A Global Farming Systems Knowledge Base

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ABSTRACT

Knowledge and information are increasingly viewed as driving forces for hunger reduction and rural development. The acceleration of learning about rural development processes at all levels requires an organising framework for the effective sharing of knowledge. The farming systems knowledge base produced by a FAO/World Bank Global Farming Systems Study is outlined in this paper. It documents trends, emerging constraints and strategic priorities of some 72 broad farming systems identified in six developing regions, organised around five rural development themes, *viz*, natural resources, technologies, markets, policies/institutions and information/human capital. Building on sustainable livelihoods concepts the Study estimates, for each major farming system, the relative importance of five household strategies for escaping poverty: intensification, diversification, increased farm or enterprise size, increased off-farm income and exit from agriculture. The knowledge base provides a robust platform for the exchange of information on rural development trends, experiences and strategies and can be used to underpin agricultural sector studies and the formulation of national rural development strategies.

INTRODUCTION

The achievement of the International Development Goal of halving hunger and poverty by 2015 has been called into question following the slow rate of reduction of the number of hungry people during the 1990s. The acceleration of smallholder growth and poverty reduction requires better access to resources, sustainable technologies, improved policies and institutions, and above all better knowledge and information.

The Farming Systems Approach (FSA) has long been concerned with the availability of information about, and for use by, farmers. One persistent characteristic of much FSA fieldwork has been the rapid and participatory compilation and analysis of information; another has been support to stakeholder partnerships that facilitate farmers' access to technical and, to some degree, managerial information. The improvement of Agricultural Knowledge Information Systems (AKIS) has attracted substantial effort during the past decade. Recently, the focus has shifted towards understanding and strengthening experiential learning systems[2].

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[2] Nearly 30 papers were accepted under this theme at the IFSA European Group Symposium in April 2002.

However, the majority of past efforts in these areas have been locally oriented. Thus, development professionals still face the challenge of linking local level knowledge and learning systems into a broader macro or regional context. This paper presents a global farming systems framework and knowledge base created during the FAO/World Bank Global Farming Systems Study, which contributed to the updating of the World Bank Rural Development Strategy[3]. The next section of the paper outlines the analytical approach, leading to a description of the knowledge base in the third section. Selected applications and extensions of the knowledge base are briefly considered in the fourth and fifth sections respectively.

ANALYTICAL APPROACH

The effective sharing of rural knowledge requires relevant analytical frameworks that are reasonable representations of reality, yet easily understood by development practitioners. The tremendous diversity of agricultural and livelihood settings needs to be simplified and codified, without eliminating important differences that should be taken into account by development practitioners. An hierarchical framework (see Fresco and Westphal 1988, and Conway 1997) organises the information in order to meet the various needs of decision makers at different levels. The FAO/World Bank Study identified farming systems, defined as populations of individual farm household systems with broadly similar resources, livelihoods and vulnerabilities (see Ellis 2000), similar opportunities and constraints, and for which similar development strategies and interventions might be appropriate[4]. Farming systems in the six developing regions of the world were identified at two levels of aggregation: generic farming systems categories cutting across regions; and broad farming systems within each region. Following the tradition of Ruthenberg (1980), the farming systems defined in this Study encompass many millions of households.

Farm household systems and their immediate external rural environment (including local effects of policies and institutions, markets and information linkages) are inter-dependent[5] and, over time, co-evolve in response to broad changes in population, markets, technologies, policies, institutions and information flows. In this Study, which was focused on poverty reduction, the responses of farm households to the evolving circumstances are categorised into five livelihood strategies: intensification of existing patterns of farm production; diversification, including market-oriented, value-added and post-harvest activities; increased operated farm, herd or enterprise size, including consolidation of existing holdings and the expansion of the agricultural frontier; increased off-farm income to supplement or replace on-farm activities; and exit from agriculture, often involving migration from rural areas.

[3] See World Bank http://wbln0018.worldbank.org/ESSD/rdv/vta.nsf/Gweb/Strategy

[5] Important linkages include labour markets (for example, off-farm employment), capital markets, information markets/flows, informal safety nets and social networks.

There is substantial literature on population-driven intensification, mostly based on the pioneering work by Boserup (1965) and Ruttenberg (1980) and carried forward by various researchers including Pingali *et al.* (1987) and Smith *et al.* (1993). Enterprise and income diversification is a common farmer response to changing resource ratios and market access (Delgado and Siamwalla 1999) and many governments now have programmes to support farm-level diversification. There is widespread recognition of the growing importance of off-farm income for smallholder households. While increased farm size and exit from agriculture were common strategies in the evolution of agriculture in many OECD countries, they have received less attention in the developmental literature. What is missing from knowledge bases supporting development practitioners is the contextual analysis of the diverse factors influencing the merits and feasibility of these different strategies for farmers in the different major farming systems of the world.

