

Agricultural Innovation Systems

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Introduction

This briefing paper sets out the general concepts and principles of the Agricultural Innovation Systems approach, and its application to agricultural research and development, particularly in sub-Saharan Africa. It is not meant to be a comprehensive treatment of the topic, and suggestions for further reading are given at the end of the paper. It is intended for those interested in applying new approaches to research with farmers, NGOs and the private sector that lead to developmental outcomes.

Key issues: why is the innovations systems approach important and necessary?

Conventional approaches to agricultural development have tended to regard innovation as the product of research, and have viewed its dissemination as a largely linear process from researchers to extension staff and then to farmers. Quite often the research community is enclosed with only minimal opportunities for farmers and other stakeholders to make inputs to the research. The conventional approach typifies a paradigm of the scientist having a monopoly of knowledge in the research context. The impact of this type of research on rural people's livelihoods in sub-Saharan Africa has remained limited, particularly in relation to other continents (FARA, 2006), and an alternative approach is needed.

The rapidly changing context for agricultural development in SSA offers new challenges (IAC, 2004) that require the re-orientation of research to approaches that emphasise development outcomes, not academic ones. Some of the changes that particularly affect Africa are:

- The globalization of agricultural production and trade
- Agricultural development is increasingly being driven by markets
- The private sector is driving innovation, and also increasingly the generation, diffusion and application of knowledge, information and technology
- Information and communication technology provides new opportunities
- Biotechnology is making impact on agricultural production and processing systems
- National development strategies increasingly emphasise support to the commercialisation of agriculture (e.g. the Ugandan "Plan for the Modernisation of Agriculture" and the Horticultural Exports Industry Initiative of Ghana) and the increasing role of markets and the private sector in agricultural development
- Environmental changes coming with climate change, degradation of ecosystems, genetic erosion, water shortages, social conflicts and upheavals pose new challenges in agricultural development.

The rapid environmental, economic and social changes occurring at global, national and local levels require a research and development approach that is able to support adaptation to those changes, while the complex, risk-prone and diverse nature of rural areas of sub-Saharan African requires a flexible, de-centralised type of research that builds on the involvement of farmers and other actors in developing and disseminating technologies and processes. Donors and programmes are increasingly turning to agricultural innovation approaches to provide that adaptability and the required developmental outcomes.

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The transformational nature of technological innovation involves a shift in traditional relationships in society (*Juma and Yee-Cheong, 2005*)

Diversity requires locally-specific technologies and practices (*Waters-Bayer et al, 2006*)

The evolution of the agricultural innovation systems approach

Since the 1970s, alternatives to top-down, linear approaches to research and extension have been evolving. They include farming systems approaches, and a host of participatory approaches, from Participatory Rural Appraisal, Participatory Technology Development, Participatory Learning and Action, Action Research, Sustainable Livelihoods and farmer empowerment approaches. Each one of these stresses different aspects or different stakeholders in the innovation and utilisation continuum. During the same period there have been major shifts towards the decentralisation of extension, the liberalisation of input supply and the empowerment of farmers to demand services relevant to their needs. The innovation systems approach brings these different components and actors together by emphasising the linkages between actors, covering the spectrum from producers through processing and marketing to consumers (Triomphe et al, 2007).

The Agricultural Innovation Systems approach arose from innovation approaches in commerce (Arnold and Bell, 2001). The World Bank looked at its applicability to the agricultural sector of developing countries in 2004 (World Bank, 2007), and again in March 2007. A major conference on Integrated Agricultural Research for Development (IAR4D) in Kampala (www.innovationafrica.net)³ also explored the characteristics of innovation systems and how these are applied to the identification and use of innovation by farmers and other researchers.

The approach is still evolving, and there is no blue-print for how to apply it. Rather it is a set of principles and best practices that together add up to a way of conducting research for development.

Definitions

Two definitions for innovation systems are given in Box 1. The applied nature of the approach is clear in these definitions. It places innovation at the centre rather than technology or research itself. It is an evolving concept, which needs flexibility in its application to different situations.

Box 1: Definitions

An **innovation system** can be defined as a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behaviour and performance.

Source: World Bank, 2007

A simpler definition of an **innovation system** is “a dynamic, multi-stakeholder partnership working together to develop and use technologies and processes to improve livelihoods”.

