Global Farming Systems Study:

Challenges and Priorities to 2030

REGIONAL ANALYSIS

SUB-SAHARAN AFRICA

A. Carloni

The Global Farming Systems Study was conducted by FAO under the overall coordination of S. Funes (Director, Rural Development Division) and the technical leadership of J. Dixon (Senior Officer, Farming Systems, Farm Management and Production Economics Service, Agricultural Support Systems Division) and A. Gulliver (Economist, Investment Centre Division). The Study benefited from the guidance of D. Forbes Watt (Director, Investment Centre Division), J. Monyo (Director, Agricultural Support Systems Division), D. Baker (Chief, Farm Management and Production Economics Service, Agricultural Support Systems Division) and A. MacMillan (Principal Adviser, Project Advisory Unit, Investment Centre Division) in FAO and of C. Csaki (Senior Advisor/Team Leader-Rural Strategy) and S. Barghouti (Research Advisor) of the Rural Development Department, World Bank.

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Preface

For more than a decade, the proportion of internationally supported public investment directed at agriculture and the rural sector in developing countries has been declining. In the year 2000, World Bank commitments to the rural sector reached their lowest ever levels, measured as a proportion of their total lending portfolio. Moreover, this has occurred at a time when the process of globalisation is bringing about profound changes in patterns of trade and investment, placing agricultural producers and rural communities, more generally, under tremendous pressure to adapt to changing circumstances. Nor is there any evidence of significant progress in reducing the incidence of hunger. In order to reinvigorate its efforts aimed at poverty reduction and sustainable growth among rural populations, the World Bank initiated in 2000 a review of its rural development strategy[1].

As part of this review, the World Bank sought the assistance of the Food and Agriculture Organization of the United Nations (FAO) in evaluating how farming systems might change and adapt over the next thirty years. Amongst other objectives, the World Bank asked FAO to provide guidance on priorities for investment in food security, poverty reduction, and economic growth, and in particular to identify promising approaches and technologies that will contribute to these goals. The identification of future changes affecting farming systems relied heavily on work undertaken in FAO over many years in monitoring trends affecting agricultural production and assessing their likely implications for future output, productivity and nutrition levels.[2]

The global study commenced with the delineation and characterisation of about 70 major farming systems encompassing all developing regions of the world. As existing data systems are based, almost without exception, on national and sub-national administrative areas, while farming systems cross national and even regional boundaries, it was necessary to re-estimate and re-analyse a wide variety of data relating to system characteristics, including physical, social, economic, demographic and environmental parameters. This analysis provided the necessary quantitative underpinning for the central, qualitative, task of developing expert judgements on the future evolution of farming systems and their developmental priorities. In all, the study encompassed the contributions of over 40 specialists in a range of disciplines, both within and outside of FAO, and took into account comments from many others.

Although any specific farming system embraces considerable heterogeneity, the diagnosis of the dynamics, constraints and opportunities of typical farm households contributes to the identification of interventions to improve system performance and sustainability. Therefore, the farming systems presented in this study are considered to provide an effective broad framework for the prioritisation of development actions and investments for accelerating agricultural development, particularly in ways which can reduce rural poverty and hunger.

The results of the study are summarized in a set of seven documents, comprising six regional reports and a global overview. This document, prepared for the Consultation on the draft Sub-Saharan Africa Rural Development Strategy, summarises the analysis and strategic priorities for the reduction of rural poverty and improvement of food security through farming systems development in the region. This document is supplemented by case study reports of successful development initiatives in the region.

S. Funes,
Director,
Rural Development Division,
Sustainable Development Department,
Food and Agriculture Organization.

[1] "Rural Development: From Vision to Action". World Bank, Washington D.C., 1997.
[2] Most recently in "Agriculture: Towards 2015/30. Technical Interim Report" Global Perspective Studies Unit, FAO, Rome, April, 2000.

Table of Contents

Alice Carloni is Senior Rural Sociologist, Investment Centre Division, FAO, Rome, Italy.

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1 Introduction

CHARACTERISTICS OF THE REGION

Population. Sub-Saharan Africa, as defined in this Study, comprises 49 countries with a total population of 626 million people and an agricultural population, including urban agricultural producers, of 384 million (i.e. 61 percent of the total population).

Natural Resources. Total land area is 2 455 million ha, of which 173 million ha is under cultivation or permanent crops – about one quarter of the potentially arable area. For the purpose of analysis, four main agro-ecological zones (AEZ)[3] can be distinguished: (i) humid; (ii) moist sub-humid; (iii) dry sub-humid, and (iv) arid/semi-arid. In the region as a whole, the arid and semi-arid zones account for 43 percent of the land area but only an estimated 16 percent of the total population; the dry sub-humid zone accounts for 13 percent of the land and 10 percent of the population, and the moist sub-humid and humid zones jointly account for 38 percent of the land area and fully 60 percent of the population. In West Africa, 70 percent of the total population lives in the moist sub-humid and humid zones, whereas in East and Southern Africa only half the population lives in these zones.

Poverty. Nineteen of the 25 poorest countries[4] in the world are found in Sub-Saharan Africa. Approximately 16 percent of the region's population lives in countries that have a GDP per capita of less than US$200 (Ethiopia, Burundi, Sierra Leone, Guinea Bissau, Malawi and Nigeria); 36 percent live in countries with a GDP per capita of less than US$300 and as many as 75 percent live in countries with a GDP per capita below US$400. In the region as a whole, an estimated 43 percent of the total population fall below either the international poverty line of US$1 per day, or below nationally defined poverty lines. In East and Southern Africa, it is estimated that rural poverty accounts for as much as 90 percent of total poverty. Although remote regions with marginal agricultural resources are poorer than other regions, these regions have a relatively low population and hence account for a relatively low proportion of total poor people. Contrary to conventional wisdom, the majority of the rural poor are concentrated in the moist sub-humid and humid agro-ecological zones.

Role of Agriculture in the Economy. Agriculture accounts for 20 percent[5] of the region's GDP, employs 67 percent of the total labour force and is the main source of livelihood of the region's poor. Although the contribution of agriculture to GDP is increasing in about one quarter of all countries in the region, it is actually declining in more than one third of them.[6] In most cases, this declining share is due to rapid growth of non-agricultural sectors, whereas increases in the

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[3] Agro-ecological zones (AEZ) are defined and delineated by FAO based on the average annual length of growing period for crops, which depends on, *inter alia*, precipitation and temperature. The length of growing period for these zones are: humid, greater than 270 days; moist sub-humid, 180-269 days; dry sub-humid, 120-179 days; semi-arid, 60-119 days; arid, 0-59 days.

[4] Among those countries ranked in the World Development Report 2000 (excludes small island countries and those with incomplete data).

[5] Calculated on the basis of totals published in the World Development Report 2000 (for countries with data available).

[6] The sharpest declines were reported in Eritrea, Angola, Uganda, Ghana, Côte d'Ivoire, Mozambique, Mauritania and Lesotho and the greatest increases in the Congo Republic, Cameroon, Rwanda, Togo, Niger, Benin, Namibia, CAR, Zimbabwe and Mali. In 16 cases agriculture's declining share of GDP is a consequence of growth in other sectors and in 2 cases it is due to conflict (Burundi, Sierra Leone). Where agriculture's share of GDP is increasing, in 9 cases this due to positive agricultural growth (Benin, Cameroon, Mali, Namibia, Niger, Nigeria, Togo, Zambia) and in 3 cases due to negative growth of non-agricultural sectors (Chad, DR Congo, Rwanda).

contribution of agriculture to national GDP stem from either growth of agricultural value added, or from declines in non-agricultural sector growth.

Although Sub-Saharan Africa accounts for barely one percent of global GDP and only 2 percent of world trade, international trade contributes a relatively large share of regional GDP. Agriculture is the dominant export sector for East Africa (accounting for 47 percent of total exports), and a significant source of exports in other areas of the region (accounting for 14 percent of exports in Southern Africa and 10 percent in West Africa).[7] The region's main agricultural export commodities are cocoa, coffee and cotton. In the region as a whole agricultural exports account for 16 percent of total exports, whereas agricultural imports – mainly cereals – account for around 11-15 percent of total imports.

MAJOR FARMING SYSTEMS

For the purpose of this analysis, 15 broad farming systems[8] have been identified (see Map 1). These were based on criteria that included: (i) natural resource base; dominant livelihoods (main staple and cash income source); (ii) the balance between crops, livestock, fishing, forestry and off-farm activities; (iii) the degree of crop-livestock integration, and (iv) scale of operation. In defining these systems, the emphasis was placed on the characteristics of the most typical core farm-household system. Whilst mapping such aggregate farming systems, it is inevitable that significant heterogeneity is included within a given system, important subsidiary system types are therefore noted. The boundaries between systems are generally imprecise, because of the interpenetration of system attributes in the boundary areas, i.e. on the ground there is a gradual transition from one farming system to the next[9]. The approximate correspondence between agro-ecological zones and farming systems, and the land area and population of each farming system, is shown in Table 1. Several farming systems overlap two or more agro-ecological zone; such as the Maize Mixed Farming System (moist sub-humid and dry sub-humid zones), and the Irrigated, Large Commercial and Smallholder, and Urban Based Farming Systems (which occur in several agro-ecological zone). The Urban Based Farming System is not mapped. A brief description of each farming system appears in the following paragraphs, and five are analysed in greater depth in subsequent sections.

Irrigated System. This farming system is based on large-scale irrigation schemes such as the Gezira Scheme in Sudan, and also includes; riverine and flood recession-based irrigation, West African *fadama* systems and Sahelian oasis agriculture. It covers only 1.4 percent of the land area in the region (including the associated rainfed inclusions) but accounts for 29 percent of the irrigated surface and nearly 2 percent of the agricultural population. The remainder of the irrigated area in the region is included within other farming systems – notably the Large Commercial and Smallholder System in South Africa and Namibia, and the Rice-Tree Crop System in Madagascar. In nearly all cases, irrigated farming is combined with rainfed cropping or animal husbandry (the Gezira is one notable exception). The irrigated farming system is quite complex, and includes large-scale, centrally managed irrigation schemes, as well as small-scale, farmer-managed schemes. Within the latter category, there are government-assisted as well as traditional irrigation-based systems. It is also possible to distinguish between irrigation proper and run-off harvesting; as well as between full and partial water control. Irrigated holdings vary from 22 ha per household in the Gezira scheme to less than 1.0 ha in informal irrigation systems. Crop failure is generally not a problem, but livelihoods are vulnerable to water shortages, scheme breakdowns and deteriorating input/output price ratios. Many state-run schemes are currently in crisis, but if institutional problems can be solved future growth potential is good. The incidence of poverty is lower than elsewhere and absolute numbers of poor are small; therefore the potential for poverty reduction is low. Agricultural growth prospects are good.

Tree-Crop System. This farming system runs from Côte d'Ivoire to Ghana, and from Nigeria and Cameroon to Gabon, with smaller pockets in Congo and Angola. The system occupies 3 percent of the region's

[7] In West Africa, agriculture's contribution to export earnings has declined over the past 3 decades due to expansion of the petroleum industry. In Southern Africa it declined due to expansion of non-agricultural sectors.

[8] Each of the broad farming systems defined for the purpose of this Study includes considerable heterogeneity. Within these broad farming systems distinct sub-systems could be defined for the purposes of national level analysis. There is substantial variation in cropping components, livestock production sub-systems (especially related to small ruminants and poultry) and off-farm income. In the convention for naming farming systems in this report, the term "mixed" connotes crop-livestock systems and the term based indicates a dominant enterprise.

[9] The process of delineation of farming systems and estimation of data involved a range of sources and substantial input of expert knowledge of agricultural conditions in different parts of the region. The figures provided herein should therefore be considered as provisional estimates, which will be refined in future.

Table 1: Farming Systems of Sub-Saharan Africa[10]

Agro-ecological zone[11]	Farming System	Land Area (% of region)	Agric. Population (% of region)
Various	Irrigated	1	2
Humid	Tree-Crop	3	6
	Forest Based	11	7
	Rice-Tree Crop	1	2
	Highland Perennial	1	8
Humid (Temperate)	Highland Temperate Mixed	2	7
Moist sub-humid	Root Crop	12	12
Dry sub-humid	Cereal-Root Crop Mixed	13	15
	Maize Mixed	10	16
	Large Commercial and Smallholder	5	5
Semi-arid	Agro-Pastoral Millet/Sorghum	8	9
Arid	Pastoral	14	7
	Sparse (arid)	18	2
Various	Coastal Artisanal Fishing	2	3
	Urban Based	little	little

Source: FAO data and knowledge.

land area, but accounts for 6 percent of total cultivated area and supports 6 percent of the agricultural population. The backbone of the system is the production of industrial tree crops; notably cocoa, coffee, oil palm and rubber. Food crops are inter-planted between tree crops and are grown mainly for subsistence; few cattle are raised. There are also commercial tree crop estates (particularly for oil palm and rubber) in these areas, providing services to smallholder tree crop farmers through nucleus estate and outgrow schemes. Since neither tree crop nor food crop failure is common, price fluctuations for industrial crops constitute the main source of vulnerability. Socio-economic differentiation is considerable but growth potential is moderately high. Poverty incidence is low to medium and there is medium potential for poverty reduction.