To develop the farming systems knowledge base, the Study team blended information from global Geographic Information Systems (GIS), existing local farming system studies, decentralised administrative data and the expert knowledge of experienced practioners – more than 50 experts with more than 1 000 persons years of practical development experience from a wide variety of disciplines. First, the global forces driving change in farming systems were identified in multi-disciplinary brainstorming sessions. Second, small multidisciplinary teams identified the characteristics and extent of each farming system zone. For this purpose, the teams used the FAO Agro-Ecological Zone (AEZ) maps as a base and added other GIS layers as relevant, including irrigation, environmental constraints, cultivated extent, livestock (in some regions) and human population[6]. Third, the extent, population and resources of each farming system were estimated from GIS databases, and typical farm system profiles were derived from decentralised administrative data local farming system studies. Fourth, taking into account the broad trends documented in FAO (2000), the teams identified the specific trends, emerging constraints and strategic development priorities for each farming system. Fifth, the results were presented in regional stakeholder consultations[7]. Sixth, the feedback from the consultations was incorporated while the analysis was extended in two ways: consolidating the findings across all regions; and estimating the relative importance of five common farm household livelihood strategies for poverty reduction (see above), by 'backcasting' from the target of halving the number of poor people by 2015 (see Dixon *et al*. 2001). Given the current slow reduction in poverty, expert panels estimated the contribution of the five strategies to the *extra* poverty reduction that would be required to meet the above target.

THE KNOWLEDGE BASE

The generic farming system categories defined across the developing regions of the world are: irrigated smallholder farming systems, in large irrigation

[6] In all 15 GIS layers were combined, under the supervision of GIS Consultant C. Auricht.

[7] See consultation documents: Africa, Carloni (2001); Middle East and North Africa, Gibbon (2001); East Europe and Central Asia, Tanic & Dauphin (2001); South Asia, Weatherhogg *et al.* (2001); East Asia and Pacific, Ivory (2001); Latin America and Caribbean, Gulliver (2001); Global Synthesis – Dixon *et al.* (2001).

schemes; wetland rice-based farming systems; rainfed farming systems in humid areas; rainfed farming systems in steep and highland areas; rainfed farming systems in dry or cold areas; dualistic farming systems with both large-scale commercial and smallholder farms; coastal artisanal fishing mixed farming systems; and urban-based farming systems. In the developing regions, large-scale farms are of importance only in the dualistic farming systems.

Within these eight categories, a total of 72 broad farming systems were identified and mapped (varying from 11 to 16 systems per region). In each region there are more than a dozen thematic layers which have been overlaid on the farming systems maps (including AEZ, rainfall, environmental constraints, altitude, cultivated extent, livestock population, human population), resulting in more than 100 regional maps which are available through the FAO website www.fao.org/farmingsystems/. An example of the resulting regional farming system maps is given in the Annex.

Basic data are available for each category of farming system and each broad farming system. System trends, emerging constraints and strategic priorities are available for the 20 systems that were analysed in greater depth. The eight categories are compared in Table 1, in respect of land resources, agricultural population and market surplus. The six irrigated and rice based wetland systems[8] contain an agricultural population of nearly 900 million people with some 170 m ha of cultivated land, of which nearly two-thirds is irrigated. There are three major categories of smallholder rainfed farming system (in humid, highland or dry/cold areas), which together contain an agricultural population of more than 1 400 million people with around 540 million ha of cultivated land. Dualistic systems comprising farms of mixed size contain a further 200 million farm people with a cultivated area of 11 million ha. Finally, two further minor categories of smallholder system – four coastal artisanal fishing mixed and six urban based systems – contain a combined total of about 100 million people.

[8] One irrigated farming system in Eastern Europe and Central Asia has relatively large farms and, for the purpose of the present discussion, is included in the category of dualistic systems.

