

Global Farming Systems Study: Challenges and Priorities to 2030

REGIONAL ANALYSIS EAST ASIA AND PACIFIC REGION

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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 strategy¹.

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 almost 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 East Asian and Pacific 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 East Asia and Pacific Region.

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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.

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1 Introduction

CHARACTERISTICS OF THE REGION

The East Asia and Pacific Region³, as defined for this study, covers 23 countries with a total population of 1,836 million (31 percent of the world population)⁴, of which 62 percent (1,114 million⁵) are directly involved in agriculture. Thirteen of the countries are located in east Asia and South East Asia, with the remainder consisting of Papua New Guinea and 9 Pacific Island countries. Considerable variation exists among countries in total population, population density and the proportion of the rural population in the total population. The most populous countries in the region are China (1,278 million or 68 percent of the region) and Indonesia (205 million or 12 percent of the region), the first and fourth most populous countries in the world. Very high population densities occur in some rural areas, for example in eastern China and the islands of Java and Bali in Indonesia. Population growth rates, although moderating, remain high in some countries.

Total land area of the region⁶ is 1584 million ha. Forest cover is estimated at 380 million ha (23 percent of land area⁷), 170 million ha of which is considered dense forest, and cultivated land is estimated at 231 million ha (15 percent of land area). The rest is

grasslands, wastelands, mountains, urban areas and waterbodies.

Some 278 million people⁸ (15 percent of the total population) in the region are considered to be living in poverty, with daily incomes of less than US\$1 a day. A quarter of these people live in China, but significant numbers are found in almost all countries in the region. About 13 percent⁹ of the total population in the region are undernourished. Variation in poverty exists between rural and urban people and between countries. The incidence of poverty in rural areas is approximately twice as high as in urban areas¹⁰. The incidence of rural poverty by country, according to national poverty lines, ranges from 4.6 percent in China to 57.2 percent in Vietnam.

The agricultural sector's value added is about 13 percent of total GDP in the region¹¹. This figure is heavily influenced by the proportion in China (17 percent). In fact, considerable variation exists among countries of the region. In Republic of Korea, the agricultural sector's added value is only 5 percent of the national GDP, while in Laos and Myanmar it is 53 percent and in Cambodia it is 51 percent. With the exception of China and Republic of Korea, the economies of the region are strongly agrarian.

³ China (excluding Hong Kong); Democratic People's Republic of Korea; Mongolia; Republic of Korea; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Thailand; Vietnam; and Papua New Guinea and the Pacific countries. In addition to Hong Kong, the analysis excludes Australia, Japan, New Zealand, Singapore and Taiwan.

⁴ World Bank Development Indicators, 2000.

⁵ Calculated on the basis of UNFPA's percentage urban population in 1995.

⁶ East Asia and Pacific in 1998. World Bank.

⁷ World Bank.

⁸ East Asia and Pacific in 1998, from *World Development Report 2000*, World Bank, 2000.

⁹ *Agriculture: Towards 2015/30*, FAO, 2000.

¹⁰ Calculated from percentages of the poor among the rural and urban populations in various years on the basis of nationally determined poverty lines in World Development Report 2000, World Bank, 2000. DPR of Korea, Republic of Korea, Myanmar and Papua New Guinea are excluded due to a lack of the poverty data in the report. For Malaysia, the national poverty incidence was applied to both rural and urban populations.

¹¹ World Development Indicators, 2000. Table 1.5. World Bank.

MAJOR REGIONAL FARMING SYSTEMS¹²

For the purposes of the regional analysis, eleven major farming systems have been characterised based on criteria that include: resource base, dominant livelihoods (main staple and cash income source and the balance between crops, livestock, fishing, forestry and off-farm activities), and the degree of crop-livestock integration. Their geographical distribution is shown in Map 1. These systems are necessarily broad-based and defined by dominant production patterns, but are considered homogeneous enough to indicate future trends and needs as a basis for future strategic support by donors. Whilst mapping such aggregate farming systems, it is inevitable that significant heterogeneity is included within each farming systems unit and thus important subsidiary system types are noted in the text. The boundaries between systems are generally fuzzy, 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. The relationships of these systems to important features of the resource base are shown in Map 2 (length of growing period), Map 3 (elevation), Map 4 (environmental constraints) and Map 5 (irrigation).

Lowland Rice Farming System. This farming system is found in both humid (270-365 growing days) and moist sub-humid (180-269 growing days) tropical environments in mainly flat landscapes and covers an estimated 197 million ha with an agricultural population of 489 million. Cultivated area is estimated at 73 million ha of which about 45 percent are irrigated. Large areas of this system are found in Thailand, Vietnam, Myanmar, South and central East China, Philippines and Indonesia. Smaller areas are located in Cambodia, Korea DPR, Republic of Korea, Laos DPR and Malaysia. The farming system is dominantly rice-based, with cropping intensity dependent on rainfall distribution, length of growing season and supplementary irrigation availability. Other important crops include oilseeds, maize, root crops, soybeans, sugarcane, cotton, vegetables and fruits in all areas and wheat in central East China. Crops are grown under both rainfed and irrigated conditions. Poverty is extensive and generally severe.

Tree Crop Mixed Farming System. This farming system is found dominantly in a humid (270-365

growing days) tropical environment, but also extends into moist sub-humid (180-269 growing days) areas, principally on flat to undulating landscapes with generally poor soils. Total system area is 82 million ha, with an agricultural population of 30 million. Cultivated area is estimated at 18 million ha, of which little more than 12 percent is irrigated. Significant areas of this system are found in Malaysia, Indonesia, Thailand, Cambodia, Philippines, Vietnam, southern China and Papua New Guinea. Major industrial crops include rubber, oil palm, coconut, coffee, tea and cocoa, with some other associated crops such as pepper and other spices. Small farms without tree crops are scattered through this zone, growing food and cash crops and producing livestock. Tree crops are grown under both large private estates and small-holder management systems. Coconut plantations are widespread throughout most Asia and Pacific countries. Poverty is moderate.

Upland Intensive Mixed Farming System. This farming system is found in humid and sub-humid tropical, subtropical and temperate environments in upland and hill landscapes of moderate altitude and moderate slope. Total system area is 311 million ha, with an agricultural population of 316 million. Cultivated area is estimated at 76 million ha, of which about one quarter is irrigated. This is the most widespread and most heterogeneous farming system in the region, with major areas located in all countries of East and Southeast Asia. The system is characterised by mostly permanent cultivation of a wide range of crops, but the specific crops preferred depend on geographic area, agro-climatic conditions, landscape slope, terracing and water regime. A significant crop area (mainly rice) is irrigated from local streams and rivers. Livestock production is important for draught power, meat production, and savings and cash income. Poverty is extensive, varying from moderate to severe.

Highland Extensive Mixed Farming System. This farming system is found in both humid (270-365 growing days) and moist sub-humid (180-269 growing days) tropical, subtropical and temperate environments in hill and mountain landscapes of high altitude and steep slopes. Total system area is 90 million ha, with an agricultural population of only 21 million. Cultivated area is estimated at 8 million ha, of which

¹² 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: Key Characteristics and Potentials of Farming Systems in East Asia and Pacific Region

Farming Systems	Land area (percent of region)	Agric Popn ¹³ (percent of region)	Principal Livelihood	Incidence of Poverty	Potential for poverty reduction	Potential for agric. growth
Lowland Rice	12	44	Rice, maize, pulses, sugarcane, oil seeds, vegetables, livestock, aquaculture	Extensive severe poverty	Moderate	Moderate
Tree Crop Mixed	5	3	Rubber, oil palm, coconuts, coffee, tea, cocoa, spices, rice, livestock	Moderate poverty mainly of smallholders	High	High
Upland Intensive Mixed	20	28	Rice, pulses, maize, sugarcane, oil seeds, fruits, vegetables, livestock	Extensive moderate and severe poverty	Moderate	Moderate
Highland Extensive Mixed	6	4	Upland rice, pulses, maize, oil seeds, fruits, forest products, livestock	Moderate to severe poverty	Moderate	Moderate
Temperate Mixed	6	14	Wheat, maize, pulses, oil crops, livestock	Extensive moderate and severe poverty	Moderate	Low
Pastoral	20	1	Livestock with irrigated crops in local suitable areas	Severe poverty especially drought induced	Low	Low
Root-tuber	1	<1	Root crops (yam, taro, sweet potato), vegetables, fruits, livestock (pigs and cattle)	Limited poverty	Good	Moderate
Sparse (forest)	11	1	Hunting, gathering	Moderate	Low	Low
Sparse (arid)	20	2	Local grazing where water available	Severe	Moderate	Low
Urban based	n.a.	little	Horticulture, dairy, poultry	Low to moderate	Low	Moderate
Coastal Artisanal Fishing	n.a.	little	Fishing, coconut, mixed cropping	Moderate	Moderate	Low

Principal farming systems are shaded

¹³ Agricultural populations are defined as those working in farming, forestry or fishing and their dependents.

about one fifth is irrigated. Extensive forested areas occur in the system, some of which is dense forest with little habitation. Major areas of this system are located in Laos, central and north Vietnam, northern Thailand, northern and eastern Myanmar, south-western China, the Philippines and parts of Indonesia. The farming system can be subdivided into permanent and shifting cultivation sub-types. Both sub-types produce crops (including perennial crops such as fruit trees), livestock, and forest products. Many tribal (ethnic) groups are involved in this farming system. Poverty is moderate to severe.