Forest-Based System. This farming system occupies 11 percent of the total land in the humid forest zone and accounts for 7 percent of the agricultural population. It is typical of the Congo Democratic Republic, the Congo Republic, southeast Cameroon, Equatorial Guinea, Gabon, southern Tanzania and the northern tips of Zambia, Mozambique and Angola. Farmers practise shifting cultivation; clearing a new field from the forest every year, cropping it for 2 years (first cereals or groundnuts, then cassava) and then abandoning it to bush fallow for 7-10 years. Cassava is the main staple, complemented by maize, sorghum, beans and cocoyams. Cattle populations are low. Population density is also low and physical isolation plus lack of roads and markets are serious problems. Forest products and wild game are the main source of cash. However, cash is in very short supply because few households have cash crops and market outlets are distant. Growth potential is moderate thanks to the existence of large uncultivated areas and high rainfall, but yield increases in the near future are expected to be modest. Development entails environmental risks, including soil fragility and loss of wildlife habitats. Poverty incidence is very high but absolute numbers of poor are low.

[10] Provisional estimates based on best available data and expert knowledge.
[11] See above footnote (3) for length of growing period associated with each zone.

Rice-Tree Crop System. This farming system is located in Madagascar – mostly in the moist sub-humid and humid zones. It accounts for only one percent of both the land area and cultivated area of the region, but supports nearly 2 percent of the agricultural population. There is significant irrigation, which amounts to 10 percent of the irrigated area in the region. Farm size is small. Banana and coffee cultivation is complemented by rice, maize, cassava and legumes. Cattle numbers are relatively low. From a resource and climatic perspective the agricultural growth potential is high. However, the overall growth potential and the poverty reduction potential is considered fairly low, due to very small farm size, absence of under-utilised resources, shortage of appropriate technologies, and poor development of markets and off-farm activities.

Highland Perennial System. This farming system in central Ethiopia – which accounts for only one percent of the land area of the region but 3 percent of the cultivated area and 8 percent of the agricultural population – supports the region's highest rural population density (more than one person per hectare of land). Land use is intense and holdings are very small (average cultivated area per household is just under one ha, but more than 50 percent of holdings are smaller than 0.5 ha). The farming system is based on perennial crops such as banana, plantain, *enset* (Ethiopian "false banana") and coffee; complemented by cassava, sweet potato, beans and cereals. Cattle are kept for milk, manure, bridewealth, savings and social security. The main trends are diminishing farm size, declining soil fertility, and increasing poverty and hunger. People cope by working the land more intensively, but returns to labour are low. Poverty is high, both in terms of incidence and absolute numbers. From a resource and climate perspective the agricultural growth potential is high. However, the overall growth potential and the poverty reduction potential is considered fairly low, due to very small farm size, absence of under-utilised resources, shortage of appropriate technologies, and poor development of markets and off-farm activities.

Highland Temperate Mixed System. This farming system occupies only 2 percent of the total land area of the region and 4 percent of cultivated area, but accounts for around 7 percent of the agricultural population. It is found at altitudes between 1 800 and 3 000 metres in the highlands and mountains of Ethiopia, Eritrea and Lesotho, and occurs to a small extent in Kenya, Angola, Cameroon and Nigeria. Average population density is high and average farm size is small (1-2 ha). Cattle are numerous and are kept for ploughing, milk, manure, bridewealth, savings and emergency sale. Small grains such as wheat and barley are the main staples, complemented by peas, lentils, broad beans, rape, tef (in Ethiopia) and Irish potatoes. The main sources of cash are from the sale of sheep and goats, wool, local barley beer, Irish potatoes, pulses and oilseeds. Some households have access to soldiers' salaries (Ethiopia/Eritrea) or remittances (Lesotho), but these mountain areas offer few opportunities for local off-farm employment. Typically there is a single cropping season, although some parts of Ethiopia and Kenya have a second, shorter cropping season. Wheat production is in crisis because fertiliser application no longer pays. Soil fertility is declining because, *inter alia*, manure is burned as fuel. There is considerable potential for diversification into higher-value temperate crops, but risks are high because of very unpredictable weather. Vulnerability stems from early and late frosts at high altitudes that can severely reduce yields, as well as from crop failure in cold and wet years. As with other food-crop based farming systems, a hungry season occurs from planting time until the main grain harvest. Poverty incidence is high, absolute numbers of poor are substantial and the potential for poverty reduction is only moderate. Agricultural growth potential is also only moderate.

Root Crop System. This farming system is situated in, and extends from, Sierra Leone to Côte d'Ivoire, Ghana, Togo, Benin, Nigeria and Cameroon. The area is bounded by the Tree Crop and Forest-Based Farming Systems on the southern, wetter side and by the Cereal-Root Crop Mixed Farming System on the northern, drier side. There is a similar strip in Central and Southern Africa, on the south side of the forest zone – in Angola, Zambia, southern Tanzania and northern Mozambique – and a small area in southern Madagascar. The system accounts for around 12 percent of the land area of the region, 16 percent of the cultivated area and 12 percent of the agricultural population. Rainfall is either bimodal or nearly continuous and risk of crop failure is low. Growth potential and poverty reduction potential are moderate; technologies for this system are not yet fully developed. Nonetheless, market prospects for export of oil palm products are attractive, urban demand for root crops is growing, and linkages between agriculture and off-farm activities are relatively better than elsewhere.

Cereal-Root Crop Mixed System. This farming system accounts for 13 percent of the land area of the region – predominantly in the dry sub-humid zone – and 15 percent of the agricultural population. It extends from Guinea through northern Côte d'Ivoire to Ghana, Togo, Benin and the mid-belt states of Nigeria to northern Cameroon; and there is a similar zone in Central and Southern Africa. Although the system shares a number of climatic characteristics with the Maize Mixed System, other characteristics set it apart, namely; lower altitude, higher temperatures, lower population density, abundant arable land, higher livestock numbers per household, and poorer transport and communications infrastructure. Although cereals such as maize, sorghum and millet are important in the system, wherever animal traction is absent root crops such as yams and cassava are more important than cereals. A wide range of crops is grown and marketed, and intercropping is very important. The main source of vulnerability is drought. Poverty incidence is low, numbers of poor people are modest and the potential for poverty reduction is moderate. Agricultural growth prospects are excellent.

Maize Mixed System. This farming system accounts for 10 percent of the land area, 19 percent of the cultivated area and 16 percent of the agricultural population of the region. Climate varies from dry sub-humid to moist sub-humid. The most typical areas have monomodal rainfall, but some areas experience bimodal rainfall. It is the most important food production system in East and Southern Africa, extending across plateau and highland areas at altitudes of 800-1 500 metres, from Kenya and Tanzania to Zambia, Malawi, Zimbabwe, South Africa, Swaziland and Lesotho. In West Africa, similar systems are found in the highlands of western Cameroon and Nigeria. Population density is moderately high and average farm sizes are rather modest (often less than two ha). The farming system also contains scattered irrigation schemes, but these are mostly small-scale and amount to only 6 percent of the irrigated area in the region. Where a bimodal rainfall pattern occurs farmers have two cropping seasons, but in drier areas they usually harvest only once a year from a given field. The main staple is maize and the main cash sources are migrant remittances, cattle, small ruminants, tobacco, coffee and cotton, plus the sale of food crops such as maize, pulses and sunflower. Cattle are kept for ploughing, breeding, milk, farm manure, bridewealth, savings and emergency sale. In spite of scattered settlement patterns, community institutions and market linkages in the maize belt are relatively better developed than in other farming systems. The main sources of vulnerability are drought and market volatility. Socio-economic differentiation is considerable, due mainly to migration, and the whole system is currently in crisis as input use has fallen sharply since its high price makes fertiliser use uneconomic. As a result, yields have fallen and soil fertility is declining, while smallholders are reverting to extensive production practices. Chronic poverty is linked to small farm size and absence of draught oxen and migrant remittances, but transitory poverty has sharply increased as a result of retrenchment of off-farm workers coupled with policy reforms affecting maize. In spite of the current crisis, growth prospects are relatively good and the potential for reduction of poverty is high.

Large Commercial and Smallholder System. This farming system extends across the northern part of the Republic of South Africa and the southern part of Namibia, mostly in semi-arid and dry sub-humid zones, and accounts for 5 percent of the land in the region and 5 percent of the agricultural population. It comprises two distinct sub-types: scattered smallholder farming in the *homelands* and large-scale commercialised farming. Both sub-types are largely mixed cereal-livestock systems, with maize dominating in the north and east, and sorghum and millet in the west. Both cattle and small ruminants are raised. The level of crop-livestock integration is moderate. Poverty incidence is high among smallholder families who often survive by means of income from employment, principally in other sectors outside the area. Vulnerability is high, since a considerable part of the farming system has poor soils and is drought-prone. Chronic and extensive poverty exists among the smallholder families. Agricultural growth prospects are moderate, and there is a low-medium potential for poverty reduction.

Agro-Pastoral Millet/Sorghum System. This farming system occupies 8 percent of the land of the region, generally in the semi-arid zone, and also accounts for 9 percent of the agricultural population. Population density is modest but pressure on arable land is very high. Crops and livestock are of similar importance. Rainfed sorghum and pearl millet are the main sources of food and are rarely marketed, whereas sesame and pulses are sometimes sold. Land preparation is by oxen or camel, while hand cultivation using hoes is common along riverbanks. Livestock are kept for subsistence (milk and milk products), offspring,

transportation (camels, donkeys), land preparation (oxen, camels), sale or exchange, savings, bridewealth and insurance against crop failure. The population generally lives permanently in villages, although part of their herds may continue to migrate seasonally with herd boys. The main source of vulnerability is drought, leading to crop failure, weak animals and the distress sale of assets. Incidence of poverty is high and absolute numbers of poor are also relatively high. The potential for poverty reduction is only moderate. Growth potential is also modest and presents important challenges. However, a sufficient range of improved technologies is available to warrant a focus on these systems.

Pastoral System. The Pastoral Farming System is located in the arid and semi-arid zones extending from Mauritania to the northern parts of Mali, Niger, Chad, Sudan, Ethiopia, Eritrea, Kenya and Uganda. There are also pastoral areas in the arid zones of Namibia and in parts of Botswana and southern Angola.[12] The system occupies 14 percent of the regional land area, but accounts for only 7 percent of the agricultural population. During the driest period of the year, Sahelian pastoralists move south to the Cereal-Root Crop Mixed System areas in the Guinea savannah, and they return north during the rainy season. The main source of vulnerability is the great climatic variability and consequently high incidence of drought. Socio-economic differentiation is considerable – many herders have lost most of their animals due to droughts or stock theft. Poverty incidence is high and absolute numbers of poor are relatively large, but the poverty reduction potential is low. The agricultural growth potential is only modest.

Sparse (Arid) System. Despite covering some 18 percent of the land area of the region, this farming system is of limited significance from the point of view of agriculture, and has low human (less than two percent of the regional agricultural population) and livestock populations. Because the *wadis* and their surrounding areas are considered part of the Pastoral System, grazing within the actual Sparse (Arid) System is limited. There are some scattered irrigation settlements in these arid areas, in most cases used by pastoralists to supplement their livelihoods – the larger schemes are, however, considered under the Irrigated System. The potentials for growth and poverty reduction are both low.

Coastal Artisanal Fishing System. This farming system occupies almost 2 percent of the land and accounts for over 3 percent of the agricultural population, with a fairly high average population density. In East Africa, the system stretches southward from Kenya to Mozambique and similar systems are also found in Zanzibar, Comoros and Madagascar. In West Africa, the system stretches southward from the Gambia and the Casamance region of Senegal, along the coast of Guinea Bissau, Sierra Leone, Liberia, Côte d'Ivoire and Ghana, to Nigeria, Cameroon and Gabon. Households, which depend on lake and river fishing, are not included in this system. The livelihood system is based on artisanal fishing complemented by multi-storied tree-crop gardens with root crops under coconuts, fruit trees and cashews. Some 4 percent of cultivated land is irrigated. Artisanal fishing includes sea fishing from boats, seine net fishing from beaches, setting of nets and traps along estuaries and in shallow lagoons, and catching of crustaceans in mangrove swamps. Poultry and goats are the main domestic animals. Cattle keeping is rare, due to tsetse infestation and land preparation is by hand. Goats are tethered under coconut palms. Off-farm opportunities are connected with tourist resorts along the beaches and with large tree crop estates. In West Africa, because of the humid climate, there is more swamp rice and little or no cashewnut. Growth potential is modest but the potential for poverty reduction is considered low. Although socio-economic differentiation is considerable and although roughly half of the population is poor, the absolute number of poor people is small in regional terms.

Urban Based System. Within the estimated total urban population of over 200 million in the region, there is a significant number of farmers in cities and large towns. Farmers outside the boundaries of cities and towns, even those with good access to urban markets, are included in the corresponding farming system. This farming system is very heterogeneous; ranging from small-scale but capital-intensive market-oriented commercial vegetable growing, dairy farming and livestock fattening, and part-time farming by the urban poor to cover part of their subsistence requirements. However,

[12] Each of the broad farming systems defined for the purpose of this Study includes considerable heterogeneity. Within these broad farming systems distinct sub-systems could be defined for the purposes of national level analysis. There is substantial variation in cropping components, livestock production sub-systems (especially related to small ruminants and poultry) and off-farm income. In the convention for naming farming systems in this report, the term "mixed" connotes crop-livestock systems and the term based indicates a dominant enterprise.

crop-livestock integration is often low. This is a very dynamic farming system that has considerable growth potential. The potential for poverty reduction is low, mainly because the absolute number of poor is low. Growth is likely to be led by expansion of urban demand for fresh food. Uptake of improved technologies tends to be greater than in other farming systems. Such growth is likely to take place spontaneously, in response to market forces and individual initiative, even in the absence of public sector support.

