network maps.

Both parametric and non-parametric statistics were employed to analyse the relationship and effects of gender, education, age, ethnicity, occupation and wealth characteristics on nodal and non-nodal farmers. The data on age is numeric in nature and a parametric test was used, while an independent t-test was used to determine if a statistical difference exists between nodal and non-nodal farmers by age. The null hypothesis for this is "There is no significant difference in age between nodal and non-nodal farmers"; the alternative hypothesis is "There is significant difference in age between nodal and non-nodal farmers."

Data on gender, occupation, education, ethnicity and wealth were of a categorical nature. Thus, the relationships between nodal and non-nodal farmers were assessed through a Chi-square test. The underlying null hypothesis is "Farmer type (nodal or non-nodal) is

independent of gender, occupation, education, ethnicity and wealth"; the alternative hypothesis is "Farmer type is dependent on gender, occupation, education, ethnicity and wealth." Those categorical variables that showed a significant relationship with farmer type, were further tested using a column proportionate and Z-proportionate test. **Analytical approach: centrality theory**

The literature shows that local seed systems can be explored through a network analysis approach that allows for both visual and mathematical analysis of human relationships (Jamali and Abolhassani, 2006). This can be done by mapping the associations among or between farmers for the sharing or exchange of seeds (Poudel et al., 2006; Subedi et al., 2003). Social seed networks vary due to a multitude of factors: networks may be loose or closed, depending on the type of crop and access to seed sources. Various sociocultural and economic factors influence exchange or sharing of seed, which critically defines the type of seed network for a particular location or community.

Thus, for an analytical approach we used the centrality theory. In this theory, three different centrality measures – degree centrality, betweenness centrality, and harmonic closeness centrality – are computed to locate the position of farmers in the social network (Poudel et al., 2006). In this paper, we have considered only degree centrality and betweenness centrality. Degree centrality measures the number of direct connectedness of an individual farmer with other farmers in the network where a high degree centrality means many direct connections with other network members (Wasserman and Faust, 1994). In the seed network analysis, numerous nodes (representing farmers) and ties (links) appear. Those nodes that have a higher number of ties than others are considered nodal farmers. In other words, farmers in the network having a high degree of centrality or a greater number of direct connections or links are considered nodal farmers (Poudel et al., 2006).

Betweenness centrality measures the relationship of a farmer with other members in terms of the position he or she occupies to control the flow of seed or information within the network. This measure is used to identify a connector farmer in the network. It also explains the interaction between two farmers who are not connected directly but are linked indirectly through a third farmer. Connector farmers are also sometime referred to as bridging farmers, as they bridge two sub-networks. Farmers having a high betweenness centrality value occupy the central position in the social seed network map. These farmers may not be directly connected to many other farmers in the network, as nodal farmers are, but by playing a connector role by linking two or more sub-networks, they help maintain the long chain of the seed system (Wasserman and Faust, 1994). Their significance lies in how strongly they can bridge the two sub-groups. Such farmers are potentially critical to the network; that is, they could be the point of failure for the social seed network if they discontinue farming, migrate elsewhere or die.

RESULTS AND DISCUSSION

Socioeconomic characteristics of sample households

The average household size of the sample group was calculated as six. In terms of ethnic distribution, 52% respondents were from Brahmin/Chhetri group, 38% were Janajati and the remaining 10% were Dalit. By religion, the majority were Hindus (96%). The literacy rate was found to be 63%: higher in males (75%) than females (51%). The average landholding size of the respondent households was calculated as 1.24 acre, which is less than

the national average of 1.75 acre (CBS, 2011). The majority of earning members (74%) were engaged in agriculture as their major occupation. Labour out-migration was common in the area, where members of the households migrated within and outside the village, district and outside the country. Out of 95 sample households, 42% had one migrant and 52% had two or more migrant members going out for job and study purposes. The remaining 6% did not have any existing migrant members.

Cropping pattern and food self-sufficiency in the study area

The study site is mainly upland, called *bari* in the local language, and agriculture is completely rainfed. The major crops grown are maize, finger millet, wheat and mustard; farmers also cultivate pumpkin, cowpea and soybean as mixed crops with maize. Farmers commonly cultivate finger millet as a relay crop with maize. Similarly, cowpea, blackgram, horsegram and soybean are grown as mixed crops with finger millet, and wheat, mustard and buckwheat are grown after harvesting finger millet. The cropping pattern of the study sites is summarized in Table 2. The cropping pattern also influences the seed exchange habits of farmers. Farmers do not have alternatives to maize and finger millet during the season when these crops are grown. If the farmers abandon either of these two cereal crops, there is a greater probability that the land will remain fallow. Due to labour shortage and tedious cultivation practices, some farmers will leave their land fallow after maize harvesting. In general, farmers do not want to keep the land fallow, but if they were forced to do so, they would leave out finger millet and continue to grow maize. According to the participants of a focus group discussion, maize is preferred because of its easy cultivation practices and as compared to the tedious cultivation practices for finger millet. Further, the cost of production is high for finger millet and its consumption is less than that of maize.

Table 2: The cropping pattern (crop combinations) observed in the area

SN	**Crop combination**
1	Maize – Fallow
2	Maize + Pumpkin – Finger millet + Blackgram
3	Maize – Finger millet + Horsegram/Ricebean
4	Maize + Pumpkin – Finger millet – Wheat + Pea/Blackgram
5	Maize + Pumpkin – Finger millet + Soybean
6	Maize + Pumpkin – Finger millet – Mustard
7	Maize + Cowpea – Finger millet + Cowpea – Wheat/Mustard
8	Maize + Soybean – Finger millet – Mustard
9	Maize – Finger millet + Blackgram – Wheat/ Buckwheat

Source: LI-BIRD, 2012

The combination and availability of crops grown in the area are important factors for accessing seed, which has implications for a household's food self-sufficiency and ultimately its food and nutrition security. The RESMISA baseline report shows that about 13% of households did not have all three meals in a day during the previous year (LI-BIRD, 2012). The focus group participants indicated that though local crop varieties are rich in nutrient content and have a greater socio cultural value compared to the high yielding and improved varieties, the latter are preferred over local varieties if easily available. Moreover, rural-urban migration and the consequent declining interest in agriculture, labour scarcity and high wages rate have forced farmers to grow a limited range crops with a focus on economic rather than socio cultural value. This has resulted in the loss of local varieties and associated knowledge,

along with less diversified food availability in the long run. If the diversity of crops is limited, the supply of nutritionally diverse food is also limited in the community. These points are to the importance of biodiversity conservation for sustainable food security. Pautasso (2014) indicates that as part of humanity's cultural heritage, the conservation of agrobiodiversity is important for many reasons, and is essential to avoid yield losses due to pests and diseases. It is also an important resource for adapting to climate change (Bellon et al., 2006).

Crop and varietal diversity and seed flow mechanism at the local level

The comparison of seed flow networks for major and minor cereals in this study is deliberate. No new finger millet varieties have been released or registered in Nepal for more than two decades (Dalle-1, and Okhle-1 were released in 1980, while Kabre Kodo-1 was released in 1990 [NARC, 2005]). Study results showed that among the finger millet growing households, 97% grow local varieties. In the case of maize, the majority of sample households (91%) grow released varieties. Maize varieties released many years ago (such as Manakamana 1, released in 1987 [SQCC, 2012]), are considered local by the farmers, since farmers have been growing the same variety for a long time and the variety has been well adapted to local conditions. The farmers are saving or exchanging seed of these varieties locally. With respect to rice, more than 90% households grow local varieties. Available varieties of these crops along with number of households and average area and source of seed are presented in Tables 3a (rice), 3b (maize) and 3c (finger millet). One reason that farmers mostly grow local varieties could be that there are very few new varieties released for the mid-hills and high altitude areas.

Table 3a: Varietal details of rice.

Name of varieties	Number of households (HHs)	Average Area per HH (ha)	Seed Source
KaloPatle	25	0.26	88% own source
Marsi	20	0.20	70% own source
Juwari	10	0.30	70% own source
DeupareJuwari	3	0.46	100% own source
DhampuseJuwari	1	0.05	100% own source
JharuwaKathe	12	0.28	58.3% neighbours
JhinuwaKathe	1	0.10	100% neighbours
DeupareKathe	14	0.31	64.3% own source
Kathe	8	0.26	62.5% own source
LumleKathe	4	0.38	50% own and 50% neighbours
KhariKathe	1	0.31	100% own source
Silange	13	0.31	69.2% own source
Bagali	3	0.17	66.7% neighbours
Bayeli	2	0.20	100% own sources
Jethobudo	3	0.24	100% own source
Anadi	1	0.05	100% own source
Bhalu	1	0.10	100% own source
Thakkhole	1	0.41	100% own source
Rato	1	0.10	100% neighbours
JeeraMasino	2	0.20	50% own and 50% neighbours
Chhhomrong Local	16	0.15	75% own source
Machhapuchhre-9	1	0.20	100% own source
**Khumal-4*	6	0.17	50% own source
**Machhapuchhre-3*	11	0.16	45.5% own source
Lumle-2	7	0.15	57.1% neighbours

** indicates released variety; others are local.*

Table 3b: Varietal details of maize

Name of varieties	Number of households	Area coverage (Ropani/HH)	Seed source
**Mankamana 1*	58	2.7	91.5% own source
**Ganesh 2*	16	2.1	81.2% own source
**Manakamana 3*	2	2.3	50% GOs and 50% NGOs
**Khumal Pahelo*	23	2.3	87% own source
Bhalu Maize	2	6.0	100% own source
Local Seto Maize	1	4.0	100% neighbours
Sano Maize	1	4.0	100% own source

** indicates released variety; others are local.*

Table 3c: Varietal details of finger millet

Name of varieties	Number of households	Area coverage (Ropani/household)	Seed source
Kalo Urchho	4	2.8	100% own source
Urchho	4	1.9	100% own source
Thulo Urchho	3	3.7	100% own source
Musure	6	2.8	100% own source
Kalo Musure	2	1.5	100% own source
Kalo Ghude	43	2.6	95.3% own source
Mangsire	21	2.1	95% own source
MangsireDalle	5	2.8	100% own source
MangsireSeto	1	4.0	100% own source
Kartike	1	4.0	100% own source
SetoDalle	5	2.5	80% own source
Oralle	2	1.5	100% own source
Jhaype	2	0.5	100% own source
Bhalu	2	1.0	100% own source
**Dalle 1*	1	2.0	100% own source
**Okhle 1*	3	1.8	100% own source

** indicates released variety; others are local.*

Table 4 shows that the most common means of seed flow on the whole is by the exchange of seeds with seeds/grains, which accounts for 42%, followed by purchase (37%) and gift (22%). The seed flow was also analysed separately for rice, maize and finger millet. The major means of seed flow in finger millet was found to be the exchange of seeds with seeds/grains. Seeds received as a gift from relatives or neighbours almost one-third, while only 16% of the finger millet seed was purchased in the community. It was also revealed that there is very loose seed network for finger millet in the community. Similarly, analysis of seed flow for rice showed that majority of farmers purchased the seeds, while 39% exchanged with others. In the case of maize, about 35% of farmers purchased seeds, another 35% exchanged seeds, and the remaining 30% received or shared seeds in the form of a gift.

Table 4: Means of seed exchange within the seed network (%)

Crops	Means of seed exchange		
	Exchange/barter	As gift	Purchase
Rice	39	14	44
Maize	35	30	35
Finger millet	52	32	16
Total	42	22	37

The study showed that there is less exchange of seed among farmers within and outside the village in the area. This may be due to the fact that most of the farmers in the study area grow local varieties (94%) of rice, maize and finger millet, and they typically save seeds (89%) at home for their needs. For rice, there is a greater number of nodal farmers and somewhat larger network as compared to maize and finger millet. This is because rice has more varietal options than the other crops.

NODAL FARMERS AND THEIR CHARACTERISTICS

Using the computation of Net Draw, farmers who play an important role in the informal seed systems and management of agrobiodiversity on farms in the community can be traced. These farmers can play a nodal or a connecting role. The results of the overall analysis using the degree centrality measure showed that 16 out of 95 farmers were directly linked with another three to six members in the network. These 16 are called the nodal farmers. Among the nodal farmers, only one female farmer was linked with other six farmers. Similarly, five farmers were linked with another four farmers and nine were linked with three farmers for the exchange of rice, maize and finger millet seed in the community. Out of 16 nodal farmers, eight were male and eight were female. These nodal farmers had a high degree centrality, or more direct connections or links with other network members than did other farmers (Poudel et al., 2006; Wasserman and Faust, 1994).

The major farmers occupying the central positions in the study – that is, the connector farmers – are indicated in Table 5. Most of these farmers are both nodal and bridging farmers; very few in the network are either nodal or bridging farmers alone. The farmers with high degree centrality scores identified as nodal farmers are often more likely to be leaders, key conduits of information, and more likely to be early adopters of anything transmitted via the network. High degree centrality individuals tend to be important influencers within their local network community. They may not be public figures to the entire network, but they are often respected locally and they occupy short paths for spreading information within their network community. A farmer with a high degree centrality may not have high betweenness centrality, or vice versa. Therefore, farmers need to be characterized as nodes, connectors, or combinations of both. Understanding farmers' roles in the community will help to identify the intervention or approach that can be employed efficiently and effectively for conservation, breeding or purely seed interventions (Abay et al., 2011). Social seed network analysis provides such details, and farmers can be approached strategically for various purposes. Understanding a farmer's position in the seed network can be useful for the design of interventions or strategies targeting conservation, participatory crop improvement, variety and seed dissemination, and seed business development at local level.

Table 5: Centrality values of the farmers in overall seed network study

SN	Respondent No	Degree centrality	Betweenness centrality	Position in network*
1	7	6	20	NC
2	25	5	66	NC
3	58	4	29	NC
4	51	4	29	NC
5	12	4	69	NC
6	83	4	24	NC
7	8	4	49	NC
8	23	3	25	NC
9	48	3	17	NC
10	28	3	15	NC
11	78	3		N
12	3	3	17	NC
13	60	3		N
14	5	3		N
15	85	3		N
16	87	3		N

**N= nodal farmer; C = connector farmer; NC = both nodal and connector farmer*

Table 6 shows that the nodal farmers' mean age is significantly higher (54) than the non-nodal farmers' (46). On the whole, the study suggests that age and education are important factors in becoming a nodal farmer, while other factors such as gender, ethnicity, wealth category and occupation play no distinct role. Age and education are considered important drivers of food security. It is revealed that relatively older and highly educated nodal farmers seem to be more food secure compared to the younger and less educated nodal farmers. Turyahabwe et al. (2013) also observe that households in Uganda headed by older and highly educated individuals are significantly more food secure than households with heads of lower age and education levels.

Table 6: Age-wise comparison between nodal and non-nodal farmers

	Nodal farmers	**Non-nodal farmers**	**p value (sig. 2 tailed)**
Average age	54	46	0.003
Relationship between type of farmers and their characters			

Type of farmer (Nodal and non-nodal farmer)	Gender	Occupation	Education	Ethnicity	Wealth
Chi-square	0.393	0.574	4.169	2.012	3.060
Degree of freedom	1	1	1	1	2
Sig.	0.531	0. 449	0.041	0.156	.217

Z-Proportion test between type of farmers and education

Type of education	Type of farmer	
	Non-Nodal (%)	Nodal (%)
Literate[4] (p)	15.9	34.5
Illiterate (q)	84.1	65.5
Z=2.09; p=0.04		

Seed network mapping

Figure 2 indicates the network mapping in terms of degree centrality. In the figure, different colours represent different entities: red is for females, black for males and blue for unknown. The size of node denotes the degree centrality of farmers such that the larger the size of node, the higher the centrality and the greater the number direct connections with other farmers in the network (Poudel et al., 2006). Arrows indicate the flow of seed from one farmer to other and the number represents the crop that is transacted among the community members.

[4] Literacy is defined on the basis of farmers' capacity to read and write, acquired through both formal and informal education.

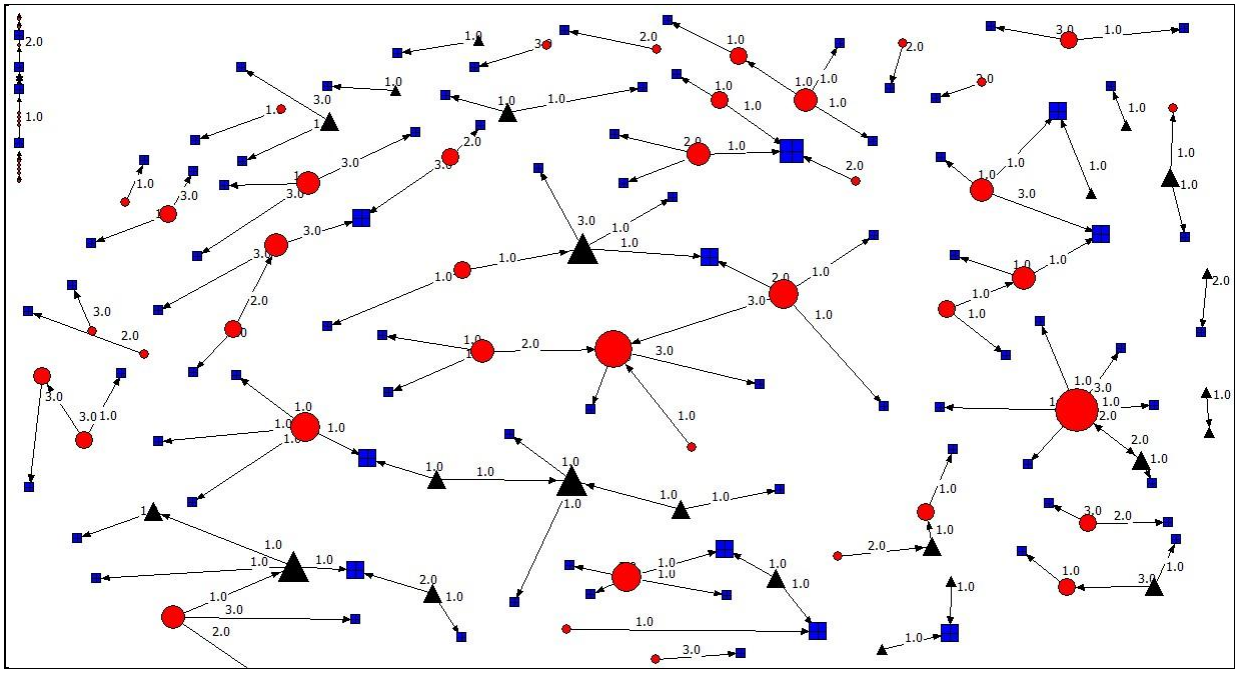


Figure 2: Network map showing the degree centrality in seed networking of rice, maize and finger millet in the research area

The number 1.0 indicates rice; 2.0 maize; and 3.0 finger millet

Figure 3 explains the process of seed flow or seed transaction in the community. The numbers represent the mode of transaction of seed/planting material in the community (1 for purchase, 2 for gift and 3 for exchange). The figure shows the existing main network of seed flow. The results of the study as indicated in the figures also show that there are some farmers who are not connected to the networks. These are referred to as isolates. These isolated farmers signify that there is always a scope to include them in the network. The network mapping also revealed that there are several networks in the community, either small or large in size (the size of the nodes). The numerous sub-networks within the main network are connected through nodal or connector farmers. All these networks are created as a function of social relationships or social interdependence in the community rather than by economic factors.

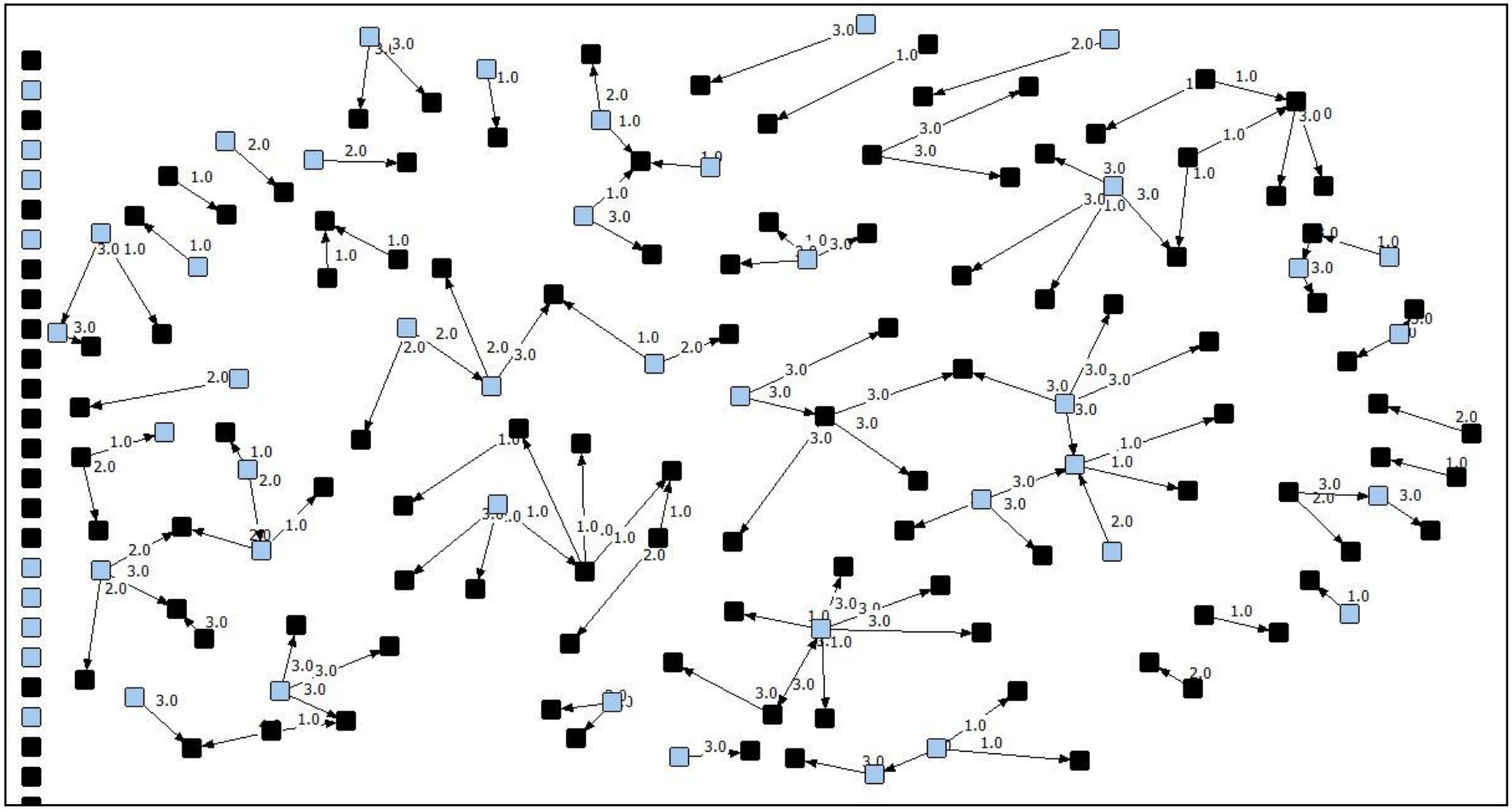


Figure 3: Seed network mapping of rice, maize and finger millet in study area
The number indicates the seed flow mechanism: 1.0 by buying; 2.0 for free; and 3.0 as gift.
Blue-coloured nodes indicate women and black, men.

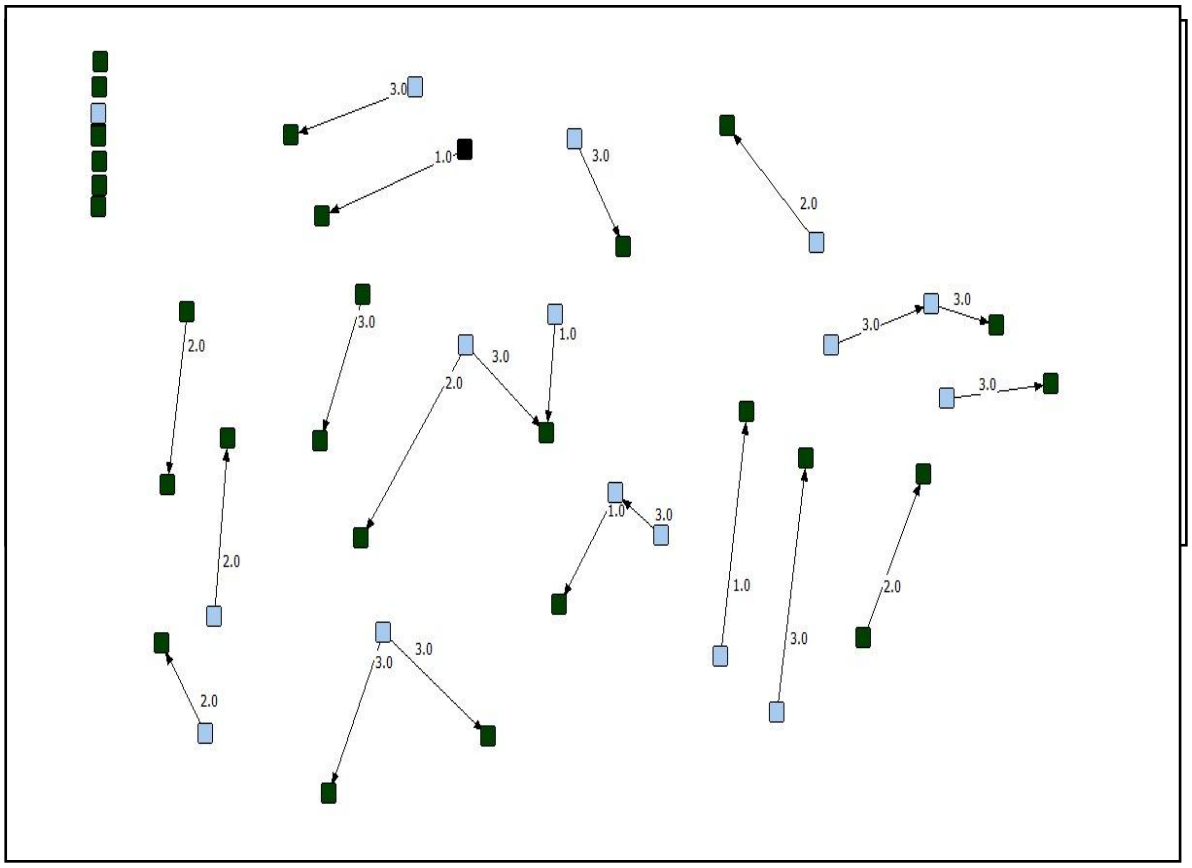


Figure 4: Main seed flow network of rice, maize and finger millet in the study area
The number indicates the seed flow mechanism: 1.0 by buying; 2.0 for free; 3.0 as gift. Blue-coloured nodes indicate women and black, men.

The analysis showed that the network for maize seed flow in the study area is extremely limited. Most households had only one link (Figure 5a, 5b, 5c). This observation also agrees with the analysis of Abay et al. (2011), who identified households with a special role in conservation. Most research on networks has focused on the presence of undirected links, that is reciprocity (Pautasso, 2014). However, seed exchange networks are not necessarily reciprocal. The network simulation suggests that directedness, together with the absence of correlation between incoming and outgoing links, can contribute to local differentiation of landraces, because seed flows tend to remain confined within small groups of farmers. At the same time, such fragmentation can make seed systems more resilient to replacement of local varieties with improved ones (Marfo et al., 2008; Cavatassi et al., 2011).

Figure 5a. Seed network map for finger millet.
The number indicates the seed flow mechanism: 1.0 by buying; 2.0 for free; 3.0 as gift. Blue-coloured nodes indicate women and black, men.

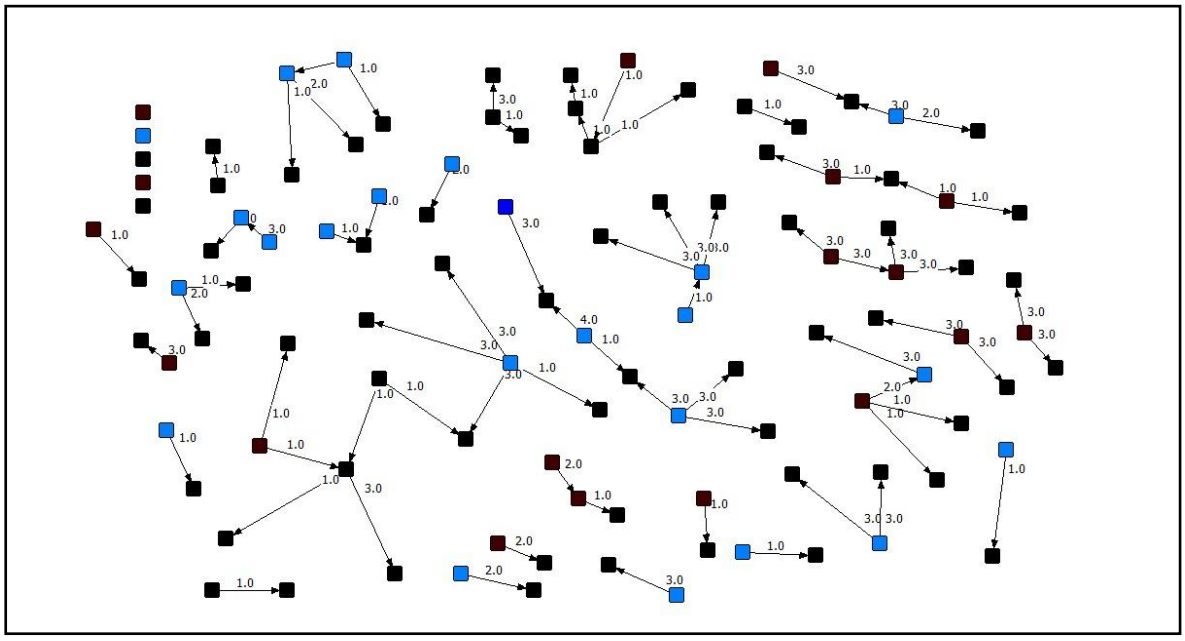


Figure 5b. Seed network map for rice.
The number indicates the seed flow mechanism: 1.0 by buying; 2.0 for free; 3.0 as gift. Blue-coloured nodes indicate women and black, men.

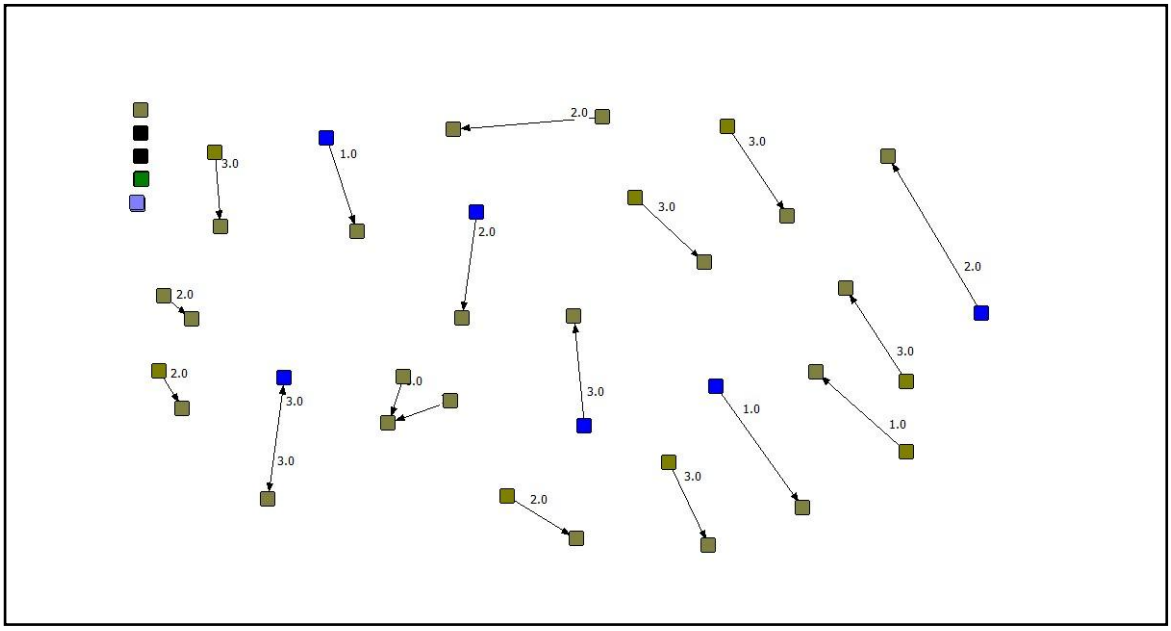


Figure 5c. Seed network map for maize.
The number indicates the seed flow mechanism: 1.0 by buying; 2.0 for free; 3.0 as gift. Blue-coloured nodes indicate women and green, men.

Seed management at the farmers' level consists of selecting varieties and seed for the next planting season, as well as for seed storage, transfer, exchange or mixture (Bellon et al., 1997; Smale and Bellon, 1999; Hodgkin et al., 2007). Nodal farmers in the community networks are vital for maintaining crop diversity on-farm and managing the processes involved in it (Subedi et al., 2003), and they are mostly effective in sharing genetic resources in the community. Farmers with a high betweenness centrality connect the other members (or sub-networks) in the community and promote the flow of seeds. Such farmers connect two or more sub-networks that are not directly connected through other farmers. [However, these farmers are often also fragile as connectors; the links they form could be disrupted if they discontinue farming, migrate to other places, or if they do not have a successor.] The seed network analysis tool, when embedded within a larger context of community biodiversity management (Sthapit et al., 2008) or on-farm management of agrobiodiversity, may help communities recognize this weak point leading to development of option of the existing nodal or connector farmers. A nodal farmer is usually rich in terms of crop as well as varietal diversity, is known and recognized by many other farmers in the community, and is more knowledgeable compared to others. Thus, if nodal farmers are appropriately mobilized there is a greater chance that any new variety of a crop will be disseminated, thus improving food security. Furthermore, as nodal farmers are the custodians and promoters of diversity, their mobilization increases their potential to be agents for sustainable food and nutrition security.

The communities that are identified as vulnerable in their seed networks, with few nodal and connector farmers, can take necessary steps to maintain varieties in their locality (Abay et al., 2011). For sustaining the network, a collective effort is required (Badstue et al., 2003), and a community seed bank may be one such initiative (Abay et al., 2011). Some studies demonstrate that social seed network analysis is a practical and participatory tool for farming communities taking conscious and collective actions that will contribute to local on-farm conservation of agrobiodiversity (FAO, 1996, 2010). Moreover, the conservation of agrobiodiversity depends on the interplay between local differentiation of landraces and their diffusion so as to counteract local extinction (Abay et al., 2011; Dyer et al., 2011). Seed systems can maintain agrobiodiversity, but they can also replace it with new improved varieties introduced by research and extension systems (Almekinders et al., 1994; Portis et al., 2012; Kawa et al., 2013), which include both open pollinated and hybrid varieties. The general absence of reciprocity in the studied seed exchange network makes it less vulnerable to the replacement of farmer varieties by the so-called improved ones. The characterization of members in seed networks using measures of centrality provides detailed information on the role that those farmers play in the network, and as such on their potential contribution to conservation, crop improvement and seed business development. Moreover, the farmers who play key roles in seed networks are critical in sharing information relevant for selection of parents and traits during participatory crop improvement process and hold a crucial position for boosting dissemination.

CONCLUSION AND RECOMMENDATIONS

This paper identified and assessed the nature of seed networks for finger millet, rice and maize operating in Dhikurpokhari VDC of Kaski district in the western hills of Nepal. It was found that the households that occupy key positions in the network are important for seed flow and for agrobiodiversity conservation. By using social network analysis tools and maps, this paper examined the key characteristics of nodal farmers as age, sex, education, occupation, wealth category and ethnicity in determining whether a farmer can become a

nodal farmer. The result of this study showed that age and education are important factors for becoming a nodal farmer, while other factors like ethnicity, gender, wealth category and occupation play no significant role.

The study further found that social seed network analysis is instrumental in locating farmers who occupy critical positions in the community as nodes of exchange and transfer, and who use high levels of crop and varietal diversity; or as connecters, linking communities. By identifying such farmers, their awareness or recognition of their critical role can be enhanced and specific actions can be initiated to strengthen their position, as a means to improve on-farm conservation and management of biodiversity and community food security measures. Moreover, understanding the patterns of exchange and flow of seed within and between the communities, and identifying nodal and connector farmers within seed networks can play a significant role in designing and implementing strategies for on-farm management of agrobiodiversity (Subedi et al., 2003; Sthapit et al., 2008). This understanding will contribute to the integration of a genetic resource and livelihood perspective for strengthening local seed systems (De Boef, 2008).

One approach to improving sustainable food and nutrition security is to increase the efficiency of seed flow among farmers through nodal and connector farmers. For this, it is important that the nodal and connector farmers are identified and empowered. These farmers should be provided with proper technical knowledge on crop, variety and diversity management by different research and development organizations working in the agriculture sector, especially those in the seed sector. The findings of this study are also useful for promoting community-based seed production (CBSP) groups at the local level; that is, making use of nodal farmers for disseminating new crop varieties. Easy access to knowledge, information and seed of both local and improved varieties will help improve diversity at the local level, which ultimately contributes to food security and on-farm conservation in the context of changing climatic conditions.

Many crops and varieties are getting less attention even though they have special value-based traits such as stress tolerance, eating qualities. It is worthwhile for development organizations (both governmental and non-governmental) working in the region to create awareness of the value of local varieties of different crops. The potential for using nodal farmers for promoting local crops and varieties can best be realized by providing capacity-enhancement opportunities and economic incentives to improve seed flow in the community. By doing so, not only do local farmers become important actors not only in the conservation and management of seeds and genetic materials, but also their control over the local seed system and their freedom to choose seeds from the variety of sources within the community are ensured. Empowering farmers within the local seed system will contribute to seed sovereignty and decrease market dependency for planting materials, which is an important aspect of sustainable food and nutrition security through conservation agriculture and increased agrobiodiversity.

