Farming Systems of North East India

Research and Development Strategies for KVKs

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PREFACE

Farming System Research/Extension (FSR/E) considers farmers and their problems in a comprehensive manner using an interdisciplinary approach that complements the existing research and development activities related to agriculture. Farming System Research helps to understand small farming systems and to improve the agricultural research and extension. These include the farm household and its needs, objectives, biological, economical and human dimensions. Keeping in view of the importance of the usefulness of the information on farming systems, Zonal Project Directorate - III had initiated a project entitled Identifying Farming Systems of North East India as a first step to identify different farming systems prevailing and practiced in North Eastern Region. The process included identification of boundaries, cropping systems, the local resources, climate, land and water management, energy, labour, capital etc. A structured schedule was prepared and standardized for the purpose and the data was obtained by involving KVKs located in 40 districts of the North Eastern Region representing hot humid plains of Assam, Tripura to the middle and higher alpine Zones of Arunachal Pradesh and Sikkim. The data obtained were analyzed for comprehension and conclusion.

The outcome of the findings are summarized and published in the present form for the benefit of the researchers, KVK functionaries and Stakeholders in the agricultural development departments of North Eastern Region. The content of the book is arranged in seven Chapters. The details about the farming system approach, concept, features and importance are given in the first Chapter. The second Chapter deals with the methodological aspects of the study and third chapter provides agricultural situation in the districts. Farming systems identified are presented in chapter four while the research and development strategies are presented in the fifth and sixth chapters respectively.

We are confident that, the publication provides valuable information on the Farming systems prevailing and practiced in different agro-climatic regions of North Eastern Region. Earlier the non availability of such information was felt at different levels and this book fulfills the requirement by providing the never before available information in the hands of KVK functionaries and different stakeholders involved in the agricultural development in North Eastern Region.

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1. Farming Systems Approach : An Introduction

Farming Systems Approach

Farming Systems Research (FSR) was initiated in the 1970s by researchers working in developing countries (mostly in publicly funded research organisations such as the CGIAR centres such as CIMMYT, ICTA, IITA, ICARDA or IRRI). They wanted to address the fact that smallholder-farmers were not adopting the technical recommendations derived from disciplinary, commodity-oriented research. Recommendations derived from this type of research were targeted at commercial farms and were, in general, unfit for the priorities and conditions of smallholders. Thus, originally farming systems research focused on smallholders and resource-poor farmers in developing countries. The aim of the field practitioners was to improve the understanding of small farmers and the way they make decisions. This insight could then be used to identify how research recommendations could be reshaped to better fit local farming systems, to better steer the research agenda of agricultural research stations, and to influence policy formulation.

In the 1980s, European researchers (some of which had been involved in development work) noted that in Europe family farms, especially those in less favoured areas, were also not adopting the technical innovations recommended by the top-down research-extension framework. Farming systems approaches were thus introduced in Europe to address the needs and potentials of family farmers as well as those commercial farmers, whose determinants for action could not be reduced to profit maximisation.

Wherever implemented, the core objective of farming systems approaches is to (1) address the complexity of real-world phenomena (instead of using reductionist and disciplinary simplifications) and (2) to work on problems that are relevant to farmers (instead of focusing on issues that are primarily of academic interest).

The goal of farming system research is to understand farmer's livelihood to consider the complexity of the real world in which farmers and farm families live and make decisions; to understand the complexity and diversity of farmer values and know-how. These influence their decision-making, their information processing, their combination of activities on- and off-farm, and ultimately their design of productive processes and the interaction with ecological processes. It is also intended to include multi-scale approaches, connecting the farm to the landscape, connecting the farm with the markets, the farmers and other rural stakeholders, livelihoods and territories. These interactions result in the diversity and heterogeneity of farming systems.

The Farming Systems Approach (FSA), can be seen as a 'school of thought' that spans a wide range of theories and methods. Farming systems approaches share a number of key elements, as they are interdisciplinary in nature. Farming systems always combine natural and social sciences, e.g. agronomy, ecology, plant breeding, livestock sciences, economics, anthropology, rural sociology. FSA understands the farm and household as one system. This implies that much attention is given to interactions like those between technical and social components and resource allocation decisions, biotechnical and ecological processes. Also FSA have a dynamic approach: with on-going changes in public policies, society's expectations, market prices or local opportunities, research focuses on the ability of farmers to cope with uncertainty and complexity.

Farmer participation is understood as crucial within the Farming Systems Approach. This is to understand farmer's goals and objectives, i.e. the coherence of farming practices; to ensure that scientific results (esp. from technical and biological sciences) are adapted and thus acceptable by farmers. Indeed, farmers are understood as the experts on the socio-economic factors (e.g. labour, values, goals, needs, preferences, social attitudes) that may constrain implementation, to produce knowledge about farming systems diversity and to produce tools that accompanies farmers on the pathways of change.

Although the holistic approach of farming systems requires that the entire farm (as well as its natural, social, economic and policy environment) serves as analytical framework, in later stages of a specific research project, work usually focuses on specific components, subsystems or interactions. However, the focus on specific components or interactions should not undermine the farming systems approach.

Indicators of a poor application of farming systems approach include: lack of systems perspective, lack of farmer-oriented attitude, lack of farmer participation, neglect of indigenous knowledge and gender issues, lack of involvement of extension and NGOs, lack of ecological sustainability, neglect of variation in time and space, lack of balance in breadth and depth of research, lack of interdisciplinarity. The fact that these weaknesses often occur in research is an indication of the difficulties met when implementing the farming systems approach, not least due to the (institutional) emphasis on rapid results and cost effective research methods. How to better implement the holistic approach is a key area of further development within farming systems research.