PRIORITISATION OF FARMING SYSTEMS

From the standpoint of poverty reduction, a strong case can be made for channelling resources to smallholder agriculture in Sub-Saharan Africa. Rural poverty still accounts for 90 percent of total poverty and approximately 80 percent of the poor still depend on agriculture or farm labour for their livelihood. The farming systems that are most important for poverty reduction (see Table 2), because they contain large numbers of poor people, are the:

- Maize Mixed System;
- Highland Perennial System;
- Agro-Pastoral Millet/Sorghum System;
- Tree-Crop System.

Growth potential depends to a large extent on the availability of under-utilised resources, intensification possibilities and market prospects. The systems with the greatest potential for extension of cultivated area are those based mainly on root crops in the humid forest, moist sub-humid and dry sub-humid AEZ; i.e. the Root Crop and Cereal-Rootcrop Mixed Systems. There are, however, significant soil and environmental constraints (see Map 4) which will require the application of sound resource management practices in these areas. In other systems, valley bottoms that usually have heavy soils are the main under-utilised resource. The farming systems with the greatest potential for intensification through further crop-livestock integration are the Maize Mixed and the Cereal-Root Crop Systems.

The greatest overall growth potential in the immediate future is found in the Irrigated, Cereal-Root Crop and the Tree-Crop Systems. The Maize Mixed System is facing a crisis, but there are possible solutions through intensification and diversification. The Forest Based System has large under-utilised areas, but soils are fragile, market access is very poor and moisture is often excessive. The Root Crop System has a moderate growth potential for supplying urban markets with root crops and for exporting oil palm. The Highland Temperate Mixed System has

Table 2 – Potentials for Poverty Reduction and Agricultural Growth

Farming System	Growth Potential	Poverty Incidence	Absolute No. of poor	Potential for Poverty Reduction
1. Irrigated	High	Low	Low	Low
2. Tree-Crop	Med-high	Low-Med	High	Medium
3. Forest-Based	Modest	High	Low	Low
4. Rice-Tree Crop	Low	Medium	Medium	Low
5. Highland Perennial	Low	Highest	High	Low
6. Highland Temperate Mixed	Moderate	Moderate	Medium	Medium
7. Root Crop	Medium	Low-Med	Medium	Medium
8. Cereal-Root Crop Mixed	Highest	Low	Low	Medium
9. Maize Mixed	Med-high	Medium	High	High
10. Large Commercial and Smallholder	Medium	Medium	Low	Low-Medium
11. Agro-Pastoral Millet/Sorghum	Modest	High	High	Medium
12. Pastoral	Modest	High	Low	Low
13. Sparse (arid)	Low	High	Very Low	Low
14. Coastal Artisanal Fishing	Modest	Medium	Low	Low
15. Urban Based	Medium	Medium	Low	Low

Note: Shaded systems are those selected as priorities.

potential for ruminant livestock production and for production of high-value temperate crops.

On the basis of potentials for poverty reduction and agricultural growth[13], five key farming systems have been selected for analysis of strategic options, as indicated in Table 2, namely the:

- Irrigated System;
- Tree-Crop System;
- Cereal-Root Crop System;
- Maize Mixed System;
- Agro-Pastoral Millet/Sorghum System.

[13] Systems selected either have high poverty with moderate growth potential or high growth potential in spite of limited poverty. Farming systems with high poverty but low growth potential were excluded.

2 Region-Wide Trends[14]

Population. The population of Sub-Saharan Africa is projected to increase by 78 percent in the coming three decades. This is faster than the projected population growth of 51 percent for developing countries as a whole. AIDS is expected to have a major effect on population growth as well as causing severe hardship. During this 30-year period, the rural population is projected to increase by 30 percent, and agricultural population is expected to expand by a slightly lower proportion, moderated by growing urbanisation. Urban population – currently 33 percent – is expected to rise to 50 percent of total population by 2030. Sub-Saharan Africa is unique in that rapid urbanisation has been occurring during a period of economic contraction.

Natural Resources. Currently, forest covers approximately four million km2 (almost 17 percent of land area). The current annual deforestation rate is 0.7 percent and the decline in forest area is expected to continue. The farming systems most affected by deforestation are the:

- Forest-Based System;
- Tree-Crop System;
- Root Crop System;
- Cereal-Root Crop System.

Currently, the Maize Mixed, Highland Perennial and the Highland Temperate Mixed systems are experiencing acute fuelwood shortages.

Arable land in use has expanded from 123 million ha in 1961-63 to 173 million ha (including annually cultivated land and permanent crops) in 1999. This represents a slow annual expansion of 0.73 percent. During the period until 2030, arable land in use is estimated to expand even more slowly; to 288 million ha (only 26 percent of total land with rainfed crop production potential).

The area affected by land degradation, including soil erosion and declining soil fertility, is increasing. Although land degradation is evident in a majority of farming systems, it is particularly notable in those such as the Highland Perennial and Highland Temperate System where – in the absence of incentives for good land management – high population density places excessive pressure on land. In some farming systems this pressure is aggravated by the breakdown of input supply services, e.g. the Maize Mixed System.

The region has a moderate level of renewable water resources, but only 2 percent of these are currently utilised for irrigation compared with 20 percent in the overall group of developing countries. Only 6.5 million ha are currently irrigated and, during the period until 2030, the area of irrigation is projected to increase very slowly to 7 million ha. This expansion of only 0.8 percent per annum compares with growth of 2.1 percent per annum during the past four decades. Thus, unlike other regions where irrigated lands will generate a major part of the increases in food production, irrigation in Africa will play a very modest role during the coming three decades.

Production Patterns and Technologies. Total annual cropped area was about 153 million ha in 1999 and is expected to expand by 40 percent to around 205 million ha by 2030. Total production of all crops in 1995-97 was just over 250 million tons, and is forecast to more than double by 2030, rising to a total of 565 million tons. This estimated production increase is

[14] Except where indicated, these data are drawn from FAOSTAT or Agriculture Towards 2015/30: An Interim Report.

expected to result from a 25 percent expansion in arable land under cultivation, a 13 percent rise in cropping intensity (from 63 percent to 71 percent) and an overall increase in crop yields of 60 percent. Major increases are expected to come from expanded production on heavy lowland soils and on irrigated land in several farming systems. However, as stated in the previous paragraph, the contribution of irrigation expansion to total cropped area and production will be extremely modest. Thus, in contrast to some other regions, the bulk of production in Sub-Saharan Africa will continue to come from rainfed farming. The increase is expected to be greater in the humid and moist sub-humid tropics than in the dry sub-humid and semi-arid areas.

Inorganic fertiliser consumption in the region is very low despite the declining soil fertility noted above. Total regional consumption is only 1.3 million tons of nutrient, out of a global total of 133.9 million tons (equivalent to an average of only 8 kg nutrient/ha within the region compared with 107 kg/ha in all developing countries). From this low initial consumption level, the growth rate of 6 percent per annum over the past 35 years has been well above the global growth rate of 3.9 percent per annum[15]. During the period until 2030, total fertiliser consumption in the region is expected to increase much more slowly – at 0.6 percent per annum – because its application is uneconomic in many circumstances under rainfed conditions. The profitability of fertiliser application on many crops is low because of poor agronomic responses on degraded land, high fertiliser prices and low farmgate prices for crop produce. Average fertiliser use per hectare is projected to reach 11kg nutrient/ha by 2030, compared with the global average of 124 kg/ha. These very low levels of fertiliser use are not being compensated for by the use of compost or other soil amendments. Consequently, the current nutrient mining of African soils will continue.

Currently, the region has 201 million head of cattle, 184 million goats and 159 million sheep. Tsetse infestation is a major factor influencing the distribution of livestock between different AEZ and farming systems. The tsetse challenge tends to be concentrated in the moist sub-humid and humid lowlands, and in drier areas near game reserves. In spite of this, increasing numbers of cattle are raised in areas which were originally tsetse infested in the moist sub-humid and dry sub-humid zones, e.g., in the Root Crop and Cereal-Root Crop Systems. This trend is likely to continue. Nevertheless, cattle numbers per household tend to be higher in the dry farming systems than in the moist systems. From 1967 to the present time, regional livestock numbers grew at 2.4 percent p.a. Between 2000 and 2030, they are predicted to grow at the marginally higher rate or 2.8 percent, due to expansion of urban consumer demand for meat, milk and eggs. This is slightly above the projected growth rate for developing countries as a whole (2.4 percent).

Globalisation and Markets. Since 1961, although the absolute value of agricultural exports has risen, the region's share of world agricultural trade has fallen. In absolute terms, the sharpest fall has been in Southern Africa, whose share of world agricultural trade fell from 9 percent in 1961 to 3 percent in 1998. In proportionate terms, however, the other sub-regions of Africa have done little better. There has been much more stability in Africa's share of world agricultural imports, which form a smaller proportion of world trade than do exports, ranging from 0.2 percent in Central Africa to one percent in West Africa.

In 1998, agriculture accounted for 47 percent of total exports from East Africa, whereas in West and Central Africa, agriculture's share of total exports dropped from over 70 percent in 1961 to only 9-10 percent in 1998, as a consequence of the development of petroleum exports. Over the same period, in Southern Africa, agricultural exports declined from 59 percent to 14 percent of total exports due to expansion of non-agricultural sectors. The region's principal agricultural exports are cocoa, coffee and cotton. Cocoa accounted for 22 percent of total agricultural exports in Central Africa and 48 percent in West Africa. For coffee, the share varied between 12 percent and 25 percent (in West Africa and East Africa respectively). For cotton, the range was between 5 percent in East Africa and 26 percent in Central Africa. In Southern Africa, by contrast, the top exports were sugar, wine and fruits (mainly from the Republic of South Africa).

Over the past three decades, there has been a broad stability in the proportion of agricultural products in total imports to the region. This now ranges from a high of around of 20 percent in Central Africa, 15 percent in East Africa and West Africa and a low of 8-12 percent in Southern Africa.

[15] Reasons include high and rising fertiliser prices as a consequence of currency devaluation, high transport costs and subsidy removal, low smallholder purchasing power and breakdown of credit for smallholder seasonal production loans.

The main agricultural imports consist of cereals (wheat, rice and maize). Over the past 30 years, these have risen from 5 percent of total cereal consumption to 14 percent. In 2030, the region would need to import an estimated 16 percent of its total cereal requirements.

The bulk of cereal imports by the region have been made on a commercial basis, rather than as food aid. Except in a few years, food aid has represented less than half of cereal imports and the proportion for 1995–8 (17 percent) was lower than in 1975–8 (25 percent). Nonetheless, in 1998 per capita food aid flows were three times as large as food aid flows to Asia and LAC. However, food aid shipments have recently fallen from 15.1 million tons of cereals in 1992/3 to just 8.8 million tons in 1998/9. In particular, shipments to low-income food-deficit countries in the region declined by 63 percent.

Food Self-sufficiency. During 1995-97, the average daily Sub-Saharan African diet contained 2 188 kcal/person/day compared with 2 626 in developing countries as a whole. It is estimated that 33 percent of the regional population was undernourished at this time, with a higher incidence of under-nourishment found in rural areas than among urban dwellers. During the period until 2030, the average energy intake is expected to increase by 18 percent to 2 580 kcal/person/day. In spite of the increased calorie supply, an estimated 15 percent of the population (or 96 million people) will still be undernourished – which represents a slight increase in the absolute number of undernourished.

Policies. Structural adjustment programmes have been implemented in a many countries in the region. Whilst these programmes have conferred macroeconomic stability on many economies, farmers face declining effective terms of trade and poorer access to many agricultural inputs such as improved seed and agro-chemicals. These effects are particularly evident in the Maize-Based Mixed Farming System.

Information and Human Capital. The reduction in government expenditure on extension and agricultural training in many countries, during the past decade, has reduced the availability to farmers of technology and market information. It is expected that existing alternative sources of information will expand and new channels for agricultural information flows to emerge. Already farmer's organisations in a number of countries have stepped up extension and training activities. In addition, the private sector's role in technical and market information provision in connection with commercial crop and livestock activities is expected to expand greatly during the coming three decades.

3 Tree-Crop Farming System

SYSTEM DESCRIPTION

The backbone of this farming system is tree crop production, notably cocoa, *robusta* coffee, oil palm and rubber. Food crops are often interplanted between tree crops. Roots and tubers (cassava, yam and cocoyam) are the main staples; tree crops and off-farm activities are the main source of cash. Livestock keeping is limited by tsetse infestation in many areas and land preparation is by hand. The main animal species are pigs and poultry. Fish farming is popular in some areas. Off-farm activities are relatively well developed. A typical farm household within this system is outlined in Box 1.