Table 1: Comparison of Farming Systems Categories

Characteristic	Small-holder Irrig	Wet-land rice based	Rain-fed humid	Rain-fed high-land	Rain-fed dry/ cold	Dual-istic (large/ small)	Coastal artisan al fishg	Urban based
Farming Systems (no.)	3	3	11	10	19	16	4	6
Total Land (m ha)	219	330	2013	842	3478	3116	70	n.a.
Cultivated Area (m ha)	15	155	160	150	231	414	11	n.a.
Cultivated/Tot al (%)	7	47	8	18	7	13	16	n.a.
Irrigated Area (m ha)	15	90	17	30	41	36	2	n.a.
Irrigated/Culti vated (%)	99	58	11	20	18	9	19	n.a.
Agric. Populatn (m)	30	860	400	520	490	190	60	40
Agric. Pers/ Cult (p/ha)	2.1	5.5	2.5	3.5	2.1	0.4	5.5	n.a.
Market Surplus	high	mediu m	mediu m	low	low	mediu m	high	high

Source: Dixon *et al.* 2001, based on FAO data and expert knowledge.
Note: Cultivated area refers to both annual and perennial crops.

In Table 1 two important attributes of farming systems are contrasted: the underlying natural resource endowment; and access to agricultural services, notably input and produce markets. This two-variable representation of the domains covered by the farming systems categories echoes Boserup (1965) and resembles some recent studies of smallholder development (e.g., Wiggins 2002). Farm household resource endowments underpin the supply side potential for intensification and for diversification (e.g., irrigated cf. dry rainfed systems). The access to agricultural services influences the different opportunity sets with which farm households are confronted (e.g., rainfed highland cf. urban farming systems).

The knowledge base also contains estimates of the contributions of five farm household livelihood strategies to the halving of poverty (see above) in each farming system. Table 2 shows the relative importance of these strategies when aggregated to the level of system category. These estimates suggest the mixes of rural development strategies for each farming system category that

would be required to close the gap between the slow reduction of hunger and poverty forecast under 'business-as-usual' projections and the International Development Goals (of halving hunger and poverty). Overall, on-farm improvements (i.e., intensification, diversification and increased farm size) would be a greater source of poverty reduction than off-farm sources (i.e., off-farm income and exit from agriculture), although this varies considerably by farming system and region.

Within the category of farm improvement, diversification is expected to be the key strategy in a majority of farming systems – benefiting from the higher income elasticities and expanding local demand for many non-traditional and processed agricultural products. The intensification of existing patterns of production, which has traditionally dominated the agenda of research institutions, will continue to be an important source of poverty reduction in a majority of system categories. Finally, a certain proportion of poor farmers will also benefit by expanding their operational asset base through increased farm size as land is consolidated, the agricultural frontier expands in some rainfed humid farming systems (notably in Latin America and Sub-Saharan Africa), or land rental markets improve[9].

Table 2: Relative Importance of Different Poverty Reduction Strategies by Farming System Category

Poverty Reduction Strategies	Small-holder Irrig	Wet-land rice based	Rain-fed humid	Rain-fed highland	Rain-fed dry/ cold	Dual-istic (large/ small)	Coastal artisanal fishg	Urban based
Intensification	3.4	1.7	1.9	0.9	1.5	2.8	0.7	1.3
Diversification	2.9	3.4	2.7	2.7	2.3	2.0	2.5	2.7
Inc. Farm Size	1.2	0.9	1.7	0.6	0.9	2.0	0	1.7
Inc.OF Income	1.9	2.8	2.2	3.0	2.2	1.8	4.2	3.6
Exit Agricultre	0.6	1.2	1.4	2.8	3.1	1.3	2.6	0.8

Source: Dixon *et al.* (2001), based on expert panel judgements.
Note: The total of scores for each farming system category equals 10.
Abbreviations: OF Off-farm; Inc. Increased.

Apart from farm improvement options, off-farm income already contributes a major part of the household income of poor farmers, and further increases are expected to be the second greatest source of aggregate poverty reduction in future years. The exit of farmers from agriculture within a particular farming system is expected to be an increasingly common phenomenon, and expected to be of particular importance among smallholders in rainfed highland and dryland areas.

[9] In addition, some poor pastoralists may succeed in expanding their herd size, or poor urban producers may expand their volume of production.

A number of counter-intuitive results emerged from the analysis. Although poverty is prevalent in dry and remote areas, a majority of poor farm families live in areas of high population density, growing food crops at a low-to-medium level of intensity on small farms under conditions of medium to high rainfall and significant agricultural development potential. Often, off-farm income represents an important source of household livelihood. Globally, diversification (including on-farm processing and other value added activities) turned out to be a much more important household poverty escape strategy than intensification; and it generally fuels agricultural growth as well. However, there was great variability in the relative importance of these strategies across farming systems.