Farming System Research/ Extension (FSR/E)

The term FSR/E in the broadest sense refers to any research and extension that views the farm in a holistic manner and considers interactions in a system (CGIAR, 1978). A farming system is a complex, interrelated matrix of soils, plants, animals, power, implements, labour, capital and other inputs controlled in part by farming families and influenced to varying degree by political, economical, institutional and social forces that operate at many levels (ICARDA, 1979). FSR/E differs from conventional, traditional and discipline oriented research in that its basis is the study of existing farming systems. This type of research is most appropriately carried out by inter-disciplinary teams of scientists who continually interact with farmers in the identification of problems and in devising ways of solving them. It aims to generate technology to increase resource productivity for an identified group of farmers. It is conceptually based on a farming system perspective and uses on farm research methods. Research with FSR perspective have various objectives ranging from increasing the body of knowledge about farming systems to solving the problems in different farming situations with the aim to increase productivity of the farming system by generating new technologies appropriate to farmers and his resources.

Features of FSR/E

FSR/E considers the farmers and their problems in a comprehensive manner using an inter-disciplinary approach that complements the existing research and development activities and is interactive, dynamic and responsive to the society (Shaner *et al*, 1982). Some of the essential features of FSR/E are as follows:

a) It is a strongly applied and empirical 'problem solving' approach to research

b) All activities of the farmers are analyzed in a holistic framework

c) Relatively homogenous groups of farmers are identified as the clients of research in specific agro-climatic zones.

d) It is an inter-disciplinary approach involving social and biological scientists

e) It involves farmers participation

f) It is a dynamic 'Learning by doing' approach

g) It involves on-farm trials, survey (socio-economic and technical) and field workshop.

h) It is mainly concerned with the downstream (applied) research which begins with an understanding of the existing farming systems and the identification of key constraints.

i) It is to be judged by the extent to which it influences the production of socially desirable technologies that diffuse quickly amongst specified groups of farmers.

FSR, in its many forms, has made a major contribution to understanding small farming systems and to improve agricultural research. These include the farm household and its needs, objectives, biological, economical and human dimensions. Different observers have identified different activities and stages in the FSR. Its objectives differ from straight disciplinary and commodity research; it encompasses benefits to farm family through understanding of its farming system; and the location of some of the work differs, being on-farm instead of on-station.

Activities involved in FSR

The basic activities involved are:

(a) Target and research area selection

(b) Problem identification and development of research base through quick reconnaissance surveys by inter-disciplinary team

(c) Planning on-farm research emphasizing alternative cropping and livestock patterns, anagement practices and other activities of household

(d) Analysis of results of on-farm research in terms of the statistical meaning of biological performance, actual resource requirement, financial feasibilities and socio-cultural acceptability,

(e) Extension of results through multi-locational testing and

(f) Effective collaboration with other agencies closely associated with the needs of resource poor farmers.

Developments in farming systems approaches

Although the core objective of farming system approaches have not changed, the issues on which research has concentrated have evolved. Here are some areas that have seen a change in focus as well as new developments:

- Early farming systems work was dominated by crops, which then widened to include livestock (esp. in less-favoured areas) and crop-livestock interactions as well as aquaculture and trees (agroforestry). Currently there are no limitations to what types of enterprises are considered (energy production, direct marketing, services, agri-tourism, health care, education, etc.). Also, there is no longer a focus on the effect of introducing a new technology. Assessing the repercussions of introducing a new enterprise in an existing system is just as important and may follow a similar pattern.

- A shift from the farm system per se to a hierarchy of systems within which the farm is one of a number of levels (crops, communities, region, markets, policy, etc.). Each level knows complex interactions (e.g. within a cropping system: crop plant population, soil, soil organisms, weeds, insects, pathogens, etc.; within a farm: crops, livestock, trees, household members). Similarly, there are complex interactions between different scale-levels (e.g. a cropping pattern is influenced by natural conditions (soil, climate), institutions, agricultural policy, world market prices, etc.). These multi-scale approaches have led to studies at the landscape level, as well as studies that focus on market chains.

- The recognition that there are different stakeholders, and that they often have different perspectives. Gender is an important dimension, as analysis often indicates that men hold different perspectives than women. Stakeholder analysis (both at the farm-level and the higher hierarchical levels) thus provides an entry point for reconciling conflicting perspectives and negotiating a common position.

- The inclusion of the non-farming community, i.e taking a territorial rather than a sectoral approach. This is all the more important in Europe, where a large share of family farmers work part-time and include off-farm employment in their strategy for survival. Some authors therefore prefer the term 'rural systems' or 'regional systems' over 'farming systems'.

- System performance is no longer limited to productivity, but includes stability and sustainability. In other words, with the understanding of systems as being dynamic, the time frame under consideration has been lengthened. Since the late 1990s change dynamics increasingly have become a topic of research, addressing a variety of dimensions: farm household composition, farmer's goals and preferences, markets and institutions. This implies new constraints as well as new opportunities and thus different system dynamics. Moreover, integrated assessment methods related to the three pillars of sustainable development need to be developed.

- With the realisation that farms change continuously to co-evolve with their social, economic and ecological contexts, the search for an 'ideal' or 'best bet' innovation was dropped. Dynamic conditions call for 'learning by doing'. Learning is not considered a passive process of teaching or transferring information to farmers, but rather as an active and on-going process of testing and acquiring new insights.

The contribution of agricultural growth to poverty alleviation

The evidence is quite clear that broad-based agricultural development provides an effective means for both reducing poverty and accelerating economic growth. This is normally achieved not only by increasing incomes for producers and farm workers, but also by creating demand for non-tradable goods - namely services and local products. It is this indirect effect on demand, and the associated employment creation in the off-farm sector of rural areas and market towns, that appears to be the main contributing factor to the reduction of rural poverty. Furthermore, as other studies show (Datt and Ravallion, 1998), agricultural growth can reduce urban poverty more rapidly than does urban growth itself, largely because of the consequent reduction in urban food costs and lower rates of in-migration from rural areas. The evidence is overwhelming that it is essential to accelerate agricultural growth if poverty is to decline rapidly (Mellor, 2000).

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

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

The concept of farming systems

Farmers typically view their farms, whether small subsistence units or large corporations, as systems in their own right. The following systems diagram (see Figure 1) of a typical farm system, drawn by Bangladeshi farmers, illustrates the structural complexity and interrelationships between various components of a smallholding. It also shows the variety of natural resources available to farm families. These resources normally include different types of land, various water sources and access to common property resources - including ponds, grazing areas and forest. To these basic natural resources may be added climate and biodiversity, as well as human, social and financial capital. The diagram also illustrates the diversity which characterizes the livelihoods of most smallholders.