³ Innovation Africa Symposium, Kampala, 20-23rd November, 2006

An **innovation** is defined here as the application of technical or organisational knowledge to a new situation.

Principles and characteristics of innovation systems

The main principles and characteristics are provided below, and summarised in Table One.

1. The most striking characteristic of the innovation systems approach is its emphasis on bringing **multi-stakeholder partnerships** together to address a need or opportunity. Interaction between stakeholders is essential in order to learn from each other and negotiate the terms of the partnership. Thus the concept embraces not only the science suppliers (traditionally researchers in government stations and Universities) but the totality of actors involved in production and marketing. Stakeholders that can form part of an innovation partnership include: farmers (of different types); market traders; processors; exporters; researchers; extension staff; input suppliers and others. The mix of stakeholders depends on the problem or opportunity to be addressed, and the composition of the partnership changes over time as the situation changes.
2. Forming, maintaining and managing partnerships require **facilitation/coordination skills** and resources. Trust is an essential ingredient of success, and any partnership has the potential for asymmetry (power, voice, benefit...) and conflict. Local institutions may need empowerment through building their capacity and the development of links to input supplies, markets and technical assistance.
3. A major difference with conventional research is that the Innovation Systems approach recognises that **innovation can arise anywhere**. It is not the preserve of formal research organisations. Farmers, CBOs, NGOs and private enterprises can be the source of the innovation, and in many cases can develop the innovation independently of formal government structures (see the Case Studies on the development of the “gari” processing industry in Nigeria and the flower industry in Kenya). In other cases, innovation is stimulated and coordinated by government initiatives that bring the relevant stakeholders together and support them through the innovation process (see the Case Study on cassava processing in Ghana). In other situations the innovation process can be coordinated by an NGO or extension programme that provides capacity building and empowerment for farmer groups, and links them to local government, research and private agencies that can support production and marketing (see the Case Study from Tanzania).

Local innovation

Innovation is a social process that can be enhanced by creating possibilities for actors to interact.

Normally, the term “innovation” at farmers’ level has been used to refer to farmers’ adoption of new technologies coming from outside, rather than the new technologies, management practices and institutions that farmers and their communities have developed themselves. Many local innovations are not of a technical nature but rather are socio-economic and institutional innovations such as new ways of gaining access to resources or new ways of organizing marketing activities.

Waters-Bayer et al, 2006 (also see www.prolinnova.net)

4. Research is important, but not always central – and one needs to consider other **bottlenecks to the use of innovations**. The livelihoods framework is useful in analysing where these constraints might be through consideration of the social, human, financial,

natural and physical assets available to communities, and the legal, institutional and political influences on them.

5. The innovations systems approach is related to some previous approaches, such as the commodity systems approach and the analysis of value chains, both of which, like the agricultural innovation systems approach, consider the whole chain from **producer through to consumer** (see the Case study from Uganda on potato production and marketing).
6. It also has a lot in common with **IAR4D** (Integrated Agricultural Research for Development). The term IAR4D was first used in 2003 by the Forum for Agricultural Research in Africa (FARA, 2004), and follows similar principles and objectives as approaches such as ICRA's Agricultural Research for Development (ARD) approach, DFID's Sustainable Livelihoods approach, and the Integrated Natural Resources Management (INRM) approach developed by the CGIAR.
7. The approach requires that organizations must **act in new ways** (flexibly, in partnership...) and with **new skills** (facilitation, conflict management, participation...) – see Table Two.
8. The **public sector** has a central role to play through developing legal and regulatory frameworks and providing an enabling policy, trade, infrastructural and support environment that encourages innovation.
9. The innovations systems approach is **not inherently pro-poor**. As with other approaches, real impact on poverty and gender imbalances will only result if special attention is given meeting those challenges.
10. A change in mindset of some researchers can be brought about through **competitive grant research** funds that insist that the applicants work together with private and civil society elements to test new technology in the real world of markets and inputs.

Table One: Defining features of agricultural innovation systems.