Industrial tree crops were initially established by indigenous farmers through a process of annual clearance. Each year a household would clear from the forest as much land as it could manage with family labour (e.g. 0.5-1.0 ha), plant coffee or cocoa, and grow food crops (a mix of cassava, cocoyam, cereals, pulses) between the immature plants. However, after a year or two, family labour would not be sufficient to manage both the newly cleared land and the care of the plots established during previous years. Farmers addressed the problem by contracting the care of their second and third year coffee gardens to immigrant farmers from the savannah zone in exchange for the right to interplant food crops among the trees. Once the tree canopy closed and certain types of food crops could no longer be successfully grown underneath them, the tree crops began bearing enough coffee to pay for hired labour.

The practices adopted by commercial outgrower schemes are often in sharp contrast with the indigenous system. Commercial schemes usually set a minimum plot size (e.g. 5 ha/grower) and farmers are expected to establish the entire area in a single year; this situation forces some farmers into debt. The lack of staggered planting also increases vulnerability to pest and disease attacks. It is a major reason why many farmers in estate schemes meet with difficulties.

BOX 1: A TYPICAL HOUSEHOLD IN THE TREE-CROP SYSTEM

A typical tree-crop farming household has 5 ha of land, all of which is under coffee in various stages of maturity. Food crops such as cassava, cocoyam and cereals are interplanted between the immature trees. It has a multi-storied homestead garden with fruit trees and vegetables. The wife owns about 20 scavenging chickens. The young sons each own a goat or two and the wife raises a couple of her own. The husband might have a shop or business. An occasional farmer has a fishpond. The household is generally food self-sufficient and earns a per capita income well above the poverty line.

A typical poor migrant worker in this farming system has a wife and family back in the savannah, who still work for the husband's father. The family feeds themselves for 4-6 months a year from their own production and addresses its food and income deficit by migration. The income from tending tree crops and growing food between the immature trees is insufficient to boost the household income above the poverty line.

Total population	50 million
Agricultural population	25 million
Total land	73 million ha
Agro-ecological zone	Humid
Arable land in use	10 million ha
Irrigated area	0.1 million ha
Cattle population	2 million

SYSTEM-SPECIFIC TRENDS AND ISSUES

The main trends affecting the Tree-Crop System relate to: population pressure on natural resources, declining terms of trade and market share, dismantling of parastatal input supply and marketing services, and withdrawal of the public sector from industrial crop research and extension. The result has been increasing poverty and growing social conflict between tree crop owners and migrant workers – especially in Côte d'Ivoire.

Strong international competition has led to depressed producer prices and a declining market share for most industrial tree crops grown in the region. The consequent low profitability has resulted in neglect of some tree crops, as well as decreased demand for hired labour on commercial estates. In some cases, low farmgate prices are also due to high taxation of export crops and the low share of export price accruing to farmers. Use of mineral fertiliser and agro-chemicals is declining due to high prices, low profitability and lack of credit for their purchase.

Smallholder services have broken down as a consequence of; (i) withdrawal of parastatals from input supply, credit, extension and crop buying operations, and (ii) the divestment of state-owned agro-processing and its take-over by large-scale private investors. The private sector has been reluctant to advance inputs to outgrowers on credit and to deduct their cost from the marketed product. With the dismantling of parastatal commodity boards, tree crop extension was handed over to public extension services. The latter have, however, been severely downsized due to inability of governments to sustain their cost. Public extension services are currently attempting to transfer industrial crop extension to private commodity producer groups.

As a result of policy reform, public sector agricultural research institutes are withdrawing from research on export crops and leaving this to the private sector. However, private commodity research focuses only on export commodities. It does not consider the other parts of the tree-crop based farming and livelihood systems. Hence the current failure to address farmers' problems concerned with food crops and soil fertility maintenance, which reduce input productivity and profitability.

SYSTEM PRIORITIES

The Tree-Crop System was once a key source of agricultural exports for a number of countries in West and Central Africa. Despite the problems referred to above, it is a high potential system and its growth prospects in the medium term are excellent. The strategic focus for development lies in the improvement of support services, particularly those related to farm inputs and export marketing. To be effective, such improvements will need to be tailored to the particular needs of different groups of farmers.

Options for dealing with deteriorating terms of trade for traditional export commodities include: (i) product quality upgrading for traditional export crops (crop rehabilitation, replanting with higher-yielding clonal planting material, better processing, grading and packaging); (ii) a search for niche markets (e.g. biologically grown cocoa); (ii) diversification into non-traditional export crops to reduce vulnerability to world price fluctuations, and (iv) in cases where prices are still administered by parastatals and export crops are heavily taxed, increasing producers' share of the export price.

The breakdown of input supply, credit and marketing services can be addressed by assisting smallholder tree crop growers to form commodity producer groups and by building their capacity to assume responsibility for input supply and marketing services. Another complementary strategy is to create self-sustaining, savings-based micro-finance institutions capable of meeting the needs of tree crop growers' for seasonal production loans. However, since micro-finance institutions cannot afford to lend for long-term uses, long-term credit or one-time matching grants for tree crop establishment may also be needed.

The breakdown of parastatal extension services can be addressed by strengthening smallholder producer associations to enable them to contract private or NGO extensionists in order to advise them on production problems. Neglect of farmers' problems related to food-crops could be overcome by groups of tree crop producers contracting research institutions (public or private) to carry out research on behalf of smallholders.

The need to boost support services – including marketing – underlines the importance of price, product quality and other market-related information. These services could be organised through forming partnerships between private-farmers organisations; although the challenge is to ensure the relevance and financial viability of the information services that are created.

4 Maize Mixed Farming System

SYSTEM DESCRIPTION

This farming system is the food basket of the East and Southern Africa region. Both local and hybrid maize are grown and the former is often preferred for home consumption because of its better taste – in spite of lower yields. Minor crops include pulses and oilseeds which, like maize, are grown as dual-purpose subsistence and cash crops. Cash crops include coffee, tobacco, groundnuts and sunflower. Cattle are the most important livestock species. Crop-livestock integration is strong; land is usually prepared by oxen, dung is collected and used to manure the fields, and animals are increasingly stall-fed on crop residues supplemented by cut fodder from fodder trees, hedges or forage plots. Although livestock density is higher than in any other production system in the region, most farmers cannot afford to keep more than two oxen and one milking cow plus 1-2 calves or heifers.

Although the maize belt suffers during major droughts, drought is not the main cause of poverty. In areas with low population density, the majority of households are able to produce enough grain to feed themselves, but households with farms of less than 0.5 ha have a food deficit. Crop failure can occur in severe drought years (1-2 years in 10). Livelihood diversification is a hedge against bad weather and marketing risks. The main causes of poverty are very small farm size or landlessness, lack of oxen, low off-farm income and deteriorating terms of trade for maize producers. A typical household in the Maize Mixed System is briefly described in Box 2.

Total population	95 million
Agricultural population	60 million
Total land	246 million ha
Agro-ecological zone	Dry sub-humid
Arable land in use	32 million ha
Irrigated area	0.4 million ha
Cattle population	36 million

Differences in wealth are largely explained by differences in off-farm earnings and their re-investment in farming or commercial enterprises, not by differences in farm income. crops Nonetheless, the upper stratum of farm families have more and better farmland, more crossbred dairy cattle and larger areas of cash crops. They also use more fertiliser, agrochemicals and hybrid seed, as well as taking more credit. Poor households consist of landless or marginal farmers, with no cattle (40 percent of households), no regular off-farm earnings and no high value crops. They grow mostly local maize for home consumption and cannot afford to buy fertiliser or hybrid seeds.

SYSTEM-SPECIFIC TRENDS AND ISSUES

It was formerly assumed that smallholder maize production in East and Southern Africa could be boosted by a combination of high doses of inorganic fertilisers and hybrid varieties; and indeed much of the extension effort over the past two decades in Kenya, Zambia, Tanzania and Malawi focused on promoting these technologies. Once subsidies on inputs and guaranteed product prices were removed, and the full brunt of devaluation came to be felt, use of high-cost inputs on maize became uneconomic. As a consequence, farmers have reverted to cultivating traditional varieties where available, and even to growing substitute crops such as sorghum and sweet potatoes. In former maize-exporting areas such as the Southern Highlands of Tanzania and Central Province in Zambia, use of purchased seed and fertiliser has

BOX 2: A TYPICAL HOUSEHOLD IN THE MAIZE MIXED SYSTEM

A typical middle stratum household would include a husband, wife and 4 of their own children plus an older relative and several orphans left by one of the husband's deceased brothers. They would live directly on their farmland in a dispersed homestead. It would have a cropped area of 1.6 ha of which one ha would be planted to maize and some sorghum, 0.1 ha to cassava, 0.1 ha to cotton and the rest to a wide range of other crops. The family would own 2-3 cattle and use its oxen to plough the land. It would obtain average yields of 1.2 tons per ha for maize and around 900 kg/ha for sorghum, 800 kg/ha for millet and 500 kg/ha for pulses. Maize and other cereals would account for 80 percent of total food production, pulses for 9 percent, cassava for 8 percent and oilseeds for the rest. The household would be food self-sufficient in average to good years and deficit in drought years. One son would work outside the farm and send occasional remittances, used to pay school fees and clothes. Homegrown maize would be the main source of subsistence and cash would come either from off-farm activities or from the sale of agricultural products such as maize, tobacco or coffee and milk. Income would formerly have been above the poverty line.

A poor household in the same community would have less than 0.5 ha of land and its main source of livelihood would be casual labour for other farmers and beer brewing by the wife. It would have no cattle but might own a goat and a couple of chickens. Many such households would be headed by women, often widows of migrant workers who died of AIDS and left them with children to support.

sharply fallen. Thus, smallholder maize growers at present are adopting more extensive husbandry techniques by reverting to low-input/low-output strategies and poverty appears to be increasing. However, in future the effectiveness of agricultural support systems – notably marketing – may be restored, at which stage a shift to intensification and diversification is likely.

The input/output price ratio for maize has steadily deteriorated as a result of trade and price liberalisation. Following the removal of input subsidies, dismantling of price supports, withdrawal of the state from grain purchasing and abolition of pan-territorial pricing, most smallholders have been struggling to adjust to rising input prices and declining maize prices. Smallholder input supply, credit and marketing services have collapsed and private sector response has been less than anticipated. In keeping with policy reforms, governments were advised to withdraw from seed production and leave it to private seed companies. However, the private companies were only interested in hybrid maize. Open pollinated varieties were uninteresting because farmers can save their seed for up to three seasons before renewing it. Hence smallholder access to farm inputs, credit, markets and good quality open-pollinated seed remains a problem.

As a result of rapid population growth, in areas such as highland Kenya, southern Malawi, Lesotho and the Communal Areas of Zimbabwe, average farm sizes have fallen to under 0.5 ha. This is too low for even a poverty line income without off-farm earnings. In some Communal Areas in Zimbabwe, there is no longer sufficient grazing land to support enough cattle to plough the land or manure the fields. There are signs of serious fertility decline and increasing soil acidity in some soils where there has been prolonged use of inorganic fertilisers without adequate attention being given to maintaining the level of organic matter. Key issues include the high cost of mineral fertiliser relative to the price of maize (given existing productivity levels on depleted soils), the difficulty of maintaining soil fertility in the absence of mineral fertiliser due to shortage of organic matter, shortage of livestock to produce manure due to feed shortage and shortage of oxen for farm power. The situation is not hopeless, however, the Starter Pack Programme in Malawi, underpinned by government and donor funds, distributed seed and fertiliser very widely and has successfully increased national maize production.

Top-down, message-based, technician-driven extension systems that were designed for promotion of single component "quick fix" technical packages (such as hybrid maize with mineral fertiliser) are ill-suited for addressing the current problems of this farming population. Even in the past, messages based on high fertiliser applications were often irrelevant to smallholders because the packages were too costly and overlooked risk under rainfed conditions. In practice, farmer and other civil society organisations are now organising seed multiplication and dissemination of technical information, and are thus beginning to fill the void left by government extension services.

In the short term, the major input supply and produce marketing issues are unlikely to be resolved. In the absence of targeted policies and programmes, land degradation is likely to spread and exert further downward pressure on crop yields. Through these processes the incidence and severity of chronic poverty are likely to increase, leading to the risk of disastrous famines when rains fail. The declining trend in maize surpluses marketed by farmers will threaten national food security in bad seasons and could force governments to import food to feed the cities.

SYSTEM PRIORITIES

Whilst the Maize Mixed System is currently in crisis, its long-term prospects are quite bright. In some parts growth could be driven by area expansion; in other parts intensification and diversification are more likely. Turnaround depends on private sector investment for the development of viable input and output marketing, so as to replace government services that have been withdrawn in the course of structural adjustment programmes. Productive and profitable technologies and practices for improved soil fertility management – and more generally, improved land management and diversification – are essential. Although significant diversification to non-food crops and livestock is expected in the medium term, this system will still continue to be the food basket of the sub-region and to underpin urban food security.

To address farmers' problems related to declining soil fertility, one main strategic option is to improve land husbandry, by implementing such approaches as conservation farming (see Box 3). This lowers cultivation costs, saves time in land preparation, and makes the best use of rainfall and creates optimum growing conditions through timely planting and by maximising in situ moisture retention by maintaining "open" soil surface conditions and a deep rooting zone – possibly using biological means of breaking dense soil layers such as plough pans. At the same time, it raises soil fertility through: (i) judicious use of legumes for biological nitrogen fixation, especially for fallow enrichment and in rotation, or as intercrops with cereals; (ii) integration of livestock in the farming system, maximising use of manure, e.g. through stall feeding; (iii) composting any available plant material, and (iv) woodlot planting to reduce use of dung and crop residues for fuel. Application of purchased phosphate or lime may also have to be part of the fertility management strategy.