Each individual farm has its own specific characteristics arising from variations in resource endowments and family circumstances. The household, its resources, and the resource flows and interactions at this individual farm level are together referred to as a farm system (Dillon *et al* 1978, Shaner *et al* 1982, Norman *et al* 1982). The biophysical, socio-economic and human elements of a farm are interdependent, and thus farms can be analyzed as systems from various points of view.

Figure 1 Farmers' View of a Farm System, Bangladesh (Lightfoot *et al* 1991)

The resource endowment of any particular farm depends, inter alia, on population density, the distribution of resources among households and the effectiveness of institutions in determining access to resources. Regardless of their size, individual farm systems are organized to produce food and to meet other household goals through the management of available resources - whether owned, rented or jointly managed - within the existing social, economic and institutional environment. They often consist of a range of interdependent gathering, production and post-harvest processes, so that besides cropping and livestock keeping, household livelihoods can encompass fishing, agro-forestry, as well as hunting and gathering activities. Off-farm incomes, which make a significant contribution to the livelihoods of many poor rural households, are also included. Farm systems are not found only in rural areas; significant levels of urban agriculture exist in many cities and towns in a wide range of developing countries.

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

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

Over the past 30 years, the original approach to analyzing farming systems has evolved markedly, as illustrated in Table 1.1 Essentially, the scope of the analysis has gradually expanded, placing increasing emphasis on horizontal and vertical integration, on multiple sources of household livelihoods, and on the role of the community, the environment and support services (Collinson, 2000). The use of the Farming System Approach (FSA) as an analytical framework became common in the 1970s, and it has contributed to a paradigm change in rural development thinking.

From a predominantly top-down, reductionist view of agricultural development dominated by technical productivity considerations, there has been a marked shift to a more holistic perspective. This is based upon a broader goal of improved livelihoods and greater household food security, where household structure, gender, social networks, local institutions, information, policies and markets all play a role. Concurrently, analytical techniques have become more participatory, with an increasing stress on indigenous knowledge, and upon group planning, experimentation and monitoring. There is now also a greater insistence on the prime responsibility for change and initiative residing within the farming community, and with this shift in emphasis, the underlying importance of human resource capacity has become more widely recognized. The current FSA approach, with its focus on the farm household as the centre of a network of resource allocation decisions, has much in common with the Sustainable Livelihoods Approach (SLA).

Table 1.1 Evolution of the Farming Systems Approach

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

Source: Adapted from Dixon and Anandajayasekeram (2000).

Note: Darker squares indicate greater focus on the element in that period.

Major categories of farming system

The FAO classification of the farming systems of developing regions, has been based on the following criteria:

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

Based on these criteria, the following eight broad categories of farming system have been distinguished by FAO in developing Regions :

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

The above criteria and broad grouping of farming systems were applied to the six main regions of the developing world in a pragmatic fashion, with a view to drawing conclusions with regard to poverty reduction and agricultural growth. The exercise resulted in the identification of 72 farming systems with an average agricultural population of about 40 million inhabitants, although individual systems range from less than one million to several hundred million agricultural inhabitants. Sometimes, sufficient differences exist within a farming system to justify reference to distinct sub-types; for example, small-scale farms and plantations or commercial farms, or low altitude and high altitude areas.

Farming System Analysis: (FSA)

Farming System Analysis (FSA) is an in-depth, quantitative analysis of an existing farming system of the study area. The farming system can be defined as "an unique and reasonably stable arrangement of farming enterprises that the household manages according to quell defined practices in response to physical, biological and socio-economic environments and in accordance with the households' goals, preferences and resources. These factors combine to influence the output and production methods. More commodities are found within the system than between systems. The farming system is part of larger systems, i.e. the local community and can be divided into subsystems cropping systems. Central to the system is the farmer himself (Shaner et al., 1982).

Development of farming systems and reduction of hunger and poverty

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

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

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

The first of these two strategies - intensification and diversification - form important components of the FAO Special Programme for Food Security (FAO 1999c). Intensification is defined in this book as increased physical or financial productivity of existing patterns of production; including food and cash crops, livestock and other productive activities. Although intensification is frequently associated with increased yields as a result of greater use of external inputs, it may also arise from improved varieties and breeds, utilization of unused resources, improved labour productivity, and better farm management - for example improved irrigation practices or better pest control.

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

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

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

Aspects of the evolution of farming systems

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

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

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

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

Figure 2 represents schematically the interrelationship of these key determinants of farm systems and, by extension, farming systems. Some of these factors are internal to, or part of, the farming system, whereas others are external. The principal exogenous (external) factors which influence the development of farming systems - policies, institutions, public goods, markets, and information - are indicated on the left side of the Figure, lying outside the dotted line that marks the system boundary.