Defining feature	Agricultural Innovation System
Purpose	Strengthening the capacity to innovate throughout the agricultural production and marketing system
Actors	Potentially all actors in the public and private sectors involved in the creation, diffusion, adaptation and use of all types of knowledge relevant to agricultural production and marketing.
Outcome	Combinations of technical and institutional innovations throughout the production, marketing, policy research and enterprise domains
Organising principle	New uses of knowledge for social and economic change
Mechanism for innovation	Interactive learning
Degree of market integration	High
Role of policy	Integrated component of the approach, providing an enabling environment
Nature of capacity strengthening	Strengthening interaction between actors; institutional development and change to support interaction, learning and innovation

Source: World Bank, 2006

Capacity development needs for Agricultural Innovation Systems

While there is no consensus on the precise nature of innovation capacity, its broad features include a combination of: a) scientific, entrepreneurial, managerial and other skills and knowledge, b) partnerships, alliances and networks linking different sources of knowledge and different areas of social, economic and policy activity, c) routines, organisational culture and traditional practices that pattern the propensity to innovate, d) clusters of supportive

policies and other incentives, governance structures and the nature of the policy process, and e) the ability to continuously learn and use knowledge more effectively (<http://www.innovationstudies.org>).

Box 3: Capacity Development recommendations from World Bank, 2007

- Research capacity should be developed in such a way that from the beginning it nurtures interactions between research, private and civil society organisations
- An effective IAS requires a cadre of professionals with a new skill set and mind set (markets, agribusiness, intellectual property law, rural institutions, rural microfinance, facilitation, system analysis, conflict management...)

Implications for national researcher and advisory services include the need to re-skill in the areas of facilitation, communication, entrepreneurship, conflict management, value chain analysis and market research. Reward systems will also need to change to reflect the changed emphasis from academic papers to developmental outcomes. In addition it also implies much closer working between research and extension on the one hand, and government, civil society and private sectors on the other. The stakeholders need behavioural change and a re-configuration of their roles and relationships to ensure a more proactive and interactive engagement for innovation. These sentiments are echoed by World Bank in their book on Enhancing Agricultural Innovation (World Bank, 2007 – see Box 3), and in calls for the reform of University curricula to include innovation systems principles and case studies.

Table Two. Human capacity needs for implementing Agricultural Innovation Systems approaches, and some mechanisms for developing that capacity

Human capacity needs for the implementation of innovation systems	Some mechanisms for enhancing human resource capacity
<ul style="list-style-type: none"> • Management of dynamic partnerships • Governance of partnerships • Facilitation • Negotiation and conflict management • Communication • Sourcing, managing, interpretation and “packaging” of information • Entrepreneurship and business skills • Systems thinking • Value chain analysis • Market evaluation • Research methods, including participatory and impact-oriented methods (action research) • Research leadership • M&E, impact assessment and learning • Mobilization and local organisation development • Rural finance • Demand identification/articulation and priority setting 	<ul style="list-style-type: none"> • Partnerships (e.g. through competitive grant schemes) • Exchanges (N-S, S-S) attachments and internships • Undergraduate and post-graduate degree studies • Vocational training • On-the-job learning • Short courses • Distance learning (e.g. professional PhDs) • Conferences and workshops • Reflection and learning events • Job rotation • Mentoring and coaching • Joint activities (e.g. joint monitoring visits, PRAs etc) • Curriculum reform and the adoption of course delivery methods that stimulate problem solving abilities
+ technical expertise and curriculum	

reform	
<i>Adapted from Kibwika et al, 2007</i>	<i>Adapted from Pound and Adolph, 2005</i>

Risks and benefits of adopting an innovation systems approach

There is a risk that organisations will adopt this approach *in favour* of previous approaches, such as farming systems, livelihoods, agricultural knowledge systems and participatory approaches. This would be a shame as each of those approaches is still valid, and their concepts should still be brought to bear when considering rural development situations. Rather the innovation systems approach should be *complementary* to these other, still valid, approaches.

A further risk is that the need for technical specialists will be disregarded in favour of those with soft skills. Again that would be a mistake, as technical specialists are still needed to investigate and provide understanding of complex technical aspects of innovations.

In contrast, the benefits include greater efficiency due to the “joined up” thinking in the production to consumption cycle as people work together to address opportunities, and the emergence of creative solutions to problems facing rural communities from a range of sources.