BOX 3: CONSERVATION AGRICULTURE

Conservation Agriculture (CA) is a farming approach, which has the main aim of making more efficient use of the soil, water and biological resources and natural processes through improved soil-water-plant nutrient management. The Better Land Husbandry approach is fully in line with, and encompasses, the principles of CA. It stems from the narrower technology set of "conservation tillage", which has been widened to incorporate other aspects of land management. CA contributes to environmental conservation as well as to enhanced and sustained agricultural productivity.

The key principles of CA are ensuring the recycling and restoration of soil nutrients and organic matter and optimal use of rainfall through retention and better use of biomass, moisture and nutrients. One key aspect is retaining, where possible, a permanent soil cover. This in consequence implies zero or minimum tillage and often entails the use of green manure crops. In extreme arid and semi-arid environments this may be reduced to maintaining below-ground root systems, as the above-ground biomass may be totally desiccated and lost. As a result of soil cover by vegetation and residues, soil erosion and water loss through runoff are eliminated or greatly reduced, crop production is more reliable and less vulnerable to climatic vagaries and higher yields can be obtained. CA requires systematic interplanting and cropping sequences. Not only does CA improve and especially stabilise yields in risky environments, it also reduces production costs, including permanent farm labour and farm power requirements, due to reduction or elimination of tillage and, once established, of weeding requirements.

CA is extensively practised in Brazil through its spontaneous adoption and adaptation to suit different farm contexts and farming systems. Problems of soil erosion – and, in drier areas, vulnerability to drought – have decreased significantly and farm output has increased leading to improved farmers' welfare and security. CA is also being developed in Africa, for example in Zambia and Zimbabwe, and limited on-farm research is taking place in Tanzania. The African Conservation Tillage (ACT) Network is contributing to CA development and expansion in different environments.

BOX 4: COMMUNITY BASED LAND TENURE REFORM

Problems related to land rights and tenure are common across sub-Saharan Africa. In addition to restricting access to credit and limiting existing disputes, developing effective tenure systems can have a profound impact on the ability of communities to enter into productive partnership arrangements with the private sector. A programme initiated in the mid-1990s in Mozambique has developed new policy and legal measures for smallholders. Under this participatory model, existing land rights are secured and new investment into rural areas is promoted. The 1997 Land Law defines the new concept of 'local community' through which land use rights are acquired by the vast majority of people according to customary 'norms and practices'. These rights are identical to those achieved by private investors seeking land through a formal request to the State (still the owner of all land under the present Constitution).

The use of farm systems analysis has been critical in developing a new legal framework that protects all resources and not just areas physically occupied and presently under cultivation. The new framework also offers protection for these farm systems as they adapt to new economic and social realities. By applying systems analysis further, and by stressing the open nature of rural social and farm systems, an 'open border' model has been adopted by Mozambique which allows investors to gain access to land inside the delimited borders of a community. This access is achieved through consultation with local people and agreements over land use, joint ventures, employment and other concrete resources that bring benefits to both the community and the investor.

Although the new policies and legislation are recently established, there are already clear indications that local communities are gaining a clearer understanding of both their land rights and the real value and potential of their resources. Farming systems are not only strengthened, but are permitted to diversify to provide rising incomes and new resources for local people. This relatively low-cost approach could provide a key input to investment support programmes throughout the African continent where similar land and farm systems problems are found.

To address pest problems without recourse to costly and environmentally damaging pesticides, the main option is to apply integrated pest management (IPM) systems, with a special emphasis on weed (especially *striga*) control – for which rotations and phosphate application are important ingredients – combined with use of disease-resistant varieties and improved crop storage (e.g. to control the large grain borer).

In areas with low population density and where there are no restrictive tenure practices in place, labour rather than land becomes the key constraint. This situation strengthens interest in such technologies as zero tillage (with draft animal power) and conservation farming (to allow dry-season/land preparation when labour demand is slack). There is also scope for integration of soybean into the rotation, and for promoting farmer-based multiplication of seeds and planting materials.

Ultimately, sustainable land management and soil nutrient capitalisation depends upon secure and equitable access to resources, and especially land and water. Various models to promote secure access to land by poor farmers have been promoted in the region, often with disappointing results. Among the novel tenure models being tested, one community-based model that is dependent upon customary tenure and community control is thought to hold promise (see Box 4).

For areas of high density, the emphasis shifts towards maximising returns to land, particularly through converting amply available labour into increased output. In such areas, it is important to increase the amount of land available for cultivation each year (e.g. through fallow enrichment using *Tephrosia, Tiphonia, etc*. It is also important, to the extent that markets allow, to encourage a shift out of maize and other low-value crops towards high-value crops such as beans, sunflower, tobacco, vegetables, perennials and flowers. Diversification could also involve development of low-lying areas for irrigated or rainfed vegetable production, introduction of improved sunflower varieties and manual oilseed presses, promotion of intensive dairying and small-scale pig and poultry production, as well as aquaculture for urban markets. The use of mineral fertiliser should be considered only where financially beneficial.

Low maize prices can also be addressed by the promotion of off-farm activities with strong linkages to agriculture. Farmers' problems of inadequate access to input supply, credit and marketing services can be minimised by promoting group activities such as bulk buying, rotational savings or joint marketing, as well as through promotion of sustainable rural micro-finance

BOX 5: COMMUNITY-BASED SEED SUPPLY SYSTEMS

The seed sector in Zambia faces problems common to other countries in SSA. Firstly, the Ministry of Agriculture Food and Fisheries (MAFF), which develops the majority of new crop varieties, does not have adequate resources to meet the costs of bulking and distributing seeds of such varieties. Secondly, the private sector is not keen to invest in the types of crops preferred by smallholders, as most retain seed from season to season.

The main agricultural activity of CARE's Livingstone Food Security Project has been the introduction of drought tolerant varieties of a number of crops – including varieties of maize, sorghum and cowpea – through a community-based seed bulking and distribution scheme. Related crops and soils agronomy information, seed handling and post harvest storage topics have been included in the extension messages shared with farmers. In the pilot phase 330 farmers participated, virtually on an individual basis. For the 1995/96 season, a group approach was introduced and over 6,800 farmers participated. A further expansion of the scheme in 1996/97 increased the number of participating farmers to 9,600, and over 12,000 by 1997/98 season. The project has therefore allowed access to good quality seed of new, early maturing varieties to a fairly large number of farmers in a relatively short time.

The scheme's rapid expansion has been aided by two factors: (i) the high priority farmers place upon drought tolerant crop varieties, and (ii) the strategy of bulking and distributing seed through community-based organisations. The effectiveness of the community-based approach is the subject of the related case study.

institutions capable of meeting farmers' seasonal credit needs. Problems of access to good quality open-pollinated seeds can be addressed by promoting farmer-based seed multiplication (see Box 5).

The availability of information to small farmers will be a critical factor in diversification. The adoption of conservation farming and IPM will require educational rather than prescriptive approaches to extension. Each farmer must be given the means to judge which avenues for livelihood improvement best match his or her resource endowment. Thus, investment in farmer training, based on revitalised farmer training institutes complementing village and field level education, will be invaluable.

5 Cereal-Root Crop Farming System

SYSTEM DESCRIPTION

Although this system shares some characteristics with the Maize Mixed System (such as 120-180 growing days with mono-modal rainfall), it has characteristics that set it apart: namely, relatively low population density, abundant arable land, poor communications, lower altitude, higher temperatures, presence of a tsetse challenge limiting livestock numbers and consequent absence of animal traction in much of the area. Although cereals such as maize, sorghum and millet are important in the system, in the absence of animal traction, root crops such as yams and cassava are more important than cereals. A wider range of crops is grown and marketed and intercropping is far more significant (see Box 6 for a description of a typical farm household).

SYSTEM-SPECIFIC TRENDS AND ISSUES

The Guinea savannah represents one of the main under-utilised resources in the region. Arable land is abundant and tends to be relatively under-utilised due to a combination of low population density, poor communications and labour shortages in the absence of animal traction. Although land is sufficiently abundant to permit crop rotation, there are already signs of fertility decline and increase in acidity in some soils; sometimes associated with prolonged use of inorganic fertilisers without attention to maintaining organic matter levels. As the application of mineral fertiliser to cereals has declined, due to deteriorating input/output price ratios, farmers are experiencing increasing difficulty in maintaining soil fertility, while weeds such as *striga* have become more difficult to control. In the northern part of the area, prolonged use of mechanisation for land preparation has resulted in loss of soil structure and organic matter.

Total population	95 million
Agricultural population	60 million
Total land	246 million ha
Agro-ecological zone	Dry sub-humid
Arable land in use	32 million ha
Irrigated area	0.4 million ha
Cattle population	36 million

In the 1980s and early 1990s, smallholder maize and cotton expanded rapidly at the expense of sorghum and root crops – especially in the more northern, drier part of the Guinea savannah – as a result of the diffusion of improved early-maturing maize varieties. This expansion was facilitated by government policies aimed at promotion of national food self-sufficiency, with the support of fertiliser subsidies, seasonal production credit and parastatal marketing support. In the long run, these policies were unsustainable, because their cost to governments was high and their impact on production was disappointing.

As trade and price liberalisation led to further deterioration of fertiliser/maize price ratios and to lower profitability of maize production, smallholder maize lost much of its attraction as a cash crop. On the other hand, currency devaluation also reduced urban demand for imported cereals and increased demand for traditional foods such as yams and cassava. This factor led to reversal of the earlier cropping pattern changes, with an expansion of the area under root crops at the expense of maize. However, since root crop production was highly elastic, as supply increased then producer prices levelled off. Hence

BOX 6: A TYPICAL HOUSEHOLD IN THE CEREAL ROOT-CROP SYSTEM

A typical Cereal Root-Crop household would farm 1.5 ha. by hand cultivation and would grow maize, sorghum, cassava, yams, cotton, and minor crops such as groundnuts, pigeon pea, cowpea, beans, sweet potato and squash, in an extensive system, but with use of organic manure (animal night corrals are periodically moved to selectively manure fields). Usually the animals that provide the manure are owned by Fulani herders who pass through the area on their annual migrations to graze on crop stubble. The household would usually not own cattle but would keep a few chickens and goats. In cotton growing areas, minimal doses of purchased fertiliser and pesticides would be used, in spite of their high cost, because crops would fail without it. But little or no mineral fertiliser would be used on maize or other food crops. Some hired labour might be used on cotton but none on food crops. The household would be food self-sufficient and have a surplus for sale – some of which would rot due to perishability and poor market access. The main sources of cash would be cotton, yams, cassava and vegetables.

A typical poor household would farm 2 ha by hand with household labour. It would grow no cotton due to lack of money for inputs and would meet its food deficit itself during the rainy (hungry) season by working for meals in other farmers' fields. During the dry season the husband would migrate to the forest zone to do casual labour for industrial tree crop farmers.

the impact of devaluation on the incomes of food crop growers has been rather modest.

Smallholder cotton also lost some of its attraction with the dismantling of parastatal programmes that supplied small farmers with seeds, fertiliser and chemicals at the beginning of the season and deducted their cost from the marketed product. Although private ginneries took over processing, most were reluctant to advance inputs to small farmers on credit and then try to recover the cost at the end of the season. In the absence of credit, and with sharply rising fertiliser prices and stagnant or falling cotton prices, farmers found it risky to buy fertiliser and agro-chemicals. Hence, productivity declined as a consequence of reduced fertiliser application, plus pest and disease flare-ups.

The success of the Onchocerciasis Control Programme (OCP) has opened up large areas of arable land to farmers. The coming three decades may well witness the development of infrastructure, access to markets and consequent intensification and diversification. Livestock populations are likely to expand, especially in the southern fringes of the farming system as tsetse pressure is reduced. Whilst land has been plentiful up to the present time, local population growth and in-migration will increase future pressure on land resources. In the absence of corrective measures, soil fertility problems can be expected – as in other more densely settled farming systems.

SYSTEM PRIORITIES

This farming system – because of its low population density and the abundance of arable land that could be brought under cultivation – is considered to be one with the highest growth potential. It has ample opportunity for growth through expansion of the cropped area as well as through higher yields per hectare (see Box 7). The opportunities involve three types of concerted action: (i) conservation farming; (ii) integrated pest management, and (iii) crop-livestock integration. In the long run, there could be scope for extension of the cropped area per household in connection with tsetse eradication, mechanisation (either through animal traction or small tractors), as well as through agricultural industrialisation. These possibilities are discussed in more detail in the case study on the moist savannah.