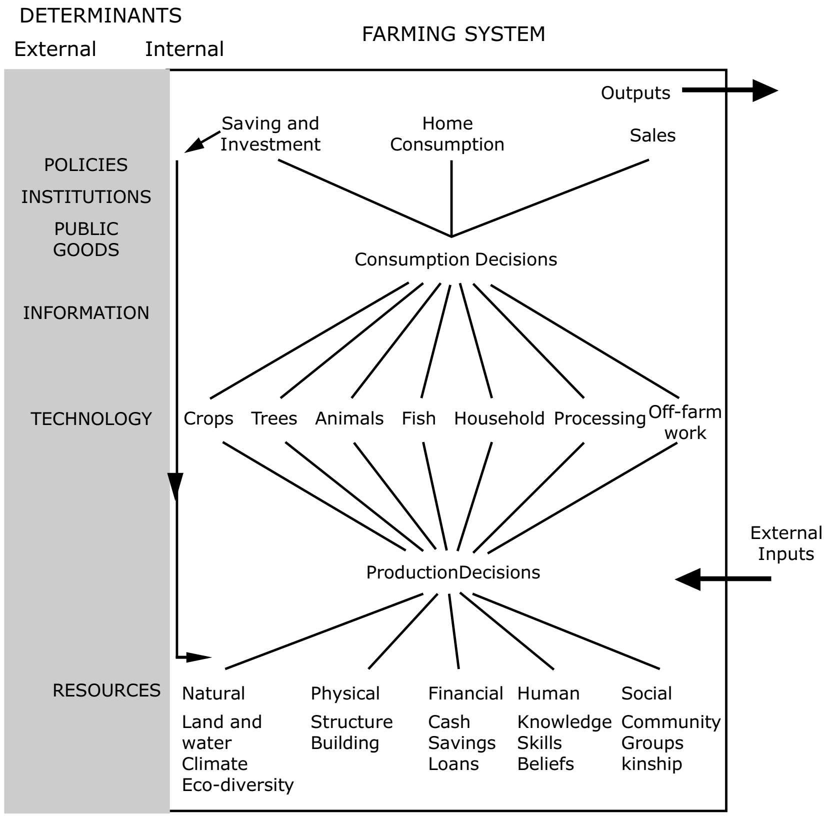

Figure 2. Schematic Representation of Farming Systems

The availability of markets and the prices on offer influence farmers' decisions on enterprise pattern, on purchases of inputs and on the timing of produce sales. The availability of economic and social infrastructure in rural areas determines the transport costs and the availability of services to the household - notably human and animal health. Similarly, information and educational services affect household strategies and decisions. Technologies, which determine the nature of production and processing, and natural resources, are largely endogenous (internal) factors and are therefore depicted as lying mainly within the boundary of the farming system. In general terms, the biophysical factors tend to define the set of possible farming systems, whilst the socio-economic factors determine the actual farming system which can be observed at a given time.

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

The five key categories of determinants influencing farming system evolution as identified and described by FAO is provided in the following sections.

Natural resources and climate

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

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

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

It is estimated that an additional 1.8 billion ha of land of 'acceptable' quality remains available for future agricultural use, but this seemingly favourable scenario is seriously constrained by a number of factors. Much of the land categorized as suitable for agriculture is only suited to a narrow range of crops (e.g. olive trees in North Africa). Secondly, more than 90 percent of available land is in Latin America and Sub-Saharan Africa, which means that further expansion is simply not an option for most of North Africa, Eastern Europe, Asia and Middle East. Even in those areas where potential for expansion does appear to exist, over 70 percent of available land is estimated to suffer from one or more soil or terrain constraints. As a result of these factors, the projected expansion (FAO 2000a) in cultivated area in developing regions to 2030 is only half the historic rate - adding about 120 million ha to the current total. Strikingly, however, by the year 2030, and despite the addition of well over two billion people to the population of developing countries, the average amount of cultivated land available for each person engaged in agriculture may actually increase due to the stabilization of agricultural populations.

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

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

Agriculture currently contributes about 30 percent of the global anthropogenic emission of greenhouse gases. Growth in the production of these gases by crops is expected to slow down in future, but methane production by livestock could increase substantially. Accumulated evidence (IPCC 2001) now strongly suggests that impacts from global climate change will be significant. Average global surface temperatures are expected to rise by an estimated 1.4 to 5.8°C in the next 100 years, while the frequency of climatic extremes (temperatures, precipitation and winds) is expected to increase dramatically. Models based on the Intergovernmental Panel on Climate Change (IPCC) scenario of a one percent increase in greenhouse gases annually, predict that within 80 years extremes currently experienced only once a century will become normal. Higher temperatures will inevitably lead to a rise in sea levels - estimated at between 0.1 and 0.9 metres over this century.

There is little doubt that both agriculture and food security will be affected by climate change. Not only will crop yields change, but huge investments in infrastructure could also be required. Among the impacts predicted by the IPCC Working Group is a reduction in potential crop yields in most tropical and sub-tropical regions and, if temperature increases are towards the higher end of the predicted range, also in mid-latitudes. Another recent study has estimated that crop yields could decline by one-fifth in many developing countries (Fisher *et al* 2001). Water availability - particularly in the sub-tropics - is expected to diminish; although some areas such as South East Asia, may have to cope with greater volumes of water as a result of more intense monsoon activity. A widespread increase in the risk of flooding is anticipated, as a result of rises in sea level and increased severity of precipitation from storms, hurricanes and monsoons. Labour availability may be affected by the expected increase in the transmission of diseases; both vector borne (e.g. malaria), and water borne (e.g. Cholera). Overall, the increased variability of climate, and thus agricultural productivity, substantially increases the risk faced by farmers, with concomitant reduction in investment and input use.

Science and technology

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

The historical focus of research by CGIAR and NARS centres on food crop production technologies, with its emphasis on improved yielding varieties, has undeniably been successful. Nearly three-quarters (71 percent) of production growth since 1961 have been due to yield increases. Increased yields have contributed to greater food security within developing regions and have contributed to declining real prices for food grains. It is significant that FAO projections to 2030 (FAO 2000a) indicate a continuing rise in average cereal yields in developing countries, under both rainfed and irrigated conditions.

However, many poor smallholder farmers in marginal areas have not benefited from these cereal yield increases, and investments in technology development for non-cereal crops have usually received a low priority. Although the private sector and large farmers' organizations have invested heavily in research for commercially important cash crops - examples include coffee, tea, sugar cane and bananas - many tropical staples and minor cash crops have received relatively little attention. Similarly, investment in livestock research has generally not been commensurate with the contribution of the sub-sector to household income or Gross Agricultural Domestic Product (GADP). Only one CGIAR research centre - the International Livestock Research Institute (ILRI) - concentrates on livestock, although other centres have animal production programmes. In contrast, agricultural research in industrialized countries has been relatively well funded with some of the work being led by the private sector. Consequently, a much greater range of new technologies is available for production systems and crops of interest to developed countries than for smallholder production systems in developing countries.