Temperate Mixed Farming System. This farming system is found in moist sub-humid (180-269 growing days) subtropical and dry sub-humid (120-179 growing days) temperate environments in central-northern China and Mongolia. Total system area is 95 million ha, with an agricultural population of 161 million. Cultivated area is estimated at 31 million ha, of which about 40 percent is irrigated. The transitional boundary between this system and the Lowland Rice Farming System is not easily defined in central-eastern China. The major crops are wheat and maize with smaller areas of rice, cotton, soybeans, sweet potato and rape, depending on local temperature and water conditions, as well as citrus and some temperate fruits. Livestock are important, particularly cattle, pigs and poultry. Poverty is moderate.

Pastoral Farming System. This farming system is found in semi-arid and arid temperate environments (with less than 120 growing days per annum) in both plain and hill landscapes. This system is extensive in western China and Mongolia. Total system area is 311 million ha, but with no more than 42 million people classed as agricultural. Cultivated area is estimated at just over 12 million ha, of which some 20 percent is irrigated. The farming system is dominated by pastoralism, except where irrigation is available at dispersed locations in the zone (and therefore not easily mapped). Pastoralism is characterised by mixed herds of camels, cattle, sheep and goats extensively grazing native pasture. Pastoralists are mostly nomadic. Crops are cultivated in restricted areas where irrigation water can be tapped from local surface and groundwater resources. Irrigated crops include cotton, barley, wheat, pulses, peas, broad bean, potato, grapes and sericulture. Severe poverty,

induced by drought, exists in both pastoral and irrigated systems.

Root-Tuber Mixed Farming System. This farming system is found in humid (270-365 growing days) and moist sub-humid (180-269 growing days) tropical environments in both plain and hill landscapes. Total system area is 20 million ha, with an agricultural population of less than 1m. Cultivated area is estimated at less than 1 percent of total area (under 0.2 million ha), and no irrigated area is recorded in this system. The system is found in Papua New Guinea and the Pacific Islands generally. The farming system is based on the traditional use of root food crops (yams, taro, sweet potato), vegetables and fruits (particularly banana), coconut and livestock. Poverty is limited.

Sparse Farming Systems. Although vast in area, the sparse agriculture systems (both forest and arid) are of limited economic importance. The total area of the Sparse (arid) Farming System, located in western China and Mongolia, is estimated at 312 million ha, supporting an estimated 9 million cattle and 57 million small ruminants. Nearly 4 million ha is cultivated, of which about two-thirds is under irrigation. Two types of irrigation occur: some large scale irrigation areas, especially in the west; and scattered small areas of irrigation used by pastoralists to supplement their livelihoods. Human population is 24 million, of which 17 million are classified as pastoral or agricultural. Apart from these arable areas, the arid areas are utilised for opportunistic grazing where water is available for livestock. The Sparse (forest) Farming System lies at moderate to high altitudes to the north and west of the main areas of Highland Extensive Farming Systems in western China and northern Myanmar, and covers an estimated area of 168 million ha with a population of 23 million people, of whom 15 million are classified as agricultural. A number of small settlements depend on potatoes and buckwheat, plus cattle and yak herds. There are nearly 10 million ha of scattered cultivation, 13 million bovines and 18 million sheep and goats supported within this system.

Artisanal Fishing Mixed Farming System. Along the narrow coastal strips of mainlands in many countries of the region and in many islands, households supplement artisanal (inshore) fishing with food production,

often rice, and cash enterprises such as coconuts and livestock. The location of this system is not separately mapped.¹⁴

Urban Based Farming System. Around most large towns and cities throughout the region, the intensive production of perishable high value commodities, such as milk and fresh vegetables, has expanded and now employs a substantial agricultural population. These farming systems are generally characterised as high external input, commercial systems with well-functioning links to the surrounding rural areas for livestock, feed and fodder supplies.

Four of the above farming systems have been selected for more detailed analysis, using criteria based

upon higher poverty incidence and potential for agricultural growth and poverty reduction in the coming 30 years, as follows:

- Lowland Rice Farming System;
- Tree Crop Mixed Farming System;
- Temperate Mixed Farming System; and
- Upland Intensive Mixed Farming System.

These four farming systems contain most of the rural poor in the region and also produce more than three-quarters of the Gross Agricultural Domestic Product (GADP). These systems are described in more detail in the following sections.

¹⁴ Fisheries development in the region is the subject of a separate strategy document.

2 Region-Wide Trends

POPULATION

The region has been settled for thousands of years and has experienced high population growth rates in the last century, resulting in high population density in many areas. In response to overpopulation, many governments have introduced birth control programmes that have contributed to falling population growth rates, and this trend will continue although there will be significant variations in the rate of decline among countries. Overall, the population in the region is projected to grow at 0.9 percent per annum to 2.13 billion by 2015, and thereafter at 0.5 percent per annum to 2.31 billion by 2030. The proportion of urbanisation within the region is expected to increase from the current 37 percent to 53 percent by 2030¹⁵. However, in many of the developing countries in the region, a large proportion of the rural population and the majority of the total population will continue to be employed in the rural sector. The rural population will, however, continue to gradually age, as younger people migrate to cities for jobs. This has adverse implications for socio-economic conditions and labour quality and availability in rural areas.

RURAL LIVELIHOODS

The past period of rapid economic growth has resulted in major socio-economic gains across most of the countries in the region, but these gains have been strongly biased in favour of the urban population. With the exception of China and Republic of Korea,

the economies of the region are strongly agrarian. Agricultural GDP has in the past been generally decreasing as a proportion of national GDP, but remains a significant proportion of total GDP.

This trend would be expected to continue in all countries, but in some countries, a majority of people would remain dependent on the agricultural sector by 2030. Socio-economic indicators (household income, poverty, health, literacy, infant mortality, morbidity, longevity, etc.) of the rural population, while gradually improving in most countries are usually significantly lower than for the urban population. Rural incomes have only increased slowly (and maybe not at all in real terms) and in almost all countries, there is a growing disparity between rural and urban incomes.

Average per capita GDP in the region is about US\$1,000 (US\$3,500 at parity purchasing power)¹⁶, which is low compared to other developing regions. There are 278 million people (15 percent of the total population) who are considered to be living in poverty, with daily incomes of less than US\$1 a day, approximately twice as many in rural areas as in urban areas. A quarter of these people live in China, but significant numbers are found in almost all countries in the region. Furthermore, the rural population remains relatively poorly educated, with significant illiteracy in a few countries and low school attainment levels. This has an adverse effect on knowledge and learning skills of farmers. While some improvements in these factors may occur, it is anticipated that these disparities will increase in many countries by 2030 unless governments undertake active policy initiatives and plans to specifically redress this imbalance.

¹⁵ For the whole of Asia. Separate data for East Asia are not available.

¹⁶ World Development Indicators 2000, Table 3.3, World Bank.

FOOD SECURITY

In the last two decades, the human diet in the region has improved significantly with a 30 percent increase of total calorie intake, resulting in significant reductions in under-nourishment in most countries. In China, the proportion of the under-nourished population decreased from 30 percent in 1979-81 to 13 percent in 1995-97, and in Indonesia from 26 percent to 6 percent¹⁷. Under-nourishment increased in only two countries – Mongolia (from 27 percent in 1979-81 to 48 percent in 1995-97) and Korea DPR (19 percent to 48 percent) in the same period. However, a number of other countries still have higher proportions of under-nourished people than the developing world average (18 percent), including Cambodia (33 percent), Lao PDR (33 percent), Thailand (24 percent), and Papua New Guinea (24 percent).

There are eight defined Low-Income Food Deficit Countries in the Region: Cambodia, China, Indonesia, Korea DPR, Lao PDR, Mongolia, Philippines, and Papua New Guinea. The current average food intake in the region is estimated at 2,783 kcal per person per day, 6 percent higher than the average for all developing countries. However, cereals (rice and wheat) contribute a very high proportion of total calorie intake. By 2015 and 2030, the food intake is forecast to increase to 3,020 kcal and 3,170 kcal, respectively. Higher calorie intake will be accompanied by improvement in the quality of the diet with significant growth in consumption of meat (65 percent increase by 2030) and milk and dairy products (90 percent).

AGRICULTURAL DEVELOPMENT

Agriculture is presently dominantly smallholder-based with widespread subsistence production. Average farm size has been declining for many decades in most countries. Only in a few countries (e.g. Thailand) has the absolute number and proportion of rural-based population decreased, which will ultimately result in larger average farm size, as happened decades ago in industrialized countries. By 2030, however, it is anticipated that farms in the region will remain traditional smallholdings, although the proportion of semi-commercial and commercial farms will increase. Total cul-

tivated land is estimated at 231 million ha, of which 134 million ha is found in China.

Only a marginal net increase in cultivated land is expected by 2030, with another 6 million ha cultivated. However, the net cultivated land in China has decreased over the last two decades and is forecast to continue to gradually decrease to 128 million ha by 2015 and to 125 million ha by 2030, as increasing urbanisation removes land faster than new land is brought into cultivation. The worst aspect of this decline is that land going out of production is the most productive land and the new land brought into cultivation is more fragile, less fertile, steeper, more drought-prone and with less soil depth. For the other countries in the region, however, an estimated net annual increase of 0.41 percent of cultivated land area is projected up to 2030, which is higher than the developing world's estimated average net annual increase (0.34 percent).