Conservation agriculture involves the introduction of reduced tillage, and improved land husbandry[16], including the use of cover crops and mulching, as well as better soil management to address the soil fertility problem. In some cases, this could involve the integration of soybeans in rotation with maize for nitrogen fixation and soil fertility management. Adoption of conservation agriculture also entails – as a condition for its success – confinement and stallfeeding of animals, integration of fodder crops to permit stallfeeding and fuelwood planting to release organic matter for composting. Integrated pest and plant management mainly involves biological control of plant pests and weeds (especially striga). Crop-livestock inte-

[16] Land husbandry can be defined as "the care and management of the land for productive purposes; only through sound land husbandry can the land's productive potential be sustained and enhanced"- see Box 12.

gration is based upon increased cultivation of fodder crops, with cut and carry feed systems, to increase supply of organic manure. In the long run, such integration might involve pushing the frontier of animal traction southward into the tsetse-prone zone using new technologies based upon FAO's successful experience with tsetse eradication under the SIT programme. Introduction of animal traction could facilitate the replication of successful models for the expansion cotton production that were promoted by the former cotton parastatals such as CIDT.

Farmers have responded to declining maize prices by diversifying crop production – increasing production of traditional root crops, pulses and vegetables for urban markets. However, when the quantity of food supplied to urban markets expanded, prices levelled off and income increases were limited. Some options for addressing the problem of low farmer incomes include: (i) improved small-scale, rural-based cassava processing to allow smallholders to capture more of the value-added; (ii) upgrading of product packaging to increase their appeal to urban consumers, and (iii) production and use of cassava chips and other animal feeds to meet the growing urban demand for meat, milk and eggs.

To address the problem of breakdown of input supply and marketing services for cotton, the best options will be to organise small farmers to take over their own input supply and marketing, and to introduce IPM methods for improved pest control.

BOX 7: EXPLOITING THE PRODUCTIVE POTENTIAL OF THE WEST AFRICAN GUINEA SAVANNAH

The Northern and Southern Guinea savannahs extend in a broad band through most West African countries, and similar agro-ecologies exist in southern and eastern Africa. The growing period ranges from about 150 days near the border with the Sahel to about 210 days in the southern part. Average annual rainfall in the area varies from 800 mm in the north to 1200 mm in the south. The Guinea savannah still has land that is very extensively used, particularly at a distance from roads. The more easily accessible land is largely used for annual crops – generally with low external inputs – and produces low yields. Crops include maize and sorghum, millets in the northern part, cotton, cassava, soybean and cowpea, yam near the southern border, and wetland rice in parts of the river plains and valley areas. Infrastructure is generally poorly developed and maintained.

Historically, development in this area has suffered from two major constraints: Onchocerciasis and trypanosomosis. Control efforts related to the Onchocerciasis Control Programme (OCP) have freed up an estimated 25million ha of arable land for agricultural development. However, tsetse-transmitted African animal trypanosomosis (AAT) is still a major constraint to agricultural development.

The opportunities and development interventions, identified and analysed in the case study, which could have a significant potential impact in the Guinea savannah zone are: (i) the spread of conservation agriculture; (ii) the intensification of the mixed crop-livestock farming systems, including localised irrigation where available; (iii) improvement of services to the pastoral and agro-pastoral system; (iv) improving crop-livestock integration (draft animals, feed from cover crops and crop by-products, manure from intensive livestock production); (v) diversification through crop introduction and rotations, promoting local post-harvest value-adding enterprises, and (vi) improving infrastructure, services and institutions designed to serve the people and the enterprises in the zone.

Farm households can achieve significant improvements in farm productivity, and their economic and nutritional status, through modifying their soil, crop and livestock management. The availability of farm power, particularly during planting operations, would become critical to any attempt to intensify cropping. The utilisation of draft animal power is also a key factor in the integration of livestock and crop agriculture. Major additional gains should be available from the implementation of simple, affordable systems for drip irrigation. The recent development of high-yielding, precocious oil palm clones adapted to certain environments outside their traditional range, has provided an opportunity for their introduction in parts of the Guinea savannah zone – specifically in valleys and river plains with moderately shallow groundwater. The development of tropical soybean varieties has now made the commercial production of soybeans possible in areas such as the moist savannah zone. In addition, West Africa possesses a distinct advantage over traditional Asian source as suppliers of cassava chips to European feed markets. Thus, there is a great potential for the intensification of this farming system, the realisation of which could be accelerated by investment in strengthening infrastructure and services.

6 Agro-Pastoral Millet/Sorghum Farming System

SYSTEM DESCRIPTION

As mentioned in the first section of this document, crops and livestock are of comparable importance in this farming system. Rainfed sorghum and pearl millet are the main sources of food and are rarely sold, whereas sesame and pulses are sometimes sold. Land preparation is by oxen, or by hoe along river banks. Camels are sometimes used in the drier parts. Ethnic groups are often former livestock-keeping peoples who have become sedentary. Livestock are kept for subsistence (milk and milk products), offspring, transportation (camels, donkeys), land preparation (oxen, camels), sale or exchange, savings, bridewealth and insurance against crop failure. Rather than carts, pack animals or animal-drawn sledges are used to transport crops. Crop-livestock interaction is limited; animals are used for ploughing, crop residues are grazed in the fields after harvest (and sometimes cut), but fodder crops are not grown and *kraal* manure is rarely applied to fields. The population lives in villages the whole year round, although part of the herd may continue to migrate seasonally with herd boys. A typical Agro-Pastoral Farm System household is outlined in Box 8.

Food insecurity is basically caused by drought and aggravated by lack of assets. Upper stratum households are food secure even in most bad years, because they have enough livestock to acquire the grain they lack. Households in the lower stratum are chronically food insecure – in both good and bad years – because they cannot grow enough grain to feed themselves and they have no livestock to exchange for grain. The middle stratum is grain self-sufficient in good years and in deficit during bad years. They are food secure in average years because they have some animals to exchange for grain, but in bad years they are highly vulnerable. Coping mechanisms include: (i) growing early-maturing, drought-resistant millet and sorghum varieties; (ii) storing grain from one year to the next; (iii) selling or exchanging small ruminants to buy grain in the hungry season, and (iv) in years when crops fail and where off-farm opportunities are available (e.g. Kenya), using off-farm income to buy grain instead of selling animals. The poorest, who no longer have any animals to sell, cope by reducing meals, collecting and eating wild foods, cutting and selling firewood and working for others in exchange for meals.

Total population	54 million
Agricultural population	33 million
Total land	198 million ha
Agro-ecological zone	Dry sub-humid
Arable land in use	22 million ha
Irrigated area	0.6 million ha
Cattle population	25 million

The main cause of poverty is successive droughts. These result in crop failure, food shortages, sharp increases in grain prices, collapse of livestock prices and weak animals whose condition leads to deaths and decapitalisation of herds through distress sales. Destitution occurs when households have eaten all their seed and lost all their breeding animals, so that they cannot plant or start reconstituting their herds after the drought ends. Apart from drought, problems include: (i) acute dry season water shortage for people and animals; (ii) shortage of seasonal grazing; (iii) physical isolation, lack of roads and market access; (iv) disadvantageous terms of trade for both crops and livestock, and (v) lack of health facilities and schools. Specific problems of this farming system include bird and locust damage to crops, very laborious grain dehulling, stock theft, encroachment of farming on riverine areas, and in Southern Africa, land shortage

BOX 8: A TYPICAL HOUSEHOLD IN THE AGRO-PASTORAL MILLET/SORGHUM SYSTEM

A typical household would have a farm of around 1.5 ha, with a level of food production of only 93 kg/capita. Most households experience food deficits even in years when crops do not fail. The average household would have 1.1 ha of millet or sorghum and 0.2 ha of pulses, with the rest planted to minor crops such as vegetables, sesame or cotton. Yields are low, averaging only 400 kg/ha for sorghum, 350 kg/ha for millet and 230 kg/ha for pulses. The household would own a few chickens, plus 2-3 cattle or 5-10 sheep and goats. Millet and sorghum would be grown almost exclusively for subsistence (including beer brewing). The main cash sources would be livestock, cotton and seasonal migration to the forest zone.

Socio-economic differentiation is based on livestock ownership. About 40 percent of households have no large animals (apart from a donkey) and 60 percent are not self-sufficient in draught power (especially in Botswana where a span of 8 oxen is needed for land preparation). In a typical poor household, domestic food production would only last for 2-6 months, depending on the rains. Casual labour on other farms, beer and firewood sales would account for 40-50 percent of household income, especially in years when crops fail due to drought.

and overcrowding due to the legacy of colonial dualism.

SYSTEM-SPECIFIC TRENDS AND ISSUES

The farming system has suffered from a general reduction in rainfall during the past two decades. Insufficient and erratic rainfall has led to low crop yields and the abandonment of groundnuts and late-maturing sorghum. There is an acute shortage of drinking water and firewood in certain areas. Soil fertility problems are emerging in the plains due to shortened fallow intervals and long periods of continuous cultivation. Land shortage is also a problem in the densely populated areas where soils are more fertile.

Crop-related constraints include drought, declining soil fertility, weed infestation – mainly by striga – in cereals and cowpeas, pests and diseases in cowpeas and groundnuts, and the high cost and general lack of credit for cotton inputs. Past research recommendations were often inappropriate to poor smallholders because they focused on yield maximisation rather than yield stabilisation and risk reduction.

Livestock-related constraints include shortage of dry-season grazing and the weak condition of draught animals at the time of greatest physical effort. Crop failure is exacerbated by the seasonal price "scissors effect" between grain and livestock. In the hungry season it takes three times as many animals to buy a bag of grain than in the harvest season; while grain prices soar and livestock prices collapse when crops fail.

This farming system has not been much affected by the withdrawal of the public sector from seed and fertiliser supply and crop marketing, because it did not benefit much from these services. Public extension services were unresponsive to the needs of resource poor farmers and often promoted packages that were too costly and risky for crop growing under semi-arid conditions. Good quality seeds of early-maturing, drought-tolerant varieties remain in short supply.

Pressure on resources is expected to intensify in coming decades with the growth of human and livestock populations in the system. In some cases, this may lead to spontaneous sustainable resource management and intensification such as in Machakos – albeit a slightly more favourable agro-ecology – but such successes are likely to be the exception rather than the rule. Soil fertility of the better, cropped land can be expected to decline in the absence of dramatic technological breakthroughs related to fertility. In the absence of sound grazing management by communities, grazing resources in many areas will also deteriorate. Under these circumstances, both chronic and transient poverty can be expected to increase.

SYSTEM PRIORITIES

In the difficult environment of the Agro-Pastoral Millet/Sorghum System, the strategic goal should be the complex consisting of: reduction of chronic poverty, improvement of household food security, and management of livelihood security. A key strategy will be to reduce the likelihood of crop failure in drought years through improved land husbandry, water harvesting (see Box 9) plus multiplication of palatable, drought-resistant, early-maturing millet and sorghum varieties. This strategy should be complemented by control of bird damage and the attacks of desert locusts. To address problems of declining soil fertility, improved methods of maintaining fertility should be identified and applied on soils of different types. The

savannah vegetation should be regenerated for strategic forage reserves and sustainable fuelwood supplies.

Specific interventions to address food and income insecurity include: (i) maximisation of soil moisture retention and utilisation through land husbandry techniques; (ii) promotion of the diffusion of run-off water harvesting structures such as *demi-lunes* (half-moon-shaped bunds) and stone contour bunds based on successful experiences in Mali, Niger and Burkina Faso (see Box 9); (iii) facilitation of farmer-based multiplication of early-maturing, drought-tolerant sorghum and millet varieties with desirable local characteristics including acceptable taste and tolerance to *striga* and bird damage; (iv) development of integrated control methods for *striga* and important field and storage pests and diseases; (v) improvement of grain storage systems, and (vi) forest regeneration for sustainable fuelwood supplies. In the livestock subsector, animal productivity will be increased through better utilisation of crop residues and by-products, promoting the use of locally adapted breeds, control of epizootic diseases and improving village poultry production.

Interventions to increase income from livestock should include: (i) the organisation and implementation of disease monitoring; (ii) approved certification schemes for the export of live animals and animal products; (iii) greater integration with crop farming for fodder supplies and sale of feeder cattle in more favoured areas – such as the Cereal Root-Crop and the Maize Mixed systems, and (iv) support to small-scale private livestock trading.

Problems connected with input supply and marketing channels for cotton can be reduced by assisting smallholder producer groups to take over these functions. Shortage of credit for cotton inputs, lack of animal traction, and hungry season food deficits can be minimised by organising networks of self-sustaining, savings-based micro-finance institutions. Loss of animals can be addressed by improving access to animal health services through community-based animal health workers. Grazing pressure can be lowered by: (i) developing sound land use and water policies for the rangelands, (ii) negotiating recognition of pastoralists' customary rights to dry-season grazing areas – including those to adjacent zones that are more humid, and (iii) promoting mechanisms for community-based conflict resolution to deal with problems between pastoralists and sedentary farmers over access to land and water.

BOX 9: IMPROVING LOCAL SOIL AND WATER CONSERVATION PRACTICES IN SEMI-ARID AREAS

In common with many semi-arid areas, Niger has suffered land degradation as a result of population pressure and drought. An IFAD-funded project tested a number of locally-based technologies to bring land back into production, reduce inter-annual variability of output and enhance the resilience of agricultural systems to climatic risk. One key success was the development of a modified form of the tassas system. This continued to expand spontaneously to new plots after the project had closed.

The tassa technique consists of digging holes some 20 to 30 cm in diameter and 15 to 20 cm deep and covering the hole bottoms with manure. This helps to promote termite activity during the dry season, thus improving water infiltration further. Farmers then plant millet or sorghum in them. Tassas have allowed the region to attain average millet yields of over 480kg/ha, in comparison with only 130 kg/ha without tassas. As a result, tassas have become an integral part of the local technology base. The technique is spreading at a surprising rate.