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

Despite these weaknesses, the global research agenda is gradually moving from a focus on individual crop performance to a growing acceptance of the importance of increased system productivity. This is viewed largely in terms of better-managed interactions among diversified farm enterprises, sustainable resource management, and improved targeting of technologies towards women farmers and poorer households. Perhaps even more importantly in the long term, institutional modalities are now shifting.

From a public sector focus, largely led by the international system, more emphasis is now being given to public-private partnerships driven mainly by the demands of clients. These changes are being accompanied by a growing understanding of farmers' problems and opportunities and a greater willingness to blend indigenous knowledge and modern information.

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

Trade liberalization and market development

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

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

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

In the longer run as barriers to trade between countries diminish, and if subsidies to producers in industrialized countries are removed, developing country products that are competitive in world markets will benefit, replacing those that have hitherto relied on protection. Broad social, economic and cultural trends will also contribute to a profound reshaping of market demand, as increased urbanization, rising incomes, improved communications and the diffusion of cultural preferences exert their effect. The availability of new production, post-harvest and transport technologies will also change demand patterns, by making possible the delivery of new products - or established products in new forms - to markets where they have been previously unattainable.

Policies, institutions and public goods

The development of dynamic farming systems requires a conducive policy environment. Moreover, the establishment of the farm-rural-urban linkages described by Mellor, 2000 requires effective demand. The greatest change in this environment during the past 30 years has been structural adjustment, the widespread introduction of which marked another step in a key policy trend that can be discerned over the last few decades; the decline of national food self-sufficiency as a dominant element in the shaping of policies for rural areas. In the 1960s, the perceived need to ensure national food security was paramount for many governments and was used to justify direct intervention in agricultural marketing, storage, import licensing, input subsidies and other areas. Although national food self-sufficiency is no longer an overriding policy aim, food security remains a key policy issue for developing countries and indeed for the whole world. This was emphasized in the FAO-sponsored World Food Summit of 1996 and the follow-up development activities.

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

The first two trends fit well within the growing tendency, at a broader social level, to encourage more local participation in decision making and resource allocation. The third is largely an outcome of the shedding of many previous governmental responsibilities to the private sector. These tendencies will probably continue to gain importance during the next one or two decades. However, while such trends offer significant benefits in terms of mobilisation of non-governmental resources and a better alignment of public activities to local needs, they have also created constraints. There has been a generally slow or erratic supply response from the private sector, which in many countries has experienced difficulties in effectively replacing public services in finance, research, extension, education, health and even in infrastructure development and maintenance - particularly in rural areas where poverty is widespread. Smaller farmers and female-headed households have suffered disproportionately. The missing element has been the creation of the new public services required to create a supportive environment for the growth of private sector activities and to ensure equity and environmental sustainability.

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

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

Information and human capital

The evolution of farming systems based upon increasing specialisation (e.g. large-scale broiler units) or integrated intensification (e.g. rice-fish-ducks) has required extra knowledge on the part of farm operators. The need for better information and enhanced human capital has also increased, as production systems have become more integrated with regional, national and international market systems. Many farmers in developed countries now have a much better understanding of the nature of the demand that they are responding to - in terms of its implications for varieties, timing, and packaging and permitted chemicals. As a result, they have progressively modified their production practices and their portfolio of products in response to changing patterns of demand. This knowledge-based approach has not yet been adopted widely in developing countries, beyond a relatively small group of educated commercial producers. However, the experiences of some small producers have shown that this approach is possible, even among producers facing severe poverty. Depending on the speed and form of evolution of farming systems, knowledge-based adjustments are likely to intensify during the coming 30 years.

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

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

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

Armed conflict, migration of men in search of paid employment and rising mortality rates attributed to HIV/AIDS, have led to a rise in the number of female-headed households and placed a considerable burden on women's capacity to produce, provide and prepare food. Despite their increasingly prominent role in agriculture, they remain severely disadvantaged in terms of their access to commercial activities. A FAO survey showed that female farmers receive only seven percent of all agricultural extension services world-wide and that only 11 percent of extension agents are women (FAO 1990b). Throughout the developing world women are denied the full legal status necessary to give them access to loans. This lack of access to rural financial services hampers women's efforts to improve their farm activities. Improvements in these areas can be expected in the coming decades, as women become better organized to assert their rights.

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

It is increasingly recognized and acknowledged by development workers that the empowerment of women is the key to raising levels of child and family nutrition, improving the production and distribution of food and agricultural products, and enhancing the living conditions of rural populations. It has been concluded that if women in Africa received the same amount of education as men, farm yields would rise by between seven and 22 percent (FAO 1990b). Similarly, better access to credit, land and extension services would enable women to make an even greater contribution to eliminating rural hunger and poverty. As gender bias is progressively eliminated during the coming 30 years - often in the face of severe cultural and religious barriers - productivity within many farming systems will be transformed.

The Systems Approach for Farming System Development

Systems Approach in Agricultural development has slowly emerged in the present decade to assume central importance in the thinking and approach of many agricultural scientists, technologists and program managers. Agricultural knowledge in recent years is compartmentalized into small and seemingly more manageable sinks due to the detailed study and analysis of even small areas of knowledge and its application. The newly developed knowledge and technologies will be of otherwise no use to the farmers unless a system is created for screening and selecting the technologies keeping in view the farmers socio personal economic conditions and informing the farmers about the concept of management and decisions making skills as the new technologies demand more of these abilities. Due to the geographical isolation, still much of these skills have not reached the local farmers and they are far behind in comparison to their counterpart elsewhere. Therefore, the agricultural development system in the rural areas should also help rural people to develop leadership and organization skills so that they can plan better, organize, operate and participate in cooperatives, credit societies and other support organizations as well as to participate fully in the development of the local communities with aided self help.

The necessary on systems thinking and farming system development has come partly from the recognition of complexity in agricultural knowledge and technological outbreak, their relevant cost effective application in natural and man made systems and partly from the need to gain control over the more threatening out comes of this technological intervention in the farmers systems. Therefore, it is need of this hour to develop a farming system specific extension approach for an effective technological utilization programs. In this section, the concepts of systems approach and its application in farming system development for developing rural areas have been discussed in a simple way.

Main concepts in the systems approach

Consequences are the changes that occur to an individual in a social system as a result of the adoption or rejection of an innovation/technology. The technologies are often introduced into the system with the expectation that the consequences will be desirable; direct and anticipated. However, adoption of such technologies may result in some unanticipated consequences which can be indirect and undesirable for the members of the system (Rogers, 1983). The psychosocial subsystem which consists of the individual behaviour, motivation, social status, role performance, decision making pattern and group network in the society is affected by the technological subsystem either positively or negatively in the way deemed desirable by the change agencies. Inter meshed with the technological, and psychosocial subsystem is the structure. The structure is concerned with the ways in which:

i) the tasks of the extension organization are divided (differentiation) and coordinated (integration)

ii) the farmer's subsystem is subdivided into various social units, their roles and functions

iii) the pattern of authority, communication and work flow in the farmers and extension subsystem

The managerial subsystem plays a central role in goal setting, planning, organizing, communicating, coordinating, implementing and evaluating the various extension programmes. It performs the typical function of linking all the subsystems with each other under its construction and supervisory role.

The word system is a very general term. It is derived from a Green verb which means "to compose". There are different definitions of the term system. For our purpose we choose the following definition:

A system is: a set of selected elements with a certain structure (interrelationship between elements) and which are engaged in processes of transformation.

Elements in a system are the smallest parts that the observer wants to consider given his/her objectives. The elements are distinguished from its environment by a boundary. The objectives of the analysis determine where the boundary is placed. For our purpose we have included the processes in the definition, since the types of systems we are concerned with, are open and dynamic systems. Systems of this kind use certain inputs in process(es) of transformation and yield outputs. As a result of these processes the system as such is subject to change, growth or development. All systems, which involve human being, are open and dynamic systems; people process the information they receive and through its process of learning, man changes. Change, growth or development can also be the result of interaction of the system with the environment and /or development interventions, i.e., deliberate activities of entities, which are not part of the system (but of the environment), aimed at changing the system in a certain direction. The degree of change that a system will undergo as a result of a certain intervention is called the elasticity of the system for that intervention.

Agricultural Systems: An Agricultural system can be defined as the combination of people and institutions in a delineated area which use land and other natural resources, labour, capital, technology and non factor inputs as well as knowledge and information in order to ensure production and processing of agricultural output for own consumption and/or exchange with goods and services produced elsewhere. The definition of a system implies that any set of related elements, which are transforming inputs, can be considered as a system. The purpose of the system analysis is to determine where the operational boundary is to be placed. In determining the boundary three different dimensions should be considered. They are:

(i) At which level should the reality be analyzed?

(ii) Which aspects of the reality should be included and which should be left out.

(iii) Which subsystems are to be included or left out?

In rural areas the farming systems are unique and reasonably stable arrangement of farming activities are undertaken by the households ina certain area to produce an output. These activities have been developed in response to the physical, biological and socio-economic environment and in accordance with households' goals, preferences and resources. These activities are related to each other in time and function and are subject to change as a result of technological developments due to interventions.

A system is an organized, unitary whole composed of two or more interdependent parts, components or subsystems and delineated by identifiable boundaries from its environmental supra system. The agricultural system in rural areas can be defined in the systems concept as a subsystem of its broader environment, consisting of:

- Goal oriented people with a purpose- farmers, technocrats, extension workers.
- A technological subsystem(s)– knowledge, techniques, equipments and extension methods.

- A structural subsystem(s)- differentiate and integrate the activities of research – farming systems research (FSR) team, technical advisory committee, subject matter specialists and contact farmers.
- A psycho-social subsystem(s)- which coordinates all the extension subsystem planning, implementing and evaluating all the programs.

For the development of agriculture in the rural areas, the development systems should therefore function as a subsystem of the society and it must accomplish its goals within the constraints that are an integral part of the environmental suprasystem under which it operates. For a successful performance, the extension system must confirm to the prevailing local social norms and requirements. for that, the farmers subsystem needs, goals, values, structural make up of the society, technology in hand, needs, capabilities and potentialities of each of the integrated subsystems under its operation must be thoroughly understood. The goal and values represent one of the more important subsystems of the people of whom the extension education is aimed at. Any technology, which is against the prevailing, values, customs and beliefs of the farmers need to be cautiously introduced. Initially, the extension approach is largely influenced by these societal values, customs and beliefs. Once the new technology gets adopted and influenced, the societal and socio-cultural values are in turn influenced by the new technology. The technological subsystems refers to the knowledge, ideas and technologies that are to be transmitted to the farmers by the extension agencies and the working knowledge necessary for the agencies to aid such transformation. The technological subsystem is therefore, largely determined by the purpose of extension agency, the farming system under which it operates, the resource potentialities of the farmers, the cost of the technology and the nature of the prevailing technology, the farmers experience, and potentialities in handling such technology and the agencies resources in transferring the technology. During such technological interventions, the psycho-social and economic subsystems of the society often come under pressure.

Extension subsystems: its objectives and interactions in achieving agricultural development

To formulate a strategy for designing and implementing an extension education programme which aims at technology transfer and utilization, in the rural areas, an insight knowledge about the functional subsystems in extension is warranted. It will facilitate a speedy technology transfer programme on the basis of the clientele needs and conditions. The importance of understanding the various subsystems, their functions and interactions for achieving an effective research, client system linkage through extension is, therefore, need to be well understood as the extension system is to function as part of an interdependent technology development system, transfer and utilization subsystems. It also, must ensure a two-way flow of information between these systems. Therefore, strengthening extension education is not just a process of training and deploying more extension workers; rather, it is a process of strengthening the whole system in the rural areas. For example, in cases where the farmers system is less thoroughly understood, or where field extension workers are poorly trained or inadequate knowledge system management without feed back often results in the failure of the entire extension programme. Therefore, improving the flow of information about farmer's problems either directly to researcher or indirectly through extension and assisting farmers to improve their organizational and leadership skills are essential features of an effective technology development, transfer and utilization subsystems. It is within the context of this overall framework that three main subsystems involved in the extension education programme of the rural areas have been discussed here.

i) Research subsystem

The research or technology development subsystem plays a vital role in development of the new technologies, the application of which expected to bring increase in production and other economic benefits to the farmers. The development of newer technology by the research subsystem in turn largely depends upon the perception of the researchers on the needs of the farmers, the farming systems under which it is applied, available resources of the farmers and his socio-cultural compatability. Therefore, the research subsystem cannot function independently as its objectives and development goals largely depend upon the client system needs and potentials. The types of agricultural technology that are developed for and adopted by farmers have a direct impact of the agricultural economy. An example is the development of labour saving technology. In this the technology largely aims at large scale mechanization which generally favours large scale production units. The land saving technology such as more intensive farming systems will tend to favour small farmers and producers. This system is mostly suitable to our rural areas condition as they absorb the excessive labour of farm families in a productive manner and because they generally involve many manual operations which need to be appropriate for small farm agriculture. At the same time they are generally less suitable for large farmers unless there is an excessive supply of inexpensive farm labour availability. Therefore, the research system alone cannot function independently and needs to be actively linked with the client subsystem either directly or indirectly through the linkage subsystem of the extension.

ii) Extension Education Subsystem

The prevailing extension education approach in the rural areas is built upon diffusion theory. In operation terms, our extension workers concentrate their attention on the early adopter categories of farmers, and new technology is expected to trickle down through early majority, late majority and finally to the laggards. This strategy is acceptable only when the government policies and research system does not favour large farmers and if technology is not biased. In reality it is not so. In turn, mostly the resource endowment of the farmers acts as the most important factor in affecting the adoption behaviour. The interpretation of studies on adoption behaviour of various client systems also revealed that many of the farmers were mostly concerned with minimizing risk rather than maximizing profit. In addition, with their limited resources base availability in the islands the farmers personal system also plays an important role in accepting a particular technology. Therefore, with the proper understanding of the client system, appropriate types of improved technologies and extension education can be evolved for a broad based agricultural development.

The proper understanding of the client subsystems, the client and research subsystem linkages are possible only through the extension subsystem and this can be achieved with ease when the extension subsystem follows appropriate educational strategy and mix. The suitable technology selection by the extension subsystem to the islands varied clientile needs most be based on the results of on-farm research and extension trials. Generally, the subject matter specialists working KVKS with extension workers need tobe involved in such on-farm research for getting first hand information of the field applicability of a particular technology and the constraints involved for its effective use. The extension personnel and SMS should help to locate representative farmers for these trials and based on these On-Farm Trials (OFT), the technical committee has to recommend the suitable technologies that need to be promoted. For a successful implementation of these recommended technologies, well trained, open minded client system linked KCKS/SMS are needed along with a suitable extension strategy and media combination. Efforts in these lines are need to be made in these rural areas.

iii) Farmers subsystem

The need for a broad based agricultural development has shifted our attention to a more consideration of the extension strategies and methods that are 'appropriate' for small farmers, including farm women, youth and settlers. The presence of different socio economic categories in rural communities, and that their circumstances are sufficiently different in the rural areas and therefore it is to mean that appropriate technology must be developed and adapted by agricultural research and then targeted through 'appropriate' extension programmes (which is presently not there) to reach these major categories. The media of transformation of the selected message to these different farmer categories need to be selected with utmost care on the basis of the client system resources and cognitive styles. Therefore, instead of working with selected progressive farmers in a community or rural areas and assuming that technology trickles down, it is important that each extension worker should understand the agricultural customs in his area, types of farming system followed, socio economic and psychological distinctions of the farmers. Only by taking all these factors in the client system under target, the extension specialist can aid the appropriate technology development and reduce some of the negative and disruptive social consequences of technological change and at last attempt an effective Transfer Of Technology (TOT) programme in the rural areas.

The education level of society at large and farmers in particular carries a significant influence for the agricultural extension programme. First of all, it affects the educational level of the recruits coming into the extension system. Secondly, it influences the technical competence that is required for extension subsystem to assist farm families. Properly conducted vocational agricultural training can expose the farmers to practical field or project experiences which gives knowledge about basic science and a good foundation for the rural farmers of the rural areas about the agriculture and its techniques.

The usefulness of the systems approach for development

We have chosen for the use of the systems approach in Agricultural Development of North East region since:

a) it can be helpful in reducing biases in our efforts to understand the rural reality, and of the role extension can play in rural development

b) the system approach provides a common language and common operational principles for different disciplines. This allows for the integration for different disciplinary approaches available with KVKS & host intitutes which is of utmost importance for rural development.

c) it allows the use of models which makes it possible to combine qualitative and quantitative data and to work with simulated models in order to design possible solutions of problems.

d) The system approach allows the formulation of practical guidelines for the understanding of the reality, as well as for the design for interventions in the reality.

It is well known that any expansion of agricultural activities in these rural areas puts great strain on the natural resource base that supports agriculture. The expansion of cropping on to land unfit for cultivation leads to erosion. It may also entail the sacrifice of primary forest, with its diversity of flora and fauna. Overgrazing by livestock can lead to the degradation of pastures. The over use of chemicals to intensify crop production poison both people and animals as well as polluting water and soil resources. And increasing dependence on water for irrigation depletes aquifers and water courses, causing shortages for other users and rising levels of soil salinity. The sustainable development of agriculture in these areas depends on many factors, not all of them easily controlled. However, the prime mover of agricultural development is new technology with options that allow farmers and other users of natural resources to produce more per unit area at lower cost without affecting the natural resource base.

Agricultural Development

New technology enters the rural agricultural sector from two major sources. until 1972, farmers themselves were the main suppliers. Traditional production system evolved through their efforts in selecting plants, in perfecting such simple tools as the hoe and plow, and in designing crop mixtures and rotations over the years of farming. Yet in today's conditions shrinking natural resources and rapidly rising human populations, traditional production systems are increasingly failing to meet the food and income needs while some are in danger of breaking down altogether. In short, farmers efforts alone are no longer enough. The second major source of new agricultural technology is science and its intervention. Through research, scientists increase their understanding of the basic physiological mechanisms that conditions plants and animal growth, of the genetic basis for desirable traits in crops and livestock, of the factors that contribute to resource degradation and of the policies and practices that can arrest this process and bring about sustainable increase in production in the rural areas. Farming System Research and Extension (FRS/E) need to be applied more widely to make agricultural production more relevant to the resource capacities of the farmers and environment. Various aspects of FSR/E including the concept, characteristics, associated models, issues concerned with adoption and its importance in the rural development are discussed here.

Models associated with FSR/E

The two models, which are closely associated with FSR/E, are briefly described here for their adoption in the rural agricultural development.

a. Farmer – Back – To – Farmer Models (Rhodes and Booth, 1982)

The basic philosophy upon which the model is based is that successful agricultural research and development must begin and end with farmer. Applied agricultural research cannot begin in isolation on an experimental station or with a planning committee out of touch with farm conditions. This means obtaining information about, and achieving an understanding of the farmer's perception of the problems and finally to accept the farmer's evaluation of the solution. Thus, research must strive to close the circle, from proper identification of the problem to farmer's acceptance or rejection.

The purpose of diagnosis is to arrive at the widest possible consensus between farmers, social scientists and technologists on the definition of the problem to be solved. At this stage, it is likely, and even desired that the disagreements will arise between the social and the biological scientist over the interpretation of problems – 'constructive conflict'. It is important the team members have a mutual respect, confidence and working knowledge of each other's discipline. With the problem in mind, the team can now proceed forcefully with on-station research guided by more farm level information in order to arrive at a potential solution. Armed with a potential solution, the team now proceeds to a testing and adoption activity with the objective to fit the technology to the local circumstances with the farmer acting as the adviser. In most circumstances, the testing and adoption will first occur in the experiment station followed by on-farm trials. The information on the technology's acceptance or rejection by the farmer who is the final judge to decide on the appropriateness of a proposed technology need to be collected. If the technology is rejected, the entire process can be repeated to determine the reasons and find ways to overcome them. The final stage involves the actual evaluation and use of the technology by the farmer under his conditions, resources and management.

b. Farmer-First And Last Model (Chambers and Ghildyal, 1984)

It is almost similar to the previous model. It starts with holistic and interdisciplinary appraisal of farm families, resources, needs and problems, and continues with on-farm and with-farmer R&D while the scientists, experiment stations and laboratories act in a consultancy and referred role. It fits the needs and opportunities of resource poor farmers better than transfer of technology models. It promises a greater contribution from agricultural research to the eradication of rural poverty in our country.

Importance of FSR in North East India:

The economic and social benefits from agricultural research can be extremely high. The dramatic advances in productivity achieved in the green revolution in irrigated North West India in the late 1960s is perhaps the internationally best-known example. The green revolution strategy was evolved in an era when the problem of poverty and hunger was largely seen as problem of production, for growing more food. It concentrated mainly on those farmers and those areas with the greatest apparent potential for producing more food. If it favoured the better-endowed areas, this was justified since they presented the conditions in which the new high-yielding technologies generated on research stations could most readily be adopted. (Chambers and Ghildyal, 1984). Of late, there have been significant shift in understanding of poverty and hunger, and setting priorities. In terms of national economy, total food production remains very important, and it is estimated that the aggregate gross demand for food grains would be 225 million tones by 2000 AD. Attention has now shifted towards giving higher priority to raising and stabilizing production on rainfed lands which constitute about 70 percent of the total cropped area contributing roughly 45 percent of total food production. Attempts are now being made to direct our agricultural research towards the needs and interacts of those who were largely by-passed by the green revolution technologies, the 60 million farm families who are resource poor having less than 2 ha of land for providing social justice, increasing production and employment opportunities. Therefore, in the rural areas with its poor resource base and unique production problems, an approach other than the conventional green revolution strategies need to be thought of.

Agricultural research organized traditionally in disciplinary or commodity lines and without adequately involving the social scientists has frequently lacked a farming systems perspective. Moreover, conventional research typically has been mostly conducted on research stations under conditions that are not representative of farmer's fields and with little or no farmer involvement. Experiments in farmer's fields ensure that technologies are formulated under farmer's conditions and overcome the difficulty of using experiment station results to make farmer recommendations particularly where experiment stations are not representative of the area because of intensive management practices or locations.

Although many farmers in the rural areas are largely in need of appropriate improved technologies, only few of their technological requirements are met. Why this occurs is the subject of scientific discussion. Some argue that farmers are at fault; some that extension is ineffective, others the technology is unsuitable and some the inputs are not available in a timely way. Among these, frequently heard explanation is that the recommended technologies themselves are simply not appropriate to farmers. Certainly one or other of these explanations is valid at sometime and someplace. It is convinced to the scientists that farmers do not adopt recommendations because they are not suitable for them. In general, farmers seek technologies that increase their income while keeping risks within reasonable bounds under their own circumstances.

On the other hand, FSR/E, which has drawn worldwide attention, has many distinctive features over the agricultural development programmes in operation at present in rural areas. Effective communication of researchers and farmers under FSR/E, ensures greater awareness of the constraints and problems of farmers in the design of technologies. Direct communication of the interdisciplinary research team with farmers increases understanding of the farmers decision-making environment and enable identification of technological alternatives more consistent with that environment. By adopting the FSR/E approach, we can provide the essential links between agricultural development planners, research and extension workers and farmers. By this, future agricultural development can be better tuned to real farmers problems and a sustainable agricultural development can be advanced in NE India.

Implementation of FSR/E: Issues

There are certain issues which must be considered while implementing the FSR/E approach in Rural areas. They are:

a) **Institutional problems**: Research and extension are at present handled separately and needs suitable integration through cooperation and coordination. But how to bring them together is a problem to be solved.

b) **Conflict:** Since it is an inter-disciplinary approach, conflict bound to arise between the agencies involved.

c) **Clientele selection:** Defining a specific relatively homogenous client groups in a heterogeneous environment like Rural areas is a major problem.

d) **Resource flexibility:** lