Farming Systems and Poverty

IMPROVING FARMERS' LIVELIHOODS IN A CHANGING WORLD

Food and Agriculture Organization of the United Nations

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PREFACE

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Small farmers produce much of the developing world's food. Yet they are generally much poorer than the rest of the population in these countries, and are less food secure than even the urban poor. Furthermore, although the majority of the world's population will live in urban areas by 2030, farming populations will not be much smaller than they are today. For the foreseeable future, therefore, dealing with poverty and hunger in much of the world means confronting the problems that small farmers and their families face in their daily struggle for survival.

Investment priorities and policies must take into account the immense diversity of opportunities and problems facing small farmers. The resources on which they draw, their choice of activities, indeed the entire structure of their lives, are linked inseparably to the biological, physical, economic and cultural environment in which they find themselves and over which they only have limited control. While every farmer is unique, those who share similar conditions also often share common problems and priorities that transcend administrative or political borders.

These broad patterns of similar production systems, practices and external conditions are used in this book as a basis for defining more than 70 major farming systems throughout the six developing regions of the world. While recognizing the heterogeneity that inevitably exists within such broad systems, it is a central tenet of this book that the farming systems approach, as used here, offers a useful framework for understanding the needs of those living within a system, the likely challenges and opportunities that they will face over the next thirty years, and the relative importance of different strategies for escaping from poverty and hunger.

To offer a basis for comparative analysis, this book looks in detail at some 20 farming systems that are judged to have the greatest potential for poverty and hunger reduction and economic growth in the next few decades. They are considered in the light of five possible broad household strategies for escape

from poverty and hunger: (a) intensification of production; (b) diversification of agricultural activities for increased output value; (c) increased farm size; (d) expansion in off-farm income; and (e) complete exit or departure from the farming system. The book asks the crucial question: What are likely to be the most successful strategies for small farmers in each system, and what sort of initiatives can best help farmers to realize them?

The material for this book is derived from a study originally undertaken at the request of the World Bank in order to provide a specifically agricultural perspective to the revision of the Bank's Rural Development Strategy. It has drawn on many years of specialised work within FAO and the World Bank, as well as in a number of other national and international institutions. Findings were supported by more than 20 case studies from around the world which analysed innovative approaches to small farm or pastoral development. This book is intended for a wider audience than the original study, and it is hoped that policy makers, researchers, NGOs and the agribusiness sector will all find its conclusions and recommendations interesting and thought provoking; and that they will carry the analysis further by applying the approach at national level to assist in the formulation of rural development strategies.

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INTRODUCTION

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THE CONTEXT

The vision that underlies this book is one of a world without hunger and poverty. Most poor people live in rural areas of developing countries and are dependent on agriculture for their livelihood. The authors are convinced that the key to eradicating current suffering is to focus upon the creation of dynamic rural communities founded upon prosperous farming. A central tenet of this book is that the analysis of the farming systems within which the rural poor live and work can provide powerful insights into strategic priorities for the reduction of the poverty and hunger now affecting so many of their lives.

The availability of food has always been a central preoccupation of mankind. Despite a doubling of the global population during the past four decades, farmers have produced sufficient food to allow average per capita food intake to grow gradually. Yet hunger persists and food reserves have fluctuated markedly during this period, sometimes falling to critically low levels. In order to address these concerns, the World Food Conference was organised in 1974, followed by the International Conference on Nutrition in 1992 and the World Food Summit in 1996. At the Summit, Heads of State reaffirmed ... *the right of everyone to have access to safe and nutritious food, consistent with the right of everyone to be free from hunger*. They also committed themselves to reducing the number of undernourished people to half their present level no later than 2015[1]. The achievement of this goal is central to the Strategic Framework of the Food and Agriculture Organization of the United Nations (FAO)[2].

The eradication of poverty[3] is another international commitment, made originally in 1995 at the World Summit for Social Development held in Copenhagen, Denmark. At the Social Summit +5 (June 2000) this commitment was

[1] FAO 1996a.
[2] FAO 1999a.
[3] At an international level, the term 'poverty' is applied with respect to those earning less than US$1 per day.

translated into the target of halving the proportion of people living in extreme poverty by the year 2015. Both the World Food Summit and Social Summit +5 targets are reflected in the Millennium Declaration[4] adopted by the United Nations General Assembly (UNGA) in September 2000.

Many other development organisations have committed themselves to similar visions of reduced hunger or poverty. For instance, in 1997 the World Bank issued a new strategy for rural development entitled *Rural Development: From Vision to Action*[5]. Similarly, after its pathbreaking global poverty survey of the early 1990s, the International Fund for Agricultural Development (IFAD) has recently renewed its commitment to poverty reduction with the publication of its *Rural Poverty Report 2001 – The Challenge of Ending Rural Poverty*[6]. A majority of bilateral aid organisations have also focused on poverty reduction as a major theme in their programmes of development co-operation. Both food and income security are emphasised in the planning and policy documents of a great many governments.

This book takes a new look at the old problem of hunger and poverty through the lens of farming systems analysis. It recognises the diversity of the livelihoods of poor farmers, pastoralists and fishing families, and explores various pathways that may offer them an escape from poverty. The analysis also charts the expected directions of change in the major farming systems throughout the developing world during the coming 30 years. Rural development ultimately depends on the outcomes of the daily decisions of millions of individual women and men. The challenge for governments, civil society organisations and the private sector is to provide the public goods, institutional environment and incentives that will enable farm households themselves to accelerate agricultural growth and poverty reduction.

Unfortunately, the best available existing projections[7] suggest only a slow decline in hunger and poverty in developing regions. Accordingly, the book outlines, for leaders in the fields of development policy and science, the key strategic priorities for action – for different farming systems, for each developing region and for the developing world as a whole. These priorities focus upon closing the gap between the projected slow reduction in hunger and poverty and the goals set by the international community in the Millennium Declaration.

In this Chapter the current extent of rural hunger and poverty in the developing world is highlighted and the contribution of agricultural growth to poverty alleviation is discussed. Subsequently, the farming systems concept is introduced and the ways in which farming systems have been defined in this book are explained. The likely evolution of farming systems over the next 30 years is then outlined, and the main factors influencing the process are reviewed. The Chapter ends with a reader's guide to the rest of the book.

[4] United Nations General Assembly 2000.
[5] World Bank 1997.
[6] International Fund for Agricultural Development 2001.
[7] Comprehensive projections to 2015 and to 2030 are summarised in FAO (2000a). These projections by FAO are referred to extensively throughout this book.

HUNGER, POVERTY AND AGRICULTURE

POPULATION

In the last four decades of the 20th century, the population of developing regions[8] has approximately doubled – to 5.1 billion in 1999. At present, about 60 percent of these people are classed as rural; of whom around 85 percent are agricultural[9] (see Table 1.1). Women constitute 44 percent of the approximately 1.3 billion persons in the agricultural labour force of these regions. In some areas there is a high percentage of female-headed households. Women play a vital role in many aspects of farming systems, including production, processing, marketing and domestic responsibilities, and their contribution to the evolution of these systems is of the greatest importance.

Table 1.1 Rural and Agricultural Populations by Developing Region, 1999

Developing Region	Total Population (million)	Rural Population (million)	Agricultural Population (million)	Females Economically Active (%) 1/
Sub-Saharan Africa	626	417	384	47
Middle East and North Africa	296	121	84	44
Eastern Europe and Central Asia	478	154	86	44
South Asia	1 344	970	750	39
East Asia and Pacific	1 836	1 184	1 119	47
Latin America and Caribbean	505	126	110	17
All Developing Regions	5 085	2 971	2 534	44

Source: FAOSTAT.

Note: 1/ Indicates the proportion of those economically active in agriculture who are women.

Over the next thirty years, it is estimated that the total population of developing regions will continue to grow, but the rate of growth is projected to decline – from the current level of 1.8 percent per annum to an estimated 1.2 percent per annum in 2030[10]. However, as a result of the constantly increasing proportion of urban

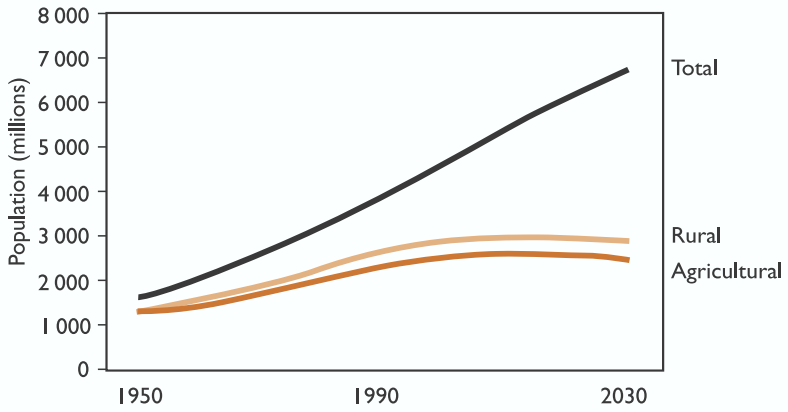
[8] World Bank classifies developing countries into six developing regions, which are used to organise the analysis underlying this book. Annex 3 lists the membership of each region.

[9] FAO defines the agricultural population as all persons depending for their livelihood on agriculture, hunting, fishing or forestry. This estimate comprises all persons actively engaged in agriculture and their non-working dependants.

[10] United Nations Population Division 2000.

dwellers (40 percent in 2000 rising to 56 percent in 2030[11]), the total rural population is actually expected to decline after 2020 (see Figure 1.1). Based on these estimates, the agricultural population of developing countries in 2030 will be little changed from its present level. Despite these forecasts, it should be emphasised that the actual future numbers of people engaged in agriculture in any developing region will depend upon the way that constituent farming systems evolve.

Figure 1.1 Population Trends in Developing Regions



Source: United Nations Population Division 2000.

Among the factors causing uncertainty over future population trends, two are particularly noteworthy. First, the prognosis for the HIV/AIDS pandemic is uncertain. At present the rates of infection are already extremely high in Africa, and the scale of infection is growing alarmingly in Asia, especially South Asia. In Africa, a few countries appear to have contained AIDS through an effective series of measures to combat its spread. It is difficult, however, to predict whether other countries will be able to emulate this experience. Also, should affordable treatments become available – either through new drugs, lowered costs of production of existing drugs, or subsidised provision of drugs to developing countries – mortality rates could be reduced significantly. The second area of uncertainty concerns the migration of people engaged in agriculture to rural towns and other urban areas. Migration rates reflect, *inter alia*, relative poverty rates in urban and rural areas, and hence are affected by factors such as international commodity prices, urban employment growth, and real exchange rates.

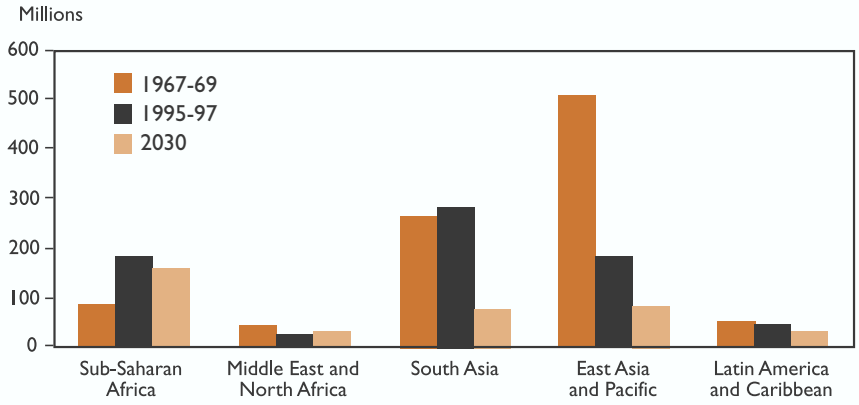
[11] United Nations Population Division 2000.

THE INCIDENCE OF HUNGER AND POVERTY

Hunger is still prevalent in many developing countries, especially in South Asia and Africa. Although, as indicated in Figure 1.2, the number of undernourished people[12] actually increased in the above two developing regions[13], the overall total has fallen since the late 1960s – from 959 million in 1969-1971 to 790 million in 1995-1997. Since total population has grown substantially, this represents a halving of the actual proportion of undernourished people – from 37 to 18 percent.

Projections indicate a further fall in the incidence of undernourishment, to around 576 million people in 2015 and 400 million in 2030[14], but this decline could be accelerated if the requisite measures are taken to reduce hunger, as foreseen in the World Food Summit. The most dramatic fall in the incidence of undernourishment has occurred in East Asia. Estimates of the 2030 situation indicate that this trend will continue, with strong declines also taking place in South Asia and the Latin America and Caribbean regions.

Figure 1.2 Incidence of Undernourishment by Developing Region



Source: FAO 2000a.

Hunger and poverty are closely related. While the lack of sufficient income to purchase food is clearly a major factor causing household food insecurity, hunger itself contributes to poverty by lowering labour productivity, reducing resistance to disease and depressing educational achievements.

[12] Undernourishment is defined as a situation in which an individual's food intake does not meet basic energy requirements.

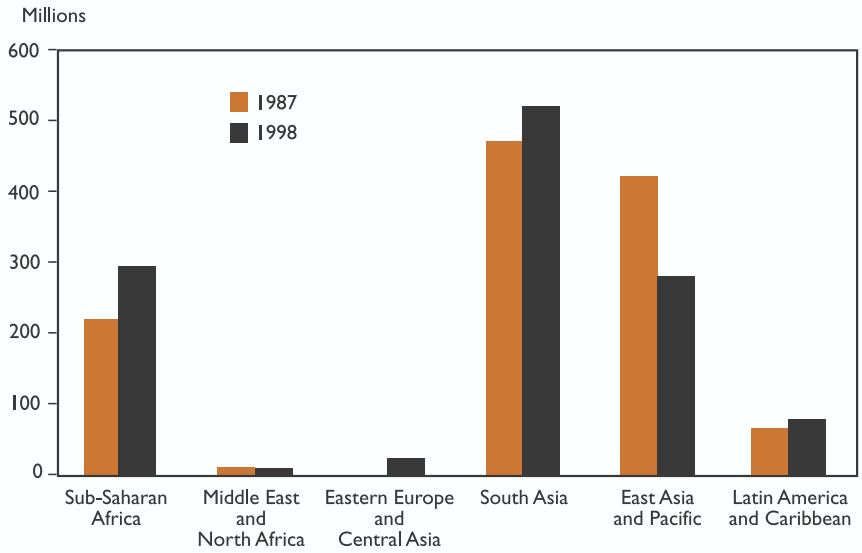
[13] Regions correspond to those used in FAO (2000a) – see Annex 3 for country groupings. Data for Eastern Europe and Central Asia are not available.

[14] FAO 2000a.

It is estimated that, across the developing world, a total of 1.2 billion people live in poverty[15] – as defined by the international poverty line of average daily consumption equivalent to US$1 per day per capita National data from a large number of countries suggest that the incidence of poverty in urban areas is less than in rural areas[16]. Although the relative importance of rural poverty varies substantially from one country to another, in developing countries as a whole more than 70 percent of total poverty is found in rural areas. Similarly, hunger is also concentrated in rural areas despite the fact that they are the locus of food production.