Implications for Agricultural Development in Africa

Already major donors such as the World Bank and DFID are advocating the adoption of the approach, and sub-regional organisations such as ASARECA are incorporating Integrated Agricultural Research for Development as the underlying research paradigm for their programmes. In addition there will be a reform of University curricula in sub-Saharan Africa to include Innovation Systems approaches, including a shift towards more client-oriented, vocational courses.

The implications of the innovation systems approach for donor support are clear. Formulation of intervention programmes should be done in the specific context of the respective countries and localities. There are no one-fit-all solutions to the developmental problems in Africa.

The intervention programmes must emphasise strong linkages among the critical stakeholders and detail the respective roles and expected outcomes. The investments in such programmes must not only be in producing the tangible outputs such as improved planting materials, technologies and products, but also the intangibles such as enhanced skills, knowledge and mutual trust.

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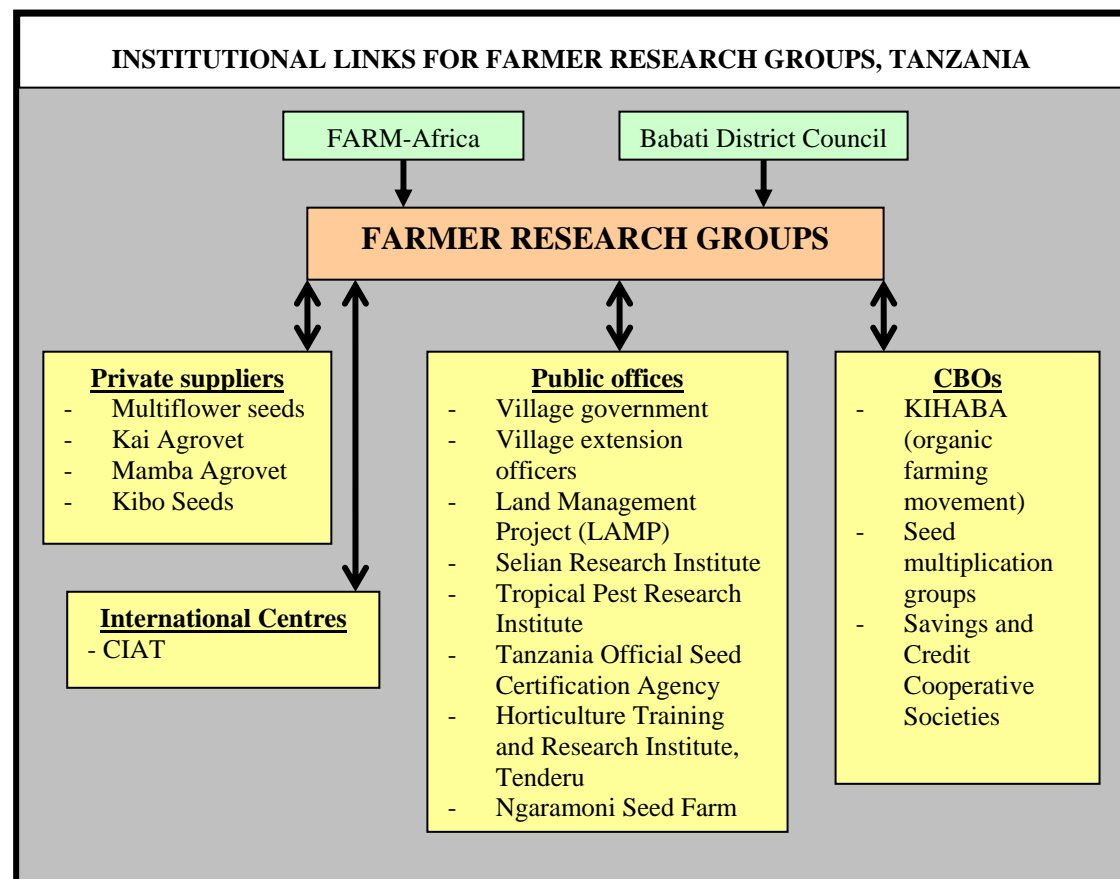
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CASE STUDIES

Tanzania: sustaining farmer-research groups (adapted from Pound et al, 2007)

In this case study local farmer research groups are at the centre of the innovation system, and are supported in their development and use of innovation by NGO, government, private and international partners.