Three main factors contributed to success: (i) an action-research approach that combines flexibility, openness to farmer initiatives, a forward-looking attitude and willingness to negotiate; (ii) a technology that yields quick and tangible benefits, yet is simple, easily replicable and fits well with existing farming systems, and (iii) a technology that can adjust to the changing local context. The tassa technique is based on a local practice that, although not high-performing, is effective.

The tassa technique appeals to farmers because it yields quick and appreciable results, restoring productivity of land that was previously unfit for cultivation while mitigating agroclimatic risks and increasing food availability in participating households by 20-40 percent. It is easily replicable because it entails only minor adjustments to local hand tools and does not involve any additional work during the critical sowing and weeding periods. Because they can be constructed by individual farmers without external assistance, tassas are particularly interesting to youths, since tassas make it possible to cultivate plateau lands, which have become a valuable resource in the face of growing pressure on land. In some areas, a new land market has sprung up, in which enterprising farmers reclaim land for resale.

7 Irrigated Farming System

SYSTEM DESCRIPTION

The broad Irrigated System includes large-scale, managed, and mechanised schemes such as the Gezira scheme; the larger farmer-managed schemes, traditional riverine and flood- recession based systems that are found in small pockets along major rivers. The dugwell-based irrigation in West African *fadamas* (wetlands) and Sahelian oases could not be mapped and are not included in the category of Irrigated Farming Systems. Small-scale irrigation schemes and water harvesting are treated similarly, although they are considered as an important productivity enhancing element of other farming systems. It is of course essential to distinguish between small schemes assisted by governments and traditional irrigation-based systems. AT2030 projections indicate that, in the next 30 years, production from irrigated land in the region could increase by 100-200 percent. Most expansion would come from yield increases on existing irrigated land but, in addition, a 58 percent increase in irrigated land would be needed to meet the region's growing food requirements.

SYSTEM-SPECIFIC TRENDS AND ISSUES

In Sub-Saharan Africa, public sector irrigation schemes have generally been expensive and disappointing. Not only have production increases been lower than anticipated, but also systems have often been unsustainable, due to low output prices and high operation and maintenance costs. Examples include the Gezira scheme in the Sudan (see Box 10), the Office du Niger in Mali, the Lower Tana River scheme in Kenya, the Awash Valley scheme in Ethiopia and the Jahaly/Pacharr scheme in the Gambia. Increasingly, economic liberalisation has led governments to attempt to restructure parastatal schemes on a commercial basis, or to hand over management to farmers in an effort to lower operation and maintenance (OandM) costs. This strategy has met with success only in the case of the Office du Niger. In the Jahaly/Pacharr scheme, farmer management was tried, but proved to be beyond local management capacity. The remaining options are to redesign it as a series of smaller, more manageable schemes, or to find a private company willing to operate it on a commercial basis.

Small-scale, farmer-managed irrigation (SSFMI) has been more successful and holds the promise of being sustained by farmers (see Box 11). However, although the region has the lowest proportion of its cropped area under irrigation in the developing world, construction of new irrigation schemes is often more expensive than elsewhere and therefore difficult to justify. For new irrigation to be economically viable, farmers have to be able to grow and market high-value crops such as vegetables, and this is only feasible in proximity to markets. Hence, much of the effort in recent decades has concentrated on rehabilitation of existing schemes. In latter years, more attention has been given to ensuring sustainability through the organisation of farmer water users' groups for operation and maintenance. However, rehabilitation of existing schemes is often beyond farmers' economic means and even if farmers can meet recurrent operating costs, rehabilitation still depends heavily on donor financing.

Total population	14 million
Agricultural population	6.6 million
Total land	35 million ha
Agro-ecological zone	Various
Arable land in use	2.6 million ha
Irrigated area	1.9 million ha
Cattle population	3.4 million

BOX 10: CHALLENGES OF THE GEZIRA SCHEME IN SUDAN

The combined Gezira-Managil scheme, located between the Blue and the White Nile, constitutes one of the largest irrigation complexes in the world under single management (around 900 000 ha), with around 100 000 tenant farmers. Three main crops have been grown – sorghum, cotton and groundnuts – in varying proportions over time depending on national policy. Cultivation was totally organised by the relevant parastatal and the main responsibilities of the tenant farmers were to maintain bunds within their fields, control water into their fields, and manage all aspects of sorghum and groundnut production. As mechanical cotton harvesting never really worked, farmers were also responsible for organising manual picking, which involves hiring labour. Production has increasingly suffered from water shortages, inadequate inputs, declining farm machinery services, lack of information and technical guidance for farmers, insufficient financial resources and poor co-ordination.

During the period 1976-1989, in spite of heavy Government subsidies, yields were low and extremely variable, and cultivated area gradually declined. Cropping intensity dropped from 75 percent to 57 percent, as 126 000 ha were taken out of production due to siltation and mismanagement of the canals, leading to reduced availability of water. In 1992, scheme operation was profoundly affected by economic liberalisation, withdrawal of the public sector from direct financing of agriculture, elimination of subsidies on crop production inputs and devolution of support services to the private sector. The prices of inputs to farmers rose sharply, especially for imported chemicals, but without a corresponding increase in product prices. Consolidating the liberalisation policy, in 1994 the government transferred responsibility for management of small and medium-scale irrigation schemes to their farmers. It did not relinquish control over the four large irrigation schemes: Gezira, Rahad, New Halfa and El Suki, but nonetheless, each scheme was expected to be self-supporting and the parastatal Agricultural Corporations managing them were expected to operate on a commercial basis.

These policy changes have not succeeded, because farmers were ill-prepared, the corporations were not oriented to independent business operation, and the schemes were generally dilapidated and required significant rehabilitation of irrigation works. As a result, the cropping areas and general level of operations have been declining since 1992, and some of the smaller schemes have been abandoned. In the absence of detailed arrangements for transition, the potential benefits were not realised, serious deficits developed and the deterioration of operations has accelerated. This situation reached crisis point in 1999 and the Government was forced to intervene. It has now embarked on a three-year, crash rehabilitation programme (2000 – 2002) intended to reverse the declining trends and restore production.

Shortage of water and lack of financial resources created uncertainties that have increasingly demoralised farmers, resulting in incomplete application of technologies and further decline in incomes. As a result, sound production practices are neglected and irrigation water is being wasted. In the absence of off-farm employment opportunities, some farmers are selling their crops in advance, or at low prices during harvest time, while others are selling livestock in order to reduce indebtedness. The growing incidence of poverty among farmers in the Rahad area has resulted in a potential poverty trap, whereby falling crop yields reduce farmers' capacity to invest in the subsequent crops, leading to further deterioration in farm incomes.

Experience with traditional farmer-constructed and farmer-managed systems has been quite positive. For instance, recent experience in Mali indicates that, when an enabling environment for smallholder development is in place, spontaneous development will occur through reinvestment of farmers' savings. It is reported that over 10 000 ha were developed spontaneously outside the Office du Niger on farmers' initiative – largely financed by the savings of migrant workers. Spontaneous growth of small-scale irrigation is also reported in Guinea-Bissau (in the *balanta* wetland rice system in the coastal plain) and in central Tanzania (e.g. Dodoma).

During coming decades, it is expected that most irrigation development will take the form of SSFMI or individual initiatives. The expansion of the latter depends critically on market-driven diversification of smallholder farming systems.

SYSTEM PRIORITIES

The Irrigated System is a high potential system, with ample scope for expansion in the region. Whilst the principal contribution of large-scale schemes is to national food security and agricultural growth, small

schemes confer the added benefit of livelihood security and poverty reduction.

Thus, an important strategic option is to reduce risks of drought-induced crop failure by promoting, where feasible and environmentally compatible, extension of the irrigated or water harvesting area through low-cost techniques that build on indigenous technical knowledge, such as flood recession and run of river.

The low profitability of existing schemes can be addressed by assisting farmers to diversify into higher-value crops and to establish market linkages for inputs and outputs. The improvement of product grading and packaging is also needed, as is support for small-scale agro-processing of perishable products. It will also be important to identify niche markets – for instance those for biologically grown produce.

Small-scale, farmer-managed schemes and traditional irrigation should have priority because of their greater sustainability. Policies that give priority to small-scale farmer-built and managed schemes – especially for high-value horticulture crops – should be encouraged. Support to small-scale irrigation under community-driven development (CDD) funds will also be important. The promotion of farmer-based seed multiplication should also be accorded high priority in connection with diversification efforts. Further priority areas include:

- Promotion of self-sustaining, rural micro-finance systems to cater for farmers' demand for short-term credit for seasonal inputs, hired labour, small-scale processing and produce trading.
- Improving water use and productivity on existing schemes by building capacity of water user groups for greater participation in scheme operation, maintenance and rehabilitation.
- Strengthening the capacity of farmer associations to buy agricultural advice and market information.
- Supporting farmers' field schools in connection with IPM for pest control in vegetables.

For large, centrally-managed schemes, interventions should be supported by a clear policy for sustainable agricultural production, free of controls over production choices, that would:

- embody a transparent pricing system;
- inform the population of the benefits and obligations involved;
- modernise and decentralise agricultural support services;
- delegate responsibility for managing the scheme to water users' associations (WUAs); and
- restructure the parastatal corporation along competitive, commercial lines.

In the short term, the priority is to rehabilitate, re-equip and modernise irrigation and drainage systems and in the long term, if technically feasible, to sub-divide larger schemes into smaller units to make it easier for scheme farmers to take over their management.

BOX 11: IMPORTANCE OF CAPACITY BUILDING IN FARMER-MANAGED SCHEMES

The Thematic Evaluation of the IFAD Special Programme for Africa concluded that the main problem in farmer-managed irrigation in SSA is not in the technologies but on the social side. Units dealing with farmer participation and water-user associations (WUAs) were under-funded and this held back the pace of development. At the project design stage, insufficient resources were allocated to institutions responsible for support to WUA formation, mobilising community participation, training farmers in on-farm water management and involving them in scheme OandM and rehabilitation. Demand-led approaches based on farmers' initiative are better than top-down efforts to stimulate farmer participation in schemes designed by engineers, and may not need such heavy "social" support.

8 Strategic Priorities and Interventions for the Region

Given the high incidence of poverty in Sub-Saharan Africa, the overall strategic goal should consist of broad-based growth targeted at poorer communities and the poorer sections of each community. A strong case can be made for channelling resources to smallholder agriculture in the region, because rural poverty still accounts for 90 percent of total poverty and roughly 80 percent of the poor still depend on agriculture or farm labour for their livelihood.The foregoing analysis of the five key farming systems, selected for analysis of strategic options, covers an estimated 46 percent of the agricultural population of the region. Four of the five farming systems are judged to have high potential:

- Two in the short term: (i) Irrigated and (ii) Tree-Crop Systems;
- Two in the medium to long term: (iii) Cereal Root Crop Mixed and (iv) Maize Mixed Systems.

The Agro-Pastoral Millet/Sorghum System is considered to have only low potential, although still with modest scope for growth and poverty reduction.

Several issues and the strategic thrusts for addressing them, emerge from the analysis contained

Table 3: Key Issues and Strategic Thrusts

Issues	Strategic Thrusts
1. Land degradation and especially declining soil fertility	1. Sustainable land management, including crop-livestock integration
2. Access to productive resources by poor farmers	2. Market-based land reforms; expansion of small-scale irrigation
3. Deteriorating terms of trade, poor competitiveness	3. Improved technology and increased efficiency. Diversification. Upgrading product quality.
4. Vulnerability to drought	4. Drought-resistant crops and varieties and production practices that include improved land husbandry for soil and moisture retention, water harvesting, small-scale farmer managed irrigation, other risk spreading mechanisms
5. Weak support services	5. Development of effective commercial and CSO based services including Public-private-CSO partnerships for the technology development, to underpin sustainable resource management,
6. Poor incentives for development, adaptation and spread of sustainable technologies	pest and weed management, house hold food security and competitiveness

BOX 12: PRINCIPLES OF GOOD LAND MANAGEMENT

An integrated and synergistic resource management approach embracing locally-appropriate combinations of the following technical options:

- build-up of soil organic matter and related biological activity to optimum sustainable levels (for improved moisture, infiltration and storage, nutrient supply, and soil structure) through the use of compost, farmyard manure, green manures, surface mulch, enriched fallows, agroforestry, cover crops and crop residue management;
- integrated plant nutrition management with locally appropriate and cost effective combinations of organic/inorganic and on/off-farm sources of plant nutrients (e.g. organic manures, crop residues, rhizobial N-fixation, transfer of nutrients released by weathering in the deeper soil layers to the surface via tree roots and leaf litter, use of rock phosphate, lime and mineral fertiliser);
- better crop management using improved seeds of appropriate varieties, improved crop establishment at the beginning of the rains (to increase protective ground cover, thereby reducing water loss and soil erosion), effective weed control and integrated pest management;
- better rainwater management to increase infiltration and eliminate or reduce runoff so as to improve soil moisture conditions within the rooting zone, thereby lessening the risk of moisture stress during dry spells, while reducing erosion;
- improvement of soil rooting depth and permeability through breaking of cultivation- induced compacted soil layers (hoe/plough pan) through conservation tillage practices by means of tractor drawn subsoilers, ox drawn chisel ploughs, or hand hoe planting pits/ double dug beds, or interplanting of deep rooted perennial crops/trees and shrubs); and
- reclamation, where appropriate (i.e. if technically feasible and cost effective), of arable land that has been severely degraded by such processes as gullying, loss of topsoil from sheet erosion, soil compaction, acidification or salinisation.