APPLICATIONS OF THE KNOWLEDGE BASE

Because the knowledge base has only been in existence for a short time, the experience with its application is still limited. However, a diverse set of uses has already been identified. The farming systems framework is an effective structure within which to develop the work of many research and development projects and programmes. A number of FAO projects are already making various uses of the knowledge base: the framework is being used in the selection of research sites, the maps are being used during the formulation of a socio-economic development project for West Africa and the knowledge base as a whole utilised in the development of regional forestry strategies. In addition, IFAD has adapted the regional maps for use during the analysis related to the West and Central Africa poverty assessment.

The framework also gives a sound foundation for grouping and disseminating best development practices – perhaps one of the most powerful global and regional applications (Collinson pers comm). These practices could cover such areas as resource management, agronomic and livestock husbandry, agri-business activities (e.g. processing and marketing) and even work with farmer groups and local institutions. In a similar vein, the framework has been proposed as a basis for the establishment of a technology exchange platform to support functions related to research and extension across analagous farming systems. For example, best development practices could usefully be shared between similar farming systems such as the Cereal-Root Crop Mixed Farming System in West/Central Africa and the Extensive Mixed (Cerrados & Llanos) Farming System in Latin America. As indicated in Table 3, both are extensive rainfed systems for which intensification of existing commodities – notably maize and legumes – and increased farm business size are the priority livelihood strategies.

An increasing number of natural resource management and rural development initiatives are transnational in character. Nowhere is this more important than in relation to water use among countries heavily dependent upon seasonal river flooding or aquifer recharging. Some of the most contentious issues in the Middle East and South Asia concern these transnational resources (Gibbon 2001, Weatherhogg *et al.* 2001). Pastoralism also has a transnational character in a number of areas – especially in Africa. In addition, the framework would be suitable for prioritisation of agricultural research, assessment of the impact

of climatic change and assessment of the potentials for carbon sequestration (Pretty *pers comm*). Finally, some of the key areas where agricultural growth is anticipated in the coming decades are transnational in scope; including the moist savannahs of West Africa, the Cerrados and Llanos of Northwest South America (see above), and the fertile *chernozem* plains of the former Soviet Union.

Table 3: Selected Characteristics of Cereal-Root Crop Mixed and Extensive Mixed (Cerrados & Llanos) Farming Systems

Characteristic	Cereal-Root Crop Mixed Farming System (West Africa)	Extensive Mixed (Cerrados & Llanos) Farming System (Latin America)
Cultivated/Total (%)	10	14
Irrigated/Cultivated (%)	1.3	1.2
Relative Importance and Priority Ranking (in brackets) of Livelihood Strategies		
Intensification	3.5 (1)	4 (1)
Diversification	2 (3)	2 (3)
Increased Farm Size	3 (2)	3 (2)
Increased off-farm Income	1 (4)	1 (4)
Exit from Agriculture	0.5 (5)	0 (5)

Source: Dixon *et al.* 2001.
Note: The total of scores for each farming system category equals 10.

Applications of the farming systems framework and analytical approach at the national and sub-national levels would represent a powerful application of the framework. Not only can the framework of objectives be articulated more precisely at the national level, but also more biophysical and socio-economic data are available. The relatively small number of regional farming systems can be enriched by the definition of further sub-systems within national boundaries (preferably in consultation with neighbouring countries, so as to avoid duplication and conflicting definitions), which can then be used to refine national and local priorities. Such national level application of the approach would provide invaluable inputs to the elaboration of national Rural Development Strategies and Poverty Reduction Support Papers, as well as other country and agency-specific agendas.

EXTENSIONS OF THE KNOWLEDGE BASE

A number of extensions of the knowledge base have been suggested and are being considered, in order to further improve coverage and precision, and to increase robustness for addressing unanticipated phenomena. An obvious improvement would entail expansion of the geographic coverage to include OECD countries, notably Australia and Western European and North American countries. Arguably, this task would be relatively easy, given the availability of agricultural data in OECD countries.

One of the most important extensions would be to enrich the knowledge base by complementary dynamic modelling of selected farming systems, shedding light on the likely impact on hunger, poverty and rates of economic growth of changes in key parameters (e.g. household incomes, or yields and prices for key agricultural products). The combination of systems characterization data, expert appraisal, and dynamic modelling would give a solid, yet practical, decision support for developmental specialists considering investments and field programmes.

Many observers have suggested that the knowledge base should be periodically updated (e.g., Jahnke *pers comm*). The availability and precision of remote sensing data is improving rapidly, so that human and animal populations can be better specified. It will, however, be important to add data on infrastructure, especially road networks, to the other resource information. Perhaps the biggest lacuna is the lack of spatially referenced data on poverty. A partnership, which includes the World Bank and FAO, is working towards global poverty mapping. When these spatial poverty data are available, they should be overlaid on the farming systems maps. The updating of this analysis on a global scale would generate a more detailed picture of emerging trends and issues and of strategic priorities in relation to rural poverty reduction.