In Tanzania, an NGO (FARM-Africa), working closely with District and Village government, has established a number of Farmer Research Groups to stimulate local innovation for improved crop productivity and natural resource management. The Groups were successful due to the linkages (facilitated by FARM-Africa) with national and international research organizations, government seed certification and training centres and private input suppliers.



However, the initiative is of particular interest for the ways that the Farmer Research Groups ensured their long-term access to these linkages, and a sustainable capacity to continue to investigate novel technologies of local relevance.

This they achieved through:

- The establishment of **community-based seed multiplication schemes**, which provide income that can then be used to finance further experiments
- Community agricultural input supply shops**, established by Farmer Research Groups in response to the need for local access to the technologies identified.
- Savings and Credit Cooperative Societies (SACCOS)**, which enable members to accumulate capital for the purchase of inputs.

The production increases have resulted in farmers being able to store grain at harvest and either sell it at a better price later on, or use it to reduce food insecurity. They have become financially independent of external donor and government agencies.

Ghana: Transformation of the pineapple industry (adapted from Essegbey, 2007)

This case study shows that where there is market potential, a commodity can be transformed from a minor food crop to a major export earner. In this case the private sector played the leading role in the transformation process. The government's role was important as it facilitated the process through the Ghana Export Promotion Council and other initiatives.

In the 1970s and 1980s, pineapple was a lesser food crop, with national average production collapsing to only 6,000 tonnes per year between 1977 and 1982. More recently, Ghana's policy of emphasising non-traditional export under the Ghana Export Promotion Council has contributed to a transformation of the industry, which now holds about 12% of the total European import market (export earnings about US\$24 million in 2006).

The critical actors in the innovation process have been:

- Large scale exporters
- Smallholder and out-growers
- Government agencies (Ministry of Food and Agriculture, and the Ghana Export Promotion Council)
- Research institutes (CSIR)
- Donor agencies (World Bank, USAID)
- Local banks, transporters and shippers

Kenya: Private-led innovation in the flower industry (adapted from Bolo, 2007)

This case shows how the private sector, backed by international expertise and finance, and supported by favourable policy, climatic and infrastructural environments, can develop a successful industry.

The floriculture industry contributes about US\$200 million per year to the Kenyan economy. The industry is characterised by a robust private sector, comprising mostly large-scale growers. Small-scale growers contribute only 3% of exports.

Despite mounting competition from other countries, Kenya's floriculture industry is expanding because of good natural resources, infrastructure, transport links and favourable government policies.

The key government policy shifts that have assisted innovation and commercial success have been:

- Removal of monopolistic trends
- Reduction of government involvement in commercial activities
- Encouragement of the private sector to take on government functions

The key actors have been:

- Large-scale grower/exporters with sister companies in Europe
- Research, development and training institutions (national and international)
- Trade, investment and promotion agencies
- Credit and finance institutions
- Input suppliers (mostly international companies)
- Quality control and regulation agencies

While the case presents a rosy picture, there are challenges. One is the weak state of the small growers, who are disadvantaged by lack of voice, technology and access to markets. A second is that the national research system is effectively sidelined, with most information coming from international centres (e.g. Holland).

Ghana: Government-led cassava initiatives (adapted from Essegy, 2007)

Two government-led initiatives have attempted to stimulate the huge potential for cassava processing in Ghana, one being more successful than the other.

Cassava is a major staple in West Africa, and grown in most agro-ecological zones of Ghana. Cassava can also be processed into gari and into starch, which is the raw material for other industrial products. The government sought to use Ghana's comparative advantage as a cassava producer to transform the cassava industry into a major earner of export revenue in industrial starch.

Whereas a Presidential Special Initiative to do this through Corporate Village Enterprises has failed to achieve this, a much smaller initial initiative, the "Sustainable Uptake of Cassava as an Industrial Commodity" is having much more success. This initiative revolves around the creation of market linkages to provide market access for small and medium sized enterprises, new product development, quality assurance and the management of supplier-buyer business relations.

The critical actors are:

- Scientific research institutes: National (Food Research Institute) and international (NRI)
- Policy Institutions (especially the Ministry of Food and Agriculture)
- Business promotion organisations ((especially the National Board of Small-scale Industries)
- Producer/processing organisations

A major lesson learned was that market access doesn't happen by itself, but needs strategic support and deliberate cultivation. Trust also has to be built between suppliers and purchasers. The case study calls not only for strengthened links between research and farmers, but also between research and industrialists. Industrialists should challenge scientists to find solutions to the problems they encounter.