CROP PRODUCTION AND YIELDS

Overall crop production in the region has been increasing at 3 percent per year during 1980s, but the rate of increase has been slowing. Further increases in production will be dependent mostly on increased crop yield and increased cropping intensity. Crop yield in the region increased by 3.6 percent annually during the period 1967-1997, and is projected to grow by another 1.2 percent annually during the period 1997-2030. Little increase is expected in cultivated land area and therefore future increases in crop production will be achieved through higher cropping intensity, which is projected to grow by 12 percent by 2030, and higher crop yield per unit area. However, considerable variation is anticipated in growth projections for various crops. While the production of paddy rice, the main crop in the region, increased at about 2.4 percent annually from 1970 to 1999 to 350 million tons (200 million tons in China) it is projected to increase annually by only 0.7 percent over the period to 2030. Wheat production in the region increased up to 1990, but since then has declined at an annual rate of – 0.7 percent, although production is expected to increase by about 1.4 percent annually during the period 2000 to 2015. The region now produces 115 million tons of wheat compared to only 30 million tons in 1970. Substantial increases in production of maize

¹⁷ *The State of Food Insecurity in the World*, FAO, 1999.

and barley are expected, while little increase in production is anticipated for millet, sorghum, cassava, and pulses. The production of oil crops, such as rape, soybean, maize, sesame, sunflower and oil palm, and fruits and vegetables are expected to increase substantially by 2030. The production of cotton is expected to increase moderately, while the production of other fibre crops is expected to stagnate. The production of beverages, tea and coffee, is also expected to increase significantly. Natural rubber production has grown at a rate of 2.7 percent in the past, doubling from 1961 to 5.6 million tons by 1999 and is expected to double again during the next 30 years.

WATER USE AND IRRIGATION

The region's renewable water resources account for 32 percent of the total renewable water resources in the developing world. The present irrigation efficiency in the region is low at 38 percent and expected to increase slowly to 42 percent by 2030, still lower than the projected developing world average of 50 percent in the same year. Cultivated land under irrigation is projected to expand from the current 71 million ha (30 percent of the total cultivated land) to 85 million ha (35 percent) in 2030. China alone irrigated 51 million ha in 1995-97 and is expected to bring another 9 million ha under irrigation by 2030.

FERTILISER

For the period 1961-1997, the use of fertiliser increased rapidly at an annual rate of 8.9 percent. As a result, fertiliser application in the region is high at 147 kg per ha compared to the developing world's average of 90 kg per ha. The high level of regional fertiliser consumption is due to the massive use in China as the average for the rest of the region is 93kg per ha. China consumes 73 percent of all the fertiliser in the region and has twice the application rate compared to the average of the other countries combined. The pace of increase is expected to slow down to an annual rate of 0.6 percent from 2000 to 2030, when the average consumption will be 180 kg per ha. Excluding China, the projected annual rate of increase in other countries will be 0.4 percent from 2000 to 2030, and the average consumption will be 106 kg per ha by the year 2030.

LIVESTOCK

Most of the past increase in livestock production in the region has been driven by the rapid expansion of the livestock sector in China. Numbers of pigs and poultry in the region increased at high annual rates of 2.6 percent and 6.8 percent respectively in the last three decades. Presently, more than 50 percent of the pigs and 36 percent of chickens and fowls of the world are found in the region. For the period 2000 to 2030, the pace of increase in China will slow down for both animal types with expected annual rates of 0.8 percent for pigs and 1.3 percent for poultry. This will still require huge increases in animal feed supplies in China, which are expected to come from a large increase in maize production at the expense of rice and wheat production. Both total and per capita meat and milk consumption have increased rapidly in the last twenty years. Between 1983 and 1993, per capita annual meat consumption increased from 16 to 33 kg in China and from 11 to 15 kg in Southeast Asia countries while per capita milk consumption increased from 3 to 7 kg in China and from 10 to 11 kg in Southeast Asia countries. The scope for increase in livestock numbers and meat production in other countries in the region is mostly limited to pigs and poultry as there is little potential for strong growth in ruminant meats (buffalo, cattle, sheep, goats). The increased production of poultry and pigs will entail increased competition between livestock and humans for consumption of grains. Ruminant livestock are an important source of draft power, meat, savings and income in farming systems throughout the region. Total populations of cattle (and buffalo), sheep and goats and dairy animals in the region are estimated at 178 million, 298 million and 3 million, respectively. The past and future trends for bovines and small ruminant production in the region are similar with annual rates of increases of 1.7 percent and 1.8 percent respectively for the last decades and projected 1.3 percent for both types of livestock for the period 2000 to 2030. However, the potential for increasing the supply of feeds for ruminants is anticipated to be a significant constraint in most countries. Little opportunity exists for improving and expanding native pastures, forages, and sown pastures in the countries in the region. Ruminant feed supplies will be expected to be mostly dependent on cultivated forages and native pastures rather than grains and concentrates.

FORESTRY

Forest cover is estimated at 380 million ha (23 percent of land area), 170 million ha (10 percent of land area) of which remains dense forest. Forest cover¹⁸ in the region decreased by 0.8 percent p.a. (3 million ha) between 1990 to 1995, due to unsustainable logging practices, and is expected to diminish further, with little reforestation of natural forests and limited establishment of forest plantations.

TRADE

The region currently accounts for an extremely high proportion of world trade in a number of agricultural

commodities including oil palm (Malaysia, Indonesia, China, Papua New Guinea and Solomon Islands), rubber (Thailand, Malaysia and Indonesia) and rice (Thailand, Vietnam and Philippines). Those countries with a strong positive balance of trade in agricultural products include, Thailand, Malaysia and Vietnam while China, Republic of Korea, Korea DPR and the Philippines have a strong negative balance of trade. Market liberalisation is expected to encourage farm diversification, production and trade of higher-value products in all farming systems. Expanding urban markets will increase internal trade in most countries in the region, with urban and peri-urban agriculture expected to expand and intensify to meet the increasing demand for vegetables and fruits and meat and dairy products.

¹⁸ For East Asia and Pacific. World Bank.

3 Lowland Rice Farming System

SYSTEM DESCRIPTION

This farming system covers some 197 million ha (12 percent of the land area of the region), contains a total population of 825 million and an agricultural population of 489 million (27 percent of the total population of the region), and is found in both humid (270-365 growing days) and moist sub-humid (180-269 growing days) tropical environment in mainly flat landscapes. Large areas of this system are found in Thailand, Vietnam, Myanmar, South and Central eastern China, Philippines and Indonesia. Smaller areas are located in Cambodia, Korea DPR, Republic of Korea, Laos DPR and Malaysia. Average household incomes are low and poverty is extensive and severe in many areas. Land ownership is secured under traditional or – less frequently – freehold tenure. Traditional rights are not recognised as legal ownership in many countries, but generally provide long-term use of land. The system is generally well serviced by roads, communications, community, goods and support services. In economic terms, this is the most important farming system in the region.

About 73 million ha of the system is estimated to be cultivated. There is considerable variation in intensity of farm production. More intensive production systems are found in areas with higher population density and smaller farm size, for example in China.

Total population	825 million
Agricultural population	489 million
Total land	197 million ha
Agro-ecological zone	Moist sub-humid
Arable land in use	73 million ha
Irrigated area	33 million ha
Bovine population	52 million
Small ruminants	36 million

BOX 1: A TYPICAL LOWLAND RICE FARM SYSTEM HOUSEHOLD

A typical rice farm household with four family members cultivates a total area of 0.24 ha with a cropping intensity of 190 percent in Thai Binh Province, Red River Delta, Vietnam. Two transplanted rice crops (89 percent of the total cropped area of the farm) are followed by sweet potatoes (5 percent), maize (2.8 percent) and soybeans (1.6 percent of the cropped area). Modern rice varieties are transplanted in both seasons, producing 2.5 tons per year of paddy rice (equivalent to 6.5 t/ha for spring paddy and 5.8 t/ha for winter paddy). The annual production of the three other crops is 246 kg (14.6 t/ha) for sweet potatoes, 50 kg (4 t/ha) for maize and 13 kg (1.7 t/ha) for soybeans. Annual production of such farm household for these four main crops totals 2.8 t (0.7 t per capita). Power tillers are used for primary tillage, and additional income is earned through provision of transportation services. The household maintains a small piggery. The household income, which has risen rapidly during the past 20 years, is only around the international poverty line.

Average farm size of the Lowland Rice Farming System is typically small, but varies significantly. Farm holdings in the Mekong River Delta have 0.79 ha cultivated area, while the cultivated area per farm holding in the Red River Delta is only 0.24 ha (refer to box 1) and 0.67 ha in South-East China. By contrast, average cultivated area on farms in central Thailand is 2-3 ha. Average farm household size can vary from 6 persons in the Mekong River Delta to 4 persons in Jiangsu Province, China.

The farming system is predominantly rice-based, with the number of rice crops ranging from 1-3 per year, depending on rainfall distribution, length of growing season and supplementary irrigation availability. The total irrigated area is estimated at 32.7 million ha, which covers 45 percent of the arable area in the farming system and represents 46 percent of the total irrigated area of the region. Total annual area of rice is estimated at 96 million ha. The second most important crop in the region is wheat (21 million ha), which is sown as a winter crop, mainly in the northern part of this farming system in central-eastern China. Other crops found in this farming system, in descending order of area importance, are vegetables, oilseeds, maize, root crops, soybeans, sugarcane, cotton and fruits. Large and small ruminants, pigs and poultry are a minor but important source of income generation. Large ruminants still provide a major source of draft power, but farm mechanisation is gradually increasing. Increasingly diversified forms of fish production are also found in association with rice cultivation.