CONCLUSION

Knowledge and information are increasingly viewed as driving forces for hunger reduction and rural development. The slow reduction in hunger and poverty currently being achieved is a major cause for international concern. The acceleration of learning about agricultural development processes at all levels requires an organising framework for the effective sharing of knowledge, in order to underpin systemic *ex-ante* analyses of household livelihood systems which can contribute to improved design of rural development programmes.

This farming systems knowledge base has been generated from wide-ranging expert judgement, selected secondary data and the latest available spatial data on population, resource use and climate. It comprises characteristics, trends, emerging constraints and strategic priorities of some 72 broad farming systems identified in six developing regions, organised around five leading areas of rural change, *viz*, natural resources, technologies, markets, policies/institutions and information/human capital. Building on the sustainable livelihoods concepts of multiple assets and vulnerability, the Study estimated the relative importance of intensification, diversification, increased farm or enterprise size,

increased off-farm income and exit from agriculture for each broad farming system.

The knowledge base constitutes a robust platform for the further exchange, within or between countries, of experiences on best practices in rural development and the diversification of rural household livelihoods. The approach is also recommended as a vehicle for incorporating farmers' circumstances, livelihood strategies and rural diversity in the assessments of agricultural sector studies, the prioritisation of research and other public good provision, and the formulation of national Rural Development Strategies and Poverty Reduction Support Papers. As a final note, the authors hope that the knowledge base will contribute to more effective design, implementation and evaluation of agricultural and rural development programmes in general, and thus ultimately to faster economic growth and poverty reduction.

ACKNOWLEDGMENTS
The Farming Systems Study was a collaborative effort of the World Bank and FAO: Many staff of both organisations contributed to the study and the resulting knowledge base described herein.

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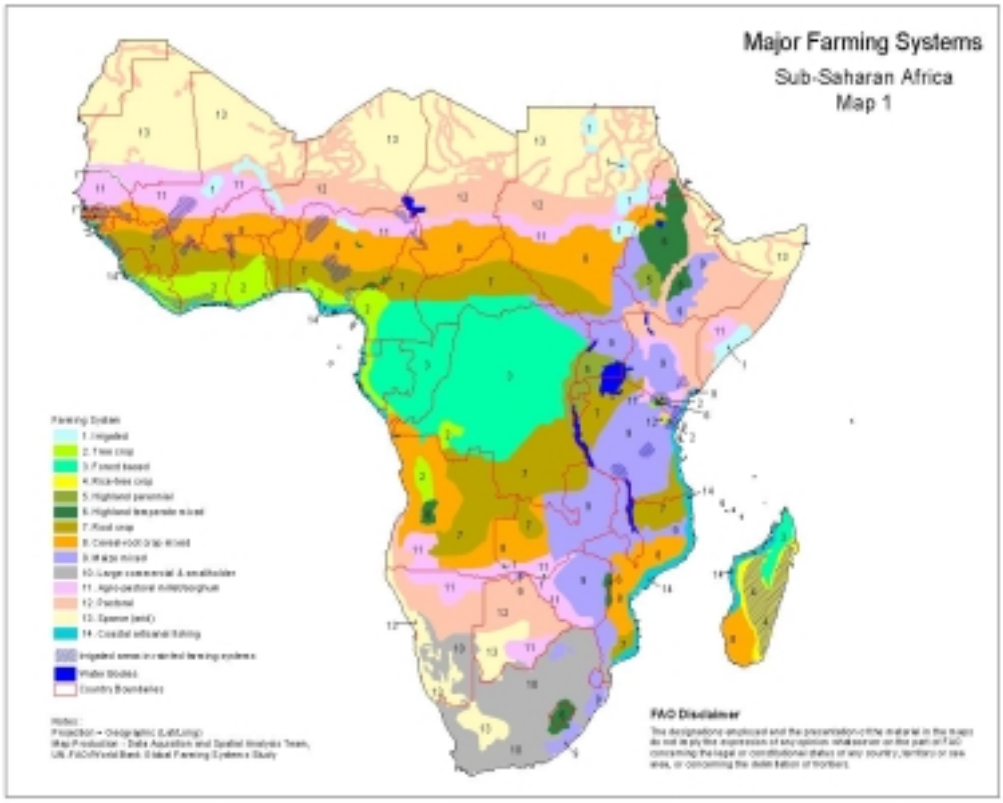
ANNEX: Map of Farming Systems of Sub-Saharan Africa



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