Nigeria: Spontaneous development of Gari processing

This case study directly contrasts with the Ghana cassava processing case by showing that strong and sustained market opportunity can stimulate a wide range of innovations at farmers, trader and processor levels without any coordinating input from government.

The south-eastern zone of Nigeria accounts for 53% of national cassava production. Processing cassava into gari for food and income is practiced by many Nigerians in rural areas. In order to harness the opportunities offered by the increasing market demand for gari, farmers devised several technical, social and institutional innovations.

Gari market began to emerge as middle men from urban centre besieged rural markets to bulk purchase gari from the farmers. Simultaneously, enterprising farm households discovered that higher cash income can also be earned from same quantity of gari if they took it direct to urban markets thus circumventing the middlemen. Gari processors also began to spring up in urban centres, purchasing roots direct from farmers.

Several prevailing factors catalyzed the thriving of gari marketing:

- (1) The favourable natural environment
- (2) Wide socio-cultural acceptance of gari in local food systems
- (3) Income-generating potential of gari

- (4) Government stimulus of the market by inclusion of gari as one of the essential commodities in the strategic food reserve programme
- (5) Improved processing technology to reduce drudgery

The innovations are of four types

- a) Technological innovations (e.g. improved varieties from research, fuel saving technologies, adding palm oil to improve colour, mechanisation of processing, reduction of the fermentation period, adjusting processing for specific market requirements)
- b) Social innovations (establishment of cooperative societies, improving access to market, diversifying markets, emergence of private ancillary service providers)
- c) Economic innovations (investment in equipment, partnerships to pool finances, use of informal local credit services)
- d) Institutional innovations (contractual arrangements between parties, including gari in the strategic food reserve programme, government provision of N50 billion loan to farmers).

These have resulted in a more conscious, systematic and strategic use of naturally endowed resources and stimulus of rural and private sector entrepreneurial tendencies.

Challenges for research and development organisations include:

- Establishment of market information system for knowledge sharing and exchange among stakeholders in gari market enterprise.
- Assessing the impact of farmers' indigenous innovation in gari marketing on rural livelihoods in south eastern Nigeria.

Uganda: “Enabling Rural Innovation” – Nyabyumba United Farmers’ Organization (adapted from Kaaria et al, 2006)

This case study shows how a farmers group first improved their production and then marketing to a fast food outlet in partnership with NGOs, research organisations and the private sector. The group followed the “Enabling rural innovation” approach which emphasises a “resource to consumption” conceptual framework and the creation of an entrepreneurial culture where farmers “produce what they can market, rather than trying to market what they produce”.

The Nyabyumba farmers group of Kabale district, Uganda, was formed in 1998, with 40 members. The group, supported by an NGO Africare, focused on producing improved potatoes from clean seed provided by the National Agricultural Research Organization (NARO). In 2000, the Nyabyumba group formed a farmer field school (FFS) to improve their technical skills on potato production and increase yields. In 2003, equipped with the necessary skills for producing high quality and quantity of potatoes, the group decided to increase their commercial sales and requested support from Africare, NARO, PRAPACE (Regional Potato and Sweet Potato Improvement Network in E. and C. Africa), and CIAT.

Through this consortium of partners, Nyabyumba Farmers’ Group received training in identifying and analyzing markets opportunities and developing a viable business plan for the potato enterprise. From the market study the group identified “*Nandos*”, a fast food restaurant based in Kampala and the local wholesale markets in Kampala. The group has set up a series of committees to manage, plan and execute their production and marketing process. To maintain a constant supply the farmers have set up a staggered planting system to ensure that there are up to 50 tons of potatoes available each month.

To increase the competitiveness of production the group has conducted research supported by NARO to determine the most suitable nutrient levels of NPK fertilizer and time of de-hauling potato plants that produces big tuber size, with higher organic content, firm skin

and higher yields as required by buyer. The farmers group has expanded to a membership of 120 members, 80 of whom are women. They have supplied 190 metric tonnes of potatoes to Nandos, bringing their income to USh 60,000,000 or approximately US\$ 33,000.