Rice is mostly grown on puddled lowland soils under both rainfed and irrigated conditions. Soils are heavy and inherently more fertile than other cropped soils, but natural fertility is declining under conditions of continuous cropping with inadequate or unbalanced nutrient inputs. The average yield of paddy is 3.1 t/ha across the region, but is heavily skewed by the higher yields obtained in China (up to 8.1 t/ha in Jiangsu Province). Countries such as Cambodia, Laos, Thailand and Myanmar, have low average yields. High-yielding varieties are used in all countries, but some countries still plant a significant area of lower yielding, traditional varieties because of their perceived higher grain quality and acceptability. Fertiliser use is moderate to high, including the use of both inorganic and organic fertilisers. High inputs of organic and inorganic fertiliser combined with the universal use of high-yielding varieties are the main determinant of high yields in China. Rice is mostly transplanted, but germinated seed or seedlings are broadcast in some countries (Thailand and some areas of China) where serious labour shortages occur. Triple cropping only occurs where transplanting is used and there is a continuous supply of water during the year.

Livestock are an important component of this system for draft power, meat, savings and income purposes. About 29 percent (52 million head) of the total large ruminants (cattle and buffalo) of the region are found in this farming system. Buffalo are very

important for draft power in the lower, wetter landscapes with cattle used more commonly in slightly higher parts. Sheep are unimportant, but 36 million goats (12 percent of the regional total) are found in this farming system. Ruminant livestock graze under extensive conditions and animal health services and practices are generally poorly developed in many areas. Pigs and poultry are important for household consumption and sale. In more extensive rice-based production systems, animals mostly scavenge during the day with some supplementary feeding. Animal husbandry and health practices are generally poor. Mechanisation is increasing throughout the system, resulting in a decreasing importance and number of buffalo. More intensive production systems for pigs and poultry are found in the more intensive farming production system practised in China. Animals are usually housed with greater productivity as a result of better feeding, husbandry and animal health practices.

On-farm fish production is an important source of food and income in this farming system. Fish are cultivated in association with wet land rice fields and in ponds. Rice cultivation has been further diversified in coastal areas in China where rice culture has been combined with other fisheries products, such as crabs, shrimps and pearls. This type of farm diversification has numerous benefits, including improved pest control, nutrient cycling and cash income that can be used in purchase of crop production inputs.

The majority of farm households in this system are food secure and sell surplus rice, cash crops, livestock and fish. Nationally, most countries can only meet or are unable to meet internal rice consumption demand; only Thailand and Vietnam are significant exporters of rice. Livestock and fish are only traded within countries. Small quantities of some other crops produced in this system are traded internationally.

SYSTEM TRENDS AND ISSUES

The production growth of the Lowland Rice Farming System is expected to slow in the coming years due to limited capacity for cultivated area expansion and an expected slowing of the rate of crop yield increases. Changes in farm production are expected to come from increased intensification and diversification of crop production, as well as product diversification. Technology changes will emphasise not only increased production and incomes, but also improved sustainability of the natural resource base. Irrigation use

efficiency is expected to increase, with some expansion of irrigation area. Increasing diversification will include not only crop diversification, but also intensifying livestock production and expansion of small-scale on-farm aquaculture (fishponds, rice-fish culture, shrimps, crabs, etc.). The trend will be to produce agricultural products with higher value. It might be anticipated that rice production would decline where other crops have higher economic value. These changes would allow greater income security and increased family incomes. Should average farm size and farm mechanisation increase as well, this would further raise household incomes and decrease poverty.

Specific issues that have to be addressed in advancing the productivity and income generation of Lowland Rice Farming System are identified as follows:

- (i) An ever-increasing agricultural population in the intensive rice-based system has resulted in an increasing fragmentation of farms. In many instances farm size is uneconomic and even with the adoption of best practices would still only be marginally profitable. If this trend continues, an increasing proportion of farmers in many countries will operate a subsistence production system.
- (ii) The adoption of intensive methods of crop production, based on high levels of inorganic fertilisers and pesticides, has in some cases affected the quality of soil and water resources. Continuous rice cultivation, using unbalanced mineral fertilisers with low input of organic manure, is in some situations creating serious deterioration in physical and chemical properties of soils with adverse consequences on crop yield.
- (iii) There is limited scope for further expansion of irrigation systems. Only a few countries are in the fortunate position of under-exploitation of water resources. In some areas, serious shortages of irrigation water occur in the dry season. Water use efficiencies are often low. Future emphasis will have to be given to improved management and efficient utilisation of water resources and water pricing.
- (iv) Past trends in farm production have been towards exclusive development of rice monoculture systems in lowland areas. The more recent trend to diversify farm production (introducing field crops, vegetables, small livestock and fish into the farming system) has resulted in increased incomes and improved family diets and human

health. Local opportunities for farm diversification need to be identified, as they are location-specific. In many areas, livestock production associated with Lowland Rice Farming System is low because of extensive management practices. Opportunities to intensify small animal production systems need to be identified in relation to the resource situation and market circumstances.

- (v) On-farm deterioration in quality and reduction in quantity of rice for sale, due to poor post-harvest management practices and inadequate storage conditions, is very significant in many areas, resulting in reduced revenues from crop sales.
- (vi) Decreasing farm profitability and net farm income due to increasing costs of production and decreasing returns for agricultural products have placed greater emphasis on off-farm income. Off-farm income is generally a significant part of total household income. Opportunities for value-adding and improved marketing of products need to be identified.
- (vii) In some countries, government agencies still maintain monopolies on supply (and pricing) of production inputs and also control the sale of crop products. Policies and actions need to be adopted to privatise the supply of production inputs and liberalise marketing of products.
- (viii) In most countries, the seed planted is generally of poor quality and not necessarily the most recently recommended variety because most farmers retain their own seed for replanting for many seed generations. While research and private companies have developed new crop varieties (including hybrids) with higher yield potential and better local adaptability, they are generally unavailable to the majority of farmers. Production of seed of improved rice varieties is mostly undertaken by government services, but quantities are much less than required by farmers. This situation has a serious adverse effect on crop yield and overall crop production and needs to be remedied.

STRATEGIC OPTIONS AND INTERVENTIONS

The central strategic options for improving the farming system relate to (i) land consolidation in order to allow economies of scale (even after consolidation fields would still be very small), (ii) improved resource

management to maintain high and growing productivity, (iii) enterprise diversification, and (iv) a high level of farm management concentrated on improved management of water resources, soil nutrients and pests. From the above analysis a series of interventions are indicated:

- Governments to undertake policy reform to promote land aggregation and consolidation leading to a gradual increase in average farm size. Such policy initiatives need to include issuing of land titles, development of markets for trading land, land leasing, establishment of land banks and use of land as collateral to finance purchase of additional land and investment in farm production activities. In addition, governments to undertake initiatives to provide alternative employment to agricultural workers in rural areas through promotion and development of locally based industries to enhance exit opportunities of farmers and farm workers and land consolidation.
- Formulate and implement programmes on integrated soil nutrient management to promote increased use of organic manures, crop rotations that include leguminous crops, and balanced fertilisation to improve sustainability of soil fertility and thereby crop yields.
- Formulate and implement training programmes and demonstrations that emphasise improved efficiency of water use, avoidance of pollution of water resources, communal operation and management and cost recovery of irrigation systems and efficient drainage systems.
- Implement demonstration, active learning and training programmes to diversify farm production (field crops, annual fruits, vegetables, small livestock and fisheries) to increase incomes, minimise and spread risks, improve natural resources and the environment and improve the diet of farm families. Programmes would aim to promote the cultivation of new crops of higher value that have good market prospects. Intensification of village-based, small livestock production (chickens, ducks, pigs, etc.) would be promoted through improved animal health, better feeding, improved animal husbandry practices and breed improvement. Local feed processing should be promoted by using crop by-products and the production of specific crop ingredients. Small

BOX 2: INTENSIVE DEVELOPMENT OF RICE-BASED FARMING SYSTEM¹⁹

The Lowland Rice Farming System in East Asia underpins the food security of several countries in the region. There are considerable productivity gaps between farms, between provinces and between countries. Very high sustained yields have been achieved in some high-performance systems such as in Zhejiang Province, China. A high level of management is required, with special attention to soil resources, complemented by continuous refinement of technology and strong support services. Although rice is still the main crop in lowland areas, diversification is increasing towards high value crops such as oil seeds and vegetables, and other profitable enterprises such as fish production. Current trends suggest that total farm productivity will continue to grow in the coming decade.

pond culture, rice-fish culture, and rice-shrimp and crab systems should also be promoted where local conditions are suitable.

- Introduction of improved post-harvest management practices, processing and storage conditions to reduce losses of crop products, in terms of both quality and quantity, resulting in higher revenues from crop sales.
- Government to divest responsibility for the production, distribution and sale of improved seeds and planting materials to the private sector to replace the generally inefficient and inadequate government seed and seedling production services.
- Promotion of off-farm sources of income to create entrepreneurship and additional employment opportunities in rural communities, particularly for the landless. Improvements in the marketing systems through provision of market information, assistance and market facilities to prevent product losses and increase the farmer's share of the consumer price.
- Development of financial mechanisms to optimally use local financial resources and gradually expand financial services. In marginal areas the support of local self-help groups (SHGs) to mobilise savings

¹⁹ For details see Wang, Z., 2001. Innovative Rice-Based Farming Systems Development: A Case Study from Zhejiang Province, China, Case Study, Global Farming Systems Study. Sustained growth in the high productivity system can be compared with the successful development of medium productivity rice based systems in the Case Study Diversification of Lowland Rice Farming System in Cambodia.

and to give small short-term loans may constitute a good starting point. Linking SHGs with formal financial institutions and the use of micro lending technologies broadens the outreach as well as the sustainability of financial services.

- Develop and promote a more holistic, integrated form of participatory research and extension that takes greater advantage of synergies, and considers the whole farm situation and the sustainability of natural resources and protection of the environment, with less emphasis on component research. Specific support should be given to the develop-

ment of research resources (equipment and human resources) to take advantage of new techniques in biotechnology and genetic engineering.

- Develop skills of farmers and extension staff in participatory characterisation of farming systems and identification of development opportunities combined with a farmer field school approach to promoting new technologies. This should be associated with improvements in the linkages between research and extension for more effective information availability, dissemination and technology development.

4 Tree Crop Mixed Farming System

SYSTEM DESCRIPTION

This system covers 82 million hectares, mainly in Thailand, Malaysia and Indonesia, with smaller areas in Cambodia, Philippines, Vietnam, southern China and Papua New Guinea, and contains a total population of 49 million with an agricultural population of 30 million. The tropical environment of this zone is mostly humid (270-365 growing days), with some extension into moist sub-humid (180-269 growing days) areas. Tree crops have been established under plantation or estate crop systems for the provision of industrial products, beverages and condiments. Tree crops are cultivated principally on flat to undulating landscapes on acid soils of low inherent fertility.

The total cultivated area of the tree crop mixed system is estimated at 18 million ha and there is only 2.3 million ha of irrigation. During the 1900s, large areas of tree crops, particularly rubber and later oil palm, were developed as large private sector estates, in Malaysia and Indonesia particularly, but today there are significant areas under smallholder ownership and management. Smallholder plantation crop areas are usually a maximum of 2-3 ha in size, depending on crop type. Incomes of smallholders are moderate and little poverty exists. Coconut plantations are more widespread throughout most South East Asia and Pacific countries and are now mostly smallholder

operations. Coffee and tea plantations are confined to specific agro-ecological areas with higher elevation. Cocoa is usually grown as an intercrop at low elevations under humid tropical conditions. Condiments, cloves, pepper, etc., are usually smallholder crops. While tree crops are the dominant production system, small farms without tree crops are scattered throughout the system, producing food (rice and maize) and cash crops (soybeans) and livestock. Within the region, livestock are unimportant in this farming system. Poverty is higher amongst these small farmers and landless farm labourers.

Governments have established specialised commodity research stations or institutes for improvement of these crops. Government research extension services have supported smallholder farmers. Crop yields have been improving through the introduction of new improved varieties developed by government research or in some cases by large multi-national companies involved in the plantation industry. New higher-yielding dwarf varieties of oil palm and coconut have been developed in recent years that when mature, will increase yield per unit area significantly. Regular applications of fertilisers combined with effective weed control measures are used in productive, well-managed plantations. All these crops require intensive labour inputs for harvesting and processing and therefore profitability is very much determined by local labour costs. In some countries, such as Malaysia, high labour costs are now seriously affecting the profitability of rubber plantations and there is a strategic shift to oil palm.

Private companies and governments have established large factories, with large investment requirements, to process crops such as rubber, oil palm, tea and coffee. Smallholders supply raw materials or slightly processed products to these factories.

Total population	48 million
Agricultural population	30 million
Total land	82 million ha
Agro-ecological zone	Humid/sub-humid
Arable land in use	18 million ha
Irrigated area	2.3 million ha
Bovine population	52 million
Small ruminants	36 million

Smallholder cooperatives are usually not well developed and individual farmers are often at the mercy of lower prices given by middlemen or factories for their raw products. Overall prices received are affected by both local and international demand for these products. Some intercropping is undertaken to increase and diversify incomes, both in the early years of establishment of new plantations and in mature plantations. In some tree crop systems (rubber and coconut plantations) industrial crop production has been combined with livestock production. In more recent times there has been a move to develop alternative products to diversify and add to incomes from some plantation crops, for example wooden products from rubber and coconut trees available when old stands are cut and replanted.

SYSTEM TRENDS AND ISSUES

The major factors influencing the tree crop sector in the future will be concerned with international demand and prices for industrial crop products, replacement of labour-intensive and costly harvesting and processing practices through mechanisation for some crops (such as rubber, oil palm and tea), development and adoption of improved production technologies, planting of much higher yielding clones, new product development and the extent to which there is any significant change in proportion of private companies and smallholder producers. Although population growth will slow in the future, there will be a strong increase in demand for industrial crop products (plant oils, rubber, beverages, natural fibres, condiments, etc.). The demand and price for those products that compete with oil-based synthetic products will be greatly determined by future oil prices.

The tree crop sector is expected to continue its moderate expansion, given the present overcapacity and the large area of immature trees. Prospective annual production increases in the region are estimated at 3.4 percent for oil palm, 2.8 percent for rubber, 3.4 percent for coconut, 1.8 percent for coffee and 3.8 percent for tea up to 2030. It is anticipated that these production increases will come from both area expansion and increasing yields. Plantation crops are generally more profitable than alternative land uses where they are cultivated. The extent to which the major private estates will increase their size will depend on overall profitability, but it is anticipated that the smallholder sector will remain important, at least in the

medium term. Some plantation (industrial) crops will continue to be grown mainly by smallholders.

The discussion in this section is confined to the smallholder sector. The key issues that have to be addressed in advancing the productivity and income generation of smallholder plantations include:

- Yield improvement of plantation crops has been dependent on government and private research and extension services developing higher-yielding clones with increased disease and pest resistance. However, this research and extension support has been mainly directed to rubber and oil palm and generally insufficient support has been given to production improvement of other tree crops.
- Total consumption of industrial crop products continues to increase and is anticipated to further increase significantly by the year 2030. Government policies are aimed at assisting smallholder plantation crop production, but government support for tree crop area expansion must be based on an in-depth analysis of future product demand to avoid oversupply and low prices.
- Prices for industrial crop products are subject to the considerable variation that occurs in the international marketplace. Many countries have established commodity boards to stabilise prices, with very mixed results. At the local level, smallholder farmers generally have to accept lower farm gate prices than market prices because of their immediate need for cash. Returns to smallholders can be increased through improved on-farm processing and collective marketing of products by smallholders' associations.
- Governments have tried to establish farmer cooperatives for smallholders engaged in many plantation industries. These generally have been weak or failed. This is a result of farmers not having received any material advantage from forming cooperatives. Still, large financial advantages can be obtained from collective purchase of inputs and joint collection, delivery and marketing of products. Alternative operational modalities have to be defined for the operation of cooperatives or farmers' associations or small business companies.
- Development of the skills of farmers involved in industrial crop production is usually weak. In many instances, there is inadequate participatory identification of problems, constraints and opportunities for product development and only limited support from government extension and specialised

research services. Linkages between government research and extension in information dissemination and technology development are also generally inadequate. There is usually also very little technology transfer to smallholders from private (multi-national) companies, even though they often have their own research and extension services directed, in the main, to plantations.

STRATEGIC OPTIONS AND INTERVENTIONS

The strategic options for the smallholder sector include increase of productivity, diversification and group business development. Related interventions that would enable significant advancement of the smallholder Tree Crop Farming System include:

- (i) Considerable scope exists to increase production in smallholder plantation systems (rubber, oil palm, coconut, etc.) with the introduction of modern clonal materials. New, usually dwarf, clonal materials with very high yield potential have been developed in some crops, such as oil palm and coconut. New rubber clones are also being continually developed in commodity institutes. There should be a progressive (accelerated) replacement of old clonal materials with new, more high-yielding clones.
- (ii) Regeneration of old plantations must take advantage of intercropping in early years to generate income. Emphasis should be given to local value-adding processing of both product and wood materials. Opportunities also exist for expansion of intercropping in mature plantations to stabilise incomes and reduce risks from price fluctuations; and for households to grow small areas of food crops and husband small stock such as goats, utilising surplus feed and fodder produced around the plantations.
- (iii) Research programmes should be broadened to include more research on the minor tree crops. Research capacity should be increased to take advantage of advances in biotechnology and genetic engineering to improve yields and disease and pest resistance.
- (iv) The establishment of business co-operatives, associations or companies should follow a gradual approach to avoid overloading with multiple functions, which would require considerable business skill and information on the performance of the client base. Thus it is preferable to start with one main business, e.g. input or output marketing. Once marketing channels and a reliable client base are developed, diversification into other business areas such as interlocking input supply and credit with output marketing can be considered.
- (v) Assistance is required to broaden the outreach of financial services provided by both formal and informal financial institutions to farmers on a sustainable basis. Business co-operatives, farmers' associations or small companies could gradually expand their activities towards financial intermediation and play an important role in savings mobilisation as a source of funds for credit supply.
- (vi) In many countries the government has given insufficient emphasis to extension and research support for industrial crop producers. Consideration needs to be given to the development of private extension support services for smallholder farmers, which could be financed by the smallholder business cooperatives. A farmer field school approach to promoting new technologies should be used as well as the provision of technical training programmes for farmers.

5 Upland Intensive Mixed Farming System

SYSTEM DESCRIPTION

This system covers some 311 million hectares and is the most widespread and diverse farming system in the region with major areas located in all countries of East and Southeast Asia. The system contains a total population of 530 million with an agricultural population of 316 million. Whilst the system is delineated by similar landscape condition, there is extreme ecological variation. It is found in humid and sub-humid tropical, subtropical, and temperate environments in upland and hill landscapes of moderate altitude and moderate to steeper slope. Soils are generally less fertile, shallower and more susceptible to erosion. Some 76 million ha of land is cultivated within the system, encompassing a wide range of crops, depending on geographic area, landscape slope, terracing and water regime.

There are some forested areas, but these are generally depleted through unsustainable logging. Deterioration of natural resources (soil, water), biodiversity (native plants and animals) and the environment occurs in many areas. Significant degradation of the natural resource base has occurred as a result of high population densities causing more extensive cultivation of fragile landscapes without the adoption of appropriate soil and water management practices. Households are vulnerable to natural disasters and

BOX 3: A TYPICAL HIGHLAND MIXED FARM SYSTEM HOUSEHOLD

A typical farm household of five members in Yunnan Province, China cultivates an area of 0.94 ha (21 percent being irrigated), with a cropping intensity of 84 percent. The main crops grown and their yields are: corn (21 percent of the total cropped area, with a yield of 4 t/ha), rice (16.5 percent of the area, yielding 6.1 t/ha) and wheat (13.2 percent of the area, producing 2.2 t/ha). Annual farm household production for these three main crops totals 1.7 t/year, equivalent to 337 kg per capita. Few external production inputs are used. The household has a pig, some poultry and one goat for fattening. The household is food insecure, and has an annual per capita income of \$166 per year, below the international poverty line.

crop failures. Local infrastructure is not well developed. Because most of the population lives in remote areas, the links to other systems are scarce. Moderate to severe poverty is found in this system, but with moderate potential to further increase production and incomes there is a moderate opportunity to reduce poverty in the future.

Most agricultural production occurs under rainfed conditions, but a significant area (18 million ha) is irrigated from local streams and rivers, much of it terraced. In some areas, for example in the Philippines and Indonesia, substantial terraces have been constructed for rice cultivation, but in most situations there is only simple terracing (bundling for rice cultivation) or no soil and water conservation structures. Crops include paddy and some upland rice, wheat, maize, sugarcane, cotton, leguminous pulses, oilseeds, fruits and vegetables. Rice is the staple crop

Total population	530 million
Agricultural population	316 million
Total land	311 million ha
Agro-ecological zone	Various
Arable land in use	76 million ha
Irrigated area	18 million ha
Bovine population	49 million
Small ruminants	42 million

in tropical and sub-tropical areas, and wheat in more northern latitudes. Both tropical and temperate fruits and vegetables are grown, depending on climatic location. While there are some more extensive areas of commercial fruit and vegetable production, home gardens are widely used for vegetable and fruit production for household consumption and sale of products.

Livestock production is an important component of the system, being used for draught power, meat production, asset value and cash income. Some 49 million cattle and buffalo (28 percent of the regional total), and 42 million goats and sheep (14 percent of the regional total) are found in this system. Pig and poultry production is also very important for meat and cash income. Livestock growth rates and production are generally low, however because in many countries animals are raised under extensive conditions using poor animal husbandry and animal health practices. More intensive production systems are found in China, particularly for pig and poultry. Where water resources are available, aquaculture is practised, usually combined with rice production. On-farm forestry is limited.

Considerable variation exists in the intensity of crop and farm production within this system, with highest production intensity found in South China. In areas of more extensive crop production, many farms operate subsistence production systems with only small sales of products to meet livelihood needs and for purchase of food. Thus average incomes are low, creating significant poverty and food insecurity. Rural credit is rarely available. Households are vulnerable to the consequences of natural disasters, crop failures and ill health. Rural infrastructure is often poorly developed, particularly in more remote areas, and access to goods and services is poor.

Shifting cultivation is practised in some hill and mountain areas, especially in South East Asia, but mainly in the Highland Extensive Mixed Farming System. This is a subsistence agriculture system characterised by widespread poverty and food insecurity. In some circumstances it can cause serious adverse effects on natural resources.

SYSTEM TRENDS AND ISSUES

The major factors influencing future changes in the upland intensive mixed farming system are expected to be concerned with (i) preservation of the natural resource base, (ii) improvement of technologies for

both crop production and watershed management, (iii) diversification into higher-value products, (iv) expansion and intensification of livestock production, (v) development of the rural financial system, (vi) increasing opportunities for improved marketing and off-farm income, and (vii) more responsive agricultural support services.

Major changes in agricultural production in this system are expected to come from intensification and diversification of crop production with little expansion of overall cropped area, and improved productivity of livestock and tree crops. The trend will be to produce agricultural products with higher value. Increasing diversification would include an expansion of perennial crops and annual cash crops (as opposed to food crops) and intensification of livestock production. The particular higher-value crops selected for cultivation will depend on access to markets – crops which are bulky and perishable will be grown close to larger markets while those with less bulk and longer shelf-life would be cultivated at more remote locations. Livestock numbers are increasing under very extensive and low input production systems, but productivity and off-take remain low. If continued, the future trend would be for only small increases in livestock numbers because of limited feed supplies. However, some intensification of livestock production is anticipated in this system as a result of an improvement in general incomes and consequent increased demand for livestock products. These changes would increase household incomes and income security and reduce poverty. Should average farm size increase, the larger production base and partial mechanisation of farm activities would further increase household incomes and decrease poverty.

The key issues facing the future development of the upland intensive mixed farming system include:

- Increasing populations in hill and mountain areas is causing increasing pressure on the preservation of natural resources (soil, water, flora and fauna). Widespread severe natural resource degradation in many areas has entailed substantial local costs in terms of lowered yields, mudslides and scarcity of water in the dry season. There are also large downstream costs from siltation and flooding. The highest priority of farmers is to produce annual food crops to sustain their families. Increasing population pressure has caused annual crop cultivation to increase on more fragile landscapes and has resulted in a decreased length of the fallow period in shifting cultivation systems. Furthermore, because farmers are poor they do not invest in field struc-

tures to control soil erosion. Collectively these factors have an adverse effect on farm production and the preservation of natural resources. If the majority of families remain in subsistence farming there will be an increasing pressure on natural resources stability in the future.

- A critical development issue in highland areas in many countries is lack of security of land tenure. Many governments, because of their political system, are reluctant to give farmers ownership to these lands. Farmers are generally unwilling to invest resources in development without secure land tenure or ownership. Land tenure, land leasing and land markets are policy issues that have to be reviewed in order to promote development in upland and mountain areas.
- Government agencies and large timber companies have been responsible for widespread and unsustainable logging of natural forests. The area of natural forest has decreased enormously in all East Asia countries in the last two to three decades. Little has been done to replant logged areas or to develop systems of sustainable natural forest management. The establishment of tree plantations has been quite limited. The management of village forest resources by communities and promotion of agro-forestry systems on farms are important development issues. Governments have generally been very reluctant to sign over responsibility to local communities to manage local forest resources.
- Technology development in the past has tended to be focused on elements of the system, often commodities, rather than on integrated development of a system that is productive, economically attractive, not too complex to manage and that provides a range of land use options in varying agro-ecological circumstances. Because the research focus has been component - rather than system-oriented, very few technologies have been developed that are economically viable and attractive to farmers and at the same time contribute to environmental and resource regeneration.
- Livestock products are a very important source of household cash income in the Upland Intensive Mixed Farming System and there is considerable potential for expansion of livestock production in this system. However, generally little emphasis has been given to the development of improved and intensified livestock production systems (improved feeds, improved breeds, husbandry practices, etc.)

and the provision of effective animal health services.

- The generally poor development of rural infrastructure in upland areas in most countries has seriously affected marketing of products because of very poor communication and transport networks.
- With a few exceptions, the Upland Intensive Mixed Farming System has received a low priority in government policy making, which has aggravated the natural constraints to development that are present in upland areas.

STRATEGIC OPTIONS AND INTERVENTIONS

The strategic options centre on sustainable natural resource management, an orientation to high-value production and improvement of agricultural services. Related interventions that would enable significant advancement of the Upland Intensive Mixed Farming System include:

- (i) Improved conservation and management of natural resources must be given high priority in the future development of this farming systems to ensure their sustainability and continued productivity. Future programmes of assistance should emphasise improved watershed management, conservation farming, water harvesting and introduction of appropriate technologies. A holistic approach is essential in micro-watershed management. Experience shows that such programmes must be strongly community-based to be successfully adopted, with full people's participation and involvement in planning, management and use of the natural resources. Soil and water management practices and techniques should be promoted as an important means of stabilising yields, ensuring maintenance of soil productivity and increasing crop production. Water-harvesting technology should be promoted where natural circumstances permit interception of surface water flows. Technologies that are introduced and promoted must be holistic, and must provide short-term, medium-term and long-term economic benefits.
- (ii) Forested areas are scattered through this system, particularly at higher elevations. Where relevant, future development programmes should strongly promote community management of village forests as this has positive effects on environmental management as well as providing important

- sources of building materials, income and food for local communities. Furthermore, on steeper lands, agro-forestry systems should be promoted with contour planting of suitable tree species (for production of fruits, timber, fuelwood and non-timber forest products) to act as conservation barriers and provide additional income generation.
- (iii) Future programmes of assistance must address the policy issues of land tenure, land leasing and land markets, which are fundamental in promoting development in upland areas. Key priorities would be to establish functioning land markets through the establishment or acceleration of cadastral and land titling procedures and establishment or strengthening of financial markets to support purchase and sale of land.
 - (iv) Development and introduction of improved technologies should emphasise a whole-farm approach to ensure increased agricultural production, a positive contribution to environmental and resource maintenance or regeneration; the technologies should be economically viable and create a diverse and stable source of income. Improved technologies promoted should include: improved cropping patterns using crops that contribute to food and cash income, soil and water conservation and fertility building; contour planting of trees and shrubs (for timber, forage, fruits and food grains); mulching and other soil conservation techniques; higher-value agricultural products; and feeds for livestock.
 - (v) Livestock development is a priority for this system. Advantage should be taken of any opportunities

BOX 4: TRANSFORMING SHIFTING CULTIVATION IN HIGHLAND FARMING SYSTEMS²⁰

Shifting cultivation is practised in the highland farming systems through a wide swathe of East Asia, including Vietnam, China, Laos, Thailand and Myanmar. There is widespread and severe poverty in this area; in addition, shifting cultivation is coming under increasing population and, in some instances, market pressure, which is shortening fallow cycles and causing resource degradation. This case study concerns the proposed intensification of shifting cultivation in Houaphanh province in the northeast of Laos, based on best available practices.