People-centred learning approaches through which farmers are enabled to learn about, and investigate for themselves, the costs and benefits of alternative land husbandry practices.

Community based participatory approaches to planning and technology development that build on rural peoples inherent skills and capability to formulate and implement their own development plans, and to develop and disseminate their own improved land husbandry technologies.

Farmer incentive based business orientation through the promotion of field-level interventions that offer farmers tangible economic, social and environmental benefits.

in those sections of this document that focus on the five selected farming systems. These issues and strategies are summarised in Table 3 in overall terms, since most apply to two or more of the selected systems.

NATURAL RESOURCES AND CLIMATE

Soil Degradation and Watershed Management. The issue of land degradation and soil fertility cuts across all systems to a greater or lesser extent. However, a particularly acute crisis is currently being experienced in the: Maize Mixed System; Cereal-Root Crop System; and the Highland Temperate Mixed System.

One well-proven solution to the problem is good land management. This is best described as a set of principles rather than a package of technology(see Box 12). The implementation of these principles can take place in a number of forms including conservation tillage and conservation agriculture (see Box 3 above).

Declining soil fertility has also been associated with economic liberalisation and the removal of subsidies. As a result of these changes, fertiliser application on maize and wheat has sharply declined in the high potential farming systems in response to fertiliser prices having more than doubled while farmgate produce prices slumped. Major areas of farming systems – such as the Southern Highlands of Tanzania in the Maize Mixed System – that used to specialise in smallholder maize, are reverting to extensive cultivation of local varieties without fertiliser, technical levels are regressing and poverty is increasing. The essential long-term problem is the depletion of soil nutrients.

BOX 13: SOIL NUTRIENT RECAPITALISATION

Fertilisers are needed for recapitalising soil nutrients. Soil fertility has declined during the land degradation from which many farming systems suffer. Soils have deteriorated in terms of structure, organic matter and nutrient content, rainwater infiltration and moisture storage capacity.

Fertilisers have sometimes been considered as a substitute rather than a complement to other farm management practices, which are required for optimal responses to fertiliser. Experience has shown that the promotion of fertilisers alone for crop intensification has yielded disappointing results.

Even under good management conditions, the use of fertilisers may not be financially viable, especially for those farmers growing food crops – particularly maize and sorghum – or in remote areas where the fertiliser prices are excessively high due to transport and handling costs. Even if profitable, small farmers, especially resource-poor farmers, may not be able to afford fertilisers.

In the absence of nutrient recapitalisation, soil productivity is likely to degrade, even under good land husbandry practices, resulting in further poverty and increased food security problems. Thus, there is a need to explore avenues through which resource-poor farmers could access fertilisers and ensure their productivity and profitability by improving land and crop husbandry.

SCIENCE AND TECHNOLOGY

Diversification. Diversification from low value to higher value crops or livestock enterprises is a major strategic thrust for the Maize Mixed, the Cereal-Root Crop, the Highland Temperate and the Tree-Crop systems. In the Agro-Pastoral Millet/Sorghum and Pastoral systems, the main strategic thrust is diversification into lower risk crops and activities in order to reduce vulnerability to drought. Diversification provides a partial answer to farmers' problems related to: deteriorating input/output price ratios for maize and wheat; deteriorating terms of trade for traditional export crops; and vulnerability to crop failure in arid and semi-arid zones.

For households with too little land to support themselves from farming alone, the main focus should be diversification of income sources into a combination of crop, livestock and non-farm activities. Diversification is particularly important for sustainable poverty reduction because it increases poor households' resilience in the face of both weather-related and market shocks.

Reduction of Vulnerability to Drought. Existing technologies for reducing vulnerability to drought need to be popularised. Drought risk affects Pastoral and Agro-Pastoralist Millet/Sorghum systems and – to a lesser extent – the Maize Mixed and Highland Temperate Mixed systems. The main thrusts for addressing the problem on the crop side are:

- introduction of drought-tolerant, early-maturing crops and varieties;
- maximisation of soil moisture retention and utilisation through land husbandry;
- water harvesting;
- small-scale, farmer-managed irrigation wherever feasible.

Farmer-based multiplication can contribute to effective seed distribution at limited cost (see the Zambia case study).

Livestock Technologies. On the livestock side, major technologies concern:

- reduction of vulnerability by developing sound land use and water policies for the rangelands;
- implementing drought early warning, mitigation and rehabilitation practices;
- control of epizootic diseases;
- development of conservation agriculture appropriate for arid and semi-arid areas; and
- development of viable non-pastoral alternatives for those that can no longer be sustained by the resource base.

Pest and Weed Control Technologies. Affordable and environmentally-friendly pest and weed control technologies should be promoted. Pest and weed problems plague all farming systems to some extent. In the forest zone the main problem is crop damage by wild animals. In the Sahel, locusts are a problem. In the Cereal-Root Crop and Agro-Pastoral Millet/Sorghum systems, weed infestation by striga is a serious concern. However, the need to find an alter-

native to costly use of pesticides is particularly felt by cotton growers and irrigated vegetable growers. The strategy will involve promotion and training in pro-active, farmer-based pest and weed control management, based upon IPM.

It is necessary to develop productive partnerships between public, private sector and civil society organisation to invest in technology development. However, the private sector lacks the incentive for research in important areas such as long term resource management. This may call for the introduction of innovative funding mechanisms.

GLOBALISATION AND MARKET DEVELOPMENT

Trade Liberalisation. Globalisation will be a double-edged sword for many farming systems. The expansion of export markets is crucial for the future of the Tree-Crop System and for the long term development prospects of the other high potential farming systems. However, through globalisation, some preferential access to markets will probably be lost during the coming decades; and some domestic production may be displaced by competitive imports. In these cases, governments may need proactively to establish safety nets or other poverty reduction mechanisms.

Market Development. Nevertheless, in general terms, not only should non-traditional exports be promoted, but there is a need for product upgrading. This strategy responds to farmers' felt need to cope with declining profitability of traditional export crops that is affecting Tree Crop systems, as well as savannah and semi-arid cotton growers and highland arabica coffee producers. Partial solutions include:

- diversification into non-traditional export crops;
- upgrading of existing export products to obtain the highest possible price (rehabilitation, improved processing); and
- a search for niche markets such as for biologically produced items.

For pastoralists, agro-pastoralists and highland livestock keepers, the main thrust will be to devise and implement disease monitoring and approved certification schemes for the export of live animals and animal products.

POLICIES, INSTITUTIONS AND PUBLIC GOODS

Land Policies. In connection with securing equitable access to land, there are two main issues: (i) how to enable rural communities in areas with low population density to protect their customary land rights without precluding growth, and (ii) how to achieve more equitable access to land in dualistic countries in Southern Africa. The farming systems affected by the former issue are mainly the Forest-Based System, the Coastal Artisanal Fishing System, and the Pastoralist and Agro-Pastoralist Millet/Sorghum systems. On the other hand, the latter issue primarily affects the Maize Mixed System and adjacent commercial farming systems. The strategic thrust for the former might be community-based land tenure reform, as illustrated in the Mozambique case study. Other possibilities include promulgation of pastoral codes in arid and semi-arid Sahelian countries and of a code of conduct for artisanal fisheries in West Africa, gestion de terroir approaches, or conflict resolution in connection with community-based natural resources management.

Long-term Investments in Public Goods. The opportunities and possible strategic thrusts for each farming system are highly context and site-specific. In all cases, top-down strategic thinking can only be a starting point. If development is to be sustainable, it must be driven from below, through farmer and community-based initiatives. However, it is also important to ensure a proper balance between short-term issues that interest smallholders and long-term investment in public goods of interest to governments, or to humanity as a whole. Examples of the latter include:

- conservation of the resource base for future generations;
- good land husbandry;
- sustainable natural resource management;
- soil and water conservation;
- environmental protection;
- maintenance of biodiversity;
- tsetse eradication; and
- carbon sequestration.

INFORMATION AND HUMAN CAPITAL

Information Services. The popular conception of the coming information age applies as fully to smallholder agriculture as it does to other industries. By 2030,

knowledge-intensive farming will be the norm in all high potential farming systems in the region, just as such systems are prevalent in OECD countries today. For example, the adoption of conservation farming and IPM will require an educational rather than a prescriptive approach to extension – each farmer must be given the means to judge which avenues for livelihood improvement best match his or her resource endowment. This implies not only wide availability of high quality technical and market information, but also requires massive investment in farmer training. Such training could be located in revitalised farmer training institutes, complemented by village and field level education.

OVERALL REGIONAL CONSIDERATIONS

The strategic entry points listed above are only a small part of the picture. Broad-based, inclusive growth ultimately depends on rural people and the policy and institutional environments within which they operate. Issues that will need to be tackled in parallel with the above technical issues, as a pre-requisite for growth, include:

- declining terms of trade; high rural transaction costs;
- inability of the public sector to ensure minimum levels of rural public goods;
- disappointing performance of past investments in agricultural research and extension;
- urban bias; over-taxation of agriculture; poor governance; low level of human capital;
- high population growth rates;
- HIV/AIDS; and
- gender inequality.

Most of the opportunities identified for the various farming systems cannot be pursued in isolation from a solution to these larger problems.

CHANGING SCENARIOS

The strategic thrusts outlined above are based on the assumption that present trends continue. Three variant assumptions are briefly discussed below.

Faster Global Warming. If global warming were to accelerate, the most affected farming systems would be those in the arid, semi-arid and dry sub-humid AEZs. Repeated and prolonged droughts are likely to cause: (i) crop failure; (ii) high and rising cereal prices; (iii) low and falling livestock prices; (iv) distress sale of animals; (v) decapitalisation, impoverishment, hunger, and eventually (vi) famine. Households would try to cope with their cash and food shortage by cutting and selling firewood, thereby exacerbating land degradation and the onset of desertification. People from the affected zones would likely move to more favoured areas. Conflicts between sedentary farmers and pastoralists would increase as a result. Migration of dryland savannah farmers to the industrial crop areas would also increase, creating further social tensions in those areas. Migration to urban slums would also increase. The Forest Based System, on the other hand, might benefit from reduction of excess moisture, but it would likely face a population influx from neighbouring areas. The new settlers would cut and clear the forest to plant their crops – which might reduce beneficial effects of carbon sequestration by the tropical forests. With increased population pressure, fallow periods would decline making it progressively more difficult for farmers to maintain soil fertility and to control noxious weeds. Yields would fall. Wildlife would be driven out and biodiversity would suffer.

Faster trade liberalisation. Since the region is one of the world's most open regions in the sense that international trade is large relative to GDP, the effect of more rapid liberalisation might be less than in other regions. Since the world market share for most of its traditional exports is already declining, as a result of stiff competition from the rest of the developing world, faster liberalisation would accelerate the decline. It is unlikely that the region can produce as cheaply as some Asian countries because of higher labour and transaction costs. Even high-quality products for speciality markets (e.g. biologically grown *Arabica* coffee and cocoa) are likely to be affected, as competitors will tend to pursue the same market niches. The Tree-Crop System would be the most affected by these changes. On the other hand, market niches for African ethnic foods could increase among immigrant communities in developed countries as a result of greater migratory flows from the region to developed countries, and widen further as others become familiar with these foods. These opportunities would apply mainly to the Cereal Root-Crop and Root Crop systems.

Ex-European colonies in the region could lose their preferential access to EU markets and would face

stiff competition from other developing regions. Access to developed country markets would continue to be limited by various types of health, veterinary and plant-sanitary regulations. The recent changes in EU regulations regarding chocolate are likely to reduce cocoa imports from the region.

Faster AIDS Pandemic. If official HIV prevalence rates in the region should prove to be grossly under-estimated, and governments continue to downplay the situation, East and Southern Africa could experience an even sharper contraction of the labour force in the prime working age group and a corresponding rise in dependency ratios, as well as the number of AIDS orphans requiring assistance. Already, traditional social safety nets are unable to cope with the existing orphans. The likely cost to the economy – in loss of productive labour, medical costs and orphan support – is likely to be overwhelming.

Up to the present time, the farming systems most affected have been the Highland Perennial and the Maize Mixed systems, but the commercial farming sector has also lost much of its skilled supervisory labour force. Because labour requirements for cassava are more evenly spread throughout the year than they are for cereals, farmers try to cope by expanding the area under cassava and reducing the area under cereals. In the Highland Perennial System, neglect of coffee and bananas is partly due to AIDS-related labour shortages. Moreover, HIV/AIDS is adversely affecting MOA staff and private agricultural service providers. Staff turnover is so high that much of the investment in human capacity building among staff of agricultural projects (e.g. overseas MSc's etc.) may have been wasted.

However, currently the most crucial issue in the short term is to halt the spread of HIV/AIDS through appropriate information campaigns and a cheap supply of condoms. There is also a need for safety nets to reinforce the efforts of rural communities to support AIDS orphans and for land tenure reform to prevent widows from losing access to, and control over, land and household property when their husbands die.

Annex: Maps