References:

Abay, F., de Boef, W., & Bjørnstad, A. (2011). Network analysis of barley seed flows in Tigray, Ethiopia: Supporting the design of strategies that contribute to on-farm management of plant genetic resources. *Plant Genetic Resources, 9*(4), 495–505.

Almekinders, C. (2001). Management of crop genetic diversity at community level. Eschborn, Germany: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.

Almekinders, C.J.M., Louwaars, N.P., & Bruijn, G.H. (1994). Local seed systems and their importance for an improved seed supply in developing countries. *Journal of Euphytica, 78*, 207–216.

Asrat, S., Yesuf, M., Carlsson, F., & Wale, E. (2009). Farmers' Preferences for Crop Variety Traits Lessons for On-Farm Conservation and Technology Adoption, EfD DP 09-15. Washington DC: Resources for the Future.

Badstue, L.B., Bellon, M.R., Juárez, X., Manuel, I. & Solano, A.M. (2003). Social relations and seed transactions among small-scale maize farmers in the central valleys of Oaxaca, Mexico. Working Paper 02-02, Mexico: International Maize and Wheat Improvement Centre (CIMMYT).

Balemie, K., & Singh, R.K. (2012). Conservation of Socioculturally Important Local Crop Biodiversity in the Oromia Region of Ethiopia: A Case Study. *Journal of Environmental Management, 50*(3), 352–364.

Baniya, B.K., Subedi, A., Rana, R.B., Paudel, C.L., Khatiwada, S.P., Rijal, D.K., & Sthapit, B.R. (1999). Informal rice seed supply and storage systems in mid-hills of Nepal. A scientific basis of in situ conservation of agrobiodiversity on-farm: Nepal's contribution to global project.

Baniya, B.K., Tiwari, R.K., Chaudhary, P., Shrestha, S.K., & Tiwari, P.R. (2005). Planting Materials Seed Systems of Finger Millet, Rice and Taro in Jumla, Kaski and Bara Districts of Nepal. *Journal of Nepal Agriculture Research*, 6, 39-48.

Bellon, M.R., Adato, M., Becerril, J., & Mindek, D. (2006). Poor farmers' perceived benefits from different types of maize germplasm: The case of creolization in lowland tropical Mexico. *World Development, 34*(1), 113–129.

Calvet-Mir, L., Calvet-Mir, M., Luis Molina, J., & Reyes-García, V. (2012). Seed exchange as an agrobiodiversity conservation mechanism. A case study in Vall Fosca, Catalan Pyrenees, Iberian Peninsula. *Ecology and Society, 17*(1), 29.

Cavatassi, R., Lipper, L., Narloch, U. (2011). Modern variety adoption and risk management in drought prone areas: insights from the sorghum farmers of eastern Ethiopia. *Agricultural Economics, 42*, 279–292.

CBS. (2011). *National Population Census 2011: Major highlights*. Kathmandu: Central Bureau of Statistics, National Planning Commission, Government of Nepal.

DDC Kaski. (2010). District Profile of Kaski. Pokhara: Office of the District Development Committee, Kaski.

De Boef, W.S. (2008). Agrobiodiversity, conservation strategies and informal seed supply. In: Thijssen, M.H., Bishaw, Z., Beshir, A., & W.S. De Boef (Eds.), *Farmers, seeds and varieties: supporting informal seed supply in Ethiopia* (pp. 125-132). Wageningen: Wageningen International.

Dyer, G.A., González, C., & Lopera, D.C. (2011). Informal "seed" systems and the management of gene flow in traditional agroecosystems: the case of cassava in Cauca, Colombia. *PLoS One, 6*(12), 1-8.

Engels, J.M.M., Dempewolf, H., & Henson-Apollonio, V. (2011). Ethical considerations in agrobiodiversity research, collecting, and use. *Journal of Agricultural and Environmental Ethics, 24*, 107–126.

FAO. (2011). Biodiversity for Food and Agriculture: Contributing to food security and sustainability in a changing world. Outcomes of an expert workshop held by Food and Agriculture Organization (FAO) and the Platform on Agrobiodiversity Research, 14–16 April 2010, Rome, Italy.

FAO. (2010). Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. Commission on Genetic Resources for Food and Agriculture. Rome, Italy: Food and Agriculture Organization of the United Nations.

FAO. (1996). The State of the World's Plant Genetic Resources for Food and Agriculture. Information document provided for the Fourth International Technical Conference on Plant Genetic Resources, 17 - 23 June 1996, Leipzig, Germany.

Frison, E., Cherfas, J., & Hodgkin, T. (2011). Agricultural Biodiversity Is Essential for a Sustainable Improvement in Food and Nutrition Security. *Journal of Sustainability, 3*(1), 238–253.

Gill, T.B., Bates, R., Bicksler, A., Burnette, R., Ricciardi, V., & Yoder, L. (2013). Strengthening informal seed systems to enhance food security in Southeast Asia. *Journal of Agriculture, Food Systems, and Community Development, 3*(3), 139–153.

Hodgkin, T., Rana, R., Tuxill, J., Balma, D., Subedi, A., Mar, I., Karamura, D., Valdivia, R., Collado, L., Latournerie, L., Sadiki, M., Sawadogo, M., Brown, A.H.D., & Jarvis, D.I. (2007). Seed Systems and crop genetic diversity in agroecosystems. In: Jarvis, D.I., Padoch, C., & H.D. Cooper (Eds.), *Managing Biodiversity in Agricultural Systems* (pp. 77-116). New York: Columbia University Press.

Jackson, M.T., & Ford-Lloyd, B.V. (1990). Plant genetic resources: a perspective. In: Jackson, M.T., Ford-Lloyd, B.V. & M.L. Parry (Eds.). *Climate Change and Plant Genetic Resources* (pp. 1-17). London and New York: Belhaven Press.

Jamali, M., & Abolhassani, H. (2006). *Different aspects of social network analysis.* Paper presented at International conference on web intelligence, 18–22 December 2006, Hong Kong, China.

Jarvis, D.I., Hodgkin, T., Sthapit, B.R., Fadda, C., & Lopez-Noriega, I. (2011). An heuristic framework for identifying multiple ways of supporting the conservation and use of traditional crop varieties within the agricultural production system. *Journal of Critical reviews in Plant Sciences, 30*, 125–176.

Joshi, K.D. (2001). Strengthening farmers seed system in Nepal: how it can be achieved. In: Rajbhandari, N.P., Ransom, J.P., Adhikari, K., & A.F.E. Palmar (Eds.) *Sustainable Maize Production systems for Nepal: Proceeding of a Maize symposium* (pp. 214-222). CIMMYT and NARC: Kathmandu, Nepal.

Kahane, R., Hodgkin, T., Jaenicke H., Hoodendoorn, C., Hermann, M., Keatinge, J.D.D., Hughes, J.D.A.H., Padulosi, S., & Looney, N.E. (2013). Agrobiodiversity for food security, health and income. *Journal of Agronomy for Sustainable Development, 33*(4), 671–693.

Kawa, N.C., McCarty, C., & Clement, R.C. (2013). Manioc varietal diversity, social networks, and distribution constraints in rural Amazonia. *Current Anthropology, 54*(6), 764-770.

Kloppenburg, J. (2010). Impeding dispossession, enabling repossession: Biological open source and the recovery of seed sovereignty. *Journal of Agrarian Change, 10*(3), 367-388.

LI-BIRD. (2012). Annual periodic report. Revalorizing small millets: enhancing the food and nutritional security of women and children in rainfed regions of South Asia using underutilized species project.
Lotti, A. (2010). The commoditization of products and taste: slow food and the conservation of agrobiodiversity. *Journal of Agriculture and Human Values, 27*, 71–83.
Louwaars, N.P. (2013). Seed Systems and Plant Genetic Resources for Food and Agriculture: Thematic Background Study. Rome, Italy: Food and Agriculture Organization.
Lowaaras, N.P., & Engels, J.M.M. (2008). Seed policies: enabling support to informal seed systems. In: Thijssen, M.H., Bishaw, Z., Beshir, A., & W.S. De Boef (Eds.), *Farmers, seeds and varieties: supporting informal seed supply in Ethiopia.* Wageningen: Wageningen International
Marfo, K. A, Dorward P.T., Craufurd, P.Q., Ansere-Bioh , F., Haleegoah. J., & Bam, R. (2008). Identifying seed uptake pathways: the spread of *Agya amoah* rice cultivar in Southwestern Ghana. *Experimental Agriculture*, 44, 257–269.
McGuire, S.J. (2008). Securing access to seed: Social relations and sorghum seed exchange in eastern Ethiopia. *Journal of Human Ecology, 36*, 217–229.
McGuire, S.J., & Sperling, L. (2011). The links between food security and seed security: fact and fiction that guide response. *Journal of Development in Practice, 21*, 493–508.
NARC (2005). A quarterly newsletter of Nepal Agricultural Research Council, *12*(1), 5. Retrieved from http://narc.gov.np/publicaton/pdf/newsletter/Vol%2012%20No%201.pdf on 22 June 2014.
Neate, P.J.H., & Guei, E.G. (2010). Promoting the growth and development of smallholder Seed enterprises for food security crops: best practices and options for decision-making. Rome, Italy: Food and Agriculture Organization.
Oerke, E.C. (2006). Crop losses to pests. *Journal of Agricultural Science, 144*, 31–43.
Padulosi, S., Mal, B., Ravi, S.B., Gowda, J., Gowda, K.T.K., Shanthakumar, G., Yenagi, N., & Dutta, M. (2009). Food security and climate change: Role of plant genetic resources of minor millets. *Journal of Indian Plant Genetic Resources, 22*(1), 1–16.
Patel, R. (2009). Food sovereignty: What does food sovereignty look like? *The Journal of Peasant Studies, 36*(3), 663-706.
Pautasso, M. (2014). Network simulations to study seed exchange for agrobiodiversity conservation. *Agronomy for Sustainable Development 34*(1), 1–6.
Pautasso, M., Aistara, G., Barnaud, A., Caillon, S., Clouvel, P., Coomes, O.T., Delêtre, M., Demeulenaere, E., Santis, P.D., Döring, T., Eloy, L., Emperaire, L., Garine, E., Goldringer, I., Jarvis, D., Joly, H.I., Leclerc, C., Louafi, S., Martin, P., Massol, F., McGuire, S., McKey, D., Padoch, C., Soler, C., Thomas, M., & Tramontini, S. (2013). Seed exchange networks for agrobiodiversity conservation: A review. *Agronomy for Sustainable Development, 33*(1), 151–175.
Pellegrini, L., & Tasciotti, L. (2014). Crop diversification, dietary diversity and agricultural income: empirical evidence from eight developing countries. *Journal of Canadian Development Studies, 35*(2), 211–227.
Pimentel, D., Wilson, C., McCullum, C., Huang, R., Dwen, P., Flack, J., Tran, Q., Saltman, T., & Cliff, B. (1997). Economic and environmental benefits of biodiversity. *Journal of Bioscience, 47*, 747–757.
Portis, E., Baudino, M., Magurno, F., & Lanteri, S. (2012). Genetic structure and preservation strategies of autochthonous vegetable crop landraces of North-western Italy. *Annals of Applied Biology, 160*, 76–85.
Poudel, D., Sthapit, B. and Shrestha, P. (2006). *Application of Social Network Analysis to Understand On-farm Conservation of Agricultural Biodiversity: Case Study from*

Nepal. Paper presented at On-farm Management of Agricultural Biodiversity in Nepal: Lessons Learned, National Symposium, 18-19 July 2006, Kathmandu Nepal.

Pray, C.E., Ramaswami, B., & Kelley, T. (2001). The impact of economic reforms on R&D by the Indian seed industry. *Food Policy, 26*(6), 587–598.

Prescott-Allen, R., & Prescott-Allen, C. (1990). How many plants feed the world? *Journal of Conservation Biology, 4*(4), 365–374.

Ravinder, R.C., Tonapi, V.A., Bezkorowajnvj, P.G., Navi, S.S., & Seetharama, N. (2007). Seed system innovations in the semi-arid tropics of Andhra Pradesh, International Livestock Research Institute, ICRISAT, Patancheru, Andhra Pradesh.

Sen, A. (1981). Poverty and Famines: an Essay on Entitlement and Deprivation. Oxford: Oxford University Press.

Serpolay, E., Dawson, J.C., Chable, V., Lammerts Van Bueren, E., Osman, A., Pino, S., Silveri, D., & Goldringer, I. (2011). Diversity of different farmer and modern wheat varieties cultivated in contrasting organic farming conditions in western Europe and implications for European seed and variety legislation. J*ournal of Organic Agriculture*, *1*(3), 127–145.

Shen, S., Wilkes, A., Qian, J., Yin, L., Ren, J.A., & Zhang, F.D. (2010). Agrobiodiversity and biocultural heritage in the Dulong valley, China. *Journal of Mountain Research and Development, 30*, 205–211.

Shrestha, P.K. (1998). Gene, gender and generation: Role of traditional seed supply system in the maintenance of agrobiodiversity in Nepal. In T. Pratap, & B. Sthapit, (Eds.), *Managing Agrobiodiversity, Farmers' changing perspective and Institutional Responses in the Hind-Kush Himalayan Region* (pp. 143-152). Kathmandu, Nepal: IPGRI, ICIMOD.

Smale, M. & M.R. Bellon. (1999). A conceptual framework for valuing on-farm genetic resources. In: D. Wood & J. M. Lenné (Eds.) *Agrobiodiversity: Characterization, Utilization and Management* (pp. 387-408). Wallingford, UK: CABI Publishing.

SQCC (2012). List of notified varieties of different crops in Nepal. Kathmandu, Nepal; Seed Quality Control Centre, Government of Nepal.

Sthapit, B., Rana, R., Eyzaguirre, P., & Jarvis, D. (2008). The value of plant genetic diversity to resource-poor farmers in Nepal and Vietnam. *International Journal of Agricultural Sustainability, 6*, 148–166.

Subedi, A., Chaudhary, P., Baniya, B.K., Rana, R.B., Tiwari, R.K., Rijal, D.K., Sthapit, B.R., & Jarvis, D.I. (2003). Who maintains crop genetic diversity and how? Implications for On-farm conservation and utilization. *Journal of Culture and Agriculture, 25*(2), 41–50.

Sundar, I. (2011). Food security through biodiversity conservation. International conference on Asia Agriculture and Animal, IPCBEE, 13 (131). Singapore: IACSIT Press.

Theiele, G. (1999). Informal Potato Seed Systems in the Andes: Why Are They Important and What Should We Do With Them? *World Development, 21*(1), 83–99.

Thomas, M., Dawson, J.C., Goldringer, I., & Bonneuil, C. 2011. Seed exchanges, a key to analyze crop diversity dynamics in farmer-led on-farm conservation. *Genetic Resource and Crop Evolution, 58*, 321–338.

Thrupp, L.A. (2000). Linking Agricultural Biodiversity and Food Security: The Valuable Role of agrobiodiversity Sustainable Agriculture. *Journal of International Affairs, 76*(2), 265–281.

Turyahabwe, N., Kakuru, W., Tweheyo, M., & Tumusiime, D.M. (2013). Contribution of wetland resources to household food security in Uganda. *Journal of Agriculture and Food Security, 2*(5), 2–5.

Uniyal, B., & Vandana, S. (2005). Traditional knowledge on medicinal plants among rural women on Garhwal Himalaya. *Journal of Indian Traditional Knowledge, 4*(3), 256–266.

UNEP (2008). *Farmers and the Future of Agrobiodiversity*. Bonn, Germany: United Nations Environment Programme.

Vogl, C.R., & Vogl-Lukasser, B. (2003). Tradition, dynamics and sustainability of plant species composition and management in homegardens on organic and non-organic small-scale farms in alpine Eastern Tyrol, Austria. *Journal of Biological Agriculture and Horticulture, 21*, 349–366.

Wasserman S., & Faust, K. (1994). *Social Network Analysis: Method and Application.* Cambridge: Cambridge University Press.

Zhang, F. and Li, L. (2003). Using competitive and facilitative interactions in intercropping systems enhances crop productivity and nutrient-use efficiency. *Plant and Soil, 248*, 305-312.

6

OPINION LEADERS AND THE HORIZONTAL DIFFUSION OF SUSTAINABLE AGRICULTURAL PRACTICES AND TECHNOLOGY: ACASE STUDY FROM GUJARAT

Jason G Dyck

ABSTRACT

The successful diffusion of sustainable agricultural practices and technologies is becoming an increasing priority among development planners. This case study, which chronicles the informal initiative of opinion leaders at the local level, will illustrate one way such sustainable options are being made available to farmers in Gujarat, India. Their horizontal propagation of sustainable agricultural practices and technologies not only promoted the conservation of on-farm and environmental resources, but also contributed to the diversification of risk management strategies and food security options for rural communities. The case study focuses on the role played by opinion leaders and their relationship to social capital in order to illuminate the challenges and catalysts of informal technology transfer. These individuals helped spread the adoption of various sustainable technologies including drip irrigation, solar water pumps, solar arrays, and organic inputs. The study examines the interactions between opinion leaders and formal agricultural institutions, as well as their interactions with informal community social networks in their work spreading such agricultural inputs. The implications of this study include the identification of gaps in current formal diffusion networks, the need greater integration of opinion leader feedback, and examples of support mechanisms for opinion leader diffusion activities. Further implications for social learning theorists abound in this documentation of informal learning networks.

INTRODUCTION

Agricultural technologies and practices that are dependent on non-renewable external inputs have enjoyed the favour of state and private development programs in India since the dawn of the Green Revolution in the early 1960's. In the face of the adverse consequences of this technological paradigm, alternative options are being sought at the community level which are more socially and ecologically sustainable. The initiative of influential individuals at the local level will be demonstrated to be one way such alternatives are being made available to farmers in India. Their propagation of sustainable agricultural practices and technologies promotes the conservation of capital and environmental resources, as well as diversifies the risk management strategies available to farmers.

The current study investigates the dynamics of the informal diffusion of a number of sustainable agricultural practices and technologies (SAPT) in Gujarat, India. It focuses on the role played by opinion leaders and their use of social capital in order to illuminate the challenges and catalysts of informal technology transfer. These individuals each provided their own unique means of ensuring the continued propagation of various sustainable technologies including drip irrigation, solar water pumps/arrays, and organic inputs. Particular sustainable practices were also documented to be part of the diffusion process and

included vermi-composting and biodiversity conservation. In addition to augmenting sustainable farming options, the new knowledge networks that were created in the process will also be shown to enhance the community'ssocial capital and food security options.

OBJECTIVES

This case study investigates the role of opinion leaders in the diffusion of sustainable agricultural practices and technology (SAPT) near the community of Talala, in Junagadh District, Gujarat, India. The primary objective of this study is the documentation of the methods and motivations of those individuals who were early adopters of such practices, and who demonstrably furthered the diffusion process. It is concerned with that diffusion work which takes place at the local level, by individuals outside the employ of private or public institutions and seeks to illuminate some of the heuristics of local diffusion agents by better understanding the dynamics of informal horizontal technology transfer. The intention of this work is to highlight areas where such diffusion efforts contributed to the increased ability of local social networks to choose technologies and practices which increased sustainability.

The focus of this study remains the agency of key individuals in the diffusion process, however, it must be emphasized that although not formally in the employ of governments or private corporations, the opinion leaders of Talala were still connected to the broader national and international agricultural information and supply chain. Although the process of opinion leader diffusion was informal, many of the practices and technologies originated from formal research networks and previous formal technology transfer efforts. Therefore, while the focus of this study will be informal transfer dynamics, it will investigate the practices of local agents of diffusion *and* their interactions with private, governmental and non-governmental agencies. The study concludes with an assessment of the role of formal institutions within each of these sectors and points to how organizations in such sectors can capitalize on the social capital of local informal knowledge networks to further promote sustainable agriculture and enhance community food security.

CONTEXT

The focus of this investigation is a select group of early adopters of sustainable agricultural technologies and practices whose social status and connection to social networks in the community granted them the ability to influence the opinions and farming systems of that community. A practice or technology was deemed to be sustainable if it did not harm the broader ecosystem or social system of which the farm was a part, if it reduced the amount of non-renewable inputs required for the farm operation, or if it helped to conserve or significantly enhance the usage of existing on-farm resources (Roling, Wagermakers, 2000).Those individuals who able to demonstrably" influence other individuals' attitudes or overt behaviour informally in a desired way with relative frequency" (Rogers, 2003, p.27), were considered to be opinion leaders for the purposes of this investigation. Specifically, individuals were considered to be an opinion leader if it could be demonstrated that they had influenced the farming practices or technological availability in their immediate area and had the potential to mobilize further opinion through social networks. These individuals were all land owners, employers of farm labour, and often showed involvement in either local government or associations.

One key distinction made by Rogers is that opinion leaders derive their local status through "technical competence, social accessibility, and conformity to the systems norms"

(Rogers, 2003, p.27). While each of the opinion leaders discussed meet certain aspects of that criteria, the final opinion leader to be discussed is an also an innovator whose farm operation hardly conforms to local farming systems' standards. While the first two individuals discussed are early adopters of a new technology, the third individual is both an early adopter of organic inputs, as well as an innovator, uniquely blending traditional and modern agricultural techniques. However, a small number of successful local orchards also employed similar organic techniques, therefore indicating the social system was not closed to similar variations from the local farming standard. This individual demonstrates that opinion leadership and innovativeness are not mutually exclusive phenomena in Talala.

The central role of opinion leaders in the technology transfer process is a well documented phenomenon, but little has been written about their role outside of formal transfer programmes or regarding their role in promoting the horizontal transfer of sustainable technologies and practices (Feder, Savastano, 2002; Gaikwad, V.R., Tripathi, Bhanwerlal & Bhatnagar, Gurnam Saran, 1972; Ascroft, Agunga, 2006). This work has focused on horizontal diffusion, which refers to the transfer of established technologies or practices from one geographic area to another (Bennet, 2002). It has done so to narrow the line of questioning to informal processes, as vertical technology transfer is less likely to take place outside of formal programmes of diffusion. Horizontal transfer is also conducive to study of the impact of informal community based social networks because of the comparatively low involvement of formal change agents in the process. (Holland, 2000)

Opinion leaders are seen as essential components of the technology transfer processes and much has been written about their role in spreading the high yielding crop varieties and associated package of practices during India's Green Revolution (Feder et al., 2002; Gaikwad, et al., 1972).The ability of opinion leaders to assist in the process of diffusion is succinctly summarized by Rogers(2003) when he notes that a review of extension programs in Latin America revealed that each change agent was responsible for contacting approximately 10,000 farmers. He directs change agents to seek out community opinion leaders so that such individuals may produce the effect of multiplying the sources of desired information. According to Rogers (2003), opinion leaders were effective in this task because they provided the "aegis of local sponsorship and sanction for the new ideas that are introduced" (p.388).Rogers, like much of the other contemporary literature, discusses opinion leaders in terms of their relation to formal change agents. This study demonstrates that opinion leaders are more than just the extensions of formal technology transfer processes and agents, and that through their own initiative are capable of promoting alternative technologies in their communities. Such grassroots technology transfer will be shown to increase the availability of sustainable farming options in Talala where such options were lacking in formal transfer processes. Speaking about sustainable development in particular, Anil Gupta (2010) writes that "mere reliance on market forces will not work to fill innovation gaps or for disseminating innovative ideas." (p.137) In this light, opinion leaders provide the same ability to multiply the channels of diffusion and lend credibility to new outside concepts, but also provide an alternative knowledge conduit which can fill gaps in the farming systems' options provided by formal networks. This study contends that in the absence of formal technology transfer programmes or agents, these individuals act as endogenous informal change agents within their own social networks. In this capacity opinion leaders are able to continue the diffusion of innovations long after the end of formal programs, or in the complete absence of such programs.

Complimentary to the concept of opinion leaders is that of social capital, which is defined as "the ability to develop and utilize various kinds of social networks" (Parthasarthy, Chopde, 2000, p. 3).Social networks are conduits through which technology and information can be informally disseminated and social capital is the capacity of individuals or groups to interact and make change within that network. Institutions such as the World Bank and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) have documented that in the absence of effective institutional efforts to promote technological diffusion, such social networks can be an effective alternative by which technological change occurs (Parthasarthy, & Chopde,2000; Grootaert, Narayan, Nyhan Jones & Woolcock, 2004; Harris, 2001). Furthermore, the concept can be useful in the analysis of individual and community dynamics due to its ability to describe "non-monetary sources of power and influence."(Parthasarthy, et al., p. 3)Analysis of the technology transfer process in general is aided by the concept due to its ability to describe its interactive and relational aspects. One of its defining features is that social capital "only exists when it is shared" and therefore it is able to describe "features of social organization, such as trust, norms, and networks that can improve the efficiency of society, facilitating coordinated actions."(Putnam, 1993, p. 167) In the realm of agricultural development, the social capital analytical framework has been used to articulate technological diffusion capacity for watersheds, irrigation management, and integrated pest management strategies (McCulloch, Knox, Dick, Hazell, 1998; Parthasarthy et al., 2000).

Coleman (1988) further ensures that such a definition was granted usage outside of its reference to membership in formal community organizations, but that social capital could be used to describe elements of the informal social structure of communities. This paper will show how opinion leaders' diffusion activities required the mobilization of social capital from both formal and informal sources, with the result being that further capacity for sustainable collective action was also created in those networks involved in the process. This study concentrates on the interactions of several key opinion leaders' roles within their social networks and their respective abilities to mobilize and create social capital.

METHODS

This study is based largely on qualitative data collected in the rural area around Talala, Junagadh district, Gujarat, in2012 using semi-structured interviews and focus groups. Local placement with one of the case study individuals and transcription of data was made possible with assistance from the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI). After an initial survey of the area through brief informal conversations with farmers, agro-input dealers, government extension agents and marketing officials, the general availability of local sustainable practices and technologies was determined, as well as which individuals had adopted it. A flexible questionnaire was compiled and revised after input from these individuals. Semi-structured interviews with the group of early SAPT adopters were used to determine if the individual was an opinion leader. From the initial survey of 12 opinion leaders, detailed follow up interviews were scheduled with three who had facilitated informal diffusion of a particular technology or practice. This case study is centered largely on their contributions, for which prior informed consent was obtained. Semi-structured interviews were also conducted with farmers who attended events held by the key opinion leaders, or lived in the near vicinity. In addition to the individual interviews, three focus groups of farmers and farm workers were conducted in the communities Talalaand neighboring village of Ramreechiin which questions were put to groups of six to ten individuals.

The key opinion leader interviews consisted in part of questions relating to the history of the individual with the given technology, their results with its implementation, their involvement in broader social networks, and their motivation and methods for disseminating the SAPT. While minor quantitative data was gathered, emphasis was on qualitative responses with specific focus on heuristic data. Medium and large farmers, who owned over two hectares and who were often employers of waged labour, comprise the sources of the bulk of the opinion leader data. In addition to the data supplied by farmers at this stage, a number of supplementary interviews were also conducted with farm labourers, agro-chemical dealers, irrigation dealers, gram panchayat members, and marketers.

After local farmer and other agriculture professional interviews were completed, a number of interviews and follow ups were scheduled with regional agriculture officials to assess the level of state intervention in the diffusion of sustainable agricultural practices and technologies. For this final round of interviews data was gathered from a number of extension officers and village level workers from the Kodinar Krishi Vigyan Kendras (KVK). Professors and researchers at the Junagadh Agricultural University (JAU) also participated in the study. Such complimentary interviews were done to contextualize the diffusion process and provide insight into the relationship between formal and informal processes. A total of 12 opinion leaders were interviewed, of which the diffusion activities of three are described in detail. 26 farmers participated in the individual interviews, and a further 23 participated in focus groups. Including non-farming individuals, a total of 38 individual interviews were conducted. The total number of people interviewed, including the focus group populations, was 61.

DISCUSSION DRIP IRRIGATION

The farming areas around the community of Talala, including parts of the neighboring village of Ramreechi, were the centers of data collection for this study. The area is located in Junagadh district, on the Saurashtran peninsula of Gujarat state, near the West coast of India. The area is described as a low coastal strip covered with sand and alluvium silt rising to an altitude of roughly 300 meters above sea level (ICAR, 2009).While the area is characterized by mixed farming operations that include groundnut, chilli, banana, rice, and sugarcane production, the area around Talala has seen a dramatic increase in the production of mangos over the last twenty years. The orchards demand significant inputs of water relative to previous cropping systems, and in this semi-arid location, such water can be expensive to supply due to limited availability and capital investment in tube wells, irrigation pipes, pumps and fuel.

One new sustainable water management practice that has enjoyed considerable success is a drip irrigation system. It was documented that drip irrigation was one of the fastest growing sustainable technologies in the Talala area; with 30.5% of land owning farmers interviewed having adopted the technology in the past 5 years. Talala's local irrigation dealership commented that they had trouble keeping up with installations of the system during peak seasons and that it was now one of their most popular selling systems. There was much enthusiasm among adopters of the technology due to the double benefits of increased production and decreased water output. The International Water Management Institute (IWMI) estimates that micro irrigation (MI) like the drip system can save 40-80% of total water output, while increasing production gains of up to 100% (Pullabhotla, Kumar, Shilp, 2012). The uses of the drip irrigation technology were found to vary greatly from use in the production of mango, cotton, banana, sugarcane, peas, ground nut, wheat, corn, chilli,

roses, and many vegetable varieties. Talala has one distributor of the drip systems and they reported that business has been increasing exponentially since the introduction of state subsidies in 2005.

The subsidy program offset the cost of new micro irrigation systems by 50% state wide, with increased incentives in more arid regions such as Kutch. Without such a subsidy program the adoption of the MI technology would have remained sluggish according to the operator of the Jain Irrigation distributor. The average system can range from Rs. 70,000 to Rs. 1.3 Lakh per hectare, making it a highly capital intensive input (Pullabhotla et al., 2012).However, with the immediate gains in crop yield and significant decrease in fuel and water consumption, most farmers said they felt that the cost saving and increased earning potential made its adoption a dependable return on investment. Its diffusion was still limited to those large and medium farmers who had exclusive access to a tube well and who could afford the initial 5% down payment on the total MI cost.

The MI system enjoyed much of its success due the state and national support it received in India. In Talala, the widespread adoption of MI has been aided by the presence of a local irrigation dealer who started carrying the MI products soon after the subsidies were in place. While the Jain dealer was enthusiastic about the receptiveness of the farmers to the new technology, he indicated that sales took some time to pick up after they put on a series of product demonstrations through the grampanchayat in 2006. The dealer noted that while there was a high attendance rates at these meetings, there was not adequate time to prepare effective demonstrations, such as an on-farm demonstration. The recent success of their product would not have happened without the enthusiasm of local farmers according to the resident Jain Irrigation dealer. While their panchayat demonstrations helped to raise awareness, they said that much of their business has come from word of mouth and farmer to farmer recommendations. According to the Jain dealer "some farmers take it upon themselves to show their neighbors and friends the benefits of this system. We hardly need to advertise since farmers do it for us" (Raju, interview May 8th, 2012).

One famer in particular had invested a great deal of his own time in doing such "advertising" for the drip irrigation system through his own on-farm demonstrations. However, this opinion leader was not in the employ of the Jain dealership, nor was he rewarded monetarily by them for his efforts. He first learned of the practice in 2007 at the College of Agriculture in Pune. There, he said the technique was presented as one which was developed in Israel under conditions requiring severe water conservation. He was informed about the possibility of state subsidies in Pune and confirmed the subsidy program specifics at the Jainirrigation dealer upon his return. He immediately invested in the MI system, claiming to be one of the first in the immediate area to do so. His early adoption of the technology was confirmed by the Jain dealer who said that sales of the MI only started becoming common after 2009. He had been to his district KVK in Kodinara number of times, yet had never heard of the MI or the subsidies. Interviews with the Junagadh KVK staff confirm that no drip irrigation systems had been tested or demonstrated at the facility.

The opinion leader, who asked to be referred to by the pseudonym Rameshbhai, experienced immediate benefits from the technology, particularly in his production of chilli peppers, egg plant and sugarcane. The next year he set out to encourage its use by those in his circle of friends, family and colleagues through a number of demonstrations on his farm. He left several rows of chillies and egg plant without the drip system in place and watered them with his standard method to show the contrast. At first he was simply interested in testing the

efficacy of his recent investment, saying it was one thing to see the system work at a government facility, but another to see it work in the "real world"(Rameshbhai interview, May 12th, 2012). He used this example to show the effects of his system to a number of small groups, including members of his circle of family and friends, as well as neighboring farmers and members of the local agricultural marketing agency to which he belonged. He was not paid for the service, nor did he receive any outside incentive for his actions, but said that he was partly motivated to increase the income of those who were important in his life. Furthermore, he said that "just like in Israel, the people of Gujarat also needed to conserve water", but not everyone had the ability to get training from Pune like he did (Rameshbhai interview, May 12th, 2012). He also enjoyed being a "teacher" and felt it part of his duty as a member of a local marketing association to share such new information with his colleagues.

Each of Rameshbhai's motivations for diffusion related to social or environmental incentives rather than a personal monetary incentive. Instead, he was interested in increasing the production and sustainability of others in his social network through the introduction of new knowledge and new technology. He noted that it was easy to bring people in his network out to see his drip system because he had an established and well known farming reputation due to his unique crops, high production, trips to the agricultural college at Pune, and membership in a voluntary marketing association. In other words, it was the initial social capital he could access through his social network that allowed such successful demonstrations to be held. Moreover, new knowledge of sustainable farming options and its accompanying subsidy scheme permanently entered Rameshbhai's social network, further increasing its options for collective sustainable development. This illustration shows how social capital is not only mobilized in order to carry out informal diffusion efforts, but is also created through it.

Rameshbhai accompanied several of his adopting friends to the irrigation dealership to ease their hesitation about setting up a preliminary assessment of their farms. He also visited those farms after the installation to help with minor maintenance and utilization. Several of his farming associates who have adopted the drip system after seeing it used on Rameshbhai's farm said they had heard of the system before through the gram panchayat, but that they had not seen the system at work before. Adopters claimed to experience between 75% and 250% savings in water output and experienced production gains ranging from 50% to 200%, depending on the crop. Despite such gains, word of mouth diffusion was limited as all those who confirmed adoption of the drip irrigation also confirmed the importance of having seen it in operation at least once before committing to such a high capital investment. When asked why he thinks his demonstrations were effective, Rameshbhai responded that the technology spoke for itself in results. He pointed to the high interest rate of bank loans being one of the major factors influencing non-adoption of the technology. "Many of my friends hoped to install similar drip systems, but could not afford the interest payments to the bank. Even with the government subsidies many people required a loan, and these are at exploitative rates." (Rameshbhai interview May 18th, 2012) Rameshbhai was enthusiastic about the potential of the technology nonetheless, commenting that if government support was not just for the equipment, but could also be extended to the farmer to do demonstrations then he would do such demonstrations more often. However, he did not wish to lose the time taken to implement two irrigation methods on the same crop or to lose production for such demonstrations. He noted that even though he has ceased such demonstrations the work promoting the system was still ongoing thanks to two of his colleagues at the local marketing agency who were adopters of the system. These adopters first saw the system on Rameshbhai's farm and have recommend it at out of town meetings with other agencies

involved in the marketing of vegetables. This opinion leader multiplier effect ensured the drip system would have ongoing informal support.

SOLAR POWERED SUBMERSIBLE PUMPS

A sustainable technology complimentary to the drip system was being promoted in Talalaby another local opinion leader. The individual responsible for showcasing the technology was Pareshbhai, the owner of a large Mango orchard. In 2012, he hosted a demonstration by the JJPV Solar Company attended by about 50 people. This on-farm demonstration was used to show the company's new line of solar arrays and solar powered submersible pumps. The pumps and solar arrays worked in tandem to reduce the need for expenditure on electricity for lighting, as well as expenditure on fuel for irrigation and water for animals. According to one JJPV representative, depending on the size of array and pump utilized, fuel inputs for submersible pumps could be eliminated altogether. The arrays ranged from 10-280 watts of output and ran pumps ranging from 0.5 hp to 7.5 hp, in addition to supplying surplus energy that could be used in the home or other outbuildings on the farm. The demonstration showed how the coupling of solar pumps to drip and sprinkler irrigation could reduce both fuel and water consumption, while increasing production. The solar distributor JJPV was based out of the city of Veraval, some 50km from Talala, and is part of a global distribution network.

Pareshbhai had previously installed a small array for minor lighting and appliances. In a catalogue from JJPV Solar the new line of submersible pumps caught his attention and he spoke to them at their office in Veraval. In the conversation he learned of discounts given to farmers who host demonstrations for their products. He offered to host such a demonstration after the install of a larger array and submersible pump. While he was motivated in part to host the demonstration for the cost saving it offered him for his own installation, he commented that "the discount was not the only reason I wanted to have this gathering. Do you know the cost of being the host to so many farmers? [JJPV] did not pay for the whole gathering; this discount barely covered the cost of being a host"(Pareshbhai interview, May 11th, 2012). The increasing cost of pump fuel was another reason for him to host the meeting, saying that farmers had to find other ways to water their mangos or the price of fuel would make it unprofitable. Furthermore, the electrical infrastructure in the area was reported to be inconsistent and the solar system was supposed to ensure a more reliable supply, especially during peak times. Pareshbhai noted that the power grid was already reaching beyond its limits and that everyone should do what they could to limit their consumption of electricity. His use of solar power was part of this conviction, as was his effort to host a demonstration. While he was unable to confirm the number of farmers who adopted the solar technology after the demonstration, the JJPV representative was able to confirm that a number of farmers signed up for an on-farm assessment after the meeting.