Recent changes in the incidence and distribution of dollar poverty by developing region are shown in Figure 1.3. Poverty is concentrated in South Asia – where it has been increasing gradually during the 1990s – and Africa, where it has been growing at an alarming rate. Conversely, there has been a major decline in poverty in East Asia and Pacific, mainly as a result of economic growth in China.

Figure 1.3 Poverty Incidence by Developing Region



Source: World Bank 2001b.

THE CONTRIBUTION OF AGRICULTURAL GROWTH TO POVERTY ALLEVIATION

The evidence is quite clear that broad-based agricultural development provides an effective means for both reducing poverty and accelerating economic growth. This is normally achieved not only by increasing incomes for producers and farm

[15] World Bank 2001b.

[16] However, a number of ex-centrally planned countries (e.g. Mongolia, Georgia) display higher urban than rural poverty rates.

workers, but also by creating demand for non-tradable goods – namely services and local products. It is this indirect effect on demand, and the associated employment creation in the off-farm sector of rural areas and market towns, that appears to be the main contributing factor to the reduction of rural poverty. Furthermore, as other studies show[17], agricultural growth can reduce urban poverty more rapidly than does urban growth itself, largely because of the consequent reduction in urban food costs and lower rates of in-migration from rural areas. Mellor concludes that *... the evidence is overwhelming that it is essential to accelerate agricultural growth if poverty is to decline rapidly*.[18]

While overall agricultural growth is undoubtedly an effective engine for both economic development and poverty reduction, the form that this growth takes has a bearing on its effectiveness in reducing rural poverty. Thus, rising productivity within labour-intensive small farms, which generates extra demand for local goods and services, can be expected to have a broader effect on poverty reduction than equivalent productivity increases on large, mechanised holdings, which typically generate less additional demand for local goods and services.

The challenge for developing countries is to identify specific agricultural and rural development needs and opportunities, and to focus investment in areas where the greatest impact on food insecurity and poverty will be achieved. This identification and resource allocation process can be facilitated by analysing farming systems in order to develop an understanding of local factors and linkages. In the course of this analytical process it is also extremely helpful to be able to aggregate locations with similar development constraints and investment opportunities through the application of a farming systems framework.

FARMING SYSTEMS AND THEIR CHARACTERISTICS

THE CONCEPT OF FARMING SYSTEMS

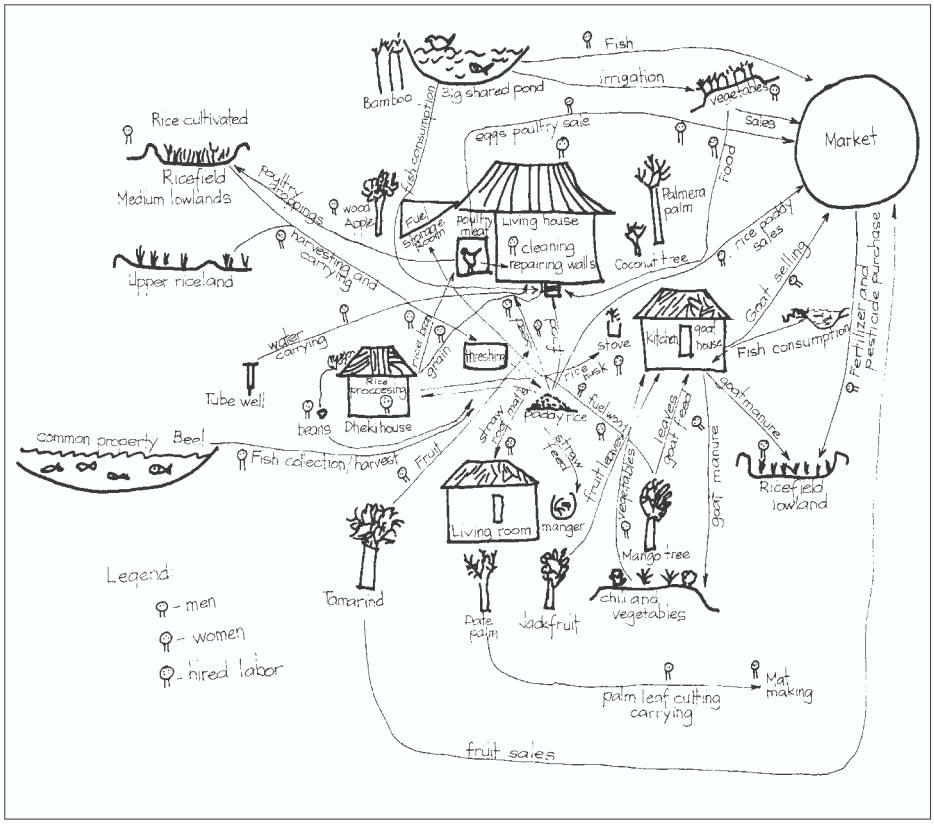
Farmers typically view their farms, whether small subsistence units or large corporations, as systems in their own right. The following systems diagram (see Figure 1.4) of a typical farm system, drawn by Bangladeshi farmers, illustrates the structural complexity and interrelationships between various components of a smallholding. It also shows the variety of natural resources available to farm families. These resources normally include different types of land, various water sources and access to common property resources – including ponds, grazing areas and forest. To these basic natural resources may be added climate and biodiversity, as well as human, social and financial capital. The diagram also illustrates the diversity which characterises the livelihoods of most smallholders.

[17] For example, Datt and Ravallion 1998.
[18] Mellor 2000.

Each individual farm has its own specific characteristics arising from variations in resource endowments and family circumstances. The household, its resources, and the resource flows and interactions at this individual farm level are together referred to as a *farm system*[19]. The biophysical, socio-economic and human elements of a farm are interdependent, and thus farms can be analysed as systems from various points of view.

The resource endowment of any particular farm depends, *inter alia*, on population density, the distribution of resources among households and the effectiveness of institutions in determining access to resources. Regardless of their size, individual farm systems are organised to produce food and to meet other household goals through the management of available resources – whether owned,

Figure 1.4 Farmers' View of a Farm System, Bangladesh[20]



[19] In the literature a wide variety of definitions of farm system and farming system are found, which emphasise different aspects of a system. For example, systems components and systems interrelationships (see Dillon *et al* 1978 and Shaner *et al* 1982) and complementary biophysical and socio-economic processes (see Norman *et al* 1982).

[20] Lightfoot *et al* 1991.

rented or jointly managed – within the existing social, economic and institutional environment. They often consist of a range of interdependent gathering, production and post-harvest processes, so that besides cropping and livestock keeping[21], household livelihoods can encompass fishing, agro-forestry, as well as hunting and gathering activities. Off-farm incomes, which make a significant contribution to the livelihoods of many poor rural households, are also included. Farm systems are not found only in rural areas; significant levels of urban agriculture exist in many cities and towns in a wide range of developing countries.

The functioning of any individual farm system is strongly influenced by the external rural environment, including policies and institutions, markets and information linkages. Not only are farms closely linked to the off-farm economy through commodity and labour markets, but the rural and urban economies are also strongly interdependent. For example, as noted above, it is quite common for small farm households to derive a significant part of their income – often 40 percent or more – from off-farm activities. Farm women and men are also linked to rural communities and social networks, and this social capital influences the management of farms.

A *farming system*, by contrast, is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate[22]. Depending on the scale of the analysis, a farming system can encompass a few dozen or many millions of households.

Over the past 30 years, the original approach to analysing farming systems has evolved markedly, as illustrated in Table 1.2. Essentially, the scope of the analysis has gradually expanded, placing increasing emphasis on horizontal and vertical integration, on multiple sources of household livelihoods, and on the role of the community, the environment and support services[23]. The use of the Farming System Approach (FSA) as an analytical framework became common in the 1970s, and it has contributed to a paradigm change in rural development thinking.

From a predominantly top-down, reductionist view of agricultural development dominated by technical productivity considerations, there has been a marked shift to a more holistic perspective. This is based upon a broader goal of improved livelihoods and greater household food security, where household structure, gender, social networks, local institutions, information, policies and markets all play a role. Concurrently, analytical techniques have become more participatory, with an increasing stress on indigenous knowledge, and upon group planning, experimentation and monitoring. There is now also a greater insistence on the

[21] Households of refugees and agricultural workers, who lack land or livestock, are generally not considered to be farm households.

[22] See also footnote 19 on diversity of definitions of farming systems.

[23] Collinson (2000) provides a comprehensive history of Farming Systems Research.

prime responsibility for change and initiative residing within the farming community, and with this shift in emphasis, the underlying importance of human resource capacity has become more widely recognised. The current FSA approach, with its focus on the farm household as the centre of a network of resource allocation decisions, has much in common with the Sustainable Livelihoods Approach (SLA)[24].

Table 1.2 Evolution of the Farming Systems Approach

Characteristics	1970s	1980s	1990s	2000s
System Level:				
Farm				
Household				
Groups/Community				
District/Zones/Catchments or Sector				
Livelihood Focus:				
Crops				
Crop-Livestock				
Multiple Household Livelihoods				
Functional Focus:				
Research				
Research & Extension				
Research, Extension & Support Services				
Multi-sectoral, incl. Infrastructure				
Stakeholder Focus:				
Public				
Public & Civil Society				
Public, Civil Society & Private				
Other Foci:				
Gender				
Household Food Security				
Productivity & Resource Management				

Source: Adapted from Dixon and Anandajayasekeram (2000).
Note: Darker squares indicate greater focus on the element in that period.

[24] While both approaches are farmer-centred approaches, which recognise diverse livelihoods, Sustainable Livelihoods (see Ellis [2000] for a comprehensive overview) places greater emphasis on vulnerability.

MAJOR CATEGORIES OF FARMING SYSTEM

As stated earlier, the delineation of the major farming systems provides a useful framework within which appropriate agricultural development strategies and interventions can be determined. The decision to adopt very broad farming systems inevitably results in a considerable degree of heterogeneity within any single system. However, the alternative of identifying numerous, discrete, micro-level farming systems in each developing country – which could result in hundreds or even thousands of systems worldwide – would complicate the interpretation of appropriate regional and global strategic responses and detract from the overall impact of the analysis. Only the major farming systems have, therefore, been identified and then mapped in order to estimate the magnitudes of their populations and resource bases. Each of these broad systems is characterised by a typical farm type or household livelihood pattern[25], although significant sub-types are described where appropriate.

The classification of the farming systems of developing regions, as specified in this book, has been based on the following criteria:

- available natural resource base, including water, land, grazing areas and forest; climate, of which altitude is one important determinant; landscape, including slope; farm size, tenure and organization; and
- dominant pattern of farm activities and household livelihoods, including field crops, livestock, trees, aquaculture, hunting and gathering, processing and off-farm activities; and taking into account the main technologies used, which determine the intensity of production and integration of crops, livestock and other activities.

Based on these criteria, the following eight broad categories of farming system have been distinguished:

- Irrigated farming systems, embracing a broad range of food and cash crop production;
- Wetland rice based farming systems, dependent upon monsoon rains supplemented by irrigation;
- Rainfed farming systems in humid areas of high resource potential, characterised by a crop activity (notably root crops, cereals, industrial tree crops – both small scale and plantation – and commercial horticulture) or mixed crop-livestock systems;
- Rainfed farming systems in steep and highland areas, which are often mixed crop-livestock systems;
- Rainfed farming systems in dry or cold low potential areas, with mixed crop-livestock and pastoral systems merging into sparse and often dispersed systems with very low current productivity or potential because of extreme aridity or cold;

[25] Farm type in the case of commercial or large-scale agriculture.

- Dualistic (mixed large commercial and small holder) farming systems, across a variety of ecologies and with diverse production patterns;
- Coastal artisanal fishing, often mixed farming systems; and
- Urban based farming systems, typically focused on horticultural and livestock production.

The above criteria and broad grouping of farming systems were applied to the six main regions of the developing world in a pragmatic fashion, with a view to drawing conclusions with regard to poverty reduction and agricultural growth. This exercise resulted in the identification of 72 farming systems with an average agricultural population of about 40 million inhabitants, although individual systems range from less than one million to several hundred million agricultural inhabitants. Sometimes, sufficient differences exist within a farming system to justify reference to distinct sub-types; for example, small-scale farms and plantations or commercial farms, or low altitude and high altitude areas. The names chosen for the farming systems reflect the eight main types outlined above. Nevertheless, the name of each system is expressed in the singular form, emphasising commonality within the system for purposes of this analysis[26].

The names also reflect key distinguishing attributes, notably: (i) water resource availability, e.g. irrigated, rainfed, moist, dry; (ii) climate, e.g. tropical, temperate, cold; (iii) landscape relief/altitude, e.g. highland, lowland; (iv) farm size, e.g. large scale; (v) production intensity, e.g. intensive, extensive, sparse; (vi) dominant livelihood source, e.g. root crop, maize, tree crop, artisanal fishing, pastoral; (vii) dual crop livelihoods, e.g. cereal-root, rice-wheat (note that crop-livestock integration is denoted by the term mixed); and (viii) location, e.g. forest based, coastal, urban based.

The spatial mapping of farming systems presented in this study represents a compromise between the usefulness of showing farming system areas in a graphical manner and the dangers of implying sharp boundaries between neighbouring systems. With a large degree of variation inevitable among individual farm households within any one system, there are seldom sharp boundaries between systems. In most cases transitions occur as one farming system gradually merges into another. In some cases, systems may be separated by narrow zones with quite distinct characteristics (e.g. on lower slopes of mountain areas), the identification of which would not be useful in a study of this nature and on this global scale.

Irrigation constitutes a special case in relation to the heterogeneity of farming systems. Where irrigation-based production is the dominant agricultural characteristic within an area, as in the case of large-scale irrigation schemes, the entire zone has been classified as an irrigation-based farming system. However, significant amounts of irrigation appear as small yet important areas of otherwise

[26] In this respect, previous authors have followed different conventions. Ruthenberg (1971) refers to families of farming systems across the world, e.g. shifting cultivation systems. Fresco (1986) provides farming system names in the singular.

rainfed farming systems, and the implications of this situation are reflected in the analysis of constraints and opportunities. Because irrigated agriculture is so different from rainfed – not only in farming system characteristics, but also in terms of priorities and strategic approaches – substantial localised concentrations of irrigation within predominantly rainfed systems have been identified through cross hatching on the farming system maps.

Of the 72 identified farming systems, from three to five systems were identified within each region for in-depth analysis. The main variables influencing the selection were: (i) potential for poverty reduction; (ii) potential for agricultural growth; and (iii) demographic and economic importance within the region. The selection includes some farming systems with few opportunities for a rapid advance in one or both of the above variables, but a majority exhibit a potential for achieving growth and/or reducing poverty levels. Rapid and sustained agricultural growth in a major farming system – even one not currently associated with high levels of poverty – could be expected to have a significant impact on aggregate poverty through migration and market linkages. Nevertheless, the emphasis in this analysis is placed, in so far as feasible, on the prospects for the *in situ* reduction of poverty levels. Factors determining a system's apparent growth potential include: (i) suitable resource endowments, including underlying agro-climatic and soil conditions, a relatively high ratio of land and other resources (water, forest) to human population, and a currently low intensity of exploitation; (ii) favourable access to infrastructure and services, including markets; and (iii) the identification of broader development constraints whose removal is considered to be feasible.

DEVELOPMENT OF FARMING SYSTEMS AND REDUCTION OF HUNGER AND POVERTY

In broad terms, there are five main farm household strategies to improve livelihoods. These can be summarised as:

- intensification of existing production patterns;
- diversification of production and processing;
- expanded farm or herd size;
- increased off-farm income, both agricultural and non-agricultural; and
- a complete exit from the agricultural sector within a particular farming system.

These strategic options are not mutually exclusive, even at the individual household level; any particular household will often pursue a mixed set of strategies.

The first of these two strategies – intensification and diversification – form important components of the FAO Special Programme for Food Security[27].

[27] FAO 1999c.

Intensification is defined in this book as increased physical or financial productivity of existing patterns of production; including food and cash crops, livestock and other productive activities. Although intensification is frequently associated with increased yields as a result of greater use of external inputs, it may also arise from improved varieties and breeds, utilisation of unused resources, improved labour productivity, and better farm management – for example improved irrigation practices or better pest control.

Diversification is defined as an adjustment to the farm enterprise pattern in order to increase farm income, or to reduce income variability. It exploits new market opportunities or existing market niches. Diversification may take the form of completely new enterprises, or may simply involve the expansion of existing, high value, enterprises. The addition or expansion of enterprises refers not only to production, but also to on-farm processing and other farm-based, income generating activity.

Some households escape poverty by expanding farm size – in this context size refers to managed rather than to owned resources. Beneficiaries of land reform are the most obvious examples of this source of poverty reduction. Increased farm size may also arise through incursion into previously non-agricultural areas, such as forest – often termed expansion of the agricultural frontier. Although this option is not available within many systems, it is of relevance particularly in parts of Latin America and Sub-Saharan Africa. Increasingly, however, such 'new' lands are marginal for agricultural purposes, and may not offer sustainable pathways to poverty reduction.

Off-farm income represents an important source of livelihood for many poor farmers. Seasonal migration has been one traditional household strategy for escaping poverty and remittances are often invested in land or livestock purchases. In locations where there is a vigorous off-farm economy, many poor households augment their incomes with part-time or full-time off-farm employment. Where opportunities for improved livelihoods are perceived, a proportion of farm households will abandon their land altogether, and move into other farming systems, or into off-farm occupations in rural or urban locations. This means of escaping agricultural poverty is referred to in the following Chapters as *exit from agriculture*.

The above five household strategies for reducing hunger and poverty will be referred to frequently in the following Chapters, in which the relative importance of the different sources is assessed. The assessment for each farming system is based on the judgement of groups of experts knowledgeable about each particular region. Table 1.3 illustrates this type of assessment for two farming systems in Sub-Saharan Africa.

The data indicate that in the irrigated farming system intensification is extremely important in terms of potential for reducing poverty, whereas exit from agriculture has relatively little attraction as a poverty reduction pathway. Conversely, in the pastoral farming system the greatest potential lies in households leaving the system

Table 1.3 Relative Importance of Different Household Strategies[28]

Source of Hunger and Poverty Reduction	Intensification	Diversification	Increased Farm Size	Increased off-farm Income	Exit from Agriculture
Irrigated Farming System	3.5	2	2.5	1.5	0.5
Pastoral Farming System	1	1	1	2	5

Source: Table 2.4.
Note: Scores add to 10 for each farming system.

altogether – the so-called exit strategy. In this particular farming system, the poverty reduction potential of intensification, diversification and increasing farm size, is considered to be low.

ASPECTS OF THE EVOLUTION OF FARMING SYSTEMS

The Farming System Approach considers both biophysical dimensions (such as soil nutrients and water balances) and socio-economic aspects (such as gender, food security and profitability) at the level of the farm – where most agricultural production and consumption decisions are taken. The power of the approach lies in its ability to integrate multi-disciplinary analyses of production and its relationship to the key biophysical and socio-economic determinants of a farming system.

In order to present the analysis of farming systems and their future development within a framework that is broadly comparable between systems and across different regions, the above key biophysical and socio-economic determinants have been grouped together into five categories:

- natural resources and climate;
- science and technology;
- trade liberalisation and market development;
- policies, institutions and public goods; and
- information and human capital.

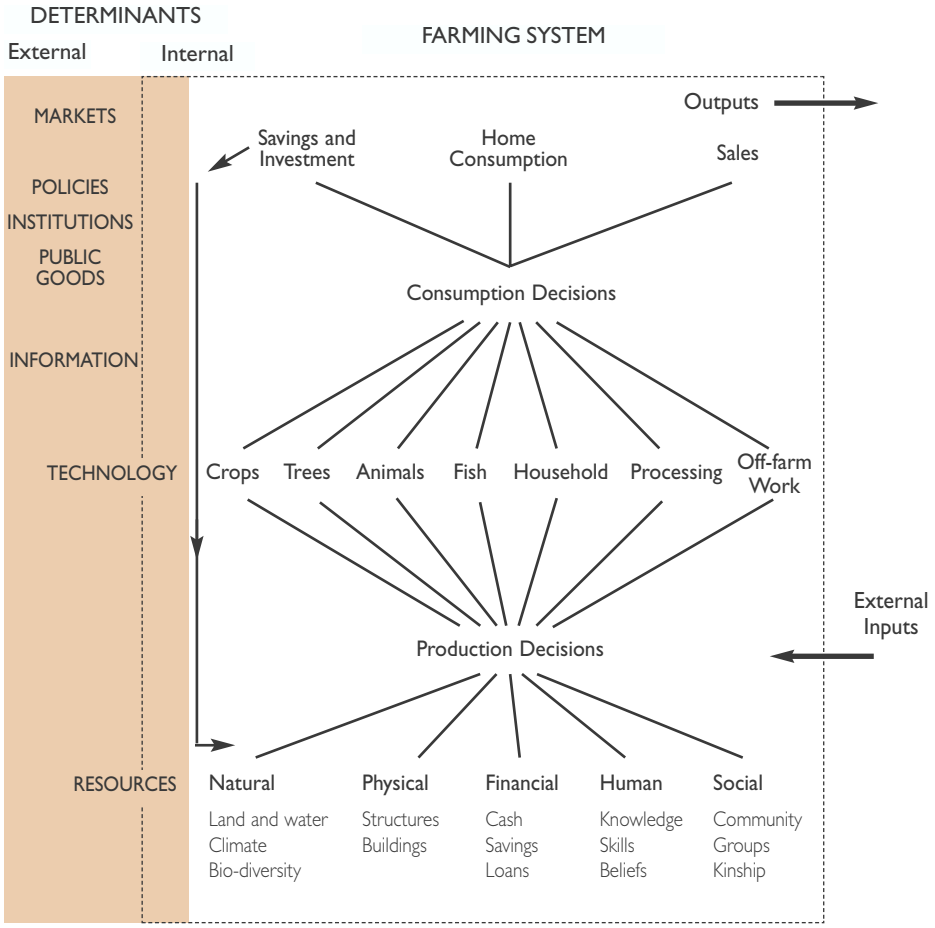
In the opinion of a range of experts[29], these categories represent the major areas in which farming system characteristics, performance and evolution are likely to be significantly affected over the next thirty years.

[28] It should be noted that safety nets are excluded from this assessment, being viewed as transitory relief measures which are not generally intended to lift households out of poverty.

[29] The experts were mostly staff and consultants of FAO.

Figure 1.5 represents schematically the interrelationship of these key determinants of farm systems and, by extension, farming systems. Some of these factors are internal to, or part of, the farming system, whereas others are external. The principal exogenous (external) factors which influence the development of farming systems – policies, institutions, public goods, markets, and information – are indicated on the left side of the Figure, lying outside the dotted line that marks the system boundary. The availability of markets and the prices on offer influence farmers' decisions on enterprise pattern, on purchases of inputs and on the timing of produce sales. The availability of economic and social infrastructure in rural areas determines the transport costs and the availability of services to the household – notably human and animal health. Similarly, information and educational services affect household strategies and decisions. Technologies, which determine the

Figure 1.5 Schematic Representation of Farming Systems



nature of production and processing, and natural resources, are largely endogenous (internal) factors and are therefore depicted as lying mainly within the boundary of the farming system. In general terms, the biophysical factors tend to define the set of possible farming systems, whilst the socio-economic factors determine the actual farming system which can be observed at a given time.

Often, the evolution of a farming system follows a predictable direction. For example, a system originally dependent solely on the use of hand hoes may face constraints as market-driven diversification occurs. This could lead to the increasing use of cattle for draught power, replacing some manual operations and, if land is available, an expansion of the cultivated area. Later, the intensification of crop production may be driven by population expansion and land shortages. Market-driven evolution sometimes leads to specialisation in production and often involves greater use of external inputs. Further stages may include partial mechanisation of crop production and substantial market integration. Ultimately, a high degree of production intensity is likely - perhaps with an export orientation - and is usually characterised by intensive use of purchased inputs, land aggregation and a high degree of mechanisation. In certain circumstances intensive mixed systems may develop. In all cases, enabling infrastructure and the availability of technical and market information will be important influences on system evolution.

The five key categories of determinants influencing farming system evolution - already listed above - are described in the following sections.

Natural resources and climate

The interaction of natural resources, climate and population determines the physical basis for farming systems. During the early stages of development, increased population generally leads to an expansion in cultivated area and, in many cases, conflict between the different users of land and water resources. Once most good quality land is already exploited, further population increases tend to lead to the intensification of farming systems. As forests and woodlands come under greater pressure, biodiversity is threatened and there may be growing tension between development and conservation goals. These trends have often been exacerbated by colonial and

post-colonial forces that have concentrated indigenous or minority peoples on poorer quality land – thus aggravating the degradation problem.

Over the past four decades the amount of land under cultivation, including permanent crops, has increased by more than one quarter – to just over one billion ha. However, the rapid growth of population in recent years has meant that the area of cultivated land per capita in developing countries has declined by almost half since the 1960s.

Since the 1960s, pasture and grazing land has expanded by a total of 15 percent in developing regions, to around 2.2 billion ha in 1994. Much of this expansion was achieved at the expense of forest and woodland, which declined to about 2.3 billion ha over the same period. Annual growth rates in cultivated area vary considerably between the regions, as shown in Box 1.2. By far the highest growth rates were experienced in Latin America and Caribbean – 1.26 percent per annum as compared with only 0.18 percent per annum in South Asia. It is worth noting that, during this period, average cropping intensity rose in total by only five percent; suggesting that growth in output has resulted mainly from yield increases and area expansion rather than from higher cropping intensity.

Box 1.2 Average Annual Expansion in Cultivated Area 1961-1997

Region	% p.a.
Sub-Saharan Africa	0.73
Middle East and North Africa	0.42
South Asia	0.18
East Asia	0.91
Latin America and Caribbean	1.26
Average	0.67

Source: FAO 2000a.

It is estimated that an additional 1.8 billion ha of land of 'acceptable' quality remains available for future agricultural use, but this seemingly favourable scenario is seriously constrained by a number of factors. Much of the land categorised as suitable for agriculture is only suited to a narrow range of crops (e.g. olive trees in North Africa). Secondly, more than 90 percent of available land is in Latin America and Sub-Saharan Africa, which means that further expansion is simply not an option for most of North Africa, Eastern Europe, Asia and Middle East. Even in those areas where potential for expansion does appear to exist, over 70 percent of available land is estimated to suffer from one or more soil or terrain constraints. As a result of these factors, the projected expansion[30] in cultivated area in developing regions to 2030 is only half the historic rate – adding about 120 million ha to the current total[31]. Strikingly, however, by the year 2030, and despite the addition of well over two billion people to the population of developing countries, the average amount of cultivated land available for each person engaged in agriculture may actually increase[32] due to the stabilisation of agricultural populations.

[30] FAO 2000a. Of course, the actual rate of expansion will depend upon the nature of the evolution of these farming systems.

[31] FAO 2000a.

[32] Changes in per capita cultivated land availability will vary widely from one region to another. Almost all additional cultivated land is expected to derive from expansion of agricultural frontiers in Africa and Latin America, while cultivated land area may actually decline in areas such as Middle East.

Despite the typically high cost of developing irrigation systems, irrigated land use has risen at three times the rate of overall expansion of farmland; total irrigated area in developing countries has doubled since 1961 – to 197 million ha. This supports the contention that many areas of the developing world have already faced constraints to further expansion for several decades, if not longer. However, intensification through irrigation has its limits. At present, it consumes about 70 percent of the total volume of fresh water used by humans, but this proportion is likely to decline during the coming 30 years as urban and industrial use grows. Despite the fact that only seven percent of total renewable water resources in developing countries are currently exploited, these competing demands, together with the fact that much of the available water is not located in areas of agricultural need, is expected to reduce current rates of irrigation growth.

The expansion of agriculture, plus changes in production technologies, has resulted in a decrease in agro-biodiversity in recent decades. In addition to the well publicized disappearance of indigenous flora and fauna, there has been a considerable reduction in the number of varieties cultivated, which has affected in particular the main cereal crops: wheat, maize and rice. A similar loss of biodiversity has occurred among domestic animals. However, modern plant breeding may go some way to reversing this trend by making it easier to maintain genetic material, and by creating a wider gene pool of modern varieties.

Agriculture currently contributes about 30 percent of the global anthropogenic emission of greenhouse gases. Growth in the production of these gases by crops is expected to slow down in future, but methane production by livestock could increase substantially. Accumulated evidence[33] now strongly suggests that impacts from global climate change will be significant. Average global surface temperatures are expected to rise by an estimated 1.4 to 5.8°C in the next 100 years, while the frequency of climatic extremes (temperatures, precipitation and winds) is expected to increase dramatically. Models based on the Intergovernmental Panel on Climate Change (IPCC) scenario of a one percent increase in greenhouse gases annually, predict that within 80 years extremes currently experienced only once a century will become normal. Higher temperatures will inevitably lead to a rise in sea levels – estimated at between 0.1 and 0.9 metres over this century.

There is little doubt that both agriculture and food security will be affected by climate change. Not only will crop yields change, but huge investments in infrastructure could also be required. Among the impacts predicted by the IPCC Working Group is a reduction in potential crop yields in most tropical and sub-tropical regions and, if temperature increases are towards the higher end of the predicted range, also in mid-latitudes[34]. Another recent study has estimated that crop yields could decline by one-fifth in many developing countries[35]. Water

[33] Intergovernmental Panel on Climate Change 2001.

[34] It should be stressed, however, that these are declines in potential yields. In many farming systems, other factors may be more limiting than the impact of global warming.

[35] Fischer *et al* 2001.

availability – particularly in the sub-tropics – is expected to diminish; although some areas such as South East Asia, may have to cope with greater volumes of water as a result of more intense monsoon activity. A widespread increase in the risk of flooding is anticipated, as a result of rises in sea level and increased severity of precipitation from storms, hurricanes and monsoons. Labour availability may be affected by the expected increase in the transmission of diseases; both vector borne (e.g. malaria), and water borne (e.g. cholera). Overall, the increased variability of climate, and thus agricultural productivity, substantially increases the risk faced by farmers, with concomitant reduction in investment and input use.

SCIENCE AND TECHNOLOGY

Investments in agricultural science and technology have expanded rapidly during the last four decades. During this period, major technical and institutional reforms occurred, which shaped the pattern of technology development and dissemination. In the early 1970s, the Consultative Group on International Agricultural Research (CGIAR) was established and National Agricultural Research Systems (NARS) were greatly strengthened. During the 1980s and 1990s partnerships among CGIAR centres and NARS were established, including the eco-regional consortia. During the past decade, however, many NARS have been under budget pressure as macro-economic reforms were implemented.

Box 1.3 Average Cereal Yield (1961-1997) in Developing Countries (t/ha)

	1961-63	1995-97
Wheat	0.9	2.5
Rice (paddy)	1.8	3.5
Maize	1.2	2.6
All cereals	1.2	2.5

Source: FAO 2000a.

The historical focus of research by CGIAR and NARS centres on food crop production technologies, with its emphasis on improved yielding varieties, has undeniably been successful. Nearly three-quarters (71 percent) of production growth since 1961 have been due to yield increases. Increased yields have contributed to greater food security within developing regions and have contributed to declining real prices for food grains. It is significant that FAO projections to 2030[36] indicate a continuing rise in average cereal yields in developing countries, under both rainfed and irrigated conditions.

However, many poor smallholder farmers in marginal areas have not benefited from these cereal yield increases, and investments in technology development for non-cereal crops have usually received a low priority. Although the private sector and large farmers' organisations have invested heavily in research for commercially important cash crops – examples include coffee, tea, sugar cane and

[36] FAO 2000a.

bananas – many tropical staples and minor cash crops have received relatively little attention. Similarly, investment in livestock research has generally not been commensurate with the contribution of the sub-sector to household income or Gross Agricultural Domestic Product (GADP). Only one CGIAR research centre – the International Livestock Research Institute (ILRI) – concentrates on livestock, although other centres have animal production programmes. In contrast, agricultural research in industrialised countries has been relatively well funded with some of the work being led by the private sector. Consequently, a much greater range of new technologies is available for production systems and crops of interest to developed countries than for smallholder production systems in developing countries.

Overall, research has been focused principally upon intensifying crop and livestock production, usually by means of purchased inputs. There has been far less research on integrated technologies for diversifying the livelihoods of small farmers in developing countries and increasing the sustainability of land use. Little is understood, for instance, about the role of organic matter in soils, the development of reduced tillage systems, the use of on-farm organic resources in combination with inorganic fertilisers and the role of legumes in biological nitrogen fixation. Similarly, there has been limited research in Integrated Pest Management (IPM) and in weed and pest control. These are topics of little interest to the private sector, but also ones which are in danger of neglect by public research institutions.

Despite these weaknesses, the global research agenda is gradually moving from a focus on individual crop performance to a growing acceptance of the importance of increased system productivity. This is viewed largely in terms of better-managed interactions among diversified farm enterprises, sustainable resource management, and improved targeting of technologies towards women farmers and poorer households. Perhaps even more importantly in the long term, institutional modalities are now shifting. From a public sector focus, largely led by the international system, more emphasis is now being given to public-private partnerships driven mainly by the demands of clients. These changes are being accompanied by a growing understanding of farmers' problems and opportunities and a greater willingness to blend indigenous knowledge and modern information.

Growing investments in biotechnology are likely to increase agricultural research productivity and have the potential to revolutionise production practices through the generation of customised crop varieties. Whilst there has been a gradual decrease in national and international public funding available for agricultural research and extension systems, private sector biotechnology research has attracted ample support, although not generally for tropical food crops. Most of this research is likely to focus on profit-generating inputs, export crops and agro-processing.

TRADE LIBERALISATION AND MARKET DEVELOPMENT

Of the broad and all-encompassing processes included under the term *globalisation*, the emphasis in this document is placed on economic reform and trade liberalisation. By the end of the 1970s, the economies of many developing countries had become highly distorted as a result of excessive government intervention and control. Most were in serious economic difficulties, with high inflation, unmanageable balance of payments and fiscal deficits, high external debt ratios and Gross Domestic Product (GDP) growth rates that were negative or failing to match the rate of population increase. To address these problems, the International Monetary Fund (IMF), and subsequently the World Bank and other international institutions and bilateral donors, initiated lending programmes under which balance of payments support was provided to a range of developing countries conditional upon the adoption of programmes of structural reform. These Structural Adjustment Programmes (SAPs) have resulted in liberalised trade and exchange rate regimes and radically reduced subsidies in many developing countries. Structural adjustment, however, has not eliminated the urban bias in policies.

Many SAPs have embodied reforms specific to the agricultural sector. These include measures to: (i) end marketing monopolies; (ii) reduce parastatal involvement in the supply of inputs, marketing and processing; (iii) reduce or remove subsidies, price controls and impediments to private sector activities; (iv) remove restraints on foreign trade; and (v) promote the private sector. Small-scale activities, requiring limited management, technical knowledge and with limited capital requirements, have been rapidly adopted. The most notable is grain milling. In many countries, the marketing of grains has been the first major agricultural service to be privatised, due to the prior existence of parallel markets and because grain marketing boards have imposed major financial burdens on governments.

More recently, international agreements and the establishment of the World Trade Organization (WTO) have further boosted trade liberalisation. Markets have a critical role to play in agricultural development, as they form the linkages between farm, rural and urban economies upon which the development processes outlined by Mellor (see above) depend. As a result of the reduction of impediments to international trade and investment, the process of trade liberalisation is already generating changes in the structure of production at all levels – including smallholder-farming systems in many developing countries. Not only is market development accelerating, but patterns of production and natural resource usage are also changing profoundly in response to market forces. The speed of change engendered by this transition has, however, also had important negative effects. Poverty increased, at least temporarily, in many farming systems during the 1980s and early 1990s, as a result of reductions in government support and declining prices for major smallholder products.

In the longer run as barriers to trade between countries diminish, and if subsidies to producers in industrialised countries are removed, developing country products

that are competitive in world markets will benefit, replacing those that have hitherto relied on protection. Broad social, economic and cultural trends will also contribute to a profound reshaping of market demand, as increased urbanisation, rising incomes, improved communications and the diffusion of cultural preferences exert their effect. The availability of new production, post-harvest and transport technologies will also change demand patterns, by making possible the delivery of new products – or established products in new forms – to markets where they have been previously unattainable.

POLICIES, INSTITUTIONS AND PUBLIC GOODS

The development of dynamic farming systems requires a conducive policy environment. Moreover, the establishment of the farm-rural-urban linkages described by Mellor[37] requires effective demand. The greatest change in this environment during the past 30 years has been structural adjustment, the widespread introduction of which marked another step in a key policy trend that can be discerned over the last few decades; the decline of national food self-sufficiency as a dominant element in the shaping of policies for rural areas. In the 1960s, the perceived need to ensure national food security was paramount for many governments and was used to justify direct intervention in agricultural marketing, storage, import licensing, input subsidies and other areas. Although national food self-sufficiency is no longer an overriding policy aim, food security remains a key policy issue for developing countries and indeed for the whole world. This was emphasised in the FAO-sponsored World Food Summit of 1996 and the follow-up development activities.

As structural adjustment programmes have progressed, policy makers have increasingly shifted their attention to the potential to increase the efficiency of service delivery through the restructuring of institutions. This has led to several results with enormous long-term impact: the shift of many traditionally public sector roles to civil society and the private sector; the decentralisation of remaining government services; and an increasing reduction of government investment in the provision of public services.

The first two trends fit well within the growing tendency, at a broader social level, to encourage more local participation in decision making and resource allocation. The third is largely an outcome of the shedding of many previous governmental responsibilities to the private sector. These tendencies will probably continue to gain importance during the next one or two decades. However, while such trends offer significant benefits in terms of mobilisation of non-governmental resources and a better alignment of public activities to local needs, they have also created constraints. There has been a generally slow or erratic supply response

[37] Mellor 2000.

from the private sector, which in many countries has experienced difficulties in effectively replacing public services in finance, research, extension, education, health and even in infrastructure development and maintenance – particularly in rural areas where poverty is widespread. Smaller farmers and female-headed households have suffered disproportionately. The missing element has been the creation of the new public services required to create a supportive environment for the growth of private sector activities and to ensure equity and environmental sustainability.

Despite this critical omission, the strengthening of local institutions – including decentralisation and democratisation at local levels – is noticeable in many countries. In recent years, the role of women in local governance has been strengthened in some countries, although long-term outcomes are not yet clear. These trends have exposed rifts between central and local authorities in setting development priorities and budgetary allocations, as well as in developing oversight mechanisms. Other policy shifts have had a dramatic effect on production incentives in some farming systems. For example, the introduction of the individual household incentive policies boosted food and agricultural production almost overnight in Vietnam – which was transformed from a food deficit country to a food exporter. Similarly, the introduction of the individual household responsibility system in China stimulated a dramatic production response and signalled a major change in production structures.

A further policy area that is growing in importance is that of access to, and control of, natural resources – particularly land and water. As populations continue to grow and marginal lands suffer increasing levels of degradation, the demands of poorer, minority and indigenous populations for more equitable access to resources will continue to intensify. Although accelerating rates of urbanisation will relieve some of the pressure, governments that are unable to develop and implement effective policies on land ownership, water management and taxation reform, will face the risk of serious social conflict.

INFORMATION AND HUMAN CAPITAL

The evolution of farming systems based upon increasing specialisation (e.g. large-scale broiler units) or integrated intensification (e.g. rice-fish-ducks) has required extra knowledge on the part of farm operators. The need for better information and enhanced human capital has also increased, as production systems have become more integrated with regional, national and international market systems. Many farmers in developed countries now have a much better understanding of the nature of the demand that they are responding to – in terms of its implications for varieties, timing, packaging and permitted chemicals. As a result, they have progressively modified their production practices and their portfolio of products in response to changing patterns of demand. This

knowledge-based approach has not yet been adopted widely in developing countries, beyond a relatively small group of educated commercial producers. However, the experiences of some small producers have shown that this approach is possible, even among producers facing severe poverty. Depending on the speed and form of evolution of farming systems, knowledge-based adjustments are likely to intensify during the coming 30 years.

Lack of education, information and training is frequently a key limiting factor to smallholder development. Many observers anticipate an information revolution that will provide large volumes of technological, market and institutional information to these farmers. However, it is unlikely that much of this information will reach most producers in low income countries in the near future; although commercial operations could benefit. Inevitably, issues of equitable access and dissemination will arise as marginalized populations are bypassed.

One of the major achievements in many developing countries during the past three decades has been the extension of literacy training and primary education to the majority of the rural population. Given the high returns to primary education that have been repeatedly demonstrated, it is considered likely that rural education will expand considerably in those countries where gender discrimination is minimal, civil conflict is absent and economic stability can be maintained. This development may leave the next generation better equipped to participate in knowledge-based agriculture and to utilise the expanding information base.

In parallel with the extension of primary education, tertiary education has expanded in most developing countries. Thus, governments, private sector and civil society, in many countries, now have a steady supply of agricultural graduates who can provide technical services to farmers. However, many observers are convinced that the agricultural education system should be overhauled and the quality and relevance of such training radically improved.

Armed conflict, migration of men in search of paid employment and rising mortality rates attributed to HIV/AIDS, have led to a rise in the number of female-headed households and placed a considerable burden on women's capacity to produce, provide and prepare food. Despite their increasingly prominent role in agriculture, they remain severely disadvantaged in terms of their access to commercial activities. A FAO survey showed that female farmers receive only seven percent of all agricultural extension services world-wide and that only 11 percent of extension agents are women[38]. Throughout the developing world women are denied the full legal status necessary to give them access to loans. This lack of access to rural financial services hampers women's efforts to improve their farm activities. Improvements in these areas can be expected in the coming decades, as women become better organised to assert their rights.

[38] FAO 1990b.

Whilst in the past many development efforts failed women – because planners had a poor understanding of the role women play in farming and household food security – greater efforts are being made to take account of their actual situation. A gradual improvement is also expected to result from improved primary education, as a higher proportion of women farmers being able to communicate directly in the same language as extension advisors, bankers or agribusiness managers. Notwithstanding the increased sensitivity to gender roles, however, there is still a widespread failure to reach women with effective services.

It is increasingly recognised and acknowledged by development workers that the empowerment of women is the key to raising levels of child and family nutrition, improving the production and distribution of food and agricultural products, and enhancing the living conditions of rural populations. It has been concluded that if women in Africa received the same amount of education as men, farm yields would rise by between seven and 22 percent[39]. Similarly, better access to credit, land and extension services would enable women to make an even greater contribution to eliminating rural hunger and poverty. As gender bias is progressively eliminated during the coming 30 years – often in the face of severe cultural and religious barriers – productivity within many farming systems will be transformed.

READER'S GUIDE

This document provides an outline of future challenges, opportunities and proposed agricultural development strategies for the developing world. The relevance of farming systems analysis has been discussed in this Chapter, and particular attention paid to describing the key trends that are expected to influence farming system evolution over the next thirty years. Drawing on FAO projections[40], and utilising a range of databases, the book delineates and analyses the main farming systems of the six major developing regions of the world in Chapters 2 to 7. As a single region may contain as many as 16 identified farming systems, from three to five systems have been selected for detailed analysis in each region. Detailed discussion of the selected key systems is divided into three sections: (i) characteristics; (ii) trends and issues; and (iii) priorities. The regional analyses each conclude with a discussion of overall strategic priorities for the region. Commonalities, challenges and crosscutting priorities emerging from these analyses are presented in Chapter 8. Conclusions and ways forward are presented in Chapter 9.

[39] FAO 1990b.
[40] FAO 2000a.

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NATURAL RESOURCES AND CLIMATE

The interaction of natural resources, climate and population determines the physical basis for farming systems. During the early stages of development, increased population generally leads to an expansion in cultivated area and, in many cases, conflict between the different users of land and water resources. Once most good quality land is already exploited, further population increases tend to lead to the intensification of farming systems. As forests and woodlands come under greater pressure, biodiversity is threatened and there may be growing tension between development and conservation goals. These trends have often been exacerbated by colonial and

Box 1.1 Population Pressure on Annual and Permanent Cropland by Region – 1995-1997 (pers/ha)

Region	Agric.	Total
Sub-Saharan Africa	2.2	3.6
Middle East and North Africa	3.1	4.5
Eastern Europe and Central Asia	0.3	1.6
South Asia	3.5	6.3
East Asia and Pacific	4.9	7.9
Latin America and Caribbean	0.7	3.2
Average	2.3	4.5

Source: FAO 2000a.