It is proposed to introduce agricultural and forestry technologies to replace shifting cultivation with sedentary farming systems and to improve incomes and food security. At present one family cultivates about 1 ha of upland rice annually and over a 10-year period the farmer cuts down 10 ha of forest. The new system aims to replace the 10 ha used for shifting cultivation with 4-5 ha of perennial-based agricultural production with 5-6 ha returned to permanent forest. Some new technologies will be tested and verified and proven improved production techniques for crop and tree species will be expanded. Food security will be achieved by increasing rice production as a result of expansion of paddy areas in valleys, adoption of improved production technologies, improvement of diversion structures, construction of small ponds or reservoirs, and installation of small pump systems. Alternative agricultural activities to provide additional sources of income were identified by farmers and village leaders. These included improvement of livestock production (buffalo, cattle, pigs, poultry including ducks), which would rely on improved feeds and veterinary services to control common diseases; expansion of fish ponds where feasible; improving cash crop production, particularly crops with relatively short production cycles such as ginger, chili, sesame, soybeans, peanuts, and garlic and onions, but generally only in areas with good market access; and improvement of production of non-timber forest products.

The transformation is expected to double production of wet land rice and increase ginger, fruit, beef, chicken and fish production even more. Both household food security and cash income of farmers will increase substantially. Natural forestry resources will also be expanded and improved on steeper and more fragile landscapes. It is expected that the lessons from implementation can be extended to the development of other areas of shifting cultivation in neighbouring provinces of Laos and other countries.

²⁰ For details see Ishihara, Y. and T. Bachman, 2001, Transformation of Shifting Cultivation in Laos PDR, China, Case Study, Global Farming Systems Study.

for intensification of village-based, small livestock (chickens, ducks, pigs, etc.) production as well as large ruminant production. Technologies introduced should provide improved animal health, better animal feeding, improved animal husbandry practices and breed improvement. Effective extension and support services will be needed as well as an established animal health service. In some situations technologies can be introduced to improve forage and pasture production for cattle feeding.

- (vi) General lack of capital constrains investment in productive activities and rural development. Donor assistance should be focused on the improvement of rural financial services, and to create greater access for farmers to formal financial services, community-managed funds, etc., with a view to graduating them to the use of commercial financial services.
- (vii) Because of the remoteness of this farming system from markets and the poor communication and transport networks, the emphasis in agricultural production has to be on products that are easily transported (low weight and high value), have a long shelf-life and can be processed locally to add market value. This must be a priority for development. In addition, in many instances the development of good rural infrastructure must be actively promoted as a pre-requisite to agricultural development in these areas. Although external assistance may help in building the infrastructure, this will not be sustainable unless the beneficiaries and local institutions participate in planning and construction, and pay for and manage their operation and maintenance.
- (viii) The Upland Intensive Mixed Farming System has received less attention and benefits from government research and extension services than lowland farming systems for many reasons (remoteness, complexity of system, lack of water resources, a lack of perception of their importance, etc.). However, the Upland Intensive Mixed Farming System represents an important part of the agriculture sector in most countries of the region. The strategic priorities for the future must be to strengthen the capacity of governments to undertake participatory identification of problems, constraints and opportunities for farm development and to provide the necessary support by government or privatised extension

and research services in these areas. The future priority is for a more holistic, integrated form of research and extension, linked strongly to farmers and with their active participation that takes greater advantage of synergies, considers the whole farm situation and emphasises the conservation of natural resources and protection of the environment.

- (ix) Skills, knowledge and educational development of farmers are crucial to agricultural development. Programmes of assistance must emphasise participatory characterisation of farming systems and opportunity identification, combined with a farmer's field school approach to promoting new technologies that have been shown to result in greater agricultural production and family incomes. Skills and knowledge building must be promoted as an essential component of future development assistance. This must be combined with much improved systems for information dissemination to and access by farmers, particularly because of the remoteness of this system from the sources of information.

6 Temperate Mixed Farming System

SYSTEM DESCRIPTION

The Temperate Mixed Farming System covers some 95 million ha in central-eastern and north eastern China, with smaller areas in Korea DPR and Mongolia and contains a total population of 247 million with an agricultural population of 161 million. The climate of the zone is mainly dry sub-humid (120-179 growing days). The transitional boundary between this system and lowland rice-based system is not easily defined in central China. Average incomes are low with modest poverty levels. Some 31 million ha are under cultivation, with wheat being the dominant crop. Other major crops include rice, maize, soybeans, sweet potato and rape, as well as citrus and some temperate fruits. Irrigation covers about 12 million ha within the system. The preferred food staple throughout the region is wheat noodles.

There are two main sub-systems: the southern system in central China – involving mixed farming of both summer and winter crops; and the northern system, in northeast China, Korea DPR and Mongolia where the climate only permits cropping during the summer. Both have rainfall mainly in summer and severe frosts in winter, particularly in the northern areas. Average farm size ranges from as little as 0.3 ha in central China to over 1 ha further

Total population	247 million
Agricultural population	161 million
Total land	95 million ha
Agro-ecological zone	Dry sub-humid
Arable land in use	31 million ha
Irrigated area	12 million ha
Bovine population	11 million
Small ruminants	34 million

BOX 5: A TYPICAL TEMPERATE MIXED FARM SYSTEM HOUSEHOLD

A typical wheat farm household with 4 family members cultivates 0.55 ha of land (60 percent being irrigated) in Shandong Province, China, with a cropping intensity of 140 percent. The land is partially irrigated but the water table is dropping with the expansion of irrigation for cash crops. The area, production and yields of the main crops are: wheat (36 percent of the total cropped area, 1.45 tons per year with a yield of 5.3 t/ha) and maize (25 percent of the area, 1.1 tons per year with a yield of 5.6 t/ha). Annual production of such farm household for these two main crops totals 2.5 tons, equivalent to 630 kg per capita. Power tillers are used for primary tillage, and earn additional income through transportation services. The household usually keeps a pig, a goat and some poultry. The household has a per capita income of about \$280, which has risen rapidly during the past 20 years.

north, with an average household of 4-5 persons. The preferred food staple throughout the region is wheat noodles.

In central China, wheat and rape are the main winter crops, and maize with rice, cotton, soybeans and sweet potato the main summer crops. Cropping intensity is about 150 percent. Crops are grown under both irrigated and rainfed conditions. Wheat yields averaged about 4 t/ha in 1999. They have risen dramatically since 1970 and even in the last decade have risen by 2.7 percent annually.

In the northern subsystem (north-eastern China, Korea DPR and Mongolia), cropping is possible only during the summer, hence wheat and other cereals are grown side by side and compete for cultivated

land. Wheat is grown on about 0.5 million hectares in Korea DPR and Mongolia, but yields are much lower (about 1 t/ha) than in China and more affected by severe climatic conditions. The higher yields in China are due to crops being grown with high organic and inorganic fertiliser inputs and intensive pest control practices. In this system, overall cropping intensity is high and scope for expansion of land area is limited.

Livestock, particularly cattle for draft power and pigs and poultry for meat, are also an important component of the system. Some 11 million cattle and 34 million sheep and goats are located in this system. Pigs and poultry are also widespread in the system. Livestock are reared and managed under extensive conditions in most countries. More intensive production systems are found in China, especially for pigs and poultry. Pigs are mostly housed and fed supplementary grain and concentrates.

SYSTEM TRENDS AND ISSUES

Wheat areas have been declining for the last decade in all countries and this decline is expected to continue in the future. In contrast, wheat yields have been increasing and overall wheat production is expected to increase slightly in the future as a result of increasing yields more than offsetting the declining crop area. Areas of maize, however, have been increasing and are projected to increase substantially in the future. Maize production is expected to double by 2030 as a result of both increased area and yield. This will be a direct consequence of a greatly increased demand for animal feeds. There is increasing fattening of store cattle for local markets using treated cereal straw, especially in the southern part of the system.

Several specific issues have to be addressed in advancing the Temperate Mixed Farming System:

- The high crop yields obtained in the intensive production system in China have resulted from very high applications of nitrogen and phosphorus. Further yield increases from increased use of inorganic fertiliser will require a more balanced use of nutrients. Potassium is now a significant limiting factor, but potash fertiliser is fully imported and much more expensive than the locally produced nitrogenous and phosphatic fertilisers.
 - About 40 percent of the crop area in this system is irrigated. Some scope exists to expand the existing irrigation systems by expanding the use of surface water and extraction of groundwater from shallow aquifers. However, in some areas over-exploitation of shallow aquifers is already evident from recorded increases in pumping depth.
- The system is strongly crop-based. Market demand for meat, vegetables and fruits is increasing as urban incomes rise. Farms should diversify to meet the shift in food demand. The demand for animal feeds is also anticipated to increase, resulting in larger areas planted to maize for animal feeds. Some conflict is expected in choice of crops based on the competing demands for food for humans and feed for animals.
 - Low population growth rates and migration to cities in China has created labour shortages at crucial times in the farming calendar. This trend is expected to continue. The need for small-scale farm mechanisation is becoming a more important issue.
 - Because of small farm size, family income is low. This leaves little disposable income. Farmers need to grow higher-value crops and increase farm size to significantly increase disposable farm incomes, as well as expand off-farm income sources.