Pareshbhai said he also hosted a number of his rural property development associates for private tours and demos of the new system. However, it was unlikely he would continue to promote the system since the majority of his farming contacts had already attended these recent demos and he would not ask for them to sit through the same meeting twice. In this light it is possible to see the limits of direct opinion leader diffusion insofar as the motivation for the diffusion of an innovation can easily dissipate after it reaches the limits of an individual's social network. However, the opinion leader multiplier effect still echoed beyond such direct efforts. Pareshbhai noted that his role as a land lord and affiliation with an informally organized group of landlords and developers helped the demonstration go

successfully because these landlords were able to spread the word to a number of their tenant farmers, who then attended the event. In this way the social capital mobilized by opinion leaders has the ability to gain further momentum by their ability to include other opinion leaders within their own social networks.

ORGANIC INPUTS

Effective water management strategies were essential in the semi-arid conditions in the mango orchards around Talala and one key opinion leader promoted sustainable farming options which reportedly kept the soil from drying out without changing either irrigation or pump technology. This individual has been disseminating his organic farming practices for nearly three decades and asserts that with the right combination of organic inputs and proper attention to soil health, many of the problems associated with dry soil can be mitigated. In particular such practices were said to mitigate losses from mango flower drop, which was the most predominant problem documented in farmer interviews. Nearly every mango farmer interviewed recounted their experience with an increasing number of dropped, brittle, and dry flowers, which failed to produce fruit. This recurring problem was also noted to be on the rise in several focus group meetings with farmers, as well as interviews with irrigation dealers, input dealers, and marketing agents. Similarly, both the Junagadh Agricultural University Horticultural Department and the Junagadh KVK horticulturalists reported their familiarity with this recent problem. Both institutions also indicated that there was no current research or field trials at their research stations dedicated to offering solutions to the problem. However, the sustainable practices and technology utilized on the farm of the opinion leader, GafarKureshi, effectively neutralized mango flower drop.

GafarKureshi is the innovative steward of the KureshiBagh organic farm, market, and nursery on the outskirts of Talala. He has been the owner and operator of this business since 1970 when he took it over from his father. At the time he inherited the farm there was 50 mango trees on the property, and since then the farm has cultivated approximately 5,200 other varieties of trees, flowers, crops and herbs. The farm sells the produce from the orchards, traditional herbal remedies, seeds, flowers, organic pesticides, organic growth promoters, organic fungicides, and fruit tree saplings. Gafarbhai has not had to address the issue of mango flower drop in his orchard, though many of his surrounding neighbors have experienced the problem. He said that the overuse of pesticides and chemical fertilizer, such as urea and diammonium phosphate (DAP), had "dried out" the soil such that even persistent watering could not remedy it (Gafarbhai interview May 20th, 2012).He continued to articulate that the over abundance of these chemicals killed off the soil's microorganisms and decreased its pH, making the soil more acidic. The horticulturalists on at the JUA and the Junagadh KVK agreed with Gafarbhai's synopsis of the soil condition problems relative to the mango drop, noting a tendency for farmers to use higher than recommended doses of the chemical inputs. According to one extension officer from the JAU, recent surveys of Junagadh district showed that in some villages the average application of DAP was over one hundred kilo's per hectare, nearly double the recommended 54 kilos. Farmer interviews confirmed the over application of DAP, as 42% reported using over the recommended amount, with individuals' applications varying from 37% to 185% beyond the recommended application per hectare. In contrast, Gafarbhai used only organic compounds in his fertilizer, which was composed of vermi-composted plant matter, cow dung and occasionally an herbal growth promoter. He notes that this kept his soil's pH balanced as well rich in micro-bacterial activity.

Gafarbhai asserts that there was not just one practice or technology that would alleviate the "stressed" soil, but that only a package of sustainable practices and technologies could bring back the soil's vitality and help the mango trees regain their potential yields. He points to the fully organic nature of his operation as being one of the principal reasons for the health of his soil and plants. The primary organic practices that Gafarbhai attributed the health of his trees and herbs were utilizing an organic fertilizer composed of vermi-composted organic matter and cow dung and the use of organic growth promoters, pesticides and fungicides. In addition to being an early adopter of such organic inputs, Gafarbhai innovated his own selectively bred varieties of vegetable, mango, and herb, as well as novel integrated pest management techniques and education tools. The innovation of new varieties and use of traditional seed saving techniques was one further practice that ensured the consistent growth rates and yields of his trees, crops, and herbs, as only the best seeds and pits were kept from year to year. A number of the varieties planted were heritage varieties, dating back multiple generations. The practice of seed saving was shown to bean important facet of sustainability at the flourishing Kureshi Bagh, asit demonstrably influenced the wealth of biodiversity available to the community and the reduced the amount of capital invested in external inputs.

Gafarbhai commented that the combination of organic pest control solutions, which did not indiscriminately kill all insects, combined with local plant biodiversity of Kureshi Bagh had encouraged a similar biodiversity in insect life. This in turn ensured that pest infestations were minimal and that he did not have the same problems with such things as sucking pests as did a number of his colleagues and neighbors, who tended to use chemical pesticides on fully homogenous mango orchards. Additionally, Gafarbhai noted that the abundance of insects ensured that the pollinator population was healthy on his farm as well, further encouraging such things as mango flower health. While his father previously used a mixture of neem tree leaves and cow urine for pest control, now Gafarbhai mostly uses a combination of ready to use organic pest control products from a non-governmental agency, the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI). These herbal extracts are derived from grassroots innovations and traditional pest control mechanisms that have been refined and value added at the SRISTI laboratory in Ahmedabad. Such products were considered sustainable insofar as they were reported to leave no toxic residue, deter pests rather than indiscriminately kill them, and were derived from renewable herbal sources. The herbal extracts are concentrated and bottled for easy transportation and application with a standard sprayer. In addition to being a user of the SRISTI products, Gafarbhai is also the main distributor in the region, selling over 1000Ltrs of the product in the past year through their on-farm market.

Gafarbhai actively encouraged the diffusion of the organic grassroots technology through a number of avenues. First, as member of the All India Organic Farmers' Society (AIOFS), he has hosted a number of gatherings and workshops of the organization at Kureshi Bagh, where the application procedures and results of the products were showcased. These gatherings brought together leading organic farmers from a number of states and samples of the SRISTI products accompanied many of the farmers home to their respective regions afterwards. Smaller on-farm tours have been conducted for other groups, including local farmers. Furthermore, over 8000 students have been given tours of the grounds and educated on some of the basic organic agricultural practices employed on the farm. When asked what the incentive was to host such demonstrations and gatherings, Gafarbhai responded that though there was some minor profit incurred through purchases at the market after such meetings, they rarely would make up for the time and effort put into such events. He was

chiefly concerned with the promotion of "harmonious" agricultural practices, meaning those practices which did not interfere with the environment's natural cycles and processes. He also noted that particularly in the Talala area it was important to encourage organic practices since ground water became saturated with chemicals over time and would find its way into his organic farm. Similarly, some of his boundary trees and fruit would become covered in minor chemical residue due to the neighbors' pesticide spraying. Also, while he may have created an environment conducive to insect biodiversity without encouraging pest infestations, he could not say the same for all the farms neighboring his, as such mango monocropped orchards could produce large amounts of particular pests, which then crossed property lines into his organic trees. Therefore, he asserts, it was imperative that more people adopt organic practices so that they could support one another.

Interviews with farmers who had been to the Bagh indicated that a number have emulated some of the observed practices, including seed saving and vermi-composting, while others had become regular users of the SRISTI inputs. These interviews revealed that despite adoption of some practices or technologies, none had converted entirely to organic production. Vermi-composting, seed saving and the use of SRISTI *Sarvatra* and *Shakti* products were among the SAPT which could be directly documented to have originated from Kureshi Bagh. The adopting farmers also indicated their approval of organic methods, but could not fully convert to such methods themselves due to time or capital constraints. Among these farmers, the high cost and low availability of labour for weed control was a major contributor to the use of such chemicals as glyphosate. Also, even those neighbors who had learned the vermi-composting technique at Kureshi Bagh did not have sufficient access to manure from cows and so had to also use DAP or urea to fertilize their land.

Of all the various SAPT diffusion discussed thus far, the conservation and dissemination of biodiversity were oneof the Bagh's chief accomplishments in Gafarbhai's opinion. Bulk sales of their varieties of mango and lemon saplings account for the majority of the Bagh's profit. He has won numerous awards dating back to 1985 for his production of high quality mango varieties, including the bagh's own selectively bred *Kesar*variety. In addition to the edible and ornamental varieties grown, an increasing number of consumers were interested in the 20 different medicinal herbs being cultivated. Medicinal products from these plants were sold at their market, as well as the seeds of many of the same varieties. Interviews with staff at the JUA confirmed the importance of the practice of biodiversity conservation for the broader agricultural research system. One horticulturalist was familiar with Kureshi Bagh and noted that there have been many instances where the university did not have the correct seed or tissue samples, but that the desired samples could often be obtained from Gafarbhai. Furthermore, researchers traveling from out of state or out of country were occasionally directed to the Bagh to obtain fresh samples of the desired herb or tree. One plant variety in particular was in high demand for samples, as well as from the powdered medicine derived from it.

The plant, m*adhunasi*, in Gujarati, org*ymnemasylvestre* in Latin, has a number of medicinal properties that have been reportedly used by traditional healers in Gujarat for centuries. The Hindi name, g*urmar*, loosely means" destroyer of sugar" and the powdered medicine derived from the plant has developed the reputation of being an effective diabetes treatment, as well as a diuretic. Other ayurvedic uses of the plant include treatment for diarrhea, ulcers, weight loss, furunculosis, and mahhumeha (Saneja, Sharma, Aneja, Pahwa, 2010).Bourgeois residents of Gujarat and Bombay are known to chew the fresh leaves of this woody vine in the morning to promote clear urine and reduce glycosuria. Gafarbhai noted

that many individuals traveled every year from larger metropolitan centers just to purchase either bundles of fresh leaves or the powdered medicinal mixture made by his wife. She noted that the medicine had been part of the family for as long as she could remember, but that they had only began cultivating the plant after it was discovered in abundance during an innovation survey done in collaboration with SRISTI in the Gir forest.

This innovation survey, known at SRISTI as a *Shodh Yatra*, has taken place every year since 1998 in a different region of India and is enjoying the success of its 33rd occurrence this year. Gafarbhai was in attendance at one of the original planning sessions for the concept and offered an invitation to start the first *Shodh Yatra* from Kureshi Bagh. On this same innovation survey the group in attendance came into contact with a traditional healer who showcased his use of the madhunasi plant and Gafarbhai began to grow and sell it soon after. The origins of a number of SRISTI's other organic inputs were also discovered on such innovation surveys. Gafarbhai has since been on two further *Shodh Yatras* in the states of Punjab and Mizoram, where he was able to further share his own innovative practices as well as learn from other innovative farmers and farming communities.

Gafarbhai's contact with the NGO sector initiated a 16 year reciprocal relationship whereby SAPT entered the formal scientific and knowledge distribution network through local informal sources, and came back to those same sources value added and capable of greater diffusion. This cycle of knowledge reciprocity is mirrored by the use and generation of social capital. Gafarbhai was part of a process which created social capital when he helped facilitate the first *Shodh Yatra*. That expanded social network now encourages the documentation and diffusion of countless grassroots innovations, further expanding local innovators and farmer's abilities to act collectively in a sustainable way. He continues to create and mobilize social capital in this way and through his various other social networks, such as with the All India Organic Farmers' Society.

IMPLICATIONS OF INFORMAL DIFFUSION

The process of informal SAPT diffusion through opinion leaders has a number of important implications for multiple sectors of the agriculture economy. Regarding the heuristic dimension of diffusion, it should be noted that motivations for diffusion were largely consistent. In instances where minor monetary incentive played a role, such as with the solar pumps and SRISTI inputs, opinion leaders reported that the cost in time, labour and material hosting events outweighed the minor monetary incentive. They indicated that the primary motivation was social and environmental considerations. Common to each account was their desire to improve the production and efficiency of the farm operations of those in their immediate social networks such as colleagues, friends and family. In one way or another, each described a certain social obligation to share their privileged knowledge. The knowledge was seen as "privileged" due to its relative inaccessibility for other farmers. In this way, opinion leaders acted as conduits for the flow of knowledge and technology from the core centers of knowledge production, to the periphery, where it could be absorbed as local social capital.

The ecological imperative of particular sustainable technologies and practices was a further compelling force according to each of the key opinion leaders interviewed. It should be noted that only sustainable technologies enjoyed the benefits of informal diffusion in this area, as there was not one non-renewable or chemical product being disseminated outside formal channels by the other opinion leaders interviewed. Sustainable practices and

technology tended to elicit a passionate commitment from farmers, who often made note of their contribution to environmental health. The qualities of "sustainability", "renewable", "organic", "natural", "green", "chemical free" and "conservation" tended to add value to a given input and opinion leaders were quick to point to such qualities when describing their inputs and operations. In this way, SAPT possessed a unique ability to self-disseminate through environmentally or health conscious opinion leaders through informal avenues. This organically occurring process of diffusion could be easily encouraged with minor support from formal agencies.

Gafarbhai's earlier comments about the use of chemicals by his neighbors affecting ground water and boundary trees further illustrates the point of the ecological imperative guiding such informal organic diffusion. Multiple accounts speak of the need for farmers to act in concert due to the interconnected nature of farms and farming communities. In this light, Gafarbhai's diffusion efforts are part of an attempt to raise the social capital for a broader social network than just immediate colleagues, friends and family. The ecological welfare of the entire Talala farming community had become a motivating factor, and he played a part in ensuring that they were able to have sufficient sustainable social network options to choose environmentally friendly, and thus neighbor friendly, practices.

One limitation of the varieties of informal diffusion observed was the capital intensive nature of some inputs. Both the drip irrigation and solar pumps were found to be exclusively accessed by medium and large farmers who were most often owners of land exceeding two hectares. Even with the subsidy scheme in place, a number of farmers reported being unable to afford the system. In this way certain sustainable technologies became limited in their dissemination beyond certain income levels. Less capital intensive SAPT diffusion, such as with vermi-compost or seed saving demonstrations at Kureshi Bagh, could be accessed by all income levels. Such demonstrations encouraged individual seed saving and their direct seed sales provided further diversity in the seed market. Local farmers indicated that this was an important issue since many of them were unsatisfied with the price, quality and selection of commercial seed for both cereal crops and vegetables. The practice of biodiversity conservation on Kureshi Bagh increased the local variety of fruits, vegetables and cereals available for local cultivation and consumption. This practice above all others therefore increased the potential for the community to enhance its food security.

The informal education network that was created by opinion leaders is one element of this study which would profit greatly from further study. Although such networks were occasionally temporary and limited in nature, social learning and transformational learning studies could impart insight into such informal agricultural education processes (Keen, Mahanty, 2005). Such work has been of particular value when discussing issues of sustainable resource management (Keen et al., 2005; Buck, Wollenberg, Edmunds, 2001). Furthermore, such theories would complement the concept of social capital by describing the social processes which guide the creation and maintenance of social networks, particularly in the realm of informal education. As one of the principal theories addressing informal learning processes at the local level, further interviews focusing on the social and transformative learning dimensions of diffusion would find a rich data set among adopters and informal disseminators of SAPT.

Further implications pertain to the institutional support structures in place in Junagadh district. This case study has documented interactions between opinion leaders and institutions from the private, governmental and non-governmental agricultural development sectors. Each

was found to serve as a critical component of the technological diffusion network, and each has the potential to further aid informal diffusion processes. Regarding the governmental agencies discussed in the study, the agriculture college at Pune, in Maharastra, was one of the first to showcase the drip irrigation technology that was now rapidly spreading through the Junagadh district of the neighboring state of Gujarat. Rameshbhai had to make a multiple day journey in 2007 to reach the Pune center to learn about the drip technology and the subsidy program. Meanwhile, in 2012 the KVK which was a two hour drive from his farm still did not have any drip irrigation to demonstrate for farmers, despite the subsidy program being in place for six years. If the KVKs could keep pace with changes in subsidy programs, and compliment the subsidy incentive with education and demonstrations, opinion leaders such as Rameshbhai would have had to expend fewer resources to adopt and diffuse a given SAPT. Such governmental responsiveness would further augment local social capital in their district by tapping into the momentum of existing programs, such as the subsidy program, and expanding the development capacity of farming social networks in the process.

The JUA actively promoted the diffusion work of Gafarbhai by sending farmers and researchers to Kureshi Bagh to obtain samples of his biodiversity. However, this relationship could be further enhanced if the JUA would initiate formal relationships with such opinion leaders. He mentioned that while the modern science of such institutes was useful and interesting, he hoped that in the future such institutions would pay more attention to the traditional techniques used by him and his family for generations. Even the new vogue of minimal tillage, Gafarbhai commented, was a common practice of some ancient Indian agriculturalists. To further support his assertion, it was learned that no organic methods were being developed or promoted at the time of the interviews. Similarly, while the problem and adverse consequences of flower drop in mangos was well known to the horticulturalists there, no active research addressed the issue. The maintenance of horizontal feedback linkages with opinion leading farmers would have revealed that further research into the matter may not have been required, as a number of sustainable practices had already been shown to mitigate the effect of mango flower drop. Such institutions would benefit from not only requesting tissue samples from such farms as Kureshi Bagh, but also from solidifying relationships through such things as student placements on opinion leading farms, formalized feedback linkages, conference invitations, or hosting opinion leader public lectures.

Private companies and distributors demonstrated mixed support for the activities of local change agents. In the case of the solar pumps, JJPV Solar provided direct monetary support to the diffusion activities of Pareshbhai, on the condition of a purchase of a pump unit. Pareshbhai spoke directly with the main distributor out of their office in Veraval and was thus able to deal with full time marketing employees on the demonstration. In this way a farmer who was not accustomed to the operations of the new technology was able to host an event that raised public awareness about the innovation. In this instance the opinion leader's informal role was minimal and he acted largely as an avenue for the dissemination work of trained professionals. When asked if he would continue giving smaller private demonstrations, Pareshbhai noted that he was glad to continue to showcase the system for his colleagues and family, who had yet to seeit, but that since he was not an expert of solar technology and preferred such large groups to be informed by those who were trained in such matters. This method had the benefit of ensuring that the complex workings of a highly technical system were covered by trained professionals, although it formalized part of the process, distancing the opinion leader from the act of diffusion.

The personal initiative shown by Rameshbhai in promoting drip irrigation remained fully informal, as trained irrigation staff provided no assistance in his efforts. The Jain Irrigation dealer in Talala was a small branch of the international Jain Irrigation Company, and only had minimal support and installation staff available. They also provided no incentives for farmers to advertise their products. Rameshbhai commented that although money was not his motivating factor in hosting demonstrations, without some monetary incentive he would be unable to further promote the drip system, because it cost him money to do so. Furthermore, it was apparent from this and other comments that he had already reached the extent of his desired diffusion audience, insofar as there was no one else in his social network he felt compelled to share the technology with. If private enterprises marketing sustainable products wish to encourage further word of mouth product promotion, then any allocation of support staff, incentives, and access to an expanded audience may prove beneficial. Based on opinion leader input, strictly capital incentives tended to have a secondary influence on the decision to spread information about SAPT. Primary motivations for diffusion centered on its potential to enhance the social capital of the individual's social network and broader community, including those networks' capacity to sustainably interact with the environment. Additionally, systematized feedback from opinion leaders would further serve to test markets for the demand for a given product before committing to the promotion of an inappropriate technology and help iron out flaws in its design.

The role of non-governmental agencies was found to be critical in ensuring that communities had access to SAPT that would otherwise not find a place in the highly competitive input market. SRISTI was the most engaged of the observed agencies in directly supporting the informal diffusion efforts of opinion leading farmers. It provided a meaningful platform for them to share their acquired agricultural knowledge and through direct collaborations with individuals, facilitated the enhanced capacity for local collective action towards sustainability. The *Shodh Yatra* innovation survey granted informal opinion leaders and innovators from different communities a vehicle with which they were able to share their innovative practices and technology with one another, as well as with a broader audience through SRISTI's national and international connections. Additionally, such initiatives demonstrably increased the resources with which such opinion leaders were able to independently promote SAPT, such as with organic inputs and the diabetes medication. The survey also solidified the social network emerging between Gafarbhai and SRISTI, ensuring that his existing local networks would have access to the NGO's accumulated social capital.

Opinion leading farmers' interactions with NGOs could further contribute to the generation of local social capital through collaborative diffusion efforts. Farmer and opinion leader feedback revealed at least one concrete means by which this could be accomplished and it related to the prominent cases of mango flower drop in the area. Gafarbhai noted that organic practices tended to prevent the occurrence of flower drop, but that conversion to organic farming took several years. One organic SRISTI product was tailored to address the problem on contact with the affected flower without the conversion of entire farm practices. The SRISTI *Prayas* herbal extract directly promoted mango flower health through a sprayable application, but it was not reported to be sold through Kureshi Bagh, which is in predominantly mango producing area. No farmers contacted in the area were aware of the existence of such a product, though 81% of mango growers contacted thought that such product could decrease production losses. Local input dealers did not carry any chemical products for mango flower drop and neither the KVK nor JAU had any active research addressing the issue. While the diffusion of sustainable technologies and practices is not the main focus of this particular NGO, further proactive support from the non-governmental

sector directed towards the marketing of sustainable farming inputs based on opinion leader feedback could enhance communities' capacity for sustainable collective action. This sector showed the greatest capacity to collaborate in the informal diffusion of technologies, in part due to its ability to address gaps in technological availability offered by the private and public sectors.

CONCLUSIONS

Informal processes of horizontal diffusion have been shown to be effective mechanisms of increasing the social capital of communities by making sustainable farming practices more accessible at the local level. The individuals facilitating this process have been shown to fill gaps in the flow of knowledge and technology by promoting SAPT in areas which were not reached by the formal diffusion network. In the process they have been shown to leverage the existing social capital of their local networks to engage in diffusion, while the resulting local influx of knowledge and technology serves to create further social capital in that same system. Further study of these informal feedback loops and linkages would be useful in reducing the promotion of inappropriate technology and supply driven inputs, while enhancing the availability of sustainable farming options and increasing the social capital of local communities.

ACKNOWLEDGEMENTS

This work was made possible by a fellowship from the Shastri Indo-Canadian Institute in conjunction with SRISTI and Anil Gupta from the Indian Institute of Management Ahmedabad. Thanks to Rameshbhai, Pareshbhai, and Gafarbhai for their time and insight. Thanks in particular to Gafarbhai for providing accommodations and hospitality throughout the interviews. Thanks to Sandeep Vithalani and SRISTI for translation services.

References:

Ascroft, Joseph, &Agunga, Robert. (2006). Excerpt from: Diffusion Theory and Participatory Decision Making.*Communication for Social Change Anthology: Historical and Contemporary Readings*. Alfonso Gumucia-Dagron, & Thomas Tufte (eds.). South Orange, NJ: Communication for Social Change Consortium. 418-421.

Bennett, David. (2002). *Innovative Technology Transfer: Framework Linked to Trade for UNIDO Action.*Vienna: United Nations Industrial Development Organization.

Buck, Louise E., Wollenberg, Eva & Edmunds, David. (2001).Social learning in the collaborative management of community forests: Lessons from the field.*Social Learning in Community Forests*. Jakarta: Center for International Forestry Research.

Coleman, J. (1988) Social capital in the creation of human capital.*American Journal of Sociology*, 94, S95-S120.

McCulloch, A., Knox, Anna, Meinzen-Dick, Ruth, & Hazell, Peter. (1998). Property rights, collective action and technologies for natural resource management: A conceptual framework. *IFPRI SP-PRCA Working Paper No. 1, CGIAR System-wide Program on Property Rights and Collective Action*. Washington: Consultative Group on International Agricultural Research.

Feder, Gershon, Savastano, Sara. (2002). *The Role of Opinion Leaders in the Diffusion of New Knowledge: The Case of Integrated Pest Management*. Vienna: United Nations Industrial Development Organization.

Gaikwad, V.R., Gurnam, Saran, Tripathi B.L., BhanwerLal and Bhatnagar. (1972). *Opinion Leaders and Communication in Indian Villages*. Ahmedabad: Indian Institute of Management.

Grootaert, Christian, Narayan, Deepa, Nyhan Jones, Veronica, &Woolcock, Michael. (2004) *Measuring Social Capital: An integrated questionnaire*. Washington: World Bank.

Gupta, Anil. (2010). Grassroots Green Innovations for Inclusive Sustainable Development.*The Innovation for Development Report 2009-2010: Strengthening Innovation for the Prosperity of Nations.*Augusto Lopez Carlos (Ed.). New York: Palgrave Macmillan.

Harris, John. (2001). *Depoliticizing Development: The World Bank and Social Capital*. London: Anthem Press.

Holland, Matt. (2000). The Change Agent.*Achieving Cultural Change in Networked Libraries.* Reid, Bruce J. & Foster, William (eds). Aldershot: Gower105-107.

Junagadh Agricultural University profile. (August, 2012). Retrieved from, http://www.jau.in/index.php/about-us/jau-profile

Keen, M., and Mahanty, S. (2005) *Collaborative Learning: Bridging Scales and Interests in Social Leaning in Environmental Management: Towards a Sustainable Future.* London: Earthscan.

Le Anh, Tuan, Singleton, Grant R., Dzung, Nguyen Viet, and Palis, Florencia G. (2010). *The roles of change agents and opinion leaders in the diffusion of agricultural technologies in Vietnam: a case study of ACIAR–World Vision collaborative adaptive research projects. Research to impact: case studies for natural resource management for irrigated rice in Asia.*Palis, Florencia G., Singleton , Grant R., Casimero, Madonna C., and Hardy, Bill, (eds.). International Rice Research Institute, Los Banos: Philippines. 261-274.

Parthasarthy, D., and Chopde, V. K.(2000). *Building social capital: Collective action, adoption of agriculture innovation and poverty reduction in the Indian semi-arid tropics*.Patancheru: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Pullabhotla, Hemant, Kumar, Chandan, &Shilp,Verma. (2012). Micro-irrigation Subsidies in Gujarat and Andhra Pradesh: Implications for Market Dynamics and Growth. *Water Policy Research Highlights #43*. Colombo:International Water Management Institute.

Putnam, R. D. (1993). *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton, NJ: Princeton University Press.

Rogers, Everett M. (2003). *Diffusion of Innovation*. New York,NY: Free Press.

Roling, N. G., Wagemakers, M. A. E.. (2000).*Facilitating Sustainable Agriculture: Participatory Learning and Adaptive Management in Times of Environmental Uncertainty*. Cambridge: Cambridge University Press.

Saneja, Ankit, Sharma, Chetan, Aneja, K.R., Pahwa, R. (2010). "GymnemaSylvestre (Gurmar): A review" in Der Pharmacia Lettre, 2010:2(1) 275-284. Retrieved from http://scholarsresearchlibrary.com/DPL-vol2-iss1/DerPharmaciaLettre-%202010-2-1-275-284.html

7

INTEGRATED HOME GARDEN FOR BUILDING RESILIENCE OF MIGRANT FAMILIES IN NEPAL

Roshan Pudasaini,
Pashupati Chaudhary,
Ram Bahadur Rana,
Suman Manandhar

ABSTRACT

With three million Nepalese working abroad, remittance is the second largest source of income after agriculture. The remitted cash does not entirely offset the absent farm labor, which not only decreases the farm production but also adds physical and psychological pressures to women. But, on the other hand, by women taking more responsibility for agricultural activities their influence in family decision-making has markedly increased. Capitalizing the opportunity to work with women for increased farm production of such smallholder farming communities, LI-BIRD promoted home garden approach targeted to disadvantaged groups, where women comprised 70% of beneficiaries (n=7,700). It included various capacity building trainings and various material supports like composite vegetable seeds, fruit saplings, small animals, mushroom and honeybees. In 2009, baseline data was collected through household survey on 10% randomly selected households. Again same size of sample was considered to measure the change in 2010, 2011, 2012 and 2013, using the same questionnaire. According to the findings the smallholder families were able to increase income through home garden surplus from $ 35 to $ 95. The average number of home garden species that were consumed by such families was increased from 13 to 28. About Discriminated women who used to beg vegetable from their neighborhood have stopped the practice as they can now grow vegetables on their own. With women farmers engaged in production and marketing of home garden produces, they have ventured into taking commercial vegetable production, which indicates that home gardening could be an entry point to lure women into commercial farming. Hence, providing necessary technical support coupled with trainings and credit facilities for homestead production can create an alternative opportunity for women, of the migrant families for nutrition/food security, supplementary income leading to household resilience.

Key words: Labor migration, Women, Home garden, Nutrition, Household income

Migration is a continuous social process, taking place voluntary or involuntary in pursuit of better quality of life (Willem 2005; Chaudhary, 2011). Embedded in societal rules and norms (de Haan *et. al.* 2002) or driven by sociocultural, economic and environmental pressure, migration contributes to family food security and economic development. Household surveys from 71 developing countries have revealed that international remittances reduce both the level and depth of poverty (*Vargas et al*., 2008). With per capita income of US $ 642, Nepal is still one of the poorest countries in the world. However, poverty in Nepal has fallen from 42 to 25 percent during 1996 to 2011 (NLSS, 2011) and migration is the main driver contributing to this achievement.

Agriculture is the mainstay of livelihoods for more than 60% of the population in Nepal. More than 50% of farming households own less than 1 ha of land often insufficient to feed their family throughout the year. Because of such small landholdings and inadequate availability of technology and inputs, Nepalese agriculture still remains at subsistence level, which fails to attract younger generation towards it. Thus they look for alternatives outside their rural communities, either in urban centers or outside the country. Remittances from Nepali workers abroad have remained the second largest source of income after agriculture. The most visible effect of remittance flow in the country is manifested through its 23 percent share in GDP as stated by World Bank's Migration and Remittance Fact book 2011. According to NLSS 2011, the percentage of households receiving remittances increased from 23 percent in 1996 to 56 percent in 2011. About 67 percent households in *Tarai* and 50 percent households in the hills and the mountains receive remittances.

Apparently, migration has contributed to ensuring food security for many rural poor households and thus constitutes an efficient strategy for facing adversities such as low agricultural productivity and the inherent risks and instability of farming activities (Vargas *et al*., 2008). Nepal is also having benefits like transfer of resources to rural areas, such as financial or in-kind remittances, as well as the generation and transmission of new skills and innovative ideas through the migrants. Such inflow of financial and knowledge capital is significantly contributing to the process of rural development. However, its negative impacts like scarcity of agricultural labour, increased pressure on women and several undesirable social changes are also increasing. Male migration has reduced the production especially due to unavailability of labour for agricultural operations on time. Much of agricultural land has been left fallow in rural areas. Similarly, same phenomenon has overburdened women owing to other multiple household responsibilities.

In the changing context, it is important to find ways to make farm and families resilient to migration so that productivity of family farms can be sustained. While a handful of studies has been conducted related to migration and remittance issues as shown above and discussed later, very little is known about ways to tackle problems associated with it. In this paper, we will discuss the impacts of migration on women and role of home gardening technology in responding to such challenges. Finally, we offer some suggestions for improving home garden approach in increasing its contribution to food security and resilience of women and children in migrant families.

LITERATURE REVIEW

Impact of migration in Agriculture

While talking about migration, agriculture, being the mainstay of livelihoods and the most affected sector due to migration, comes first in Nepal. Nearly 74 percent households are engaged in agriculture (NLSS, 2011) with the varying farm size and production potential. The decision of migration itself has found to be affected by the availability of land of a family and its productivity (Bhandari, 2004; Gartaula *et al.* 2014). Households with large amounts of land tend to have higher income and can survive easily but the families, which are very poor and have little land, may find it necessary to send a household member to work elsewhere so that all members of the household can survive (Lee, 1985). In Nepal about 53 percent are "small" farmers, operating less than 0.5 ha of land and the figure has increased by 13 percent for the last 15 years (NLSS, 2011). This fact contributes to the 'push' factor of labour movement towards the area having higher income generating options. Besides, lack of

security at home, debt and will to live a better life push the youths to the foreign countries for employment. The consequent exodus of people has resulted in shortage of labour especially male in the agrarian society because migration is a male dominant phenomenon in Nepal (Gurung *et al*., 2011). Migration affects the migrant's family and the society as well especially the migrant's spouse, who has the sole responsibility to take care of their children, usual household activities and also has to take care of farming. Therefore, it seems obvious that male migration significantly increases workload on women especially in agrarian households.

Negative Impacts in Women's Livelihood

The number of Nepalese women migrating outside the country in search of job is meager as compared to men due to socio-cultural factors just like in other South Asian countries such as Bangladesh and Pakistan (Battistella, 2003). Male migration has both negative as well as positive impacts. Feminization of agriculture is one of the outcomes of migration; for last 15 years armed conflicts and higher outmigration of men folks from rural areas of Nepal have increased the burden on women and also increased feminization of agriculture (Ghale, 2008; IOM, 2010). Furthermore, remitted cash does not entirely offset the absent farm labour within the migrant households, since hired labour is likely to be costly, less intensive and mostly not available on time. This not only decreases the farm production but also adds on physical and psychological pressures to women (H/, 2006). Agriculture as well as associated women can benefit only if new resources are judiciously invested in agricultural and non-agricultural production apart from consumption, housing, education and health. Now it is clear that the women drudgery is being increased due to male migration, since they have to assume additional responsibility for some or all of the migrant's tasks while still continuing their previous activities. However, it is not clear how much control they have on the share of the remittance up to the date. Even with the growth of the local economy from remittance in the village, women do not always benefit substantially (Vargas et al., 2008). Only twenty three percent of migrants' spouses make decision on how to use remittance amount (NLSS, 2011). However women's role in decision-making is increasing with the absence of male household heads. But in most of the cases, still the second male member takes the chance to decide on how to use the fund.

The amount of money sent by the migrants depends upon the type of the job in the host country, the salary level and their lifestyle in the foreign place. In most of the cases, the migrants from disadvantaged ethnic caste with weak economic background are unable to remit enough money as the family expects, as the major portion of the income goes to the settlement of loan taken for different processes that incurred in the immigration. The latest reports indicate that the remitted money is expensed mainly for daily consumption and for repaying the loans. About 79 percent of the total remittance received by the households is used for daily consumption while 7 percent is used for loans repayment (NLSS, 2011). A study done by ICIMOD (2010) suggests only 18 percent of the salary could be sent home as monetary remittance. Hence the low level of remittance and low level of agricultural productivity conjoin to make life very difficult for de facto women heads. As a result women are involved in a number of low paying off-farm activities like sale of fuel wood, animal fodder, wage labour etc. as part of continuous struggle to survive and support their family. Sometimes women seem to be trying to start businesses on their own with or without support of remittance when they become alone. The success rate of their businesses is very low in most of the cases, because such enterprises are typically small and with a high failure rate due

to women's heavy workload and time constraints and lack of access to finance, education and trainings (Garcia and Paiewonsky, 2006).

There are several psycho-social implications that might result in a woman's life due to her husband's migration. In many cases, women may suffer from loneliness, social withdrawal and reduced confidence in absence of her husband. Similarly children may suffer from lack of role models, discipline or parental care and their education. Besides social problems such as family disintegration, early pregnancy and increased drug use among children also have been reported in the past as a consequence of migration. Besides, wives of migrant men are highly vulnerable to natural or artificial shocks to livelihood due to the destruction of household assets like livestock and declined agricultural production over years due to absence of their husbands from home for longer period. The decline in livestock population is observed to jeopardize the future agricultural production potential of the household by limiting the amount of farmyard manure available for soil fertility maintenance (H/Micheal, 2006).

OPPORTUNITIES

Apart from the negative impacts there are some new areas of growth introduced by migration in agriculture as well as in women's livelihood. Migrants' families have now better access to food and health services (IOM, 2010). Similarly their capacity to invest on on-farm or off-farm income-generating activities has also increased in many cases. When men leave their wives and children at home, the wives start learning to live in new and challenging environment. Since most of the working age men between 15 and 59 years migrated outside the country for employment, it is commonly the women who are now responsible for agricultural job. Due to this fact, women influence in family decision-making has markedly increased. In most of the cases the wives have become empowered with the increased level of confidence after their husbands' migration. If there is land insufficient to support quality livelihood, the wife may decide to take casual wage labor or enter into trading (H/Micheal, 2006). They always try to know how to make their lives more secured. Most of them start communicating to the outer world with the newly developed access to mobile phones, radios, TVs and other household appliances. They extend their relationship with banks or other financial institutions to receive and manage remittances (IOM, 2010). Access to development programmes also increases due to their exposure. Overall, they develop new relations and are more responsible for managing household affairs, including agriculture, livestock and education of their children. But these all are just an improvement and cannot be related to the impact of migration only. Still there are huge difficulties being faced by women regarding knowledge, availability and access of nutritious food as well as social respect (UNFPA, 2007).

INTEGRATED HOME GARDEN AS A STRATEGY

In Nepal, the trend of landlessness or nearly landlessness is ever increasing. Although agriculture is the mainstay of the country, the majority of the farming households are subsistence farmers who own less than 1 ha of land. The migrants' families left behind, especially the wife, found to suffer more in the case of poor and small holders having the low rate of per capita remittance receipt as indicated by NLSS, 2011. More than 50 percent farmers are already small holders and the access to cultivated land is diminishing over time as a result of rapid population growth as well as land fragmentation. This can lead our communities to relatively deprived households over time. In such context, promoting

integrated agriculture in a form of home garden interventions has been proposed by LI-BIRD as one of the ways to increase farm productivity.

Home garden, with the literal meaning *Ghar Bagaincha*, refers to a traditional land use system around homestead, where several species of plants and animals are grown and maintained by household members and their products primarily intended for the family consumption (Shrestha *et al.*, 2002). A total of 72 percent HHs in Nepal grow vegetables in home garden (NLSS, 2011, Gautam *et al.*, 2004). Home gardens in rural areas of Nepal are the major sources of family vegetables and fruits as they supply 60 percent of the total vegetables and fruit requirements of the family (Gautam *et. al.*, 2004). Besides fruits and vegetables, a home garden holds a variety of small enterprises integrated within. For example components like livestock, poultry, fish, seed production, nursery management, honeybee, mushroom, value addition and marketing etc. are integrated in home garden. All those components have been managed connectedly to have a synergistic production, greater than the sum of its parts (Sthapit *et al.* 2010). As compared to the sole crop production system, it gives considerably higher and diversified type of products. An integrated home garden is able to contribute to nutrition, income as well as enhance other social capacities of rural women (Pudasaini *et. al.*, 2013). LI-BIRD's work on integrated home garden has shown that the left behind women of a migrant's family who lack options of livelihood and have small landholding have remarkably benefitted through such homestead level intervention. By culture, home gardens are more close to women in Nepal, regarding the management decisions and access to income. It does not require high amount of financial investment. With low-cost management technologies and family labour, a home garden produces a diversity of nutritious products along with the scope of having income exemplified by many women who are being appreciated not only by their families but also by their communities. It further adds courage to them and inspires them to venture into commercially viable undertaking in fresh vegetable production. There are also some cases where portions of remittances are invested to buy additional land to grow vegetables and fruits on commercial scale. The skills to this commercialization are gained from home garden.

RESEARCH METHODOLOGY

LI-BIRD with financial support from Swiss Agency for Development and Cooperation (SDC) and technical support from Bioversity International, initiated home garden as a research project (2002-2005) in four districts viz. Jhapa, Ilam, Rupandehi and Gulmi to understand and document the historical/cultural perspective, structure, composition, utilization and underlying indigenous knowledge systems of Nepalese home gardens. This phase provided empirical evidences to claim that home garden is important and reliable source of food, nutrition and income and can contribute to livelihood security of resource poor and socially excluded farming families. Since 2006, LI-BIRD has scaled up the good practices, experiences and learning of home garden project through diverse partners in 16 districts in phase II (2006-2008) and phase III (2009-2013) programme.

A baseline survey was conducted in 2009 to generate benchmark information on home gardens of selected sites. The baseline assessed the existing situation of household's food availability from the home gardens and to identify the gap periods for limited supply of diverse nutrition through home garden. The initial status of economical and social capacity of the disadvantaged families was also recorded by the survey. Such parameters were annually measured in subsequent years until 2013. This paper analyses the trend as well as differences to find out the actual progress on nutrition, economy and social capacity of the disadvantaged

families due to the improved management of home garden. Following the stratified sampling procedure 769 HHs from 23 villages of 10 different districts (Jhapa, Ilam, Dolakha, Ramechhap, Okhaldhunga, Rupandehi, Gulmi, Bardiya, Kailali and Kanchanpur) were selected ensuring the inclusion of all the economic & geographic criteria. Among those, male migration existed in 40% households. During the course of project implementation LI-BIRD prepared four outcome monitoring summary (OMS) reports in subsequent years till 2013. The OMS data were collected from randomly selected 1,162 households out of total 7,700 beneficiaries across the project intervention area using selected questions from the questionnaire of baseline survey, year by year. Including baseline data of 2009 the project now has five year's continuous progress data for the same indicators of various outcomes. We also reviewed report prepared by the external reviewers to make sure we are not biased, as such reports present independent and honest views and suggestions. Besides, we reviewed progress and annual reports prepared by the project team at different times.

This paper tries to consolidate all the reports so that we can analyze the pattern of progress, which can add a solid strength to the outcomes that is being claimed by home garden project. More specifically, we tried to explore % household consuming 1-10 species and >10 species from 2010-2013, % households with different number (<5, 5-10, >10) of home garden components in 2010 and 2013, species richness (0-10, 11-25, 26-50 and >50 species) from 2009-2013, expenditure on vegetable (0-1000 Rs and >1,000 Rs) from 2009-2013, income generated (0-5,000 Rs and >5,000 Rs) from home garden from 2009-2013. The data was analyzed using SPSS/PC module.

FINDINGS AND DISCUSSION

Impact on Family Nutrition

Forty-two percent of children under five are stunted in Nepal (NLSS, 2011). Similarly, the malnutrition rates in children up to five years are: 39 percent underweight, 43 percent stunting, 13 percent wasting and 48 percent with anaemia (NLSS, 2011 and WHO 2009). Stunting is higher among females than males in rural areas. A lack of sufficient micronutrients in the diet results into serious health problem, which may even endanger their lives. Mostly children and pregnant and lactating women are suffering from micronutrient deficiencies in under-developed countries like Nepal. Women with reduced purchasing power might suffer more from nutritional unavailability after the migration of their husbands with low or no remittance supplied. Problem of deficiencies of Vitamin A, Iron and Iodine, which are most prevalent in rural Nepal, can be addressed by the promotion of home garden agro-biodiversity management (G. C., 2004). Women who have limited access to maternal health services like nutritional supplement can have required amount of all types of micronutrients including Vitamin A, Folate, Iron, Calcium etc. through home garden during the sensitive period of pregnancy and lactation.

Supplementation, food fortification, nutritional education and dietary diversification (basically through agricultural interventions) are some approaches being adopted to address micronutrient deficiency in Nepal (Talukder *et al.*, 2010). Among these approaches, dietary diversification strategies are considered more sustainable because these are often community-based and have the advantage of being more economically feasible, culturally acceptable and women friendly as compared to the other methods improving micronutrient status in rural people (Gibson and Hotz, 2001; Ruel, 2001; G. C., 2004). Increasing availability and consumption of micronutrient-rich foods through a homestead-based production is considered

as a sustainable approach because it empowers family members especially women to take ultimate responsibility over the quality of their diet through their own production of nutrient-rich foods and educated consumption choices (Ruel and Levin, 2001). Experiences from South Africa, Bangladesh, Cambodia and Nepal showed that the women become more aware of their health benefits from agriculture-based dietary diversification after getting involved in home garden promotion activities. They appreciate the fact that they no longer had to buy vegetables since they are associated with home gardening for livelihood (Faber, 2003; Talukder *et al*., 2004; 2010 and LI-BIRD, 2009).

Narmaya Tamang is one of those women who relied on her integrated home garden to improve her family nutrition and income. Shortly after Narmaya's husband went to Iraq, the Company he used to work for collapsed and he was unable to supply remittance to his home. Ms. Tamang then had to struggle to provide food and education to their children (one son and one daughter) on her own.

Through the Home Garden project she participated in trainings on nutrition and low-cost home garden management technologies. She learned the value and techniques of integrating different species of vegetables, fruits and spices in her home garden. With the help of the LILI project, she got access to irrigation facility for her home garden. By adding pig and poultry, she was further able to increase income from home garden production.

Her home garden now provides vegetables round the year for her family and she makes some saving as well. She is saving Rs. 1,500 per month which she was spending to buy vegetables. Instead, she makes money of Rs. 3,000 from the HG product surplus sale. She could well nourish her children and have no difficulties to send her children in school due to added income from the Home Garden.

Narmaya's husband is now back to his village shocked by his bitter experience in Iran. He was very much pleased with the income his wife was earning from the home garden. Now they work together in their home garden and he also makes additional income by working on road construction by the District Road Support Programmeme. Together they repaid their loan and their average monthly income from both of the sources is Rs. 12,000. 'Life is good now,' reflects Narmaya.

Home garden project implemented by LI-BIRD was able to increase year round species richness in home gardens. In 2009, 17% HHs had greater than 25 species (vegetable, fruits and spices, fodder, medicinal plants and others) in their home gardens whereas in 2013 that increased to 79% (Annex 1). Realizing the fact that all the types of plant species in home garden may not be edible, comparison of data was made for the 'species that are currently being consumed'. In 2009 the average number of species being consumed by the impact group was 13 (n=1162, σ = 7.13). Analyzing the trend, consumption of greater than 10 additional species was remarkably increased during 2012 and 2013 (Fig 1). The final OMS suggest the average species consumed by the impact group to be 28 (σ = 8.86, n=1162). Considering that the increased amount and diversity in consumption increases the nutritional availability, this evidence shows the potential of home garden promotion activities to contribute nutritional status improvement of rural families.

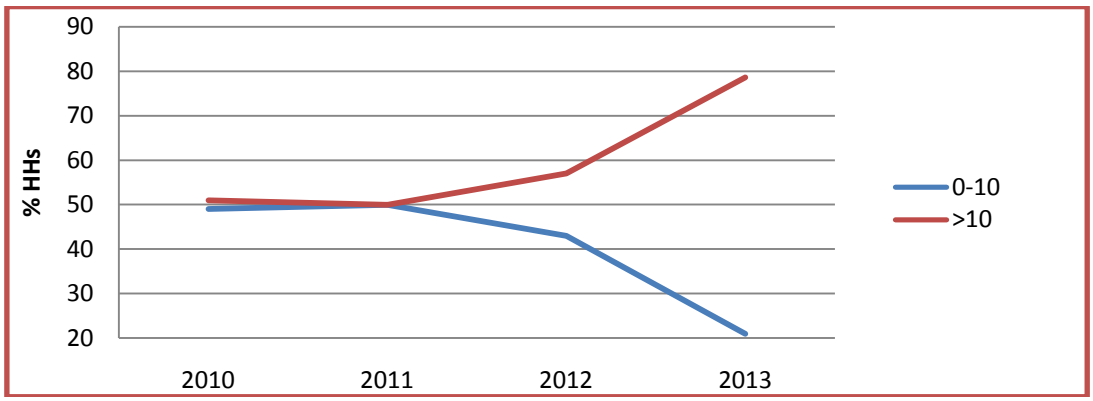


Fig 1 Increased consumption of home garden species by year

In a review carried out by external team of experts (agriculture and nutrition), it was reported that the home garden project was able to have relatively larger nutritional security and economic impact on the disadvantaged groups and small landholders of rural Nepal though the project was undertaken in a very small scale around the home premises. Similarly, after the implementation of the project, the scarcity of vegetables has been reduced over 60 percent of the beneficiary households during the lean period and above 80 percent of the households became aware of the importance of home garden species, nutritional value and integrated production system. The results indicate that home garden can become effective for livelihood enhancement of disadvantaged communities in migration-prone areas which is supported by Joshi and Pradhan (2012).

IMPACT ON INCOME GENERATION

In Nepal, 28 percent of all household income comes from agriculture, 37 percent from non-farm enterprises, and 17 percent from remittances (NLSS, 2011). In rural Nepal, the largest share of income comes from agriculture, whereas urban households diversify their income generation sources ranging from wage, rent and enterprise-based income. Poverty in rural areas of Nepal is endemic and household income level is much lower in that area as compared to urban areas. Migration of male has been found to affect agriculture as well as livestock holding in rural areas, negatively in most of the cases. Major consequences of male migration to agriculture are labour scarcity and decreased capacity to invest at least until the household starts receiving remittance in sufficient amount. Due to the increased workload and inability to maintain management cost, most of the de facto women household heads may

decide to decrease the number of livestock, as seen in Ethiopia (H/Micheal, 2006). As a result both the farm production as well as income falls down.

The prices of agricultural commodities, especially vegetables and fruits have in general increased by almost three to four times in Nepal during the past few years, especially after 2008. Vegetables and fruits were in the first and second positions of the increased price list of food items during the fiscal year 2011 (World Bank, 2011). Home garden can reverse the outflow of hard earned remittance to urban markets by minimizing the dependency of poor families in external source for vegetables, fruits and fresh meat. Home gardening is a low-cost production system that contributes to the household economy and food security. The family can consume a large proportion of the products of homesteads and the surplus is sold in the market. The consumed produces of home garden could be taken as indirect form of income because it saves hard earned money to be spent for food or vegetables. The amount of income derived from home garden is primarily determined by crop composition in the garden and integrated components like livestock, poultry, fish etc. In Nepal home gardening is the traditional system of integrated agriculture, which holds a potential of increased production through the introduction of improved technologies and inputs.

Participation of rural women in homestead agriculture is already high in Nepalese context because it is naturally feasible and advantageous to women. Women from the family that have small land holdings have the highest degree of involvement in agriculture (Karim and Wee, 1996). Women are involved in seed management, crop management, harvesting and marketing of home garden crops. They also have strong say in decision-making such as selecting the crop species or adding integrated components (livestock, fish etc.) in home garden. Hence women seem to have more control over the income from home garden as compared to other household income sources (Adhikari *et al.*, 2004; Karim and Wee, 1996). Home garden provides women with income of their own, which is essential because of the increasing importance of money during absence of their husbands with the increased responsibility of expenses on food, child education and family health.

Components that give opportunity to have direct income and can be integrated in a home garden as well as easily managed by women (e.g. livestock, mushroom and other practices) were promoted by the home garden project of LI-BIRD (Annex 2). There was significant increment in households that are having at least 10 types of integrated components in their home garden (Fig 2).

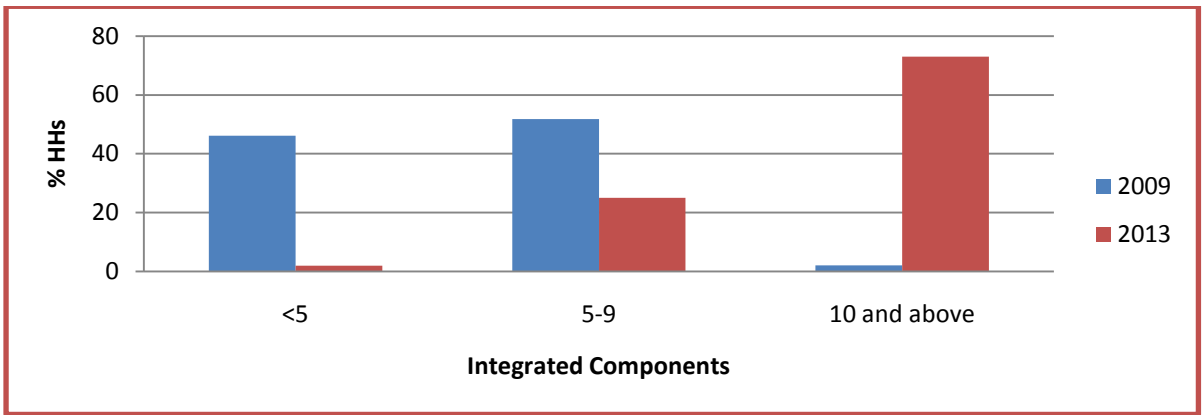


Figure 2. Change in pattern of integration of income generating components in home garden

Families have remarkably reduced expenditure in vegetable purchase by the end of 2013. In 2009, households spending more than Rs 1,000 on vegetable was 83%, which was down to 35% in 2013 (Fig 3). In 2009, 46% households sold surplus home garden produces to have cash earning, whereas in 2013 this figure increased to 71%. Not only the number of households but also the amount of earning by individual household has increased every succeeding year (Annex 4). Households with no practice of surplus sale have been reduced from 55% to 29%. Similarly, households that are earning minimum Rs 5,000 has been found consistently increasing from the first year of intervention (Figure 4). Average income from the Home Garden intervention raised from Rs 3,376 (n=523, σ = 5,793, median = 1500) in 2009 to Rs 9,218 (n=825, σ = 12,015, median value = 5,000) in 2013.

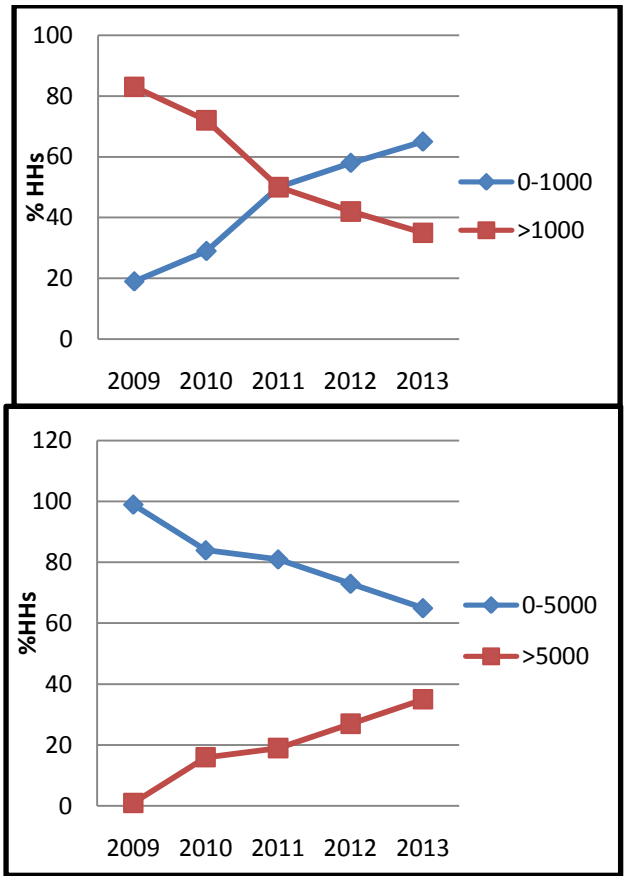


Figure 3: Change in pattern of expenditure on vegetables

Figure 4: Increase in home garden income by year

Home gardens are capable of contributing to household income, although the figure of direct earning is bit small in amount. Similarly it is now clear that there is scope of improvement in Nepalese home gardens to make smallholders financially more productive. Home garden has been found to be very effective entry point for starting vegetable or fruit production on a commercial scale.

IMPACT ON WOMEN EMPOWERMENT

In general the situation for Nepalese rural women is characterized by low levels of access to education, healthcare, and economical, social, and political opportunities. To raise the status of women in Nepal and increase their contribution to the country's economic development, government and development organizations have focused their efforts on

empowering women. Among various components "increasing access to economic opportunities" and "strengthening women's self-confidence" are two major components in empowering women in Nepal, (Mahat, 2003). Yet, no significant improvements are visible in women's access to economic resources regarding the empowerment process during past years (Acharya *et al.,* 2007). In the rural communities, we still find discriminatory wage structures and unequal access to earned income. Now the government focuses on increasing women participation on commercial farming for their increased access and control over livelihood sources. Migration of household head might further add on economic vulnerability and social injustice on rural women. In such situation home garden practice gives women a chance to gain control over productive resources and enable them to make independent financial decisions. Having the less required skills but good potential to produce food, the integrated home garden can be easily considered as a livelihood option by the disadvantaged women. Once they can earn on their own, respect in family as well as community grows up. It further adds on their self confidence and inspires for further progress.

Experiences of LI-BIRD (annual reports of HG project) suggest that most of the *dalit* women have stopped vegetable-begging practice. Having built a level of thinking that they can now do something on their own, there is no need of blessing from elite groups of the community at least for their food. Home garden project of LI-BIRD provided opportunity for the women in the community to participate in the home garden group activities on equal footing; thus giving them a sense or feeling of the equal social status. A review team (Joshi and Pradhan, 2012) found that the project has contributed to reduction in thinking and practice of gender and caste-based discrimination. Such an environment has been perceived by the communities in the project districts as a kind of respect and social justice to the Dalit (so-called untouchable) women who had vulnerable situation previously due to discriminatory practice of excluding them from the mainstream development process.

Various plans and strategies like agriculture perspective plan or different five years plans focus on commercial agriculture promotion in Nepal for the nation's poverty alleviation and economic growth (ANZDEC, 2003). Commercial Agriculture Development Project (CADP) implemented by Government of Nepal also focuses on disadvantaged groups as well as women (Annual report, 2011). However, despite all efforts to bring about transformative changes and growth in the agriculture sector of Nepal, the attempt has not fully translated into reality. Fragmentation of agricultural land is a major challenge to the commercialization and development of Nepalese agriculture having almost half of the total farms with the size less than 0.5 ha (Samriddhi, 2011). In such context small farmers involved in subsistence agriculture may not be interested in commercial agriculture as they lack experience and might feel insecure. However a gradual involvement in production and marketing can increase their interest as well as capacity. To increase women participation in commercial agriculture, homestead-based income generating activities could be the means. Evidences show that, once women start to earn from small scale farming, men also start contributing, which increases the chance of the business to grow. Migrants especially who cannot earn satisfactory in foreign place have shown higher tendency to be involved in such business when they return. As an integrated home garden composes various crops and enterprises, farmers can choose the most appropriate and beneficial in their contexts. The choice of the crops and enterprise depends upon individual resource types, family history and the recent experience of the individual, among others. Hence the learning from home garden as an integrated intensive farming system can support the growth of rural women towards commercial farming.

CONCLUSIONS AND RECOMMENDATIONS

Migration, the major livelihood option of rural Nepal, has contributed to reduced poverty and improved livelihood of Nepalese people though there are some negative impacts observed in agriculture. Similarly women, mainly the wives, from migrants' families are having difficulties in their life during absence of their spouses with the increased drudgery and vulnerability in the case of low remittance flow. Still there are some opportunities for women created by the situation. The meantime difficulties teach women to fight the situation and they start thinking the way out. Women with the support for their increased decision-making power, increased access to service institutions and remittance in the fortunate cases might have potential to start a business. Again due to the absence of adequate investment capacity and experience of farm-based income generation, such women likely face numerous problems while starting a business for household income. As a solution an integrated home gardening could be the most suitable production system regarding the family food security as well as economy. The women can easily enter into homestead agriculture business with nominal capital investments. It increases availability and consumption of micronutrient-rich foods and saves the regular outflow of huge amount of money for food, especially vegetables. In addition, an integrated home garden provides options to increase income by the women on their own, which is essential because of the increasing importance of money during the absence of their husbands with the increased responsibility of expenses on food, child education and family health. Due to such a change in status they start to gain kind of respects from the family and the community who put the women in migrant families in vulnerable situation previously due to discriminatory culture. This encourages women to grow further and have more income. By selecting one or few successful enterprises among the integrated components of homestead farm, women can start commercial production too. In the situation where the spouse returns without significant remittance, there is a lot of chance for them to join the homestead agriculture business. This gives further strength to the business and can turn the poor household to a successful farm.

Participating in intensive homestead production, women can contribute to intensive agriculture production activities. However due to lack of knowledge and utilization of proper technology and manageable practices the production remains below the accepted level. It may be due to the lack of communication and understanding of their beliefs by the change agents. So it is a crucial need to know the gap between existing beliefs and performances of our rural women regarding home garden production activities. Rural women need some technical backstopping and quality inputs like supply of seeds, improved livestock breeds, sustainable plant protection technology, sustainable soil and water management, niche market or market channel for home garden products and strong linkage with local government and service providers. Providing necessary extension support coupled with training and credit facilities for homestead production can greatly increase the extent of participation of rural women in integrated home garden production system.

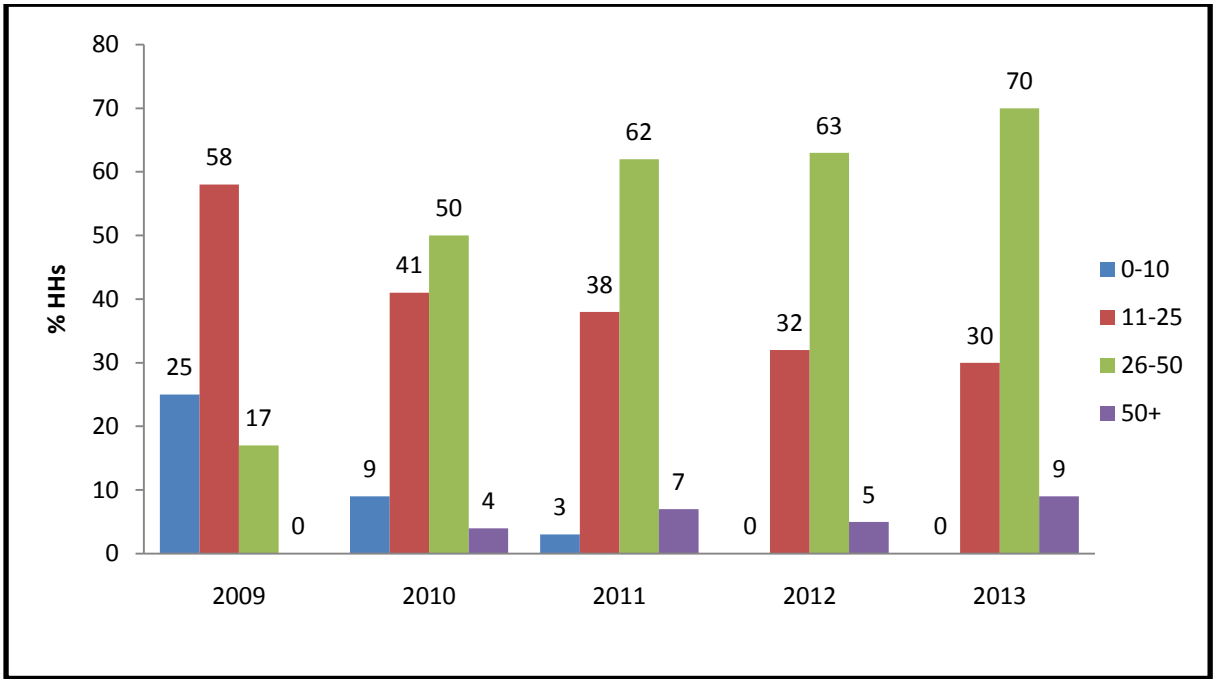
A conducive environment having favorable policy and programmes (e.g. integrated agriculture) that can address directly the challenges of women from migrants' families should be created. If the government and other stakeholders help to develop infrastructural facilities like irrigation, transport, communication and market for the agricultural products the process will be easier and efficient and benefits can be multiplied. Women's access to necessary means of production such as land, credit, information, technology are either very limited or isolated even when efforts are made. Hence, there is a need of massive reorientation of understanding of inclusive agricultural development where women's leadership is recognized

and ensured. Helping rural households to develop adaptation mechanisms, which may strengthen their ability to cope with climate change impact, is also important. An analysis of contribution of home garden to food security and household resilience in migrant and non-migrant families and management practices followed by each type is suggested. It can help develop policies in favor of migrant families, who are more vulnerable than non-migrants families in several fronts.

ACKNOWLEDGEMENTS

We acknowledge anonymous reviewers, home garden staff of LI-BIRD, farming communities, as well as Biodiversity International and SDC for the funding support to different phases of home garden project.

Annex 1: Figure: Change in species richness in HG by year



Annex 2: Elements that are considered as integrated components of home garden

1. Vegetable	9. Honey bee
2. Fruit	10. Mushroom
3. Spices	11. Duck
4. Fodder	12. Pigeon
5. Goat	13. Rabbit
6. Poultry	14. Nursery Management
7. Pig	15. Seed Production
8. Fish	16. Off season vegetable

References:

Acharya, M., P. Ghimire, P. Mathema, B. Acharya, C. Koirala, N. Shrestha and B. Sapkota. (2007). Gender Equality and Empowerment of Women in Nepal. United Nations Population Fund (UNFPA).

Adhikari, A., D. Singh, R. Suwal, P. K. Shrestha and R. Gautam. (2004). The Role of Gender in the Home Garden Management and Benefit-Sharing from Home Gardens in Different Productction System of Nepal. In Gautam, R, B R Sthapit and P K Shrestha (eds.) 2006. Home Gardens in Nepal: Proceeding of a workshop on "Enhancing the contribution of home garden to on-farm management of plant genetic resources and to improve the livelihoods of Nepalese farmers: Lessons learned and policy implications", 6-7 August 2004, Pokhara, Nepal. LI-BIRD, Bioversity International and SDC, pp 84-98.

ANZDEC. (2003). Nepal Commercial Development Project, ADB TA 3949-NEP. Final Report Volume 1: Main Report. Prepared for Government of Nepal, Ministry of Agriculture and cooperatives and the Asian Development Bank. ANZDEC Limited, New Zealand in association with ACI and CMS.

Battistella, Graziano. (2003). International migration in Asia, in Migration patterns and policies in the Asian and Pacific Region. *Asian Population Studies Series 160*. New York: United Nations.

Bhandari, P. (2004). Relative Deprivation and Migration in an Agricultural Setting of Nepal. *Population and Environment*, Vol. 25, No. 5. Human Sciences Press, Inc.

Chaudhary P. (2011). Transboundary conservation in Kanchenjunga landscape in the Eastern Himalayas. A PhD thesis submitted to University of Massachusetts, Boston, USA.

De Haan, A., K. Brook and N. Coulibaly (2002). 'Migration, Livelihoods and Institutions: Contrasting Patterns of Migration in Mali', *Journal of Development Studies* 38 (5): 37-58.

Faber, M. and A. J. S. Benade. (2003). Integrated home-gardening and community-based growth monitoring activities to alleviate vitamin A deficiency in a rural village in South Africa. *Food, Nutrition and Agriculture*, Vol 32. pp. 24-32

Garcia, M. and D. Paiewonsky. (2006). Gender Remittances and Development: The Case of Women Migrants From Vicente Noble, Dominican Republic. United Nations International Research and Training Institute for the Advancement of Women (INSTRAW)

Gartaula H. N., P. Chaudhary and K. Khadka. (2014). Land Redistribution and Reutilization in the Context of Migration in Rural Nepal. Land. Vol (3) pp. 541-556.

Gautam, R., R. Suwal and P. K. Shrestha. (2004). Status of Home Gardens of Nepal: Findings of Baseline Survey Conducted in Four Sites of Home Garden Project. In Gautam, R, B R Sthapit and P K Shrestha (eds.) 2006. Home Gardens in Nepal: Proceeding of a workshop on "Enhancing the contribution of home garden to on-farm management of plant genetic resources and to improve the livelihoods of Nepalese farmers: Lessons learned and policy implications", 6-7 August 2004, Pokhara, Nepal. LI-BIRD, Bioversity International and SDC, pp 51-65.

Ghale, Yamuna. (2008). Scoping Study on Women's Leadership in the Agriculture Sector in Nepal. Submitted to Women Organizing for Change in Agriculture and NRM (WOCAN).

Gibson, R. S., and C. Hotz. (2001). Dietary diversification/modification strategies to enhance micronutrient content and bioavailability of diets in developing countries. *British Journal of Nutrition* (2001), 85, Suppl. 2, S159±S166

Gurung, A., O. P. Gurung, and S. E Oh. (2011). The impact of labor out-migration on local livelihoods: a case study of Nepal, journal of agricultural life and environmental sciences 23, 44-60.

H/Micheal G. B. (2006.) M. A. Thesis on Impact of Male Out-Migration on Rural Women's Livelihood: The Case of Chencha Woreda, South Ethiopia 'Unpublished'. Addis Ababa University, Addis Ababa, Ethiopia.

International Organization for Migration (IOM). (2010). A Rapid Situation Assessment on Agriculture and Migration in Nepal. Submitted to Food and Agriculture Organization of the United Nations, Pulchowk, Nepal.

Joshi, N. N. and B. Pradhan.(2012). A Report on External Review of Home Garden Project Phase III. Prepared for Swiss Agency for Development and Cooperation (SDC) Nepal.

Karim, N. A. and M. M. B. Wee. (1996). Role of women in vegetable agribusiness. Vegetable crops agribusiness. Proc. Workshop held at BARC, Farmgate, Dhaka, Bangladesh, 2-4 May 1995. 177-182; Publication No. 97-457.

Lee, S. (1985). Why people intend to move: Individual and community level factors of outmigration in the Philippines. Boulder and London: Westview Press.

LI-BIRD. (2009). Annual Report. 2007-08. Local Initiatives for Biodiversity, Research and Development (LI-BIRD), Pokhara, Nepal.

Mahat, I. (2003). Women's Development in Nepal: The Myth of Empowerment. PRAXIS, The Fletcher Journal of International Development, VOLUME XVIII, pp. 67-72

NLSS. (2011). Nepal Living Standards Survey 2010/11: Statistical Report. Central Bureau of Statistics, National Planning Commission, Government of Nepal, Kathmandu, Nepal.

Pudasaini, R., S. Sthapit, R. Suwal and B. Sthapit. (2013). The role of home gardens and local, neglected and underutilized plant species in food security in Nepal and meeting the Millennium Development Goal 1 (MDG). In: Fanzo *et al.* eds. Diversifying Food and Diets, Routledge, USA.

Ruel, M. T. (2001). Can Food-Based Strategies Help Reduce Vitamin A and Iron Deficiencies? A Review of Recent Evidence. *International Food Policy Research Institute*, Washington, D.C.

Ruel, M. T. and Levin, C. E. (2001), Assessing the potential for food based strategies to reduce vitamin A and iron deficiencies: A review of recent evidence. Food Consumption and Nutrition Division Discussion Paper no 92.

Samriddhi. (2011). A discussion paper on: Commercialization of Agriculture in Nepal. Samriddhi, The Prosperity Foundation, Kathmandu, Nepal.

Shrestha, P., R. Gautam, R.B. Rana and B.R. Sthapit. (2002). Home gardens in Nepal: status and scope for research and development. In: J. W. Watson and P. B. Eyzaguirre (eds.) 2001. Home gardens and in situ conservation of plant genetic resources in farming systems, 17-19 July, Witzenhausen, Germany/IPGRI, Rome, pp. 105-124.

Sthapit, S. R. Suwal and R. Pudasaini. (2010). In Nepal, A Home Garden Is Greater Than the Sum of Its Parts. Nourishing the Planet. Worldwatch Institute. Retrieved on: http://blogs.worldwatch.org/nourishingtheplanet/in-nepal-a-home-garden-is-greater-than-the-sum-of-its-parts/

Talukder, A., G. Sapkota, S. Shrestha, S. Pee and M. W. Bloem. (2004). Homestead Food Production Programme in Central and Far-Western Nepal Increases Food and Nutrition Security: An Overview of Programme Achievements. In Gautam, R, B. R. Sthapit and P. K. Shrestha (eds.) 2006. Home Gardens in Nepal: Proceeding of a workshop on "Enhancing the contribution of home garden to on-farm management of plant genetic resources and to improve the livelihoods of Nepalese farmers: Lessons

learned and policy implications", 6-7 August 2004, Pokhara, Nepal. LI-BIRD, Bioversity International and SDC, pp 27-34.

Talukder, A., N.J. Haselow, A.K. Osei, E. Villate, D. Reario, H. Kroeun, L. SokHoing, A. Uddin, S. Dhunge and V. Quinn. (2010). Homestead food production model contributes to improved household food security and nutrition status of young children and women in poor populations. Field Actions Science Reports. Special Issue 1. Online since 17 February 2000, Connection on 15 October 2012. URL: http://factsreports.revues.org/404.

UNFPA. (2007). Gender equality and empowerment of women in Nepal. Report retrieved from: http://un.org.np/node/10577

Vargas, L. R., M. Villarreal, G. Lanly and M. Osorio.(2008). International migration, remittances and rural development. *International Fund for Agricultural Development* (IFAD).

Wellman B. and S. Wortley (1990). Different Strokes from Different Folks: Community Ties and Social Support. *American Journal of Sociology*, 96: 558-588.

WHO. (2009). Regional Workshop on National Nutrition Surveillance, Kathmandu Nepal, 30 November–2 December 2009. World Health Organization, Regional Office for South-East Asia

Willem R. (2005). Coping with displacement: Social networking among urban refugees in an East African context. Kyoto University Press & Trans Pacific Press.

World Bank. (2011). Nepal Economic Update. Poverty Reduction and Economic Management, SAR. The World Bank.

8

REACQUIRING A TASTE FOR DIVERSITY: CHANGING FOOD HABITS, THEIR CAUSAL FACTORS, AND THE VALUE OF DIETARY DIVERSITY IN JUMLA, NEPAL

Naomi Happychuk,
EpshaPalikhey,
Laxmi Lama,
Sajal Sthapit,
Shailesh Shukla

ABSTRACT

Understanding local food systems including food habit changes and the factors contributing to these changesis critical to ensuring effective interventions of food security. While diversity of foods is widely recognized as an important aspect of sustainable diets and food security, the value people place on dietary diversity is rarely considered in local interventions. In the remote, high-hill district of Jumla in Nepal, diversity is particularly important for food security. Despite this, many people choose to eat the same meal of *dalbhat* twice a day, leaving to question the value they have for dietary diversity. This has implications for the interventions used by policymakers and practitioners to address issues of food insecurity. This study examines community-perceived food habitchanges and the factors contributing to these changes in Jumla, in addition to the value people place on dietary diversity. A participatory research approach employingeight focus group discussions was used to elicit and examine community perceptions. A variety of causal factors were cited as responsible for changes in both consumption and production of food over the past sixty years, particularly the onset of pests and diseases, the effects of climate change, and food aid. While access and availability pose major barriers to dietary diversity in Jumla, persistent food habits were found to underlie consumption patterns. It is therefore necessary that the production and markets for local foods are enhanced, development and food security are planned collectively, and new cooking methods and recipes are promoted to enable people to*reacquire a taste for diversity.*

INTRODUCTION

Biodiversity is important in managing the goods and services that people need (e.g. food), contributing to ecosystem services (e.g. pollination, control of greenhouse gas emissions and soil dynamics) and for social, cultural and conservation benefits (Frison, Cherfas&Hodgkin, 2011; Johns & Sthapit, 2004). Diversity within a food system exists in several different forms, each with their own importance to food security. Crop diversity and genetic diversity (within crops)are important in boosting productivity (as has been found in home gardens),reducing the risk of crop failure in high stress environments, enhancing resistance to outbreaks of pests and diseases, regulating and supporting ecosystem services (e.g. enhancing pollinator availability) and improving adaptability and resilience to climate change (Frison, Cherfas&Hodgkin, 2011).

Dietary diversity is another crucial aspect of diversity in food systems which contribute to food security. Consumption of a diversity of foods is believed to contribute to better nutrition and health through the supply of micronutrients and other important components such as fibre (Frison, Cherfas&Hodgkin, 2011, p. 245). Dietary diversity has been linked to child development through reducing stunting and malnutrition(Arimond&Ruel, 2004), improving childhood survival in developing countries (Pelletier &Frongillo, 2003) and having a direct positive impact on economic productivity when children become adults (Hoddinott, Maluccio, Behrman, Flores, &Martorell, 2008). Furthermore, there is some evidence that dietary diversity reduces disease, morbidity and mortality (Frison, Smith, Johns, Cherfas, &Eyzaguirre, 2006).The importance of a diversity of foods to maintain a healthy and active living, or food security, is one of the most longstanding and universally accepted recommendations for human health both at the global, regional and local levels (Burlingame &Denini, 2010; FAO, 1996; FAO 2012; Hatloy, Hallund, Diarra, &Oshaug, 2000; WHO (Europe), 2003; UK Food Standards Agency, 2009). Diversity in the food system is particularly important for rural and remote populations, which are largely dependent on subsistence farming and where access to diverse foods through market imports is often limited and the impact of climate fluctuations are hard to predict.Consumption and production patterns however, are shaped by a variety of ever-changing environmental, social, and economic factors.

This study is based in the District of Jumla, in the Mid-Western Development Regionof Nepal. Located in the high-hills,where air and road accessibility are irregular and dependent on the weather, and farming is largely subsistence based. Jumla is ranked 64th out of 75 districts in its HDI (Human Development Index) score. Over half of the children under five are malnourished and life expectancies (of 63.14 years) are among the lowest in the country (Government of Nepal & UNDP, 2014).Due to its challenging and remote environment, this area has been the subject of previous studies including those by Bishop (1990) and Whiteman (1985) which explore livelihood strategies and crop productivity, respectively. However, socioeconomic development in Jumla is increasing. The recent construction of the Karnali Highway, connecting various VDCs in Jumla to Surkhet, a regional hub,has brought significant changes to the accessibility of imported foods in the region, thereby influencing local food systems. As a result of challenges in accessing chemical fertilizers and herbicides, and in an effort to find a niche market for the national export of foods produced in Jumla, the District Agriculture Development Office (DADO, a government agriculture extension service office), declared Jumla an organic district in 2007, bringing further changes to local production systems (Rajbhandari, 2010). Various other development initiatives, as well as reported impacts of climate change, have contributed to changing food habits in Jumla.As numerous studies have indicated, understanding changing food habits and the factors influencingfoodhabit changes is crucial to enhancing the ideas, goals, and policies for ensuring food security (FOODSECURE, 2013; Lentz, 1999). These studies however, seldom consider community-perspectives on food systems, which are critical to understanding the status and role of local food systems in enhancing community food security. Community-sourced information is a crucial means of shedding light on people's knowledge and awareness of food security and sustainable diets and the corresponding gaps in information or social stigmas surrounding food systems (necessary for appropriate interventions). It also highlights which factors community members consider to be most significant in impacting their food habits.

Picture 1: Barley fields rotate with rice crops along the road from Chandannath to Talium

Equally important to food security is dietary diversity, which "…reflects household access to a variety of foods, and is also a proxy for nutrient adequacy…" (FAO, 2013). In many areas of Nepal, regardless of affluence or access to a diverse variety of foods, *dalbhattarkari*, or simply *dalbhat*, a meal consisting of plain, boiledrice (*bhat*), and small sides of lentils or pulses made into a soup (*dal*), and vegetables cooked as a curry or simply stir-fried (*tarkari*), is consumed twice a day with snacks ("*khaaja*") consumed around these meals. While previous studies have found that rising incomes lead to the diversification of diets away from the traditional dominance of rice (FAO, 2004), this is not the case in Jumla, where rising incomes seem to have corresponded with a greater consumption of rice. This brings into question the value people place on dietary diversity. Previous studies have found that despite access to a diverse variety of foods, people may choose to base their diet on one "simple but perfect meal" (Lentz, 1999). As Lentz explains, "It seems to be this satisfaction with, and even pride in, the indigenous simple but perfect meal that accounts for the amazing persistence of food habits" (1999, p. 17).To what extent then, does the desire for dietary diversity influence current food habits? If people do not value diversity, initiatives should be based on education and awareness, to promote both food security and sustainable diets. If they do value dietary diversitythen it is important to understand, why they are not consuming a greater variety of foods? Understanding people's value for dietary diversity isconsequently a major gap in previous literature on food security.Therefore, this study contributes to food security knowledge and initiatives, through identifying and documenting community-perceived food habit changes, and their causal factors, and understanding the value people place on dietary diversity.

PURPOSE AND OBJECTIVES

The purpose of this paper is to identify and document food habit changes and the causes of these changes in Jumla, Nepal, as depicted by community members, and to determine their value for dietary diversity. Specific objectives include:

1. To describe the existing food habits and changes to themas perceived by community members
2. To identify and document key causal factors behind food habits and changes
3. To assess the community perception and value of dietary diversity

REVIEW OF LITERATURE

Food Habit Changes:

Much of the literature on food habit changes relates to dietary changes experienced by immigrants (Rosenmöller, Gasevic, Seidell& Lear, 2011; Wandel, Råberga, Kumarb, &Holmboe-Ottesenb, 2008), changes associated with life stages, such as childhood, marriage, and menstruation (Bove, Sobal, &Rauschenbach, 2003; Bryant,Truesdale& Dye, 2006; St-Onge, Keller, &Heymsfield, 2003), andchanges experienced by people under specific conditions such as smoking (Dallongeville, Marécaux, Fruchart, &Amouyel, 1998) and illness (Ikeda, Brown, Holland, Fukuhara, & Hodges, 2002).Many studieslink dietary changes with nutrition,as in cases of obesity (Agostoni et al, 2011; Popkin, Adair, & Ng, 2013), and with climate changes (Lobell et al, 2008; Shindell et al, 2012).

Studiesof food habits in developing countries typically are in reference to global food movements and case study comparisons (e.g.Brouwer, 2006;Den Hartog, van Staveren& Lentz, 1999). In literature specifically focused on Nepal, emphasis has been placed on the impact of environmental changes on food systems (Bista, Amgain& Shrestha, 2013; CGIAR, 2013), nutritional studies (Abhishek, Ashish&Faujdar, 2014), and food security assessments(FAO, 2010; Oxfam, 2011) rather than on the documentation of changing food habits. Changing food habits can include where foods are purchased and eaten, attitudes towards specific foods, tastes, and the effects of marketing. Globally these changes are leading towards more homogenous and less diverse diets (Fanzo, Cogill&Mattei, 2012, p. 2). There is a lack of literature on community-depicted food habit change.

CAUSAL FACTORS CONTRIBUTING TO FOOD HABIT CHANGES

Literature onthe causal factors of food habit changes either discuss general, global drivers of change, such as changes in demographics, economics, sociopolitical context, cultural context and science and technology (Ericksen, 2007), or more specificcausal factors of changing food habits, which are particularly prominent in the media, such as high food prices (The World Bank, 2013) and climate change (Schmidhuber&Tubiello, 2007). Other studies have focused on future predictions of changes to food habits and their causal factors (Godfray et al, 2010).

Agricultural intensification, poverty, population pressures, urbanization and lifestyle changes are recognized as substantial contributors to changing food systems (Fanzo, Cogill&Mattei, 2012), however much less is known about what influences food consumption. Fanzo, Cogill and Mattei (2012) suggest that consumption patterns are determined by income, lifestyle, and behaviours which are influenced by culture, media, and information. There is a lack of literature based on community-identified factors contributing to food habit changes.

THE VALUE PEOPLE HAVE FOR DIETARY DIVERSITY

Very few studies have focused on the value people place on dietary diversity. Dietary diversity primarily appears in literature which explores its connection to food security, or more specifically to nutrition and socio-economic status, two important aspects of food security (FAO, 2013; IFPRI, 2002; Rijal, 2010). Dietary diversity has been regarded as a key feature of a healthy diet (ensuring the intake of essential nutrients) and as an important aspect

of a "sustainable diet" which has low environmental impacts and contributes towards food and nutrition security and a healthy life for future and human generations (Burlingame & Denini, 2010; Fanzo, Cogill&Mattei, 2012).

Other literature has emphasized measures of dietary diversity (Drescher, Thiele, &Mensink, 2007; Ruel, 2003), of which there are many, and none of which is standardized in practice. Two popularized ones are those put out by the Food and Agriculture Organization (FAO) of the United Nations and the USAID's FANTA (Food and Nutrition Technical Assistance) Project, which measure dietary diversity using a Household Dietary Diversity Score (HDDS) and/or a Women's Dietary Diversity Score (WDDS). These require household or individual surveys thatdocument food consumption and categorize foods into nine to 12 food groups, based on nutritional value (FANTA, 2006; FAO, 2013).

While many studies have identified the value of biodiversity and genetic diversity, which often correlate with dietary diversity (Frison, Cherfas& Hodgkin, 2011; Toledoa& Burlingame, 2006; Sthapit, Rana, Eyzaguirre& Jarvis, 2008), the extent to which people value dietary diversity is seldom examined. Considering the level to which dietary diversity is recognized as an important aspect of food security, the lack of information on people's value for dietary diversity is a major gap in the literature which this paper tries to address through documenting community-identified food habit changes, their causal factors and the value that people place on dietary diversity.

Exploring changing food habits, their causal factors, and dietary diversity is particularly important in the remote district of Jumla, Nepal where people are largely dependent on subsistence farming and where access to diverse foods through market imports is often limited and the impact of climate fluctuations are hard to predict. Furthermore, socio-economic development in Jumla has typically not corresponded with increases in dietary diversity, which means that understanding the value that people place on dietary diversity is crucial to ensure adequate interventions for food security and sustainable diets.

RESEARCH METHODS

The objectives of this study were achieved through a participatory research approach (Chambers & Conway, 1992), which included eight Focus Group Discussions or FGDs (ODI, 2009) within the district of Jumla during the lean season (June, 2014), reflecting the time of year with greater food insecurity. These were held in four VDCs (Village Development Committees) in Jumla, which are the smallest administrative units of the government. Figure 5 illustrates a map of VDCs in Jumla while Table 1 depicts the details of the FGDs. The VDCs used for FGDs were selected based on LI-BIRD's involvement in Jumla (allowing for ease of access and organization of FGDs) and for their differences in food determining traits (described in Table 1).

The first two FGDs, while contributing important information, were primarily used as preparatory discussions, to gain information on regular food customs and habits and develop appropriate questions and context for interpreting results. FGD participants were selected with the help of community members, with emphasis on including people of an older-age (to better reflect on food habit changes) and a relatively even mix of women and men (38% and 62% respectively), with the exception of the youth and women's FGDs (see Table 1). Ideally these latter two FGDs would have been done in each VDC to allow for a greater regional comparison; however time constraints limited the scope of this study. Participant's fell

between the ages of 20 and 77 years. Their identity remained anonymous. The vast majority of participants identified as farmers, while a lesser extent identified as restaurant and hotel owners, food vendors, or agriculture extension officers, and less than five were not directly involved in a food-based occupation but instead identified as teachers, health workers, and NGO employees. While many of the questions proposed to participants in the FGDs were the same, others were adapted to fit the context or meant to build-off or verify previous responses. This study documents food habits as described by community members.

To attain information regarding food habit changes and their causal factors, participants in each of the VDCs were asked to reflect on food-related changes, when they recall them happening, and why they believe these changes have occurred. Participants helped to construct a timeline (see Figure 2) which has been compiled in a graphic representation (see Figure 6), with the exception of the youth and women's group FGDs which were not focused on food habit changes. As is customary in Nepal, responses were given based on the Nepali calendar (the BikramSambat calendar), of which it is presently the year 2071. All dates had to be converted to the Gregorian calendar, and therefore where exact months and days could not be recalled, translated dates may be misrepresented by a corresponding calendar year to that which is recorded.

While analysis of food habit changes and the factors contributing to these changes was primarily qualitative, two tables were made to quantify this information and compare it to the qualitative responses. One table recorded all types of food mentioned in the FGDs and organized them into food groups in the column "past" or "present", depending on how that food was referenced (see Table 2). There were no precise time boundaries given for defining the "past" and the "present". When dates were supplied, those prior to the year 2000 (Gregorian calendar) were included in the "past" quantifications and those in the year 2000 and after were included in the "present". Only specific food types in reference to consumption were included. The number of food types was totalled per food group to give an indication of food habit changes and dietary diversity over time as expressed in the FGDs. While conclusions cannot be made from this table alone (as it is possible that people did not state all of the foods consumed in the past or present), this chart is useful in comparison with qualitative findings. The other table (Table 3) documents the factors contributing to food habit changes (as noted by participants), and quantifies the number of times they were stated (in relation to changing food habits) within any of the FGDs, and the number of FGDs they were cited in, which may be indicative of the causal factors which people perceive to be the most significant in contributing to food habit changes.

Figure 2: Constructing a Timeline with FGD Participants in Patmara

As previous studies measuring the value people have for dietary diversity are limited, this objective was assessed based on community responses to three aspects of diversity: current consumption patterns, food preferences, and perceptions of dietary diversity. Current consumption patterns are a primary measure of dietary diversity and can be reflective of the value people place on diversity (FANTA, 2002; FAO, 2013). Analysis of consumption patterns included food types, the number of food groups (based on five common food groups including cereals/grains, vegetables, fruits, meats/meat alternatives, and dairy and egg), and the relative proportion of food types, as is consistent with the components of dietary diversity measurements (FANTA, 2002; FAO, 2013). Beverages were not included. Rather than inquiring about consumption within a specific time period and then quantifying the results by score (as is common in formal dietary diversity analyses held at the individual and household level), acquiring this information through FGDs required questioning respondents as to the frequency of consumption of these foods, and comparing the extent to which people diversify their diets from the common Nepali diet of *dalbhat* (rice, lentils or pulses, and vegetable) twice a day, or the extent of diversification within this consumption (e.g. the types of rice, *dal*, and vegetables consumed). Table 2 supports findings of diversity in consumption patterns through quantifying food types and food groups cited by respondents. Food preferences were acquired through asking questions to participants about their "ideal" food consumption in a day and foods they would like to consume more of. Participants were later asked whether or not they think their diet is diverse, if they believe diversity is important and how they might increase diversity in their diets, to gain an understanding of perceptions of dietary diversity. It was important to ask these questions last to ensure it did not influence other responses, as participants may seek out the "right" response to the questions. In analyzing the value of diversity, participant's perception of diversity was used as the primary indicator with current consumption patterns and food preferences used to support or comprehend the results. Discrepancies between these latter two aspects of diversity values with people's perception of diversity may be indicative of barriers to dietary diversity (whether physical or psychological) which must be addressed to ensure food security.

FINDINGS AND DISCUSSION

Food habit changes

People are consuming more vegetables, fruits, and meats than in the past, but less dairy, and egg.

General findings from the FGDs indicate that people are consuming more vegetables, meats and fruits than they did in the past, which has been associated with "socioeconomic development" and "richer diets" (Kastnera, Rivasa, Kochc&Nonhebela, 2012, p. 6868). Greater consumption of a variety of fruits and vegetables and regular integration of animal-derived foods in one's diet has been found to lead to better health and nutrition and thereby contribute to food security (Frison, Cherfas& Hodgkin, 2011). The introduction of new vegetable seeds and varieties, has led to the consumption of new types of vegetables, though some respondents claimed to have eaten more wild vegetables in the past which are presently too difficult to obtain (illustrated in Table 2).Consumption of local, mixed beans, primarily used in *dal*, remains an important part of people's diets. Fruit is the least consumed of the five food groups included in this study and is largely dependent on income and access (as vendors outside of the bazaar do not sell imported fruits). Local apples (through government marketing-for-export initiatives) and plum varieties are important sources of fruit when in season.

Whereas meat was only eaten for special occasions in the past, it is now eaten monthly or weekly, depending on people's income, as many reported the high prices of meat now as compared to the past. Most meat is purchased from the market or a local community member and may be sourced from local animals (primarily sheep and goat) or delivered (already processed) by plane. A reduction in livestock rearing due to less available grazing land as a result of population increases and agricultural production was reported, which has also reduced the availability and consumption of dairy products (including milk, curd, and ghee or butter) and egg, as shown in Table 2.

Figure 3: People Purchasing Vegetables from the Market in the Chandannath Bazaar

Availability of white rice has replaced consumption of traditional cereals/grains

People are consuming more white rice which has been made accessible through market access, aid programs, and road construction, where local, red rice *(JumliMarsi*) is not produced (such as in Patmara), or to supplement the lack of production and availability of local rice. Increases in rice consumption have corresponded with decreases in the consumption of *roti*, a flatbread which is typically made from local grains, including wheat,

barley, millet, buckwheat, and maize, in addition to declines in other recipes (described in Table 4) which require local crops. Many of these traditional and underutilized crops are believed to contribute to food security through reducing dependency on one or two staples (such as white rice), contributing to food quality and preserving dietary diversity (which has been linked to health and nutrition) (Mayes et al., 2011).

A number of explanations were given for this decline, including preference in the taste of rice over local grains and decreased drudgery in preparing and cooking rice as compared to *roti*. In Talium a respondent explained, "There were more varieties of dishes in the past. We used to alternate between local rice, maize *roti*, *lagad* made from buckwheat, *bhat* from proso millet, and *bhat* from foxtail millet." While a few respondents indicated that appreciation of the local grains has increased, the majority claimed that despite recognizing the nutritional values of these local crops they preferred to eat rice instead and imported white rice is more available and less expensive than local rice, even in the villages where local rice is produced. The decline in local cereal varieties with the accessibility of white rice is illustrated in Table 2.

While consumption of white rice has increased over the past 50 years, people have incorporated other forms of "*bhat*" from proso and foxtail millets or maize in their diet for many generations. Respondents described having a habit of eating rice; when local rice is not available, people eat the rice that is available (including imported or improved varieties). The value of rice consumption may be linked to social status, as participants indicated that only rich people ate rice in the past, and today only the wealthy (or those with their own production) can afford to eat the local rice. Furthermore, government officials and people of particular stature were granted greater quantities and could afford better quality rice when it was first delivered to Jumla through food aid programs. People near the bazaar were perceived to consume more rice than those in villages, which were presumed to consume more *roti*.

More foods are purchased from the market than in the past, and these are primarily white rice, imported snacks, and additives.

A common assertion among FGD participants was that they are now consuming less local foods and more imported foods than they did in the past, primarily because local foods are not easily available or are very costly. Despite the diversity of imported foods now available in the market (including a wide variety of vegetables and fruits), which could be a source of improved food security, the majority of respondents said they only purchase white rice, instant noodles, biscuits (crackers or cookies), oil, sugar, and salt, all of which are consumed in greater quantities than in the past. While white rice has replaced the consumption of local cereals and grains, the low cost and ease of access of instant noodles and biscuits, (which can be quickly obtained and brought to work in the fields), have resulted in these replacing the consumption of *roti* or boiled potatoes as snacks. Purchased oil (typically mustard, soybean, or sunflower), has also replaced the production of local oils from the seeds of wild plums, cannabis, and the *Prinsepia* plant (*dhatelo*), as illustrated in Table 2. The majority of respondents indicated that all other foods consumed (primarily vegetables) comes from their own production; though some purchase vegetables from the market which they do not grow or when their own vegetables are out of season. Purchases of fruit and other foods were rarer, though those in closer proximity to the bazaar purchase a larger variety of market foods more frequently.

People prefer local foods to imported foods

Participants discussed the better taste, nutritional value, and quality of local foods over imports, but noted that these foods were often unavailable (under-produced) or very costly, which was said to be the only reasons people consume imports. A price list of common local and imported foods in Chandannath and Talium, is given in Table 5, showing that imports are generally much less expensive than the same foods produced locally. The paradox of exporting organic products and importing lower quality foods for consumption was understood by participants. A number of participants proclaimed that they do not trust imported foods because of the chemicals used on them and believe that they are adulterated (e.g. white rice mixed with lower quality white rice). Some respondents believed that people have lower life expectancies, are not as strong and healthy, and are getting sick now, from eating more imported foods, including food aid, which has typically been in the form of imported white rice. While there is no evidence to confirm this, the nutritional value of locally grown foods and traditional crops and cereals are well documented (Fanzo, Hunter, Borelli &Mattei, 2013) as are the declines in nutritional value of rice (including proteins, vitamins and minerals) with the higher degree of polishing it receives (as in white rice, which receives 8-10 percent bran removal through polishing) (FAO, 2006). When asked if the direction of food habit changes was positive or negative, the majority of participants replied that food security has increased, because people can now get enough food (whereas in the past there were food shortages), however they also noted that nutrition has decreased because they are eating less local foods and more food imports. What might not be well understood is the increased dependency people have on external sources for food supply, leaving them more vulnerable to food system shocks.

Food production is more geared towards market sales than in the past

In many ways food production is aligned with changes in food consumption. People are producing more cash crops now, primarily apples, beans, and potatoes which can be marketed for export, in addition to new vegetable varieties which they can sell at the market. This is a result of the decreased labour involved in the production of these cash crops (as compared to local millets), as well as the lack of market for local crops. Barley and maize were reportedly used as much for animal feed as for human consumption, and various grains are now used more for producing local alcohol (*raksi*) than for food, indicative of the changing uses of traditional crops. One of the farmers from Talium said that he is producing less local crops (such as millet and buckwheat) because the demand for these has declined. Lack of production also affects demand however, through driving up prices and the unavailability of foods discouraging purchasing patterns. While most respondents claim to produce for their own subsistence, many stated that even when their own production was insufficient to meet household needs, they still put aside produce to sell in the market. This can promote food security through providing people with income which can be used to purchase a diversity of market foods, however most respondents in this study indicated that they mostly limit market purchases towhite rice, processed snacks (instant noodles and biscuits), oil, and sugar.

Women are the primary custodians of the food system

While there is some indication that gender roles in food production and consumption have changed, this remains primarily the role of women. Some women said they receive help from their children (particularly girls) and/or husbands with food production, but this is rare

and decreasing with greater opportunities for wage labour outside of the agriculture sector. Respondents from the women's FGD stated that if community members see men working (in the fields), they talk negatively about it. Women are responsible for carrying produce to the market to sell, sometimes walking for hours with large, bamboo baskets strapped to their foreheads. In a number of cases, respondents indicated that men only help with food-based labour when they are "not drunk" or "playing cards".

Decisions about which foods to produce or consume lie with the women or occasionally are shared between husband and wife and are based on the family's food needs, the potential for food sales, and consideration of weather or pests and diseases. Family members may influence food consumption, particularly with men requesting to have rice (which is also easier to prepare than traditional grains such as millets), and children requesting various "treats" such as meat, fruit, dairy, or instant noodles. Whereas in the past, women were expected to eat different and less preferred foods than men, such as *roti* or *bhat* made of proso millet rather than rice, respondents said they now consume the same food.

FACTORS CONTRIBUTING TO FOOD HABIT CHANGES

There are diverse factors contributing to changes infood habits

During the course of the FGDs, participants cited 20 major causal factors of food habit changes which have been documented in Table 3. These include environmental (e.g. disease or drought), economic (e.g. wage income and purchasing power), and social factors (e.g. children in school), and many which span between these sectors, illustrating the interconnected nature of thecausal factors of food habit changes. While some of these "naturally" progressed without planning or intention (e.g. the decline of natural vegetation or population increase), others were the results of deliberate policy changes (e.g. food aid or the introduction of new vegetable seed varieties). Some were synonymous with socioeconomic development in Jumla (e.g. road construction, reduction in ethnic disparities, and knowledge of health and nutrition), while others illustrate persistingbarriers and challenges to development (e.g. irrigation problems, high levels of drudgery and lack of profit associated with local crops). The oldest of these causal factors, described in the 1960s and 1970s by participants, (as illustrated in the Timeline, Figure 6), relate to poor weather, pests and diseases, and the introduction of white rice, primarily through food aid programs. The most recent of these factors (in the past 10 years) reference Karnali Highway construction ("food for work" -relating to wage and market access) and cash-crop production in the region.

The greatest factors contributing to food habits changes have been on food production

The majority of the causal factors listed by respondents (70 percent) were in reference to changes on production patterns rather than consumption. These include environmental challenges (hail, temperature increases, pests and disease), the reduction in the number of people working in agriculture (due to education, increased off-farm opportunities for wage labour, and shifting attitudes towards changing lifestyles e.g. "people are lazier"), and the comparative advantage of planting cash crops as opposed to local grains and cereals (including decreased labour and increased profit). Only six causal factors of change were reported which have affected food consumption habits and these largely relate to increased access to imported goods (through food aid, road construction, and purchasing power) and increased knowledge and education (in health and nutrition and seed and vegetable varieties).

Figure 4: Women Planting Rice in Talium

"Pests and diseases", particularly rice blast, was the number one cited causal factor of food habit changes

Of all of the factors contributing tofood habit changes reported during the FGDs, the most commonly cited was the impact of pests and diseases on local food production. While this included reported locust outbreaks, unknown pests, and smut disease on wheat, the vast majority of respondents referred to blast disease in rice. As illustrated in Table 3, "pests and diseases" was listed as a majorcausal factor of change in all of the FGDs and was also cited the most frequently (in addition to issues of climate change) throughout the FGDs.The blast problem in local rice was cited (in the Chandannath FGD, illustrated in Figure 6),as beginning in 1998 and corresponded with increased deliveries of food aid to the region. While pests and diseases are common in a variety of crops, rice blastwas reported to be one of the primary reasons why people do not produce more local rice today (due to the production risks), in addition to the high demands of labour required in rice production, particularly with the district being organic. In fact the few cases in which people suggested that there may still be use of agricultural chemicals in Jumla, was in reference to "Butachlor",used as an herbicide in rice fields.The frequency in which pests and diseases were cited as causal factors of changing food habits may be indicative of the significance of rice as a staple crop. Both crop and genetic diversity have been used to alleviate these issues in rice production.

Food aid and climate change are also significant factors contributing tofood habit changes

Following pests and diseases, food aid and the effects of climate change were among the most cited causal factors of food habit changes in Jumla. As shown in Table 3, these were commonly referenced both throughout and within the FGDs. The involvement of various governmental and non-governmental organizations in Jumla over the past 50 years has reportedly been influential in changing food habits. Most specifically, these organizations have increased the quantity and accessibility of internationally, imported white rice throughout the district. More recent road construction, as well as acquired preferences, and affordability of imported white rice, have made this a staple in the typical Jumli diet.

The presence of food aid, (the Nepal Food Corporation (NFC) and the World Food Programme (WFP) being the most frequently cited), and the associated availability of imported white rice, were referenced both as positive and negative causal factors of change. In many ways they helped secure a sufficient supply of food to residents in Jumla,who no

longer have to rely on their own subsistence production for survival; however food aid was also cited as being of poor quality, unequally distributed, and as displacing local, more nutritious crops. Despite recognizing these characteristics of food aid, the corporations giving imported rice as food aid, said they do so because that is what local people are demanding. The potential for local rice (*JumliMarsi*) production is not able to fill population demands in Jumla (Sapkota et al., 2010).

While the effects of climate change are diverse, respondents most frequently referenced increasing problems of drought, unpredictability and changing precipitation patterns, and rising temperatures as threatening and challenging agricultural production. Intermittent rainfall and fluctuating temperatures have been found to affect rice production in Jumla (Sapkota et al., 2010). Despite recognizing the effects of climate change, community members do not seem to be shifting towards the production of more climate resilient crops such as millets, amaranth, and buckwheat. Therefore, although climate change is recognized as one of the most significant threats to the food system, there are other factors (taste, labour, marketing ability, knowledge) which are limiting the production of these crops. Other significant factors contributing tofood habit changes(cited frequently among and within the FGDs) include the shift to cash crop production, the rise in opportunities for wage labour (and corresponding decline in people engaged in agricultural production),and greater access to market goods (particularly through road construction).

Dietary diversity: Food consumption can be diverse but frequently is not

While there is no standardized measurement of dietary diversity, consideration of food type, food group, and proportion size, are generallyregarded as important components (Ruel, 2003). In each of the four VDCs, participants stated that they regularly consume *dalbhat*, (rice, pulses, and vegetable curry), twice a day as their primary meals and *roti* for snacks in-between meals, with rice being the food consumed in the greatest quantity. In the responses provided by participants, *dalbhat* consisted of local or white rice depending on production and availability (local rice is preferred but less commonly consumed), pulses were almost exclusively local beans, vegetables mostly included cauliflower, potatoes, radish and spinach, and *roti* was madefrom the flour of various grains including finger millet, barley, maize and wheat (and often a combination of these).

Many people in Jumla, and predominantly men, whom respondents indicated are particularly insistent on consuming rice (served in the form of *dalbhat*), seem to feel they need to eat rice to feel satisfied. As one FGD respondent explained, “In the past, we used to consume a lot of local rice and we sort of have a habit of eating rice” (Chandannath). One of the “hidden” barriers to dietary diversity in Jumla therefore, may be the persistent habits of food consumption. This corresponds to a recent statement by NeKSAP (the Nepal Food Security Monitoring System) which stated that in Jumla, “A majority of households are consuming cereals and pulses (bread and beans) as traditional food habits, but food consumption is not diversified” (NeKSAP, 2014).

Some studies have indicated that rice can be an importantdriver of dietary diversity by requiring that various sides of vegetables and meats or meat alternatives (such as *dal*) be consumed with it (Batres-Marquez, Jensen& Upton, 2009). In many areas of Nepal both *dal* and *bhat*are mixed with vegetables, spices, and/or ghee to enhance the flavour, but this is dependent on economic status and is not a common practice in Jumla.One participant from Talium however,explained that having beans and vegetables as sides to accompany imported,

white rice was necessary to enhance the taste (as compared to the more flavourful*JumliMarsi*). While FGD participants did say that they rarely consume vegetables or pulses without rice, the small proportion of vegetables consumed alongside the large quantity of plain rice, in addition to the lack of diversity within these side dishes (from meal to meal), leave to question the relevance of this assertion in Jumla. Alternatively, if the cheap, white rice from the market is encouraging families to consume more vegetables, then it is also conceivable that the white rice is actually contributing to better nutrition. Both of these are empirical questions that can be explored in future studies.

A formal assessment of dietary diversity (conducted at the individual or household level)would allow for more precise results of the frequency and proportion of food types consumed,which is particularly important when assessing nutritional value (FAO, 2013). Table 2illustrates the assortment of foods consumed by respondents, how consumption has changed from the past to the present, and the diversity of foods eaten within each of the five categories of food groups. The one type of food that was reportedly currently consumed by respondents in all FGDs is white rice. Respondents said that rice is easy to cook, people prefer it, and that they "cannot find as much local food anymore" (women's FGD in Talium). Availability, particularly through one's own production, is a key determinant of food consumption.

One limitation of household surveys of dietary diversity is that they imply equal distribution of food consumption within the household (UNDP, 2012). While participants generally described consuming the same foods within the household, children at times received a greater diversity of foods as requested. For example, most respondents said they do not consume fruit, meat, or dairy products regularly due to the high cost of these foods; however children are sometimes treated to these "tasty" foods as they request them, though families can rarely afford them. Closer to the bazaar in Chandannath, children are also treated to instant noodles (fried with a small portion of vegetables or more commonly eaten dry, straight from the package). As has been suggested in previous studies, women are the "gatekeepers" of food consumption, but children and husbands still have influential roles in requesting certain foods (Lentz, 1999). Therefore despite being the custodians of food systems, prioritizing men and children means that women are likely to make the most sacrifices (in health and nutrition) to their own diets.

People lack diversity in cooking/preparation methods

Nearly all respondents in the FGDs indicated that they only knew a limited number of ways to prepare foods. Most foods were prepared following the *dalbhattarkari*recipe of pressure-cooking rice and pulses (separately), and braising or frying vegetables into a curry. Other techniques such as fermenting, drying, and smoking foods are used to a lesser extent, primarily for preservation of vegetables and meats. While a number of recipes were shared for local cereals and grains, as shown in Table 4, these have largely been replaced by the consumption of white rice. Employing easier processing technology for traditional grains may help to diversify the ingredients and recipes used. Most respondents indicated that they would like to learn new recipes and different ways of preparing foods. While a few respondents said they had received training in new cooking methods including different types of cakes and porridge, few of them had the kitchen supplies needed to prepare these dishes.

Dietary diversity is desired, but not necessarily prioritized

When respondents were asked if they were happy with their current diets (primarily consisting of *dalbhat* twice a day, and snacks such as *roti* in-between), they replied that they generally were, noting that food supply was more secure than in the past. They also said that they would like to incorporate healthier and tastier foods which included many of the local grains such as buckwheat and millet, and greater diversity among food groups in their diets. As one participant from Chandannathresponded, "We are quite satisfied with our diet, but we want to have more variety".

Participants were also asked to name their ideal meals within a day. In all four VDCs, the ideal foods listed by participants were quite diverse in food groups and food types, including a mix of rice (preferably local), *dal*, *roti* made from different grains (barley, buckwheat, finger millet and wheat), more meats and dairy products and a greater variety of fruits and vegetables. When asked to describe which vegetables they would ideally consume, respondents in Patmara replied "whatever we can get", underscoring the "food for subsistence" mentality and seasonal availability of diverse foods in Jumla, which limits (likely forlegitimate reason) the extent of dietary diversity. Imported foods were rarely mentioned as a part of this ideal meal, though some said they may prefer instant noodles if they lack the time to prepare *roti*, or noted that children's preferences would likely include more instant noodles and biscuits. The primary reason given for not consuming more of these "ideal" foods was their high costs and lack of availability in the market. While these responses indicate a preference for diversity, many participants said they would eat these "ideal" meals everyday if they could.

When asked which foods people disliked the most, respondents commonly replied *roti* because of the work it took to prepare, orinstant noodles because they were unhealthy. Others (and most notably the youth) said their least favourite foods were amaranth, barley, foxtail millet, and prosomillet because they did not like the taste. The concern respondents have about nutrition is at times contradictory with their consumption habits. Consumption of "unhealthy" imports over "healthy" traditional grains suggests that convenience and taste are important determinants of food consumption.

While there was some indication that with increased income people would improve their dietary diversity, there were a number of factors which suggested that this may not be the case. As most food for consumption comes from subsistence production, extra income may not mean that people begin to buy more types of foods from the market, as income from sales is currently used primarily to purchase white rice and additives such as oil, sugar, and salt, rather than a greater diversity of food types. Secondly, many of the foods that people desire more of are locally produced, and (according to respondents) difficult to acquire (due to cost and availability in the market), preventing them from purchasing these foods. Thirdly, many people said that despite wanting different types of foods, they do not trust them. Imported products are believed to be produced using chemicals and adulterated with lower quality foods, while some participants said they were even skeptical of some local foods, such as ghee, which could be mixed with cheaper additives (such as vegetable oil). Finally, when asked which foods would be purchased if extra income were available, respondents from Chandannath declared that if they had more money they would migrate to the city. This indicates that for smallholder farmers in rural areas with limited economic and employment opportunities, dietary diversity, while desirable, is not an issue of priority.

People value diversity but there are barriers to accessing it

In all FGDsrespondents stated that dietary diversity is important for health and nutrition as well as for taste. While many said their diets are currently diverse, others expresseda desire to further increase diversity. Whether dietary diversity had increased or decreased over time was more contested. One respondent claimed that "diversity of foods has decreased because mostly white rice is eaten and *roti* only for a snack" (Chandannath), while another said "We think that diversity in our food has increased as compared to before. We get seeds of diverse vegetables from the District Agriculture Development Office" (Talium). In general, respondents explained that there are more foods available now than there were in the past butthat they are less nutritious.

Respondent's recognition of thediversity of foods available and of the poor nutrition of their own diets, illustrates the barriers that people have to accessing nutritiousfoods. While participants have certainly vocalized their preference for local food, many traditional grains and cereals and dairy products are not available in the market, as production of these has declined. Within the main streets of the bazaar one is hard-pressed to find a shop which sells local rice, and where it is sold the price can be one or two times that of imported rice, as illustrated in Table 5. Prices for most other cereals and grains could not be attained as these foods are not available in the market. Therefore local food is both unavailable and inaccessible, two factors which limit healthy diets (Johns & Sthapit, 2004).

In Jumla, people lack both physical and financial access to dietary diversity, which has important implications on food security (WHO, 2014). While the construction of roads, linking many VDCs to the Jumla bazaar and onward to Surkhet District, has substantially improved physical access to market goods, for many Jumli residents these goods are still multiple hours away by walking. While local foods are costly to purchase in the market, many of the healthier imported foods such as fruit and meat are also expensive, as illustrated in Table5. For the people of Jumla, these challenges of availability and access are significant barriers to dietary diversity.

CONCLUSION AND IMPLICATIONS

As this study illustrates, food habits in Jumla are changing as a result of diverse but interrelated environmental, social and economic factors which have impacted dietary diversity and the value people place on it.

Fruits, vegetables and meats are consumed with greater frequency than in the past, though dairy and egg consumption has declined.The availability of cheap rice has allowed for the consumption of*dalbhat*more regularly and consequently the use of other traditional grain varieties has declined. While people can now more easily consume sufficient quantities of food, the quality of food consumed has not necessarily improved. Though people prefer local (and organic) foods, the availability, convenience and low cost of less nutritious imports have resulted in greater consumption of these foods. Food production is more geared towards market sales and particularly the more profitable apples, beans, and vegetable crops over the less demanded traditional crops such as millets and buckwheat. Though consumption is still largely subsistence-based, people are purchasing imported white rice, instant noodles, biscuits, oil, sugar and salt from the market regularly. Women continue to be the primary custodians of food systems, though the preferences and opinions of men and children are influential. While greater consumption of fruits, vegetables and meats can promote greater

food security, the loss of production and consumption of traditional cereals and grains and the current purchasing patterns of white rice, processed snacks and food additives (oil, sugar, and salt) threaten it.

The changes to food habits appear to be influenced by a diversity of interconnected factors, the majority of which are related to changes in food production. Pests and diseases and particularly the onset of rice blast was the most frequently cited causal factor of food changes, both among and within FGDs. Food aid and the corresponding availability of imported rice in addition to the impacts of climate change were other commonly cited factors.

While people in Jumla value dietary diversity, their own consumption is limited by availability, access, and food habits and preferences. Local foods (such as dairy products and traditional grains) are difficult to obtain in the market, due to their limited production, and those foods which are available are extremely costly as compared to their imported counterparts. Lack of physical and financial access also restricts the consumption of healthy imports (including meats and fruits). While dietary diversity is certainly limited by socioeconomic factors in Jumla, many people seem fixed in consistent food consumption habits which further restrict it. The regular consumption of *dalbhat* as a dietary preference is consistent with findings by Lentz (1999) in which food habits are sustained through satisfaction and pride for one "simple but perfect meal".Therefore, it is suggested that people in Jumla need to *reacquire a taste for diversity* in order to improve food security and promote sustainable diets (Burlingame &Dernini, 2010).

Based on the findings of this study, governmental and nongovernmental organizations in Jumla should create and promote a market for local foods, and better support the production of a diversity of foods, particularly targeting women and youth who are a pivotal part of the food system. Traditional and organic cereals and grains should be further promoted to urban consumers who do not have access to these foods otherwise, and who may be willing to pay a higher price for them.These measures can be important in decreasing dependency on subsidized imports and food aid, while supporting agricultural employment which is crucial for food security (WHO, 2014),and has been declining due to greater opportunities in wage labour and education.

The environmental and socioeconomic linkages to the food system, as evident in the variety of factors contributing to food habit changes, emphasize the need for development and food security initiatives to be considered collectively, as there has been a lack of collaboration between the various organizations working on these interventions in Jumla. Furthermore, organic food production needs to be supplemented with the knowledge and materials required to use organic herbicides and pesticides, and crop specialization must be matched with ensuring access to a variety of food imports. While specialization in food production can be an important driver of economic growth, it works best where people have access to food imports, which can supplement the diversity that is lost in production (UNDP, 2012).

Educating community members on the importance of dietary diversity for food security (including nutritional benefits and climate change resilience) would increase demand (and production and consumption) of traditional cereals and grains and may expand and diversify the types of food aid supplied to the region which could benefit community members economically, environmentally, and socially (through improvements to health). Knowledge and information are influential in changing food habits (Fanzo, Cogill&Mattei,

2012). Various organizations involved in food security initiatives in Jumla should work to promote new processing technologies, cooking methods and recipes which enable resident's toreacquire a taste for diversity. These need to be applicable to local conditions (limited power, fuel, and water) and kitchen supplies. With adequate support and investment, there is much potential for Jumla to increase and diversify its food system through expanding on previous initiatives (such as the production and processing of organic apple products) and linking those to new ones (such as the development of a bakery or brewery, as was suggested by a respondent in Chandannath). Through integrating dietary diversity in production, processing, and consumption patterns, people of Jumla can reacquire a taste for -and habit of- dietary diversity.

Potential for Future Research and Development Interventions

These findings illustrate the significance of understanding the value of dietary diversity as a significant factor in determining food habits. Additional studies in other regions should further explore these connections, in addition to rural and urban comparisons in Nepal and elsewhere. Understanding how rice consumption affects nutrition as well as the nutritional value of local foods as compared to imported foods in Jumla, and particularly the nutritional qualities of the local rice, *JumliMarsi,* as compared to improved varieties and the various types of imported rice available, would also help to evaluate food habit changes in the region. The changes in food habits over time, the factors contributing to these changes, and the value people have for dietary diversity are clearly intricately connected. Understanding these connections is critical to enhancing food security.

ACKNOWLEDGEMENT

The authors acknowledge the financial and technical support for this study from LI-BIRD, Department of Agriculture and Nepal Agricultural Research Council managed projects in Jumla, which are funded by Bioversity International, the Development Fund (Norway), the European Commission, the Global Environment Facility, the International Fund for Agricultural Development and The United Nations Environment Programme. Funding support through the Masters in Development Practice University of Winnipeg, Canada helped in supporting this international field practicum undertook by the first Author.

Appendix

Figure 5: VDC Map of Jumla (Map compiled by EpshaPalikhey from various data available from the Department of Survey, 2002)

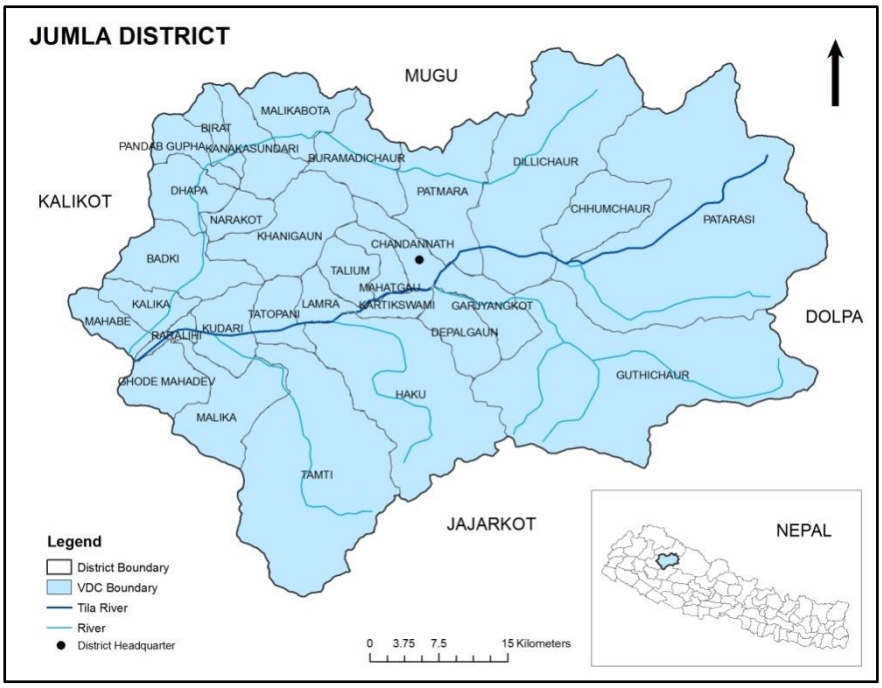

JUMLA DISTRICT
MUGU
MALIKABOTA
BIRAT
PANDAB GUPHA
KANAKASUNDARI
RURAMADICHAUR
DILLICHAUR
KALIKOT
DHAPA
PATMARA
CHHUMCHAUR
PATARASI
NARAKOT
KHANIGAUN
CHANDANNATH
BADKI
TALIUM
MAHATGAU
KALIKA
LAMRA
KARTIKSWAMI
GARJYANGKOT
TATOPANI
MAHABE
KUDARI
DOLPA
RARALIHI
DEPALGAUN
GUTHICHAUR
GHODE MAHADEV
HAKU
MALIKA
TAMTI
JAJARKOT
NEPAL
Legend
District Boundary
VDC Boundary
Tila River
River
District Headquarter
0 3.75 7.5 15 Kilometers

Figure 6: Timeline

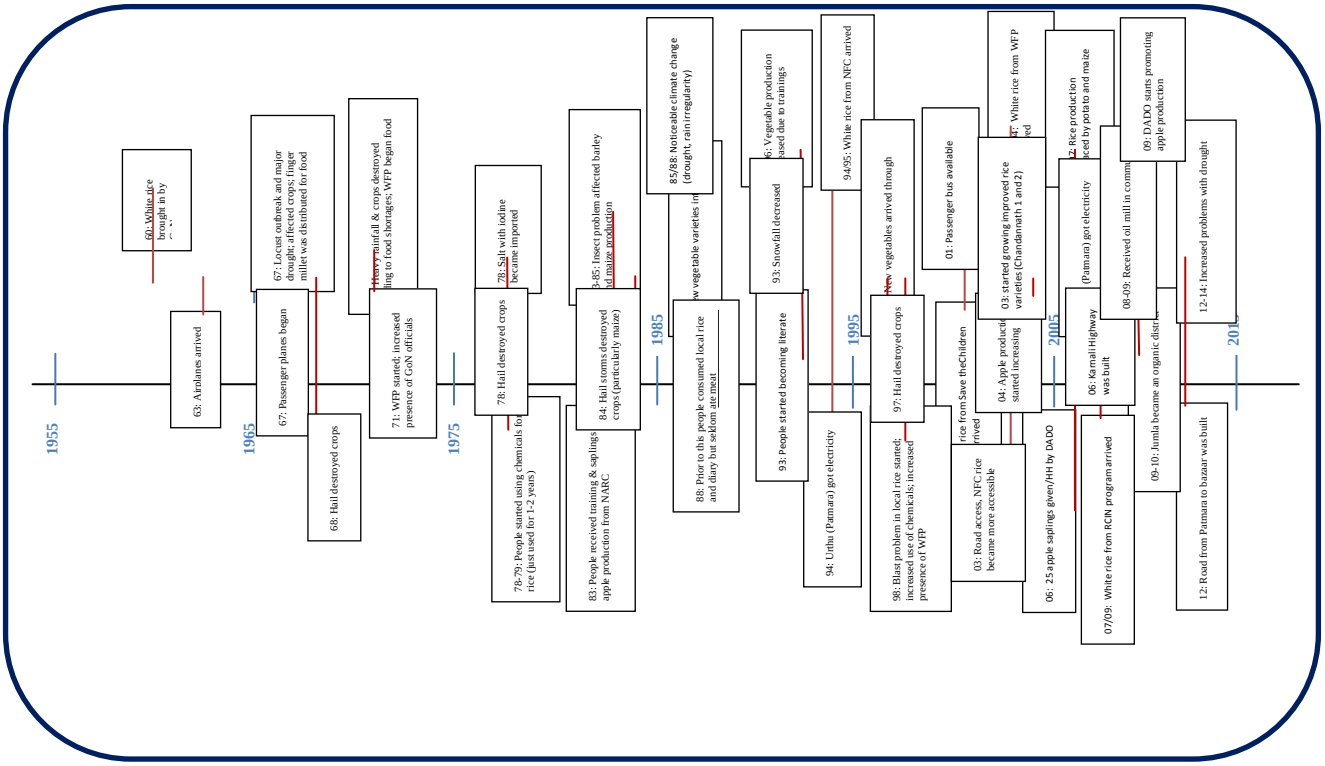


Table 1: Focus Groups Discussions[5]

Date (2014)	Focus Group Discussion	Food Determining Traits	Number of Women Participants	Number of Men Participants	Total Number of Participants
June 3	Chandannath, Preparatory Discussion	-	2	8	10
June 7	Talium, Preparatory Discussion	-	5	13	18
June 15	Chandannath, Youth Discussion	-	4	4	8
June 19	Depalgaun, General Discussion	Irrigation with rice production	1	16	17
June 22	Patmara, General Discussion	Least market access; Lower standard of living; Irrigation but no rice production	6	6	12
June 28	Talium, Women's Group	-	11	0	11
June 29	Chandannath, General Discussion	Market access; Higher standard of living	4	8	12
June 30	Talium, General Discussion	Poor irrigation, reliance on precipitation	8	13	21
-	-	-	41 (38%)	68 (62%)	109

[1] Regarding food determining traits: Market access is based on proximity to the main bazaar in Jumla while standard of living is measured by average annual income per person (District Administration Office, 2009)

Table 2: Food Consumption per FGD, Pastand Present

CONSUMPTION	Chandannath June 3/PAST	Chandannath June 3/PRESENT	Talium June 7/PAST	Talium June 7/PRESENT	Depalgaun June 19/PAST	Depalgaun June 19/PRESENT	Patmara June 22/PAST	Patmara June 22/PRESENT	Chandannath June 29/PAST	Chandannth June 29/PRESENT	Talium June 30/PAST	Talium June 30/PRESENT
Cereals/Grains												
amaranth	1											
barley	1	1	1		1			1	1	1		1
buckwheat	1		1		1				1		1	
finger millet	1	1	1		1			1	1	1		
foxtail millet	1				1				1		1	
maize	1	1				1	1	1		1	1	
porso millet	1				1				1		1	
rice (white)	1	1		1		1	1	1		1		1
rice (local)	1	1	1		1	1	1		1	1	1	
rice (beaten)										1		
wheat	1	1	1		1		1	1		1		
TOTALS	10	6	5	1	7	3	4	5	6	7	5	2
Vegetables/Pulses												
amaranth leaves	1											
beans	1	1	1		1	1	1	1		1	1	1
black-eyed beans						1		1				
black gram			1									
broadleaf mustard	1	1			1							1
buckwheat leaves	1		1		1						1	
cabbage		1										1
carrot		1						1				
cauliflower		1				1		1		1		1
cress	1											
cucumber		1										
gourd or other squash	1											
horse gram			1			1						
lambs quarter											1	
lentils		1								1		
maize	1	1	1									1
mushroom	1		1									
nettle	1					1						
onion												1
opium leaves	1	1										
peas			1			1						
potato	1	1			1	1	1	1		1		
pumpkin	1	1	1								1	
radish	1	1						1		1	1	
rice bean	1		1									
soybean	1	1	1		1				1			1
spinach/"*saag*"										1		1
sweet potato	1											
taro leaves	1	1										
tomato		1				1						
turnip	1											
wild elephant foot												
yam leaves	1	1										
wild vegetables	1		1		1		1					
zucchini						1						
TOTALS	20	16	11	0	6	9	3	6		6	5	8

Meat												
buffalo												
chicken		1						1				2
fish	1											1
goat	1	1				1	1	1				5
pork												
rabbit								1				1
sheep	1	1				1	1					4
TOTALS	3	3				2	2	3				13
Fruit												
apple	1	1				1						1
banana						1						
local plums	1											1
mango						1						
pomegranate						1						
watermelon						1						
wild fruit	1		1									
TOTALS	3	1	1			5						2
Dairy and Egg												
butter/ghee	1	1			1				1			4
curd	1				1				1			3
egg												
milk	1		1		1				1			4
TOTALS	3	1	1		3				3			11
Oil												
purchased (mustard,												
soybean, sunflower)		1				1		1		1		1
apricot, peaches, plum	1		1									
cannabis			1									
mustard			1									
persimmon	1											
principia	1		1		1							
walnut	1		1									
TOTALS	4	1	5		1	1		1		1		1
honey	1		1		1							
Other Imports												
biscuits	1			1				1		1		
noodles				1				1		1		
salt	1	1	1					1		1		1
sugar	1									1		
TOTALS	3	1	1	2				3		4		1

Table 3:Factors Contributing toFood Habit Changes

DRIVERS OF CHANGE	Chandannath June 3	Talium June 7	Depalgaun June 19	Patmara June 22	Chandannath June 29	Talium June 30	# of Times Cited	# of FGDs Cited in
AFFECTING PRODUCTION…								
shift to cash crop production (less labour, more profit, can't do both local and cash crops)	2		2		1	1	6	4
chemical use		1			1	1	3	3
children in school/"ghar dailo" program (not farming)			1			1	2	2
climate change -drought/precipitation irregularity/temperature increase	1	3			1	4	9	4
deforestation (less natural vegetation)		1					1	1
high labour/work/time involved in producing local crops	1	1	1				3	3
irrigation problems	1					1	2	2
lack of land/population increase	1	1	2			1	5	4
low market demand/low profit for local foods			1				1	1
"people are lazier"; don't want to work hard		1		1		1	3	3
pests and diseases (rice blast, black smut in wheat)	3	1	1	1	2	1	9	6
poor weather (hail, heavy rainfall)				2	1		3	2
received training to produce new foods (vegetables, apples, cash crops)					1		1	1
wage labour (less people working in agriculture)	1	1			2	3	7	4
AFFECTING CONSUMPTION…								
food aid/food-for-work, increasing white rice consumption (GOs, NGOs, INGOs)	2		1	2	1	1	7	5
greater access to market goods (road construction, airplanes)	3		1	1	2		7	4
income increase -wage labour, cash crops (more money to purchase market goods)	1	3					4	2
introduction of new vegetables/seeds		2		1			3	2
knowledge about health/nutrition		1		1	2	1	5	4
reduction in caste/ethnic discrepancies	1						1	1

Table 4:Traditional Recipe List

SN	Food item	Detail
1	Asuro	Fermented dried roots of local radish, *chotoboiled* in water adding some salt and spices
2	Bhange noon	Spice made from the roasted and ground cannabis seed with some salt
3	*Bhat*	Grains of rice/foxtail millet/proso millet or grits of maizecooked in water until all the water is absorbed or evaporated leaving behind fluffy grains or grits
4	Bhuja	Dried *karela*, balsom gourd (also referred to as "cuchhekarela" or "barela") boiled in water adding some salt and spices
5	Bhutekochamal	Toasted rice eaten as a snack
6	Chamre/Khatte	Fried white rice with sugar
7	Cole	Mixture of grains of maize, beans and barley cooked adding salt and spices
8	*Dal*	Soup made from beans/black soybean/black gram/horse gram (variety with very small grain), seasoned with salt and optionally spiced with dried allium, cumin seeds, dried chillies or other spices depending on the beans or pulses being used.
9	Dhakana	Boiled local pumpkin
10	Dhido	Flour porridge made by cooking maize, finger millet, or buckwheat flour in boiling water with continuous stirring until a dough-like consistency is achieved as the starch in the flour swells in the process of cooking. This dish is similar to *Ugali* commonly consumed in East Africa.
11	Dhokayo	Dried leaves of *banko*, a variety of wild elephant foot yam which is believed to be rich in calcium and protein

12	Gundruk	Fermented dried leaves of edible greens. Used to make *gundruk* stew which can contain potatoes, tomatoes, soybeans, seasoning and spices
13	Khocha	Water bread made from boiling balls of soybean flour in water
14	Pabro	Dried leaves of taro boiled in water adding some salt and spices
15	Phando	Soup made from the mixture of flour of small black soybean, bean, maize, wheat, barley, rice bean, etc adding some salt and spices
16	Phaparkodhesu (edible up to 30-32 days after making)	2 ways of preparation • A very thick (about 1-2 inch) bread made from buckwheat flour, ghee and honey especially cooked in iron pan and afterwards the bread is roasted in light fire flame • A big ball of bread made from mixing buckwheat flour and honey. It's uncooked.
17	Phaparkolagad	A thick unleavened pancake made from buckwheat flour batter
18	Phaparkoraeto	Soup made from barley flour adding dried leaves of buckwheat by rubbing it using both the hands when the soup is boiling
19	Pido	Round balls of *saatu* (see 21) prepared after adding salt and water
20	*Roti*	Unleavened flat bread or *chapatti* made by kneading wheat or barley flour into smooth dough, rolling the dough into circles and cooking on a pan.
21	Saatu	Flour made from roasted grains of buckwheat, finger millet, soybean eaten with hot water, tea, milk, or curd
22	Thukpa	A soup made from flour of finger millet/barley adding some ghee
23	Usinachamal	Parboiled rice. The rice is partially boiled in the husk, let to dry and then milled to remove the husk.

Table 5: Price List[6]

Food Type	Price (rupee) of Locally Produced Food		Price (rupee) of Imported Food	
	Chandannath	Talium	Chandannath	Talium
Cereals/Grains				
jumli marsi (local) rice	130-140	100	-	-
improved local rice varieties	-	85-90	-	-
white rice	-		50-120	60-120
wheat	*	*	*	*
amaranth	*	*	*	*
barley	-	30	-	-
buckwheat	-	80-85	*	*
foxtail millet	*	*	*	*
finger millet	*	*	*	*
maize	-	40	-	-
porso millet	*	*	*	*
Vegetables/Pulses				
beans	120-150	100-200	-	-
black-eyed beans	-	40	-	-
black gram	-	-	140	140
cabbage	50	20-50	50	-
carrot	60-80	60-80	-	-
cauliflower	60-120	30-80	40-80	-
cucumber	160	60-200	100	-
eggplant/brinjal	80-150	25-80	-	-
gourd/squash	-	40-60	120	-
horse gram	-	-	140	120-150
lentils	-	-	140-180	100-120
onion	60-80	50-80	60	-
peas	150-200	100-200	160	-
potato	30-60	25-70	-	-
pumpkin	80-100	50	80	-
radish	40-50	20-50	40-50	-
soybean	-	60	100	-
spinach/"*saag*"	5-20/bundle	5-15/bundle	-	-
sweet potato	-	-	100-120	80-100
taro	150-200	80-100	-	-
tomato	100-180	20-200	80	-
zucchini	60-80	50	-	-
Meat				
buffalo	300	200	-	-
chicken (broiler)	-	-	450-500	450-500
chicken (local)	600	600	-	-
fish	500	500	-	-
goat	550-600	550	-	-
pork	300-350	300-350	-	-
rabbit	-	300	-	-
sheep	600	550	-	-
Fruit				
apple	35-60	25-100	-	-
banana	-	-	100-120/dozen	100-120/dozen
grapes	300-350	150-200	-	-
local plums	2-5/plum	2-5/plum	-	
mango	-	-	110-150	120-140
watermelon	-	-	80-100	-
Dairy and Egg				
butter/ghee	-	500-600	850	-
curd	120/litre	100/litre	-	-
egg (broiler)	-	-	10-15/egg	10-15/egg
egg (local)	-	20-25/egg	-	-
milk	100/litre	100/litre	-	-
Other				
biscuits	-	-	10-100/package	10-70/package
noodles	-	-	10-20/package	10-20/package
salt	-	-	30	30
sugar	-	-	90	90
honey	-	800-1000	-	-
oil	-	-	160-200/litre	90/litre

References:

[6] Unless otherwise indicated prices are per kilogram. As of August 1, 2014, one Canadian dollar is equal to 89.41 Nepalese rupees. Improved local rice varieties include Chandannath-1 and Chandannath-3. Large price ranges reflect in- verses out of-season prices

*These grains are not generally available in the market

Abhishek, S., Ashish, S., &Faujdar, R. Household food insecurity and nutritional status of children and women in Nepal. (2014). *Food & Nutrition Bulletin, 35*, 3-11.http://nsinf.publisher.ingentaconnect.com/content/nsinf/fnb/2014/00000035/00000001;jsessionid=4410fovdesda6.victoria

Agostoni, C., Braegger, C., Decsi, T., Kolacek, S., Koletzko, B., Mihatsch, W… van Goudoever, J. (2011). Role of Dietary Factors and Food Habits in the Development of Childhood Obesity: A Commentary by the ESPGHAN Committee on Nutrition. *Journal of Pediatric Gastroenterology & Nutrition, 52,* 662–669. DOI: 10.1097/MPG.0b013e3182169253

Arimond, M. &Ruel, M.T. (2004). Dietary diversity is associated with child nutritional status: Evidence from 11 demographic and health surveys. *The Journal of Nutrition, 134,* 2579-2585. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15465751

Batres-Marquez, P., Jensen, H. & Upton, J. (2009). Rice consumption in the United States: Recent evidence from food consumption surveys. *Journal of the American Dietetic Association, 109*, 1719-1727. DOI: http://dx.doi.org/10.1016/j.jada.2009.07.010

Bishop, B.C. (1990). *Karnali under stress: livelihood strategies and seasonal rhythms in a changing Nepal Himalaya.* U.S.A.: Committee On Geographical Studies, University of Chicago.

Bista, D. R., Amgain, L. P., & Shrestha, S. (2013). Food security scenario, challenges, and agronomic research directions of Nepal. *Agronomy Journal of Nepal, 3*, 42-52. DOI: http://dx.doi.org/10.3126/ajn.v3i0.8985

Bove, C., Sobal, J., &Rauschenbach, B. (2003). Food choices among newly married couples: convergence, conflict, individualism, and projects. *Appetite, 40,* 25-41. DOI: 10.1016/S0195-6663(02)00147-2

Bryant, M., Trues*dal*e, K. P., & Dye, L. (2006). Modest changes in dietary intake across the menstrual cycle: implications for food intake research. *British Journal of Nutrition, 96,* 888-894. DOI: http://dx.doi.org/10.1017/BJN20061931

Burlingame, B. &Dernini, S. (2010). *Sustainable diets and biodiversity: directions and solutions for policy, research and action*. Retrieved from www.fao.org/docrep/016/i3004e/i3004e.pdf

CGIAR –Consultative Group on International Agricultural Research. (2013). *Climate risk and food security in Nepal—analysis of climate impacts on food security and livelihoods.* Retrieved from http://ccafs.cgiar.org/publications/climate-risk-and-food-security-nepal%E2%80%94analysis-climate-impacts-food-security-and#.U-OZzOl0yP_

Chambers, R. & Conway, G. R. (1992). *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century.* Retrieved from https://www.ids.ac.uk/publication/sustainable-rural-livelihoods-practical-concepts-for-the-21st-century

Dallongeville, J., Marecaux, N., Fruchart, J-C., &Amouyel, P. (1998). Cigarette Smoking Is Associated with Unhealthy Patterns of Nutrient Intake: a Meta-analysis. *The Journal of Nutrition, 128,* 1450-1457. http://jn.nutrition.org/content/128/9/1450.full.pdf+html

Den Hartog, A. P., van Staveren, W., &Brouwer, I. (2006). *Food Habits and Consumption in Developing Countries: Manual for Social Surveys*. The Netherlands: Wageningen Academic Publishers.

District Administration Office. (2009). *Village Development Committee Profile*, (Chandannath, Depalgaun, Talium, &Patmara). Kathmandu, Nepal: Public Offset Press House.

Drescher, L., Thiele, S., &Mensink, G. (2007). A New Index to Measure Healthy Food Diversity Better Reflects a Healthy Diet Than Traditional Measures. *The Journal of Nutrition, 137,* 647-651. http://nutrition.highwire.org/content/137/3/647.full

Ericksen, P. (2007). Conceptualizing food systems for global environmental change research. *Global Environmental Change.* DOI:10.1016/j.gloenvcha.2007.09.002

FANTA –Food and Nutrition Technical Assistance. (2002). *Dietary Diversity as a Household Food Security Indicator.* Retrieved from http://www.fantaproject.org/research/dietary-diversity-household-food-security

FANTA –Food and Nutrition Technical Assistance. (2006). *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide*. Retrieved from http://www.fantaproject.org/monitoring-and-evaluation/household-dietary-diversity-score

Fanzo, J., Cogill, B. &Mattei, F. (2012). *Technical Brief: Metrics of Sustainable Diets and Food Systems.* Retrieved from http://www.bioversityinternational.org/e-library/publications/detail/metrics-of-sustainable-diets-and-food-systems/

Fanzo, J., Hunter, D., Borelli, T. &Mattei, F. (2013). *Diversifying Food and Diets: Using agricultural biodiversity to improve nutrition and health.* New York: Routledge.

FAO -Food and Agriculture Organization of the United Nations. (1996). *World Food Summit.* Retrieved from http://www.fao.org/wfs/index_en.htm

FAO -Food and Agriculture Organization of the United Nations. (2004, September). *Westernization of Asian Diets and the transformation of food systems: Implications for research and policy.* Retrieved fromhttp://www.abeima.net/export/sites/abengoa_corp/resources/pdf/biofuels/Food_prices/1_P_Pingali.pdf

FAO -Food and Agriculture Organization of the United Nations. (2006). *Rice International Commodity Profile.* Retrieved from http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Rice/Documents/Rice_Profile_Dec-06.pdf

FAO -Food and Agriculture Organization of the United Nations. (2010, June). *Assessment of Food Security and Nutrition Situation in Nepal.*Retrieved fromftp://ftp.fao.org/osd/CPF/Country%20NMTPF/Nepal/thematic%20studies/Food%20Security%20_Final_.pdf

FAO -Food and Agriculture Organization of the United Nations. (2012). *Building Resilience for Adaptation to Climate Change in the Agriculture Sector: THE ROLE OF THE INTERNATIONAL TREATY ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE.*Retrieved fromhttp://www.fao.org/fileadmin/templates/agphome/documents/faooecd/ITPGRFA_01.pdf

FAO -Food and Agriculture Organization of the United Nations. (2013).*Guidelines for measuring household and individual dietary diversity.* Retrieved from http://www.fao.org/docrep/014/i1983e/i1983e00.pdf

FOODSECURE. (2013). *Long-Term Drivers of Food and Nutrition Security.* Retrieved from http://www.researchgate.net/publication/236588073_Long-Term_Drivers_of_Food_and_Nutrition_Security?ev=prf_pub

Frison, E., Cherfas, J. and Hodgkin, T. (2011). Agricultural Biodiversity Is Essential for a Sustainable Improvement in Food and Nutrition Security. *Sustainability, 3,* 238-253. DOI:10.3390/su3010238

Frison, E.A., Smith, I.F., Johns, T., Cherfas, J. &Eyzaguirre, P.B. (2006). Agricultural biodiversity, nutrition, and health: Making a difference to hunger and nutrition in the developing world. *Food and Nutrition Bulletin, 27,* 167-179. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16786983

Godfray, C., Crute, I., Haddad, L., Lawrence, D., Muir, J., Nisbett, N… Whiteley, R. (2010). The future of the global food system.*Philosophical Transactions of the Royal Society, 365,* 2769-2777. DOI: 10.1098/rstb.2010.0180

Government of Nepal & United Nations Development Programme. (2014). *Nepal Human Development Report 2014.* Retrieved from http://www.npc.gov.np/new/uploadedFiles/allFiles/NHDR_Report_2014.pdf

Hatloy, A., Hallund, J., Diarra, M.M. &Oshaug, A. (2000). Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). *Public Health Nutrition 3,* 57-65. DOI: 10.1017/S1368980000000628

Hoddinott, J., Maluccio, J.A., Behrman, J.R., Flores, R. &Martorell, R. (2008). Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *Lancet 371,* 411-416. DOI: 10.1016/S0140-6736(08)60205-6

IFPRI –International Food Policy Research Institute. (2002, June). *Dietary Diversity as a Food Security Indicator.* Retrieved from http://www.ifpri.org/sites/default/files/publications/fcndp136.pdf

Ikeda, M., Brown, J., Holland, A. J., Fukuhara, R., & Hodges, J. R. (2002). Changes in appetite, food preference, and eating habits in frontotemporal dementia and Alzheimer's disease. *Journal of NeurolNeurosurg Psychiatry, 73,* 371–376.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1738075/pdf/v073p00371.pdf

Johns, T. & Sthapit, B. (2004). Biocultural diversity in the sustainability of developing-country food systems. *Food and Nutrition Bulletin, 25,* 143-155. Retrieved from http://www.ingentaconnect.com/content/nsinf/fnb/2004/00000025/00000002/art00007?crawler=true&mimetype=application/pdf

Kastnera, T., Rivasa, M. J. I., Kochc, W. &Nonhebela, S. (2012). Global changes in diets and the consequences for land requirements for food. *PNAS, 109,* 6868-6872. DOI: 10.1073/pnas.1117054109

Lentz, C. (1999). *Changing Food Habits: Case Studies from Africa, South America and Europe.* Amsterdam, The Netherlands: Harwood Academic Publishers.

Lobell, D., Burke, M., Tebaldi, C., Mastrandrea, M., Falcon, W. & Naylor, R. (2008). Prioritizing Climate Change Adaptation Needs for Food Security in 2030. *Science, 319,* 607-610. DOI: 10.1126/science.1152339

Mayes, S., Massawe, F.J., Alderson, P.G., Roberts, J.A., Azam-Ali, S.N. & Hermann, M. (2011).The potential for underutilized crops to improve security of food production. *Journal of Experimental Botany,* 1-5. DOI:10.1093/jxb/err396

NeKSAP –Nepal KhadhyaSurakshyaAnugamanPranali (Nepal Food Security Monitoring System). (2014). *Jumla District Food Security Network Bulletin.* Retrieved from http://neksap.org.np/uploaded/districts/538ffd865f38bJumla_May_2014.pdf

ODI –Overseas Development Institute. (2009). *Research Tools: Focus Group Discussion*. Retrieved from http://www.odi.org/publications/5695-focus-group-discussion

Oxfam. (2011). *Improving Food Security for Vulnerable Communities in Nepal.* Retrieved from http://www.oxfam.org/sites/www.oxfam.org/files/cs-improving-food-security-nepal-010611-en.pdf

Pelletier, D.L. &Frongillo, E.A. (2003). Changes in child survival are strongly associated with changes in malnutrition in developing countries. *The Journal of Nutrition, 133,* 107-119. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12514277

Popkin, B. M., Adair, L. S., Ng, S. W. (2013). NOW AND THEN: The Global Nutrition Transition: The Pandemic of Obesity in Developing Countries. *Nutrition Reviews, 70,* 3-21. DOI: 10.1111/j.1753-4887.2011.00456.x

Rajbhandari, M. (2010). *Apple Production Ripens Remote Jumla.* Retrieved from http://www.snvworld.org/download/publications/grinding_out_added_value_through_lao_rice_mills.pdf

Rijal, D. (2010). Role of food tradition in conserving crop landraces on-farm. *The Journal of Agriculture and Environment, 11,* 107-119. http://www.nepjol.info/index.php/AEJ/article/viewFile/3658/3139

Rosenmöller, D. L., Gasevic, D., Seidell1, J. & Lear, S. (2011). Determinants of changes in dietary patterns among Chinese immigrants: a cross-sectional analysis. *International Journal of Behavioral Nutrition and Physical Activity 2011, 8*:42. DOI:10.1186/1479-5868-8-42

Ruel, M. (2003). Operationalizing Dietary Diversity: A Review of Measurement Issues and Research Priorities. *The Journal of Nutrition, 133,* 39115-39265. http://jn.nutrition.org/content/133/11/3911S.full

Sapkota, S.,Paudel, M.N.,Thakur, N.S., Nepali, M.B. &Neupane, R. (2010). Effect of Climate Change on Rice Production: A Case of Six VDCs in Jumla District. *Nepal Journal of Science and Technology, 11,* 57-62. DOI:10.3126/njst.v11i0.4124

Schmidhuber, J. &Tubiello, F. (2007). Global food security under climate change. *Proceedings of the National Academy of Sciences of the United States of America, 104,* 19703-19708. DOI: 10.1073/pnas.0701976104

Sen, A. (1981). *Poverty and Famines: An Essay on Entitlement and Deprivation.* Oxford: Clarendon Press

Sen, A. (1984). *Resources, Values and Development.* Oxford: Basil Blackwell

Shindell, D., Kuylenstierna, J., Vignati, E., van Dingenen, R., Amann, M., Klimont, Z… Fowler, D. (2012, January). Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security. *Science, 335,* 183-189. DOI: 10.1126/science.1210026

Sthapit, B., Rana, R., Eyzaguirre, P., & Jarvis, D. (2008). The value of plant genetic diversity to resource-poor farmers in Nepal and Vietnam. *International Journal of Agricultural Sustainability, 6,* 148-166. DOI:10.3763/ijas.2007.0291

St-Onge, M., Keller, K. &Heymsfield, S. (2003). Changes in childhood food consumption patterns: a cause for concern in light of increasing body weights. *The American Journal of Clinical Nutrition, 78,* 1068-1073. http://ajcn.nutrition.org/content/78/6/1068.full

The World Bank. (2013). *Long-term drivers of food prices.* Retrieved from http://econ.worldbank.org/external/default/main?pagePK=64165259&piPK=64165421&theSitePK=469382&menuPK=64166093&entityID=000158349_20130521131725

Toledoa, A. & Burlingame, B. (2006). Biodiversity and nutrition: A common path toward global food security and sustainable development. *Journal of Food Composition, 19,* 477-483. DOI: 10.1016/j.jfca.2006.05.001

U.K. Food Standards Agency. (2009). *Nutrition Essentials*. Retrieved from http://www.eatwell.gov.uk/healthydiet/nutritionessentials/

UN –United Nations. (2008). *Jumla District.* Retrieved from http://www.un.org.np/sites/default/files/Jumla_0.pdf

UNDP –United Nations Development Programme. (2012, February). *A Human Development and Capability Approach to Food Security: Conceptual Framework and Informational Basis*. Retrieved from http://www.undp.org/content/dam/rba/docs/Working%20Papers/Capability%20Approach%20Food%20Security.pdf

Wandel, M., Raberg, M., Kumar, B., &Holmboe-Ottesen, G. (2008). Changes in food habits after migration among South Asians settled in Oslo: The effect of demographic,

socio-economic and integration factors. *Appetite, 50,* 376-385. DOI: 10.1016/j.appet.2007.09.003

Whiteman, P. (1985). The Mountain Environment: An Agronomist's Perspective with a Case Study from Jumla, Nepal. *Mountain Research and Development, 5,* 151-162. Retrieved from http://www.jstor.org/discover/10.2307/3673254?uid=3739408&uid=2134&uid=2&uid=70&uid=3737720&uid=4&sid=21104737565467

WHO (Europe) (2003). *Food based dietary guidelines in the WHO European Region.*Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0017/150083/E79832.pdf

WHO –World Health Organization. (2014). *Food Security.* Retrieved from http://www.who.int/trade/glossary/story028/en/

9

DIETARY DIVERSITY, CONSUMPTION PATTERNS AND COMMUNITY FOOD SECURITY (CFS) AMONG THREE TRIBAL GROUPS IN KORAPUT DISTRICT, ODISHA, INDIA

Smita Mishra,
V A Nambi,
T.R.Prabhakaran,
N. Kalaiselvan,
R K Mahana

ABSTRACT

Availability of food crops, dietary diversity and its utilization in tribal traditional foods among the three tribal communities *Bhumia, Paroj* and *Penthia*of Koraput district Odisha, India is examined. One hundred and ninety households from twenty six tribal villages were sampled using structured questionnaires on food frequency and 24 - hours recall diet survey to elicit information about their food habit, consumption pattern, special traditional recipes, frequency and period of consumption, seasonal availability and major sources of food materials. The study revealed that fifteen food groups from plant and animal origin are consumed by tribal households and diversity within each food group is high. Access to various foods in different combinations provides households as well as the community assertion of food security round the year. Special nutritious traditional dishes consisting of a combination of various food groups are popular among the tribes and are claimed to be healthy. Documentation of traditional dishes and their scientific validation is essential to improve and strengthen the food and nutritional security of tribal people at household as well as community level.

Key words: Dietary Diversity, Bhumia, Paroja, Penthia, Koraput District, Consumption patterns and food habit, Food and Nutritional security.

Dietary Diversity, Consumption Patterns and Community Food Security (CFS) among three Tribal Groups in Koraput District, Odisha, IndiaThe concept of community food security (CFS) focuses on nutrition, education, health, sustainability, and anti-hunger. It moves beyond individual households to look at community-based strategies and partnerships with the positive anticipation and goals of improving access to nutritious and affordable food, increasing self-reliance, and promoting local responses to food and nutrition issues (Lopez et al., 2008; Bletzacker, et al., 2009; Gundersen et al., 2011; Kaiser 2012). The idea of CFS is defined as: "all persons in a community have access to culturally acceptable, nutritionally adequate food through local non-emergency sources at all times." The CFS concept encompasses social, economic, and environmental basis of food systems which calls for further research (Rabinowitz and Martin, 2013).

Over the last six decades, the Government of India and the federal states have made consistent and diverse attempts at addressing food security in India. One of the well known efforts is the Public Distribution System (PDS), which expanded from a few urban centres in

the early 1950s to more or less the whole country by the early 1980s and played a crucial role in ensuring access to food grain for a significant proportion of the population (Athreya et al 2014). The most recent of such efforts is the enactment of the National Food Security Act, 2013 that aims to provide food and nutritional security to people by ensuring access to adequate quantity and quality of food at affordable prices. The act entitles provision of 5 kilograms (kg) of rice, wheat, or coarse cereals per person per month at a subsidized price of Rs. 1–3 / kg and aims at covering two-thirds of India's total population of 1.25 billion. This is crucial for the poor to combat high levels of hunger and malnutrition especially the Scheduled Castes (SC's) and Scheduled Tribes (ST's) living in rural areas. It is widely believed that low access to food and employment are some of the key reasons for persistent poverty among these groups (Kishore et al., 2013).

SPECIFIC CONTEXT OF THE STUDY AREA

The Koraput district of Odisha falls under the Kalahandi- Bolangir- Koraput (KBK) region, known for its persistent poverty and mal-nutrition. KBK region has specific rudimentary problems compared to other parts of Odisha for which the region continues to remain backward. A high percentage of scheduled tribes (ST), numbers of families living below poverty line (BPL), low rate of literacy have direct relevance to the level of poverty and mal-nutrition persisting in the region despite quite a large number of development endeavours have been put in place by the State, Centre and various non-government organizations. Although a large amount of investments in agriculture and other sectors were made in the past, considerable intended unintended neglect have been noticed in certain key sectors like nutrition, health, food security and education that have tremendous bearing on the qualities of life of certain groups of people.

Koraput district is a tribal district and falls under the hunger hotspots of the world. Poverty is immense in the district and malnutrition continues to be the wide spread problem even though there has been significant improvements in food production during the last fifty years. Various poverty alleviation programmes had been implemented to bring in overall economic improvements of the poor. A number of nutrition related programmes like the Integrated Child Development Scheme (ICDS), including Supplementary Nutrition, Nutrition and Health Education, Health Care, Immunisation and Childhood Care and pre-School Education, National and State Old Age Programme (NOAP and SOAP), Mid-day-Meal Programme (MDM), Emergency Feeding Programme etc have been launched and continued over the past many years (Kar et al 2007) had hardly been able to reduce the rate of poverty and malnutrition among rural and tribal people. Till date, 83% live in rural areas, all of whom live below the poverty line. The literacy rate is 15.89% in rural areas and 67.17% in urban areas.

The district is renowned for its rich biological as well as human cultural diversity. It is considered as one of the centres of origin and diversity of Asian cultivated rice *Oryza sativa* L.(Ramiah and Ghose 1951;Oka 1974 and Sharma et al 2000).A vast range of agro climatic and socio cultural settings has given rise to enormous diversity in landraces and traditional varieties of rice which are highly adapted to local conditions (Pani and Patra 2003).

Besides, rice a variety of millets, pulses, oilseeds and vegetables are also cultivated at varying altitudes 150-1000 meters MSL. Ancestors of present day tribal communities have played a significant role in conserving, improving and sustainably utilizing local crop genetic resources for household food and nutrition security. Tribal culture together with their

conservation ethos has enabled to maintain on-farm intra-specific diversity of this large number of food crops, suitable to various agro ecologies.

The communities'contributions to the conservation of genetic resources and improvement through selection, preservation and knowledge addition have been recognized and rewarded by International and National Organizations.

In the year 2002, the tribal Communities of Koraput were awarded the *Equator Initiative* award at the World Summit on Sustainable Development (WSSD) in Johannesburg for community conservation and directing it to poverty reduction. In 2007, the tribal communities of Koraput received the Genome Saviour Award instituted by the Protection of Plant Variety and Farmers Rights Authority (PPV&FRA) of the Government of India for their contribution to the conservation of plant genetic resources particularly rice, in the biodiversity rich center. In 2010 Koraput was recognized as a Globally Important Agricultural Heritage System (GIAHS) site by the Food and Agricultural Organization (FAO) for maintaining unique tribal traditional agricultural practices, conservation and utilization of inherited traditional knowledge for local food security vis-à-vis cultural diversity (Koohafkan and Altieri, 2011). The region is not only known for its genetic richness but also as an Agrobiodiversity Hotspot (Nayar 2009).[7]

In addition to agrobiodiversity, the district has a forest cover of 10,50,000 hectares that constitutes 6.7% of the district's geographical areaand contributes significantly to the tribal economy. They contain several economically useful, wild food and medicinal plants that are used by the communities for their sustenance (orikor@nic.in).Wild food plants are more significant to the poor and marginal groups in times of seasonal food scarcity many a times as an important source of essential foods. A wide range of cultivated and wild foods provide a safety net against nutritional deficiencies by maintaining a continuous supply. (Das 2006; Mishra and Chaudhury 2012).

The nutritional status of humans is entwined in complex relationships determined by a chain of events from food production to consumption and set against the backdrop of cultures and nations (Kataki and Babu, 2002). Optimal nutrition can protect humans against many diseases/disorders resulting from nutrient deficiencies or excess (Aberoumand 2011). Balanced and adequate nutrition is therefore important in improving the health of communities in general and of groups at risk in particular. The dietary assessment of the community indicates if the intake of the macro and micro nutrient are adequate. There is an intimate connection between food, natural resources and farming system among traditional tribal societies in Odhisha (Das 2006), which is undergoing changes over the years due to the expansion of externally linked markets, inflow and outflow of cash and interventions mediated by the state like the public distribution system (PDS).The present study was therefore carried out in tribal villages paying attention to the availability of various agricultural crops, edible forest species and animal husbandry system (Das, 2006) with the assumption that inclusion of maximized diverse food groups and food items in the traditional diets would have helped them to maintain dietary diversity over time and space;

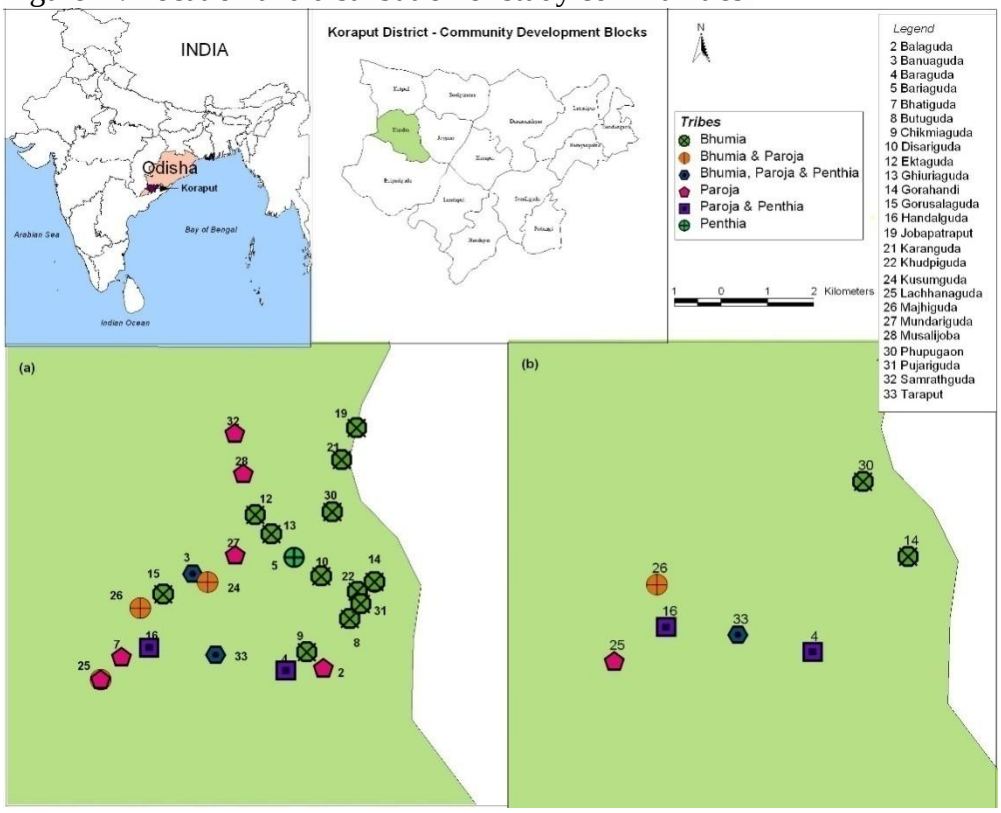
[7]Occurrence of rich genetic resources useful to humans and the varied ethnic cultures which conserve, select, adopt and domesticate wild relatives of cultivated plants. Areas rich in plant genetic resources, economic plant species, endemic species, progenitors of cultivated plants, their wild relatives, with vast array of variability in different ecosystems, i.e. farm lands, grasslands and woodlands, which have evolved under various environmental stresses and evolved or co-adopted through man's agro-pastoral interventions.

explore the linkage between biodiversity, dietary diversity and community food security and the changes that are unfolding.

Koraput district (17^{o} 23' 59" -20^{o}42’ 0"N; 81^{o} 14' 24" - 84^{o} 12' 0"E), located in the southeastern part of Odisha state, India (Figure 1), is characterized by scattered, sharp, isolated hills with thin forest cover. The hill slopes are highly eroded, over grazed and of low fertility. The climate is warm and humid, with mean maximum and minimum temperatures of 30.6°C and 17.03°C, respectively. The normal rainfall of the district is 1521.8 mm spread over a mean of 82 rainy days.

The district is home to 62 different tribes who exhibit a remarkable diversity of ethnicity, language and culture. Each tribe has distinct identity in terms of socio cultural rites and religious functions; although striking parallels and close similarities between and among the tribes are seen (Patnaik, 2005; Mohanti et al, 2006).

Figure 1 : Location and distribution of study communities



The economy of the district is largely agriculture-based which is rainfed and practiced at a subsistence scale.Of the total working population 39 % are engaged in farming, a large percentage of them are small and marginal farmers (~ 70%) having less than two hectares of land. Many tribal farming households are often unable to produce enough food, both in terms of quantity as well as required diversity due to a range of constrains (Arunachalam *et al*, 2006). The M.S.Swaminathan Research Foundation has been addressing some of these issues related to agricultural biodiversity, traditional knowledge, food and nutritional security since early 1990s.

As part of the ongoing efforts, a project entitled Alleviating poverty and malnutrition (APM) was operated in three Agrobiodiversity Hotspots one being in Koraput, jointly

implemented by the M. S. Swaminathan Research Foundation, Chennai, India and the University of Alberta, Edmonton, Canada with an objective of attaining better food and nutritional security at individual, household and community levels through multiple pathways with special emphasis on promotion of kitchen gardens, poultry rearing, pisciculture, *on-farm*and*off-farm* enterprises. The interventions are in alignment with appropriate nutrition-specific interventions aimed at addressing alleviating poverty and malnutrition using nutrient-rich foods like vegetables, fruits, foods from animal-sources and bio-fortified or fortified staples (IFPRI 2012).

OBJECTIVES

The broad objective of the study was to comprehend the dietary diversity and food consumption pattern of three tribal communities namely *Bhumia*, *Paroja*and *Penthia*usinga combination ofquantitative and qualitative data generated throughNutritional Assessment Surveys.

To achieve the broader objective, following sub- objectives were addressed in the present study: (i) a brief overview of the socio-cultural aspects of three tribes, (ii) to capture the current pattern of dietary diversity, (iii) to document changes in the dietary pattern, (iv) to estimate the food group and nutrient intake using 24 hours recall survey and (v) to document some of the recipes of local foods, reported in 24 hours recall survey and highlight its relationship with biodiversity.

Research Methods

A Nutritional Survey was carried out using a systematic random sampling procedure during June to November 2013consisting of (i) Food Frequency Survey was carried out among 500 households in 25 project villages of Kundura Blockand (ii) 24 hours recall diet survey (weighment method)was carried out among 100 households in 7 project villages. The pre-tested questionnaires were filled out through personal interviews by field investigators trained in the survey methodologies, who were also regularly monitored during data collection. From the surveys, information on 190 tribal households [*Bhumia* (n=108), *Paroja*(n=61) and *Penthia*(n=21)] for food frequency and 80 tribal households [*Bhumia*(n=35), *Paroja*(n=30) and *Penthia*(n=15)] for 24 hour recall were culled out and used in the present analysis.

The food frequency survey was carried out to understand the food habit of communities and capture information on different food groups (totaling to 15 groups). In addition, the survey also captured the raw quantity consumed, frequency of consumption, seasonal availability and major source.

Under the 24 hours recall survey, information on age, sex, physiological status, physical activity of the household member who took meals during the previous 24 hours was collected. Each respondent was asked to report all food items and drink consumed by each member of the household and to provide details on name of the food item, ingredients and quantity of raw material used for preparing each itemand the information meticulously recorded. The raw quantity of each ingredient used for preparing food was weighed using a digital weighing scale, different sizes of cups and spoons. Food-items were compiled later to calculate the Consumption Unit (CU) (Rao *et al*., 2012).

One CU refers to coefficient of energy requirement of reference man, who is an adult male, aged from 20 to 39 years, weighing 60 Kg., doing sedentary work. The intake of various food groups are computed and expressed as average per CU/day, based on the equation:

$$\text{Average Intake per CU/day (g)} = \frac{\text{Total Raw amount used (g)}}{\text{TotalCU of Household (Consuming the food)}}$$

Using the above equation, the mean intake of Food group (per CU/day) and mean intake of Nutrients (per CU/day) were calculated.

Focus Group Discussions (FDGs) were conducted among women from seven intervention villages for collection of data on group specific local tribal foods identified in 24 hours recall survey and its cooking methodologies.

Data collection procedure was lengthy with each household spending close to 3 hours for filling out one questionnaire. It may also be mentioned that women were hesitant to provide details of their consumption pattern as it was a reflection of their social status.

FINDINGS AND DISCUSSION

Nineteen homogeneous and six heterogeneous villages inhabited by *Bhumia*, *Paroja*and *Penthia*tribeswere surveyed.Two villages had all the three ethnic groups in different proportions (Fig 1). Villages are in close proximity to the forest and most villages are small in size. The majority of the households were male dominated (93%) and in 83% of the households average family size ranged between 2 to 6 members. More than 43% of the people in surveyed households were illiterate and 42% had completed primary, upper primary and schooling. Raising crop, livestock and poultry were the primary livelihoods followed by non-farm wage employment. Nearly seventy percent of the respodents were marginal and small farmers owning a maximum of 2 acres of cultivable land. The average land size cultivated by tribal households was 0.8 acres. Nearly 55% of their income was generated from crop production followed by farm wage earning(16.56%) and on farm wage earning(12.86%) followed by livestock production, salary/ pension, business/ trade, remittance from migration and other sources contributing a small fractions of their incomes. The average annual income for *Bhumia*households was maximum (Rs 33425/)followed by *Paroja*(Rs 28211/) and Penthia(Rs 27611/) households.Food expenditure was highest among *Penthia*(52.2) followed by *Bhumia*(49.3%) and *Paroja*(48.4%).

The results are presented as sections that cover: (i) socio-cultural aspects of three tribes, (ii) current dietary diversity pattern, (iii) changes in the dietary pattern, (iv) consumption based on 24 hours diet recall (v) relationship between local foods and biodiversity.

I. Socio-cultural aspects of three tribes

This section provides the socio cultural dimension as well as livelihood pattern of three tribes.

1. ***Bhumia*** society is patrilocal, patriarchal and patrilineal. All posts in the traditional village Panchayat (Local Grassroot Institution) are hereditary. *Diari* is the religious head of the village and performs ceremonial worship for both individual and community level. Their main festival is*Balijatra* in the month of April during which they observe elaborate fertility rites along with *Chaitraparab* in March/ April. *Budhi Takurani* is their chief village. Other deities worshipped are *Nisani, Mauli*, *Ran Devata* and *Hundi debata*. Till date theyhave a strong believe in the efficacy of magic and sorcery. The *Dhemsa* dance is popular among them.

They are settled agriculturists; most of them own land, plough, bullocks and other agricultural tools and implements. Rice is cultivated in lowlands, oilseeds, pulses in uplands and vegetables in the kitchen garden. Agriculture is supplemented by agricultural labour, wage earning and collection of minor forest products during the lean months. They hunt small game but do not practice fishing. They speak *Desiya* language.

2. Paroja villages have well-organized socio political system. The traditional village panchayat is run by *Jan*i, *Muduli* and *Challan* whose positions are hereditary and carry high social prestige. They observe several seasonal festivals viz. *Bihan Thapa, Asadhi Parab, Nuakhia, Diali Parab, Baulani Jatra, Pus Parab, Chait Parab*round the year. They are simple, friendly and very hard working.

They are seasoned cultivators and agriculture is the mainstay of their economy. They practice both wet and dry system of cultivation along with collection of forest produce, wage earning and animal husbandry. They grow paddy both in low and uplands and other millets, pulses and oilseeds in uplands. They raise maize and vegetable crops in the kitchen garden. Mangoes, edible fruits, roots and tubers are collected from the forest.

They worship a number of gods and deities for their well being. The important deities are *Danteswari,* the Earth goddess, *DongerDebta,* the forest god, *Mahapuru,* the supreme god, and *Nisan Debta*. Dead ancestors, who are called *Duma Debta,* receive routine worship and sacrifices during festive occasions. They speak *Desiya* language.

3. Penthiaare a numerically small tribe, 76.88% live in Koraput mostly in heterogeneous villages that are located in plains. They live in separate hamlets; settlement patterns resemble that of their Hindu neighbours. They speak *Oriya* and are bilingual. Posts are hereditary in traditional village panchayat viz. *Bhata Naik, Pradhani, Dalei, Dhoba, Bhandari and Chalan.*Religious priests are invited by well to do families to carry out social ceremonies and religious functions.

Penthias are settled agriculturists. Most of them are landless and earn their living working as agricultural and industrial labourers. Fishing and hunting are rarely practiced. Rice is their staple food. They also eat different millets viz.Finger millet, *Little millet,Foxtail millet,* flowers of *Mahula(Madhuca latifolia)*and mango kernels. They do not eat Beef or Pork. Fowl is their favourite non vegetarian food. They are lovers of dance and music.

Nuakhia (Eating of new rice), *Amba Nua* (New Mango eating ceremony), *Pausa Purnima.Samalai Thakurani* is worshipped on all important occasions, specifically during outbreak of epidemics.

They have a high social status and are served by barber and washerman. Religious Priests from higher social category s are employed on certain occasions by well to do families. They treat certain tribal groups namely *Koya, Paroja, Gadaba, Bondo, Kondha* as inferior to them. They also do not take water or any other cooked food from Other Backward Classes.

II. Current dietary diversity pattern

Analysis of data on food frequency revealed that three ethnic groups had access to all the fifteen food groups; list of food groups and items, diverse sources are provided in Table 2, 3 and4. The total number of food items varied among the three groups. *Bhumia*were in the highest order consuming 115 food items followed by *Paroja*and *Penthia*using 104 and 97 respectively, which could be linked with the household income in the order of Bhumia> Paroja> Penthia. This finding is supported by several other findings showing significant positive associations between dietary diversity and household socioeconomic status within countries (Thorne-Lyman et al., 2010; Rashid et al., 2006; Rah et al., 2010; Hoddinott and Yohannes, 2002; Hatløy et al., 2000; Anzid et al., 2009).

Cereals and millets

Four different cereals, namely rice, maize ,wheat, and semolina were used by all the three ethnic groups. Raw rice either hand pounded or milled was consumed daily. Rice flakes were consumed occasionally whenever available by nearly 25 % of total Bhumia, *Paroja*and *Penthia*households.

Rice used was met from their own cultivation , external markets and Public Distribution System (PDS)is presented in Table 4.

After rice, maize was available and consumed in rainy and winter season. A total 67 households reported using maize in their meal. Maize cultivation was carried out by 17% of the total households which could be related to late monsoon as well as labour management. The order of maize cultivation was *Bhumia>Paroja>Penthia*. Of the 190 households, Wheat and semolina were occasionallyconsumed by 23 and 17 households respectively which were availed from market.

Finger millet was the most used millet across three tribes.All the *Penthia*households consumed daily whereas 63 % of *Bhumia*and 56% of *Paroja*households had finger millet gruel everyday. Little millet was consumed occasionally only by 6 and 2 households of *Bhumia*and *Paroja*respectively.*Penthia*community did not include it in their diet.

Even though *Penthia*community had finger millet in their daily diet, 100% of it was purchase from market,followed by 67.6% of *Bhumia*and 54% of Paroja. The rest was from own cultivation. *Penthia*might not practice dry farming in uplands, that could be the reason fortotal market dependancy.

Pulses and legumes

Eight different pulses were consumed across three communities in all seasons with diverse frequencies. Common and local pulses namely red gram, black gram and horse gram and five introduced pulses i.e. green gram,lentil, bengal gram, dry peas and soyabean

(Das 2006; Mishra & Chaudhury 2012) form a part of tribal diet as per their preferences. Of the introduced pulses Bengal gram, Soyabean and Peas were used by a few households whereas Lentil and Green gram were consumed by more households, which could be due to the market availability, comparatively lower price and cooking time. Only 3 *Bhumia*and 1 *Paroja*household consumed pulse in their daily diet.

There was no specific season of consumption since most of those pulses were purchased from the market. Barring 18 households, 15 from *Bhumia*and 3 from *Paroja*all other households accessed pulses through market(Table 4).

Green leafy vegetables

Amaranthus followed by green and/or dried leaves of radish and pumpkin were popular green leafy vegetables(GLVs)across three communities. Collection of *Barada* (*Bauhinia purpurea* L.) and *Sunusunia* (*Marsilea minuta* Linn.)from semi-wild conditions and a common among three tribes. Other seasonal collections were fresh petiole of *Cassia*by *Bhumia*, green leaves of *Chakunda* (*Cassia tora*) by *Paroja*and *Koilari* (*Bauhinia variegata* L.) by*Penthia.* Of the introduced species, cabbage, spinach and drumstick leaves were popular cauliflower.

Barring 3 *Bhumia*households, others did not consume GLVs daily. Like vegetables GLVs were highly seasonal and the order of availability was winter>rainy>summer. Table 4 explains the various sources availed by the communities.

Roots and tubers

A number of cultivated roots and tubers were commonly and widely used across three ethnic groups of which *Colocasia*, Elephant's foot yam (*Dioscorea elephantipes),*Yam, Ordinary yam (*Dioscorea alata* L.) ,Sweet potato and Radish were highly seasonal but dominant. Maximum accessibility was reported in winter followed by rainy and summer. Of the total households 82% availed roots and tubers through market Potato and onion were purchased and consumed daily.

Other vegetables

A large number of vegetables were documented from the survey. *Bhumia*and *Paroja*households had access to twenty six, whereas *Penthia*had access to twenty three different vegetables (Table 3). In addition to traditional vegetables, a number of introduced vegetables i.e. French beans, Cabbage, Cauliflower, Knol khol, Pointed gourd, Papaya, Lady's finger, Ivy gourd, Snake gourd, Ridge gourd, Spine gourd, Spring onion, Cluster beans, Plantain, Plantain stems also has been adopted in the diet across three communities.

Fig 2: Consumption pattern of vegetables

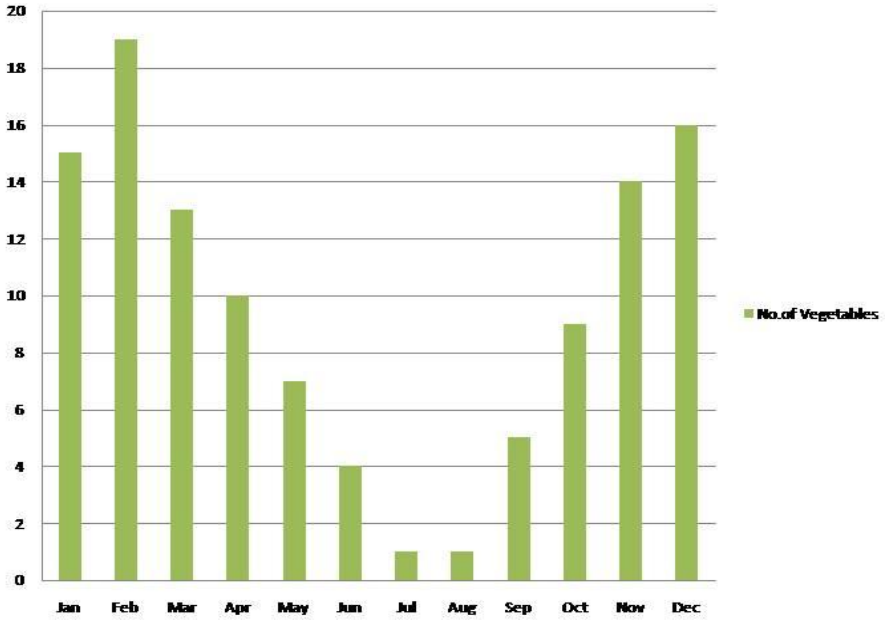


Table 3: List of food items under each food group

Tribes / Food groups	***Bhumia***	***Paroja***	***Penthia***
Cereals	Rice, Maize , Wheat , semolina **Value added** 1. Popped rice 2. Pressed rice 3. Rice flakes 4. Rice flakes powder	Rice, Maize , Wheat , Semolina **Value added** 1. Popped rice 2. Pressed rice 3. Rice flakes	Rice, Maize, Wheat , Semolina **Value added** 1.Rice flakes
Millets	Finger millet ,Little millet	Finger millet, Little millet	Finger millet
Pulses & Lugumes	Bengal gram, *Bhodei*, Black gram, Dry peas, Green gram, Horse gram, Lentil ,Red gram, Soya Bean and Soya Bean chunks	Bengal gram, Black gram, Dry peas, Green gram, Horse gram, Lentil, Red gram and Soya Bean	Bengal gram, Black gram, Dry peas, Green gram, Horse gram, Lentil , Red gram and Soya Bean
Green leaves	Amaranthus, *Barada*, Cabbage, Drumstick , Fresh petilole of *Cassia*, Pumpkin, Radish, Spinach and *Sunsunia*	Amaranthus, *Barada*, Cabbage, Cauliflower, *Chakunda*, Drumstick, Pumpkin, Raddish, Spinach and *Sunusunia*	Amaranthus, *Barada*, Cabbage, Drumstick, *Koilari*, Pumpkin, Raddish, Spinach and *Sunusunia*
Roots&Tubers	Big onion, Carrot, *Colocassia*, Elephant foot yam , Ginger, Ordinary yam, Potato, Radish and Sweet potato	Big onion, *Colocassia*, Elephant foot yam, Ordinary yam, Potato, Radish, Sweet potato and Yam	Big onion, Carrot, *Colocassia*, Ordinary yam , Potato, Radish, Sweet potato and Yam
Othrer Vegetables	Ash gourd , Banana stem, Beans, Bitter gourd, Bottle gourd, Brinjal , Broad Beans, Cabbage, Cauliflower, Cluster Beans, Cow pea, Cucumber, Drum sticks, Green Chilly, Jackfruit, Jackfruit seed, Knol khol, Ivy gourd, Ladys' finger, Papaya, Pointed Gourd, Pumpkin, Pumpkin flower, Ridge gourd, Snake gourd, Spine gourd	Ash Gourd, Beans, Bitter Gourd, Bottle gourd, Brinjal, Broad Beans, Cauliflower, Cow pea , Cucumber, Drumstick, French beans, Green Chilly, Ivy gourd, Ladys' finger, Jackfruit, Jackfruit seed, Knol khol, Papaya, Peas, Plantain, Pointed Gourd, Pumpkin, Ridge gourd, Runner Beans, Snake gourd, Spine gourd	Ash gourd, Bean, Bitter gourd, Bottle gourd, Brinjal, Broad Beans, Cabbage, Cauliflower, Cow pea, Cucumber, Drum stick, French Beans, Green chilly, Ivy Gourd, Jackfruit, Knol khol, Ladys' finger, Papaya, Pointed Gourd, Pumpkin, Ridge gourd Spine gourd, Spring onion

The frequency of consumption was highly variable and mostly seasonal across the tribes. About 70% of *Penthia*households consumed vegetables everyday while ~20% of *Paroja*and *Bhumia*households had daily. The trend observed in vegetable consumption was winter > rainy> summer across the tribes. The cosumption of vegetables declined gradually from January to June and again increasedfrom September till December. In July and August communities hardly consume any cultivated vegetables (Figure 2). To overcome this they depend more on wild foods (mushrooms, bamboo shoots).

Table 4 indicates market dependency for vegetables . Nearly 78% of the households consumed vegetables availed through the local market indicating a positive adoption as the potential role of vegetables in alleviating micronutrient deficiencies is increasingly recognized. Borrowing from neighbours was reported for all the three groups even though percentage was very low(~2%)indicating rudimentary social networking which is an integral part of tribal culture.

Table 4: Sources of food groups documented during dietary diversity survey

S.No.	Name of the Food Groups	*Bhumia* (%age of Households)						*Paroja*(%age of HouseHolds)						*Penthia*(%age of Households)					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
1	Cereals	0	31.47	66.89	1.12	0.52	0	0	11.51	81.08	7.41	0	0	0	42.92	52.1	4.98	0	0
2	Millets	0	27.52	72.48	0	0	0	0	0	100	0	0	0	0	73	27	0	0	0
3	Pulses & Legumes	0	1.84	98.16	0	0	0	0	0	100	0	0	0	0	1.47	98.54	0	0	0
4	Green Leafy Vegetables	23.18	18.03	55.48	0.33	2.98	0	2.08	2.08	91.67	0	4.17	0	16.51	8.6	71.16	0	3.73	0
5	Roots & Tubers	1.01	16.11	82.77	0	0.11	0	4.8	9.1	86.1	0	0	0	0.62	21.02	77.96	0.4	0	0
6	Other Vegetables	1.04	19.7	76.51	0	2.75	0	0	29.2	69.3	0	1.5	0	0.31	10.84	86.1	0	2.75	0
7	Milk & Milk products	0.9	3.68	91.74	0.9	2.78	0	0	6.67	86.67	0	6.67	0	0	15	83	0	2	0
8	Fish	24.66	1.01	74.33	0	0	0	0	0	100	0	0	0	5.56	0	93.21	1.23	0	0
9	Egg	0	0	100	0	0	0	0	0	100	0	0	0	0	1.16	98.84	0	0	0
10	Meats & Flesh	0	0.66	99.34	0	0	0	0	1.05	98.95	0	0	0	0	0.41	99.59	0	0	0
11	Fruits	11.63	6.88	79.58	0	1.91	0	1.41	2	88.29	0	8.3	0	10.98	18.44	69.74	0	0.84	0
12	Sugar & Jaggery	0	0	100	0	0	0	0	0	97.22	0	2.78	0	0	0	99.17	0.83	0	0
13	Fats & Oils	0	0	100	0	0	0	0	0	100	0	0	0	0	0	100	0	0	0
14	Nuts & Oils	3.75	15.79	74	3.22	3.24	0	6.41	1.32	92.27	0	0	0	1.24	15.18	83.14	0	0.44	0
15	Others	31.94	7.67	58.18	0	2.21	0	33.33	3.33	60	3.33	0	0	35.85	19.68	42.35	0	2.13	0

1. Wild Collection; 2. Own Cultivation; 3.Market; 4.PDS; 5. Borrowed from Neighbors; 6. Borrowed from Grain Bank

The Source mentioned refers to the major source availed by the particular households

Milk and milk products

Milk and milk products were reported as part of their diet across three tribes. Both *Bhumia*and *Paroja*households had access to buffalo as well as cow's milk besides milk powder. For *Penthias,* cow's milk and milk powder were available. All the three tribes had curd in their diet. *Paneer* (Cottage cheese) was consumed by *Bhumia*and *Penthia*households.

Number of households having milk daily in their diet was low; 33.33% of *Penthia*households followed by 21% of each *Bhumia*and *Paroja*. Milk was available round the year. Of all the households nearly 87% had availed milk from market (Table 4).

Earlier milk and milk products were not an integral part of tribal diet; cattle and buffaloes were reared primarily for manure and draught power as well as for their meat. Most of the tribal families do not milk cows and, in fact, barring a few many are not aware of uses and benefits of milk. (Das, 2006). Over the years, the non tribal incursion has changed the dietary habit of tribes (Behura & Mohanty, 2006).

Fish

Various fishes including both local and cultured have been consumed by three tribal groups over a year. Local fishes were common in the diet of all three communities followed by dried marine fishes. Prawn was found only in *Bhumia*diet besides a number of specific local fishes viz. *Chenga* (*Channa gachua), Gadisha* (*Gadusia), Maguro* (*Clarias batrach)* and *Todi* (*Mastacembalus (EEL)* available in the ponds or seasonal ditches as well as cultured fishes like Catla (*Catla catla*) and *Rohu* (*Labeo rohita).* Two local fishes *Gadisha* and *Maguro* were reported in *Paroja*foods in addition to Catla and *Rohu.Penthia*tribes relied upon Catla and Rohu on addition to those mentioned above. Nearly 90% of the households depended on market throughout the year but consumption rate was low for 75% of them i.e. once in fifteen days.Even though *Pisci* culture has helped the communities to have access to fishes round the year compared to earlier seasonal availability still there is a need to increase the frequency of consumption.

Eggs

Chicken eggs were included in the *Bhumia*, *Paroja*and *Penthia*diets; all were having easy access to eggs through market though frequency of consumption varied from once in a week to occasionally . Except one *Paroja*household all the other households purchased egg. Earlier eggs were very often used in tribal magico religious fuctions. In 2005, the Government of Odisha introduced Poultry Farming in 30 most backward remote blocks of seven southwest districts benefitting 56,180 households of which 80% are ST. Over the years, development of markets for eggs in the area has brought about changes in traditional food habits and the egg was adopted in their regular diet, thereby providing enhanced nutrition (Govt. of Odisha, 2005).

Meat and flesh

All the tribal households had access to meats of hen, duck, goat and sheep throughout the year. Tribal culture encourages animal sacrifice on special socio-cultural and magico religious functions; inclusion of worshipped meat in their food basket is an age old tradition.

Except four families all others purchased meat from external market. Chicken is the most preferred meat and consumed once in a month followed by mutton. Duck and lamb were occasionally consumed by a few families. Unlike vegetables, there was no fixed season for specific meat consumption.

Fruits

Several fruits including local as well as urban were available and consumed by all households.Fruits like Tomato, Black berries, Guava, Jackfruit, Mango were the most common consumed fruits; Tomato being consumed daily across the tribes. Dates, Durian and Pineapple were exclusively consumed by the *Bhumia*; Custard apple by *Paroja*and *Kendu* (*Diospyros melanoxylon* Roxb.) by *Penthia.* Apple, Orange, Grapes and Banana were reported in the food habits of three tribal groups with occasional consumption. Influx of urban people into tribal areas might have helped to change such consumption habits.

Availability and access to fruits was highest in summer followed by rainy and winter which is a reverse trend with vegetables and food grains. More than 60% of households had access to Mango and Jackfruit through market; Guava and Watermelon by 35% and 15% households respectively. Exceptional were Blackberry and *Kendu* collected from the wild by seventeen households and purchased by eight households. Around 70% of households reported consumingbanana once or maximum twice a week. Though availability of introduced traditional fruits was plenty in the market, access to those was occasional in all the surveyed households.Efforts should be made to increase the frequency as those are established sources of nutrients.

Sugar and jaggery

The survey revealed that more than ninety eight percent of total households had sugar in their daily food. All had an easy access to it through local market except one *Paroja*household who availed it through PDS. *Jaggery* was consumed occasionally by 62% of the total households. All the households purchased *jaggery* from the market.

Fats and oils

A total ofsix edible oils *viz. Refined*, Palm, Sun flower, Rice bran, Soybean and Mustard were reported to be used by all the three communities. Palm oil was used by 90% of households followed by *Refined*, Sun flower and Rice bran oil by a limited number of households. All oils were purchased from the market. Soyabean and mustard oils were used by one household.

Nuts and oils

All the three communities had easy access to a number of nuts. Dried and roasted Cashew nuts, tender and fruit coconut and fresh and roasted groundnut were part of the diets. The Odisha State Horticulture Department has been planting cashew in tribal villages for the last 10-15 years. Ground nut has been introduced as a commercial crop by State Department of Agriculture which was reflected in the tribal food basket. Tribal communities use coconuts in their socio-cultural and magico religious functions regularly. Access to tender coconut

might be possible for the traders and improved road transport. Almond was reported in the diet of *Bhumia*and *Penthia*tribes which was introduced in the region.

Others

Others include mushrooms, bamboo shoots and tamarind together. Inclusion of mushrooms and bamboo shoots in diet was highly seasonal and confined to monsoon which lasts for about four months and considered as lean period. Both were collected from wild as well as purchased from the local market. Regular use of Tamarind throughout the year in tribal diet was reported for all the three tribes. Only 7.67% of the total households were reported to hadothers from their own cultivation. *Paroja*tribe was depending most on market followed by *Bhumia*and *Penthia*(Table 4). Social networking was found to be active in *Bhumia*as they borrowed all the three food items from their neighbours. In case of *Penthia*it was nil whereas 6.38% of *Paroja*households borrowed bamboo shoots from their neighbours. It is evident that in the developmental process the three tribes are in the order of *Penthia>Bhumia>Paroja.*

The survey disclosed that a number of food groups comprising of diverse foods were available throughout the year and consumed at different frequencies in different seasons(Fig 3) across the three tribes highlighting the existence of dietary diversity in tribal food pattern. Diversity in diet is important as it support to increase the possibility of achieving an adequate diet, lessen the risks of developing a deficiency or excess of any one nutrient, ensure an appropriate balance of micronutrients as well as energy. Adult and child diets containing a greater number of different foods or food groups are associated with greater energy and nutrient intakes (Kant, 2004; Rose et al., 2002; Ogle et al., 2001; Tarini et al., 1999; Onyango et al., 1998). Nevertheless, diverse diets give benefits beyond just enhanced nutrient intakes.

Fig 3 Seasonal food availability in the surveyed villages

All the three ethnic groups consumed a number of non-staple foods namely pulses, vegetables and fruits, fish, animal products, sugar and edible oils besides forest collections which indicated a higher level of dietary diversity (Hoddinott and Yohannes, 2002). Since communities are residing in agrobiodiversity hotspot there is more species diversity than genetic diversity leading to high dietary diversity. This could be supported by the studies carried out by Penafiel et al.(2011) and Belanger and Johns (2008) who tried to establish the probable connection between Biodiversity and Dietary Diversity; Biodiversity has been proposed to be a requirement for dietary diversity and health benefits. Some recent studies have focused on role of biodiversity in improving nutrition (Frison et al., 2011; Belanger and Johns, 2008; Burlingame et al., 2009a) though at times it is assumed that higher biodiversity and improved nutrition are closely related though supporting research or theoretical framework is lacking.

III. Changes in the dietary pattern

Over the past few decades, there has been a gradual shift from subsistence agriculture, livestock rearing, seasonal forest food collection, fruits and vegetables cultivation to increasing dependence on public distribution system (PDS) and outside markets among the tribal communities leading to significant changes in food habits which is a concern for both researchers and policy makers (Behura and Mohanty 2006). Migration of outsiders to tribal areas is changing the settlement pattern and ecosystem as a whole to some extent preventing them to access their own food resources.

Communities had access to a wide range of foods from agricultural lands based on their value system , had their novel methods of choosing their food basket from forest resources, livestock rearing and gardening and local availability. Their access to multiple food sources was providing them food supply on a continuous basis and acted as a safety net against nutritional deficiencies (Behura & Mohanty, 2006; Mishra et al 2008, 2009 and Mishra and Chaudhury 2012).

Over the last fifty years traditional varieties and landraces of most crops have disappearedfrom the agricultural landscape, farmlands, and woodlands as high yielding varieties are making inroads into the islands of rural or tribal communities who conserve heirloom genetic resources (Nayar 2009).

Adoption of improved crops and modern agricultural practices has transformed the land use pattern. Uplands which are used for cultivation of diverse short duration food crops namely rice, maize, millets, pulses, oil seeds and vegetables are either leased out for commercial plantations of Cashew, Eucalyptus or leveled to make it suitable for subsidized government supplied improved varieties.

Traditional varieties had several advantages over improved varieties; best suited to local ecological conditions, nutrient-rich having good cooking quality, palatable, suitability for preparation of different local dishes and value added products and are fundamentals for socio-cultural celebrations and management of natural resources.

A number of short duration red rices were established to have 52% more iron and zinc compared to white rice (Ahuja 2007). The database generated from the present study showed milled raw rice as the staple which either is from own cultivation or PDS and market.

There was a habit of making rice flakes from red and coarse rice for snacks, *Bhumia*tribe was reported to have consumed more rice flakes compared to the other two tribes. Additional intake of red rice would be providing them more micro nutrients (Privita et al 2014).

Finger millet is reported to be the most widely consumed millet besides little millet to some extent. In 1996 a survey conducted by MSSRF reported 8 different millets from the region with different maturity period and diverse food value(Mishra and Chaudhury 2012). Within each millet species a number of local varieties were available with varying duration and usages. Tribal communities are not able to spare time and labour for millet cultivation owing to delayed monsoon; area and productivity are sharply declining in the villages(Mishra et al 2014).

Little millet is having a high cultural value and is cultivated with finger millet under multiple cropping system of farming which is vanishing from the landscape.

Earlier seasonal greens were collected from wild or semi wild conditions besides *Amaranthus* species. It has been reported that a total of five greens during the survey period in contrast to 13 greens in 1996. This could be due to reduction in forest cover to 22.43 % of the geographic area from 70% in the last five decades (Rath 2002).Accessibility to a large number of vegetables is a significant achievement within last twenty years. Compared to eight common vegetables namely Pumpkin, Bitter gourd, Tomato, Ridge gourd, Bottle gourd, Runner beans,Elephant foot yam, Colocasia, Amaranthusgrowing in kitchen garden for household consumption followed by random cultivation of high yielding varieties of vegetables introduced by State Horticulture Department.

MSSRF has been promoting vegetable cultivation from 2006 in its working villages in its Biodiversity based programmes. Adoption of pedal pump, promotion of kitchen garden as nutritional intervention could be linked to the higher number of available vegetables in the market as well as in tribal diet. Supply of vegetables from *malis* (traditional vegetable cultivator) to local markets through road transport could be considered as another possibility of increased access to more vegetable.

There is no significant change in availability of number of pulses and legumes over the years but five new species have been introduced in the tribal diet (Mishra & Chaudhury 2012). Migration of tribal communities to urban areas and vice versa, outside traders visiting the local markets, access of roads to interior villages for transport of commodities are some of the reasons for availability of new pulses in the region. The inclusion of pulses in regular frequencies is a new trend which has been captured in both the studies. It could be related to the functioning of ANM, ICDS, and MDM programmes influencing tribal communities to rely on proteins in their regular meal.

With the gradual dwindling of forest cover, availability of wild tubers, fruits and nuts as well animals and birds have declined in number. The nutrient requirements fulfilled from locally available food materials were no longer plentiful for the communities. Wild tubers which were contributing to the food basket of communities were not reported during diet survey. Nine common species were providing major as well as minor meals to the communities during July to October which is a food scarcity period (Mishra et al 2008).

Over the years wild tubers have been replaced with potato in tribal markets and included in their diet might be due to its availability throughout the year in the market; price is constant and comparatively low compared to other seasonal vegetables. Children attending local schools, staying in the hostels for higher education are getting used to potato based curries in MDM and hostel mess and the demand for cooking such dishes at home.

Tribal women and young girls used to catch local fishes, prawns and small crabs from rice fields and seasonal ditches either in the beginning or towards the end of rainy season. Access was limited and subject to seasonality. Men at times were placing the traditional fish catching devices across running water for the whole night and collecting fishes in the morning for use as household consumption. Cultured fishes purchased from the market occupied an important place in tribal food habit. Though the rate of consumption is low, availability is spread across the year. Exposure, increased income through Government sponsored developmental programmes specifically Mahatma Gandhi National Rural Employment GuaranteeAct (MGNREGA)providing an opportunity to earn and utilize cash for family food.

Inclusion of egg in tribal meals is quite remarkable. Availability of eggs in the local market and low price compared to fish and meat could be the driver of change in diet pattern of communities.

Drastic change was observed in tribal food habit with relation to milk and milk products, fats and oils, sugar and *jaggery*. Traditional tribal foods were not comprised of milk or milk products. Delivery of milk packets by Odisha Milk Federation (OMFED), Kamadhenu Company exposed the communities to milk and curd and occasionally cottage cheese for use at home. Establishments of road side or market tea stalls encouraged milk vendors to visit the place for delivery. Cash income through private or Government developmental works helped them with the capability to spend. Milk has become an integral part of tribal diet. Use of oil in regular cooking was not a common practice. Vegetables were mostly boiled with salt and turmeric powder and seasoning was given with minimum oil and dry chilli.

Niger oil (*Guizotia abyssinica*), *Tolo oil* (*Madhuca latifolia*) and *Kirchi* oil were used as edible oils by the communities (Das 2006). Niger was extensively cultivated in hill slopes and uplands whereas the later two were collected from semi wild or wild. The study revealed that presently Palm oil is predominant among all the tribes and most important cooking oil followed by five other oils. Instead of extracting oil households are purchasing it from market. The use of oil in tribal cooking was minimum; they were used more to boiled food than fried items. Use of oil in everyday cooking was reported indicating a change in tribal food habit.

Daily consumption of sugar and occasional consumption of *jaggery* is a new finding as tribal traditional foods were devoid of sugar and *jaggery* except special sweet dishes/ delicacies which were prepared with *jaggery*. The practice of taking tea, snacks in local markets gradually make them habituated to sugar. The availability of sweets, bakery products has also changed their food habits.

IV. Consumption based 24 hours diet recall

The survey revealed that three regular meals were taken at home besides morning and evening tea across three tribes(Table 4); the frequency and time of food intake was largely related to their work schedule. Drinking tea with or without milk was during breakfast or before was reported in majority of the households surveyed. Biscuit with tea by the *Penthia*and *Pakodi (salty fried snack)* by*Bhumia*tribe was also recorded.

Milled raw rice with finger millet gruel is the staple food. Thick soup of Red gram, Lentil, Horse gram, Cow pea, Bengal gram and Green gram were reported as a part of their lunch and dinner across the tribes. The frequency of consumption was not similar though it was central in their food habit. Finger millet gruel made up of only finger millet flour and water (*pej*) with a thin consistency or finger millet flour with broken rice and water (*jau*) was prepared and consumed either in the morning or afternoon with or without rice.

A wide range of curries i.e. vegetable curry made up of either single or mixed vegetables, *Ambila* curry, Soybean curry, Mushroom curry, Bamboo shoot curry, Fish and Dry fish curry, Chicken curry is an essential part of tribal lunch and dinner. Dry fry of different vegetables and seasonal greens with oil and minimum spices were very popular among the tribes. Table 5 shows the list of vegetables and greens used for cooking.

Table 5: 24 Hours diet recall acrossthree tribal groups

Tribes / Food frequency	***Bhumia***	***Paroja***	***Penthia***
Before Food (BF)	Black or Milk tea	Black or Milk tea	Black or Milk tea
Breakfast	Rice, *Roti(Wheat bread)*, Puri(Fried wheat bread), Pakodi(Fried salty pulse), Tea, Finger millet gruel, *Dal*,(Thick pulse soup) vegetable curry	Black or Milk tea	Rice, *Roti(Wheat bread*, Tea, Finger millet gruel, *Dal*,(Thick pulse soup) vegetable curry and Vegetable fry
Lunch	Rice, *Dal*,(Thick pulse soup), Finger millet gruel, Vegetable curry, Soyabean chunks curry, *Pakoda*	Rice, *Dal*,(Thick pulse soup), Finger millet gruel, Mixed vegetable curry, Green gram dalma, *Charu* (tamarind and Tomato soup), Chicken curry, Dry fish curry, Amot Curry	Rice, *Dal*,(Thick pulse soup), Ambila curry, *Charu* (tamarind and Tomato soup), Mixed vegetable curry, Soyabean chunks curry, Mushroom curry, *Maize Dosa, Green gram dalama*
Snacks	Tea, Finger millet gruel	Tea, Finger millet gruel	Tea, Finger millet gruel
Dinner	Rice, *Charu (tamarind and Tomato soup)*, *Dalma*,(Thick pulse soup with vegetables) , Finger millet gruel, Finger millet soup, Curry, Vegetable fry,Leafy green vegetables fry, Dry fish curry, Bamboo shoot curry, Mushroom curry, chicken curry	Rice, *Dal*,(Thick pulse soup), Finger millet gruel, Finger millet juice, Mixed vegetable curry, *Dalma,Charu (tamarind and Tomato soup)*, Chicken curry, Dry fish curry, Amot (Special local)Curry	Rice, *Charu (tamarind and Tomato soup),Dalma*,(Thick pulse soup with vegetables), Finger millet gruel, Finger millet soup, Vegetable fry, Leafy green vegetables fry, Dry fish curry

Pulses and vegetables are cooked in edible oils along with onion, cumin seeds, mustard seeds, salt or iodized salt, turmeric powder, dry chili or chili powder for regular meals whereas for special meals tomato, garlic, ginger and powder *of various spices* are used for making spicy food. The food habit has changed to spicy in many households across three tribes which could again be linked to the influence of their non-tribal neighbors and external markets.

The number of vegetables used in cooking varies from tribe to tribe. Sixteen vegetables were reported to be used in making curry in *Bhumia*households whereas *Paroja*and *Penthia*used ten vegetables each. Since villages were located in the same agro-ecological zone, many of the vegetables were common among them. *Amaranthus* and drumstick leaves were common for all the three tribal groups and the recipes followed were similar. Use of spices for preparing vegetables as well as non vegetarian food was least among *Paroja*compared to other two tribes.

Earlier tribal families were having three regular meals at home(Das 2006). Around 10 AM they used to have rice with finger millet gruel. At about two in the afternoon, they used to had few cups of finger millet gruel and at 8 PM they used to eat rice and finger millet gruel. Pulses were prepared as a part of the evening meal. Every meal includes chutney made out of tamarind, mango or *mahua*. Meat and fish may be added to roots and vegetables which are cooked with chilli and turmeric. These are delicacies that vary from day to day but the main diet remains unchanged.

Over the years changes in the cooking pattern and food items has been observed. Though rice and finger millet are still the staple and integral part of tribal diet, there are major changes in the cooking pattern. The trend of using pulses has changed and the frequency of consumption has increased. Use of oil, spices to make spicy food items were recorded across three communities. Drinking of tea regularly in morning and evening is a recent trend. There was an intimate connection between food, natural resources and farming systems (Das 2006) which has been changed over the years to market and cash besides PDS. Purchase is dominating across the tribes than own harvest (Table 4).

IV. Daily mean food intake and median nutrient intake

The daily mean food intake [gram (g)/CU/day) and median nutrient intake [CU/day] across three tribes are presented in Table 6 and 7. The tables represent descriptive statistics of food and nutrient intake, and are compared with Recommended Daily Intakes (RDI) and Recommended Daily Allowances (RDA) respectively by the Indian Council of Medical Research (ICMR). The median nutrient intake is used for comparison with RDA, because it is better suited for skewed distributions to derive at central tendency since it is much more robust and sensible.

Table 6: Daily mean intake of food items across the tribal groups (g/cu/day)

Caste groups	No of HHs	Food Groups	Cereals	Millets	Total	Pulses & Legumes	GLV	Other Veg.	Roots & Tubers	Nuts & Oil Seeds	Fruits	Fish	Meat & Flesh	Milk & Milk Pro.	Fats & Oils	Sugar & Jaggery
Bhumia	**35**	**Mean**	546.78	0	546.78	45.00	7.21	64.09	87.97	0.20	19.46	2.69	8.87	3.62	6.07	12.64
		Median	552	0	552	33	0	57	85	0	5	0	0	0	6	9
		SD	201.19	0	201.19	40.32	19.56	49.94	49.80	0.66	28.07	15.94	34.68	11.47	4.04	11.85
		Mean Intake as % RDI	0	0	**146**	**60**	**7**	**32**	**44**	**0**	**19**	**0**	**0**	**1**	**30**	**51**
Paroja	**30**	**Mean**	539.26	0.40	539.67	35.02	17.35	40.11	59.13	0.09	18.03	0	4.93	16.29	6.90	11.48
		Median	572	0	572	17	0	15	51	0	1	0	0	0	5	9
		SD	156.54	2.17	156.55	40.20	37.98	50.46	41.21	0.46	27.93	0	21.45	34.44	5.29	9.87
		Mean Intake as % RDI	0	0	**144**	**47**	**17**	**20**	**30**	**0**	**18**	**0**	**0**	**5**	**35**	**46**
Penthia	**15**	**Mean**	493.75	5.83	499.58	45.51	10.15	123.80	142.99	3.00	10.61	0	0.17	17.71	8.05	21.65
		Median	522	0	522	63	0	100	105	0	5	0	0	0	8	21
		SD	260.81	22.59	255.90	36.19	22.32	141.11	165.59	9.63	15.49	0	0.65	29.61	5.84	12.94
		Mean Intake as % RDI	0	0	**133**	**61**	**10**	**62**	**71**	**0**	**11**	**0**	**0**	**6**	**40**	**87**
Recommended Daily Intakes			0	0	**375**	**75**	**100**	**200**	**200**	**0**	**100**	**0**	**0**	**300**	**20**	**25**

Table7:Daily median intake of nutrients across the tribal groups (cu/day)

Caste groups	No of HHs	Food Groups	Proteins (g)	Energy (Kcal)	Calcium (mg)	Iron (mg)	Vit. A (µg)	Thiamin (mg)	Ribo-flavin (mg)	Niacin (mg)	Vit. C (mg)	Total Folate (µg)	Free Folic Acid (µg)
Bhumia	**35**	**Mean**	58.04	2374.99	353.20	12.72	147.93	1.13	0.87	14.55	45.71	98.68	37.01
		Median	58	2423	302	11	60	1	1	13	30	92	37
		SD	23.61	825.55	203.12	6.83	278.25	0.47	0.42	6.67	49.37	41.59	14.54
		Median Intake as % RDI	**97**	**104**	**50**	**62**	**10**	**83**	**57**	**81**	**75**	**46**	**37**
Paraja	**30**	**Mean**	56.52	2363.74	410.76	13.60	308.20	1.04	0.85	13.86	52.67	88.80	35.20
		Median	57	2357	404	12	79	1	1	13	22	71	33
		SD	18.73	725.00	199.53	7.54	609.86	0.39	0.30	5.20	78.72	61.23	20.02
		Median Intake as % RDI	**94**	**102**	**67**	**71**	**13**	**75**	**57**	**78**	**54**	**36**	**33**
Penthia	**15**	**Mean**	59.13	2367.39	575.89	21.42	136.79	1.48	1.05	16.89	53.01	117.28	38.53
		Median	57	2429	430	16	102	1	1	16	39	114	35
		SD	29.63	1133.31	687.34	16.37	147.68	0.94	0.60	9.86	57.44	79.54	28.83
		Median Intake as % RDI	**95**	**105**	**72**	**95**	**17**	**117**	**71**	**98**	**97**	**57**	**35**
Recommended Daily Intakes			**60**	**2320**	**600**	**17**	**600**	**1.2**	**1.4**	**16**	**40**	**200**	**100**

On an average, cereals are consumed above the RDI by all three communities. The pulses and legumes are consumed marginally by *Bhumia*and Penthia, while negligible for Paroja. There is significant difference in case of consumption of roots and tubers and other vegetables among the three tribes; *Penthia*group consumed the highest compared to *Bhumia*and *Paroja*with 3:2:1. The milk intake is almost negligible and fruit intake is marginal across three groups. The use of sugar and jaggery is highest for *Penthia*tribes followed by *Bhumia*and Paroja.

The median intake of protein and energy is almost similar for all three tribes very close to recommended intake. Calcium intake is highest in *Penthia*followed by *Paroja*and Bhumia. Vitamin A is negligible compared to recommended intake, while Thiamine, Riboflavin and Niacin intake is close to recommended intake across three tribes. Recommended intake of Vitamin C is met by Penthia, about 75% and 50% are met by *Bhumia*and *Paroja*respectively. Total folate intake is highest in *Penthia*compared to *Bhumia*and *Paroja*group.

The finding obtained on nutrient intake of tribal communities is matched with the food intake using the findings of Gopalan et al (2007). The calcium intake go with the community's consumption of milk and milk products, other vegetables, finger millet and nuts and oil seeds as these are established sources. The intake of vitamin C is also related to the consumption of roots and tubers, other vegetables including garlic and ginger which are recognized sources. Folic acid matches with the consumption of pulses and legumes and other vegetables.

Penthia group is found to be in the highest position among three tribal groups in consuming nutrient rich foods. This can possibly be linked to their habitation which are mostly within the sub-plan area of the state and hence served with various special developmental programmes implemented through the Integrated Tribal Development Agency (ITDA). High social status and level of literacy due to their exposure and learning from their non-tribalHinduneighbors are additional contributory factors.

V. Relationships between local foods and biodiversity

A few specific local foods were recorded along with their ingredients in 24 hours recall survey. A brief documentation of traditional foods was attempted through FDGs (Focus Group Discussions) to make sure the link between consumption patterns and biodiversity. The detailed compositions of the specific foods are various combinations of major food groups. The nutrient content of each specific food was assumed high as households claimed that consumption of such foods kept them active and strong.

The various combinations of food items and groups to standardize the recipes for specific food preparation might have taken years together with trial and error to conserve local biodiversity. The inherited traditional knowledge would have helped the communities to select and try upon the combinations of locally available food items for their special recipes. Some of the foods which are common across three tribes and tribe specific food are briefly described to highlight the importance of tribal wisdom:

Mandia Pej is indigenous fermented finger millet based gruel having characteristic flavor. Finger millet flour is soaked with little water either overnight or three to four days depending on the age of the earthen pot. The following day, water is boiled and broken rice added into it. Once broken rice is fully cooked, soaked finger millet flour is poured slowly into the cooking vessel with constant simultaneous stirring until all the ingredients are thoroughly mixed, boiled and cooked. Many families prefer as they believe this to be highly nutritious.

Bamboo shoot curry is a special and popular dish prepared by all the tribal communities and consumed as a side dish during monsoons for a period of nearly four months. Young bamboo shoots are peeled off and chopped into small pieces for instant use as curry with meat or with tamarind and slices of dried mango and salt for enhanced palatability.

Mushroom curry is prepared during the rainy season which serves as a side dish and highly nutritious. Mushrooms are cooked in palm oil along with potato, tomato, onion, ginger, garlic, turmeric powder and salt. ***Charu*** is made up of tamarind and eaten as it is a watery side dish. Both are boiled with plenty of water, salt and turmeric powder. Seasoning is given with red chilli, mustard seeds to make it appetizing. All the three communities reported to consume *charu* in place of pulses (*Dal*) both for lunch and dinner.

Dalmawas made with green gram and six to eight vegetables either for dinner or for lunch. Though the concept of making pulses with green leafy vegetables exists, the specific term *Dalma* and its recipe was introduced after communities started cultivating green gram in the *rabi* season. It is healthy, nutritious and is a common side dish for all the three communities.

Amotis an indigenous traditional rice based food with characteristic thickness, consistency and flavour, consumed by *Paroja*. It is a source of high carbohydrate, protein, iron, fibre, vitamin C and spices and popular in that socio cultural set up . In the traditional method of preparation, rice is soaked and grounded in a grinding stone for instant use. Rice paste is mixed with required water and red gram seeds are added to it during boiling. Green leafy vegetables (Table 4) are added depending on the availability. Either tamarind pulp or dried mango is added in minimal quantity along with salt. Seasoning is given with red chili, garlic and cumin to make it delicious.

Chunagola is a special rice based dish prepared by *Bhumia*communities. Ground rice is added to boiled vegetables and cooked together for some time to make it thick. Tamarind pulp or slices of dried mango is added for sour taste.

Ambila curryis another typical traditional food consumed by the *Penthia*tribe. *Soronda kanda* (*Dioscorea glabra*), *Amaranthus* leaves, tamarind, salt, chilly and garlic are cooked in oil to make this curry. This goes well with rice as a side dish. *Soronda kanda* is available in plenty between May, June and July when availability of other vegetables is minimum.

CONCLUSIONS AND IMPLICATIONS

From the present study it was clear that all the fifteen food groups mentioned in the dietary diversity was available in the study villages. Irrespective of the season, every household had access to various food items that were either availed from markets, own

cultivation, PDS, wild collection, and neighbours. The consumption pattern reflected that they had access to both plant and animal based food items. Increased integration of livestock in the farming system is likely to lead to better access to animal based food items. These patterns of tribal food consumption not only fulfilled food and nutritional needs but also strongly reflected their cultural identities.

The results of daily mean intake of food items and nutrients brought out clearly that cereals were the chief source of energy for all the three communities. The mean intake of GLVs, other vegetables and roots and tubers were minimal among three tribes which need to be improved through specific interventions at community level. Kitchen gardens would be an ideal option to increase the availability, accessibility of diverse GLVs and seasonal vegetables which can contribute to fulfilling the purpose of community food security. Enhanced cultivation of pulses and legumes and their consumption should also be encouraged. Across the tribes, intake of vitamin A is the lowest, compared to other nutrients. Consumption of this critical vitamin which contributes to overall well-being needs to be improved through appropriate strategies. Nutrition based training programmes specifically Nutrition and Health Education should be imparted to create awareness on the role of micronutrients in health and well-being.

In recent years, conventional food habits of tribal communities are on the wane. With the expansion of markets, new food items having less nutritional value have surfaced and increased in their diets due to market dependency and reduced consumption from own cultivation. This clearly indicates the beginning of the restructuring of agri-food systems and is likely to threaten 'autonomous spaces' that are based on self-reliance, eroding their capacity for autonomy and self-determination (Pimbert 2009).

Efforts need to be made to expand the possibilities of food provisioning from the commons like forest lands, field edges, fallows and roadsides to complement cultivated foods and support to conserve biodiversity. Appropriate interventions the like introduction of some of the wild species into home gardens or farmlands will ensure that they would continue to contribute to the tribal household food basket. In addition, favorable government policies may be explored to improve access to wild food diversity found in commons and seasonal commons as a means of supplementing household nutrition. Traditional Knowledge on foods prepared and consumed by tribal communities is poorly documented and requires attention. Transmission of such traditional knowledge among the younger generation is critical and efforts in the direction required. An understanding on social networking on food exchange among kin and relatives, friends and neighbours would also help in strengthening community food security among the tribal communities. Such knowledge can be used as a culturally appropriate pathway for establishing food security at individual and community level.

ACKNOWLEDGMENTS

This project was undertaken with the financial support of the International Development Research Centre (IDRC), www.idrc.ca, and the Government of Canada, provided through Foreign Affairs, Trade and Development Canada (DFATD),www.international.gc.ca The authors gratefully acknowledge the large number of tribal households that spared their time in sharing valuable information during the surveys. The survey team (too numerous to list) led by Dr.C.S.Mishra, Co-PI in Jeypore site were

responsible for the survey. The assistance rendered by Ms.A.Uma, Secretary, Ms.N.Aditi, Intern and Ms.Jayashree, Accounts Assistance is gratefully acknowledged.

References:

Aberoumand, A. (2011). Assessment of Dietary Intake and Nutritional Status of Students in the Ramin University of Iran. Ind. J. Nytr. Dietet. 48, 478-482.

Ahuja, U., Ahuja, S.C., Chaudhary, N. & Thakrar, R. (2007). Red Rices: Past, Present and Future. Asian Agri-History, 11(4), 291-304.

Anzid, K., Zahra Elhamndani, F., Baali, A., Boetsch, G., Levy-Desroches, S., Monter, Lopez, P. & Cherkaoui, M.T. (2009). The effect of socio-economic status and area of residence on household food variety in Morocco, Annals of Human Biology, vol 36, 727–749.

Arthreya, V.B., Rajagopal, A. & Jayakumar, N. (2014). Reports on some aspects of food security policy interventions. M.S. Swaminathan Research Foundation, Chennai, 101.

Arunachalam, V., Chaudhury, S. S., Sarangi, S. K., Ray, T., Mohanty, B. P., Nambi, V. A. & Mishra, S. (2006). Rising on Rice: The Story of Jeypore. M.S. Swaminathan Research Foundation, Chennai, 39. Retrieved from http://www.mssrf.org/sites/default/files/rising%20on%20rice_booklet.pdf

Behura, N. K. & Mohanty, K. K. (2006). Tribal Orissa Readings in Social Anthropology. New Delhi, Dominant Publishers and Distributers. pp 319.

Bélanger, J. & Johns, T. (2008). Biological diversity, dietary diversity, and eye health in developing country populations: establishing the evidence-base, EcoHealth, vol 5, 244–256.

Bhagowalia, P., Headey, D. & Kadiyala, S. (2012). Agriculture, Income, and Nutrition Linkages in India, Insights from a Nationally Representative Survey: IFPRI Discussion Paper 01195, 31. Retrieved from http://www.ifpri.org/sites/default/files/publications/ifpridp01195.pdf

Bletzacker, K. M., Holben, D. H., & Holcomb Jr, J. P. (2009). Poverty and proximity to food assistance programs are inversely related to community food security in an Appalachian Ohio region. Journal of Hunger & Environmental Nutrition, 4 (2), 172-184.

Burlingame, B., Charrondiere, R. & Mouille, B. (2009a). Food composition is fundamental to the cross-cutting initiative on biodiversity for food and nutrition, Journal of Food Composition and Analysis, vol 22, 361–365.

Das, K. (2006). Tribal Crop- Livestock Systems in South-East India, New Delhi Manohar Publishers & Distributors, 283.

Frison, E.A., Cherfas, J. & Hodgkin, T. (2011). Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security, Sustainability, vol 3, 238–253.

Gopalan, C., Rama Sastri, B.V. & Balasubramanian, S.C. (2007). In eds. Rao, B.S.N, Deosthale, Y.G. & Pant, K.C. (2007). Nutritive Value of Indian Foods. 161.

National Institute of Nutrition, Indian Council of Medical Research (ICMR), Hyderabad, India, 161.

Government of Odisha. (2005). Poultry Farming. An Intervention for Sustainable Livelihood in Tribal Districts (OTELP) of Odisha. SC and ST Development Department, Bhubaneswar, 40.

Government of Orissa. (2004). Tribes of Orissa: Bhubaneswar, Tribal & Harijan Research-cum-Training Institute, Tribal welfare department, 295.

Gundersen, C., Waxman, E., Engelhard, E. & Brown, J. (2011). Map the Meal Gap- A report on the child food insecurity in the United States in 2009: Feeding America, Chicago, 21. Retrieved from http://feedingamerica.org/hunger-in-america/hunger-studies/map-the-meal-gap/~/media/Files/research/map-mealgap/ChildFoodInsecurity ExecutiveSummary.ashx?.pdf

Hatløy, A., Hallund, J., Diarra, M.M. & Oshaug, A. (2000). Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali), Public Health Nutrition, vol 3, 57–65.

Hoddinott, J. & Yohannes, Y. (2002). Discussion Paper No. 136: Dietary diversity as a food security indicator, Washington: International Food Policy Research Institute, Food Consumption and Nutrition Division.

Kaiser, M. L. (2012). Cultivating a landscape for food justice: an exploratory study of community food security measurement to inform community-based intervention strategies. Doctoral dissertation, University of Missouri. Retrieved from https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/15004/research.pdf

Kant, A.K., Schatzkin, A., Harris, T.B., Ziegler, R.G. & Bloc, G. (1993). Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study, Am J ClinNutr, vol 57, 434–440.

Kar, G.C., Sarangi, L. & Nanda, A.(2007). A Study of Food Related Nutritional Deficiency in KBK Districts of Orissa. Agricultural and Rural Development Consultancy Society (ARDCOS) 115, Basundhara Aptt, Rasulgarh, Bhubaneswar, Orissa.

Kataki, P.K. & Babu, S.C. (2002). Food Systems for Improved Human Nutrition: An Introduction. (Eds.), Kataki, P.K. & Babu, S.C., Food Systems for Improved Human Nutrition: Linking Agriculture, Nutrition, and Productivity. The Haworth Press, Inc. New York, London, Oxford.

Kishore, A., Joshi, P.K. & Hoddinott, J. (2013). India's Right to Food Act: A Novel Approach to Food Security. Global Food Policy Report, IFPRI. 29-42.

Koohafkan, P.& Altieri,M.A. (2011). Globally Important Agricultural Heritage Systems A Legacy for the Future, 41.www.fao.org/nr/giahs/en

Lopez, R. A., Drake, L. T., Martin, J., & Tchumtchoua, S. (2008). Assessing Community Food Security Across Connecticut Towns. Journal of Hunger & Environmental Nutrition, 3(1), 51-66.

Mishra, C.S., Taraputia, T. & Suchen, B. (2014). Policy Advocacy for Climate Smart Agriculture in Millets: An Initiative for Ensuring Food Security in Tribal Communities of Koraput Tract, Odisha, India. Global Advanced Research Journal of Agricultural Science. Vol. 3(7) 179-185.

Mishra, S, Chaudhury, S.S., Swain, S. & Ray, T. (2008). Wild edible tubers (Dioscorea spp.) and their contribution to the food security of tribes of Jeypore tract, Orissa, India. Plant Genetic Resources Newsletter, IPGRI, Rome, Italy, 156, 63-67.

Mishra, S, Chaudhury, S.S., Swain, S. & Ray, T. (2009). Multiple Cropping System for Conservation and Sustainable Use in Jeypore Tract of Orissa, India. Asian Agri- History, 13(1), 39-51.

Mishra, S. & Chaudhury, S.S. (2012). Ethno botanical flora Used by Four Major Tribes in Koraput, Odisha, India. Genetic Resources and Crop Evolution, 59, 793-804.

Mishra, S., Chaudhury, S.S., Swain, S. & Ray, T. (2009). Multiple Cropping System for Conservation and Sustainable Use in Jeypore Tract of Orissa, India. Asian Agri-History,13(1), 39-51.

Mohanti, K.K., Mohapatro, P.C. & Samal, J. (2006). Tribes of Koraput. Published by Council of Analytical Tribal Studies, Koraput, 107.

Nayar, M.P., Singh, A.K. & Nair, K.N. (2009). Agrobiodiversity Hotspots in India: Conservation and Benefit Sharing. Vol. (1), i-xii + total pages 217.

Ogle, B.M., Hung, P.H. & Tuyet, H.T. (2001). Significance of wild vegetables in micronutrient intakes of women in Vietnam: an analysis of food variety, Asia Pac J Clin Nutr, vol 10, 21-30.

Oka, H.I. (1974). Experimental studies on the origin of cultivated rice. Genetics 78:475-486.

Onyango, A., Koski, K. & Tucker, K.L. (1998). Food diversity versus breastfeeding choice in determining anthropometric status in rural Kenyan toddlers, Int J Epidemiol, vol 27, 484-489.

Pani, D. & Patra, B.C.(2003). Genetic Improvement of Rice Varieties in Orissa. In S.D.Sharma & U.V. Prasada Rao edited Genetic Improvement of Rice Varieties of India. Today and Tomorrow 's Printers and Publ.(India) 793-850.

Patnaik, N. (2005). Primitive Tribes of Orissa and their Development Strategies. D.K.Printworld (P) Ltd., New Delhi, 304.

Penafiel, D., Lachat, C., Espinel, R., Van Damme, P. & Kolsteren, P. (2011). A systematic review on the contributions of edible plant and animal biodiversity to human diets, EcoHealth, vol 8, 381–399.

Pimbert, M. (2009). Towards Food Sovereignty International Institute for Environment and Development gatekeeper 141, 24.

Privita Edwina, R. G. E., Ajitha, C., Eganathan, P., Gayathri, S., Saranya, J., Arivudai Nambi, V., Smita, M. & Susanta Sekhar, C. (2014). Biochemical and antioxidant

activities of pigmented landraces of Oryza sativa - Koraput District, Odisha, India. International Food Research Journal 21(5), 1941-1949.

Rabinowitz, Adam N. & Martin, J. (2013). A Modified Rapid Assessment Method for Assessing Community Food Security. Selected Paper at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6.

Rah, J.H., Akhter N., Sembra, R.D., De Pee, S., Bloem, M.W., Campbell, A.A., Moench-Pfanner, R., Sun, K., Badham, J. & Kraemer, K. (2010). Low dietary diversity is a predictor of child stunting in rural Bangladesh, European Journal of Clinical Nutrition, vol 64, 1393–1398.

Rah, J.H., Akhter N., Sembra, R.D., De Pee, S., Bloem, M.W., Campbell, A.A., Moench-Pfanner, R., Sun, K., Badham, J. & Kraemer, K. (2010). Low dietary diversity is a predictor of child stunting in rural Bangladesh, European Journal of Clinical Nutrition, vol 64, 1393–1398.

Ramiah K. & Ghose RLM. (1951). Origin and distribution of cultivated plants of south Asia - Rice. Indian Journal of Genetics 11:7-13.

Rashid, D.A., Smith, L. & Rahman, T. (2006). Determinants of dietary quality: evidence from Bangladesh, American Agricultural Economics Association Annual Meeting, Long Beach, CA.

Rath, B. (2002). People–Forest–State. A Statistical Review of the Triangular Relationship in Orissa. Vasundhara, Bhubaneswar, Orissa, India. Available from: http://www.vasundharaorissa.org/download22/People%20%E2%80%93%20Forest%20%E2%80%93%20State%20A%20Statistical%20review%20of%20the%20Triangular%20Relationship%20in%20Orissa.pdf. Date accessed: 22 July 2009.

Rose, D., Meershoek, S., Ismael, C. & McEwan, M. (2002). Evaluation of a rapid field tool for assessing household diet quality in Mozambique, Food and Nutrition Bulletin, vol 23, 181–189.

Sharma SD, Tripathy S & Biswal J. (2000). Origin of O. sativa and its ecotypes. In Nanda JS (ed) Rice Breeding and Genetics: Research Priorities and Challenges. Science Publishers, Enfield and Oxford and IBH, New Delhi, 349-369.

Tarini, A., Bakari, S. & Delisle, H. (1999). The overall nutritional quality of the diet is reflected in the growth of Nigerian children, Sante, vol 9, 23–31.

Thorne-Lyman, A.L., Valpiani, N., Sun, K., Sembra, R.D., Klotz, C.L., Kraemer, K., Akhter, N., de Pee, S., Moench-Pfanner, R., Sari, M. & Bloem, M.W. (2010). Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. Journal of Nutrition, vol 140, 82S–188S.