STRATEGIC OPTIONS AND INTERVENTIONS

The main strategic options focus on intensification and diversification of the farming system. The related interventions that would enable significant advancement of the Temperate Mixed Farming System are:

- (i) While an 18 percent expansion of irrigated area by 2030 is anticipated in China, the more important future priority there and in other countries is to institute programmes to improve the effectiveness of existing irrigation systems and the efficiency of water use.
- (ii) Further intensification of crop production will come as a result of promotion of higher-yielding varieties, particularly hybrid varieties, better balanced use of fertilisers, increased water availability and more efficient water use. It is uncertain to what extent the supply of future production inputs will come from the private or the public sector. However, future assistance should promote farm mechanisation and the development of the private sector for provision of goods and services.
- (iii) Greater emphasis in the future will be given to small-scale intensive livestock production, mainly

pigs, and to growing vegetables and fruits, as market demand for these higher-value products increase with rising incomes of urban people. Cattle have been successfully fattened based on treated cereal straw. A shift in crop production from basic foodgrains to increased production of animal feeds, particularly maize, is expected. Government research and extension services will need to provide the appropriate technical advice and support for these changes in the production system.

7 Strategic Priorities and Interventions for the Region

Poor socio-economic indicators in many countries of the region are a result of widespread subsistence agriculture, lack of land and financial resources, lack of opportunities for intensification and diversification of farm production, and lack of opportunity for off-farm employment and income for many rural or farm households. This is caused by many factors, including overpopulation, land fragmentation into uneconomically small parcels, deterioration of natural resources, lack of secure access to land, lack of access to new skills, knowledge and information, lack of credit and inadequate production input supplies, and poor marketing prospects (distance, infrastructure, local market demand, etc.). The challenge for the future is to create the enabling factors needed to catalyse the rural communities and households to invest their resources in agricultural development to obtain strong economic growth.

The clear message from the above analysis is for donor assistance to countries in the East Asia region to concentrate on the basics. While the present focus and policy of the Bank gives more emphasis to social issues, such as poverty, community involvement, and socio-economic conditions of rural households, the resolution of these social issues in rural areas depends on strong agricultural growth. Poor members of rural communities are disadvantaged because they do not have sufficient physical (land) and financial resources to generate enough agricultural production and to earn adequate disposable income. Opportunities have to be created to increase their labour productivity in farming and to utilise their labour in the non-farm sector. Certain types of strong agricultural growth, if equitable, will create beneficial opportunities for all, including opportunities for disadvantaged rural households to become involved in non-farm income generation as suppliers of goods and services or

primary processors of raw products.

The primary goal of donor assistance should be to create the necessary conditions to promote strong agricultural growth to facilitate poverty reduction. Strong agricultural growth will lead to strong economic growth that will benefit the whole rural population. In agrarian economies, strong agricultural growth is dependent on the enabling set of factors that creates commercial farming systems where large surpluses of agricultural products are produced for sale in the market place, whilst at the same time improving household food security. Within this overall framework, specific strategic thrusts directed at poverty-stricken, food insecure and disadvantaged families are necessary.

The strategic thrusts required to create the enabling environment for strong agricultural growth in the East Asia region include:

NATURAL RESOURCES

Market-led Land Aggregation. The basic problem of low rural household incomes in the East Asia region is that too many people have access to too few resources for agricultural production. Technology advances that bring increased efficiency of production hardly keep pace with diminishing unit resources as population increases and land fragmentation continues. In this scenario, the socio-economic situation of individual rural households is barely improved, while overall agricultural output increases. Small farm size is one serious obstacle to growth of the agricultural sector. The majority of farmers are quasi-subsistence producers on uneconomically small, low-value production oriented farm units. Furthermore, in those countries under state-managed control, lack of secure

land tenure or ownership is an additional obstacle to agricultural growth. With the land being owned by the state or given without full and transferable title, farmers are reluctant to invest in land development. Moreover, without land title, farmers are unable to use land as collateral to access credit and it is not possible to develop an effective land market, a necessary ingredient in land aggregation. Strategic future support is required to assist governments in developing programmes to provide transferable tenure rights on rural land to individuals; establish functioning land markets; remove other obstacles to land aggregation for fragmented and extremely small holdings; and create local part-time and full-time off-farm employment for farmers on sub-marginal units and for those displaced from the land.

Resource Management. A considerable proportion of the significantly degraded agricultural resource base of the region can be recovered through improved management – improved soil management, better utilization of scarce water resources and sustainable forest management represent three major thrusts. The investment requirements are potentially immense and far exceed the Bank's capacity, or its role for that matter. Along with improved resource management, existing agricultural production needs to be intensified in a sustainable fashion in order to maintain and increase household incomes in the face of declining terms of trade for cereals.

SCIENCE AND TECHNOLOGY

Income Diversification. Diversification of farm production into higher-value products and adding value to farm produce increases overall household incomes and improves income stability. Diet changes resulting from improving economic circumstances up to 2030 are expected to greatly increase the demand for higher-value products (milk, meat, fruits, vegetables, etc.). Such a shift in product demand will promote farm diversification. Training and demonstrations of new technologies are required to improve production, post-harvest management, packaging and marketing of these products. Opportunities for local agro-processing should also be promoted to add value to agricultural products.

Technology Creation and Transfer. While the private sector is expected to increase their provision of goods and services to farmers, it is anticipated that govern-

ments will still have to provide certain essential support and services to poor small farmers. The strategic priorities for the future must be to strengthen the capacity of governments to undertake participatory identification of problems, constraints and opportunities for farm development and provide the necessary enabling framework for effective public-private extension and research services. Government research must keep abreast of private research developments. The applications of biotechnology in its broadest sense, and genetic engineering specifically, must be evaluated and used where appropriate. Research in the future must also be more holistic and integrated, strongly linked with extension and farmers, take greater advantage of synergies, consider the whole farm situation and emphasize sustaining the natural resources and protection of the environment. The latent potential of farmers for experimentation, adaptation of technologies and farmer-to-farmer extension needs to be exploited. The strategic priorities for agricultural research in the region include increased water productivity, management of soil structure and fertility, and restoring productivity growth in cereals.

GLOBALISATION AND MARKET DEVELOPMENT

Agricultural development must exploit local and international comparative advantages in a more globalised future economy. This requires greater access to developed country (OECD) markets and the removal of agricultural subsidies by them. Governments must identify and promote specific production systems that benefit local farmers through exploitation of local agro-ecological, marketing, and farm resource advantages. The declining terms of trade for cereals and lower prices must be offset by the economies of scale generated by increasing farm size and mechanisation, reduced transaction costs associated with better transport networks, and cheaper prices for production inputs. Export demand for and income from industrial crops is expected to increase. However, government trade policies and planning must assist the orderly development and production of commodities that have international comparative advantage, such as rubber, oil palm, rice, etc., to prevent oversupply and ensure stable prices.

Local rural infrastructure improvement is required in more remote areas to improve market access. Improving general economic circumstances up

to 2030 will change diets and increase the demand for higher value products (milk, meat, fruits, vegetables, etc.). Together with the declining terms of trade and lower prices of cereals, this will lead to increased diversification of farm production into higher value products and adding value to farm produce that would lead to an overall increased level and stability of household income. The increasing demand for livestock products will increase the demand for animal feeds, creating conflict in choice of crops because of the competing demands for food for humans and animals.

Training and demonstrations of new technologies are required to improve production, post-harvest management, packaging and marketing of these products. Opportunities for local level agro-processing should also be promoted to add value to agricultural products. The formation of agricultural cooperatives would also improve the marketing of agricultural products and supply of production inputs for small farmers. Furthermore, in the tree crop sector, small-business enterprises should be promoted to improve processing, marketing and prices of products.

POLICIES, INSTITUTIONS AND PUBLIC GOODS

Rural Finance and Credit. Donor institutions have generally been very reluctant to deal with the issue of unavailability of credit to individual farmers. Rural banking services and credit institutions are badly in need of restructuring and refinancing. Assistance is critically needed from donors to create greater access by farmers to formal financial services, to improve the functioning of rural financial markets, to stimulate rural savings and community-managed funds, etc., and to graduate farmers to using commercial financial mechanisms.

Agricultural Policies. Many countries in the region (China, Vietnam, Laos, Cambodia and Myanmar) are still, to a significant degree, under state-managed control, even though rhetoric would indicate they are moving to a market economy. These countries particularly, as well as others, have many policies (export, import, foreign exchange, prices, etc.), regulations and practices that are disincentives to growth of particular commodities, to investment in soil and water resource enhancement, or to agricultural input use in general. Future emphasis in assistance will have to be more strongly directed to the adjustment of policies

that still cause serious distortions in the macro-economy and the agricultural economy and create disincentives for farmers to invest in agricultural development. Infrastructure is an important driving force for farming systems development, especially related to water resources management, to soil management, and to transport and markets. An enabling environment for the development of vigorous decentralized government and support service industries (such as seed, machinery and agro-processing) needs to be created.

INFORMATION AND HUMAN CAPITAL

Skills, knowledge and educational development of farmers are a key to agricultural development. Farmers are typically poorly educated, with significant levels of illiteracy in some countries. Most governments do not have strong educational programmes for farmers and access to information is difficult and limited. Skills and knowledge building must be promoted as an essential component of future development assistance, combined with much improved systems for dissemination and access of farmers to information. Modern information technology development (computerised networks, local accessing of computer based information, etc.) will become a key component of agricultural development in the future.

Annex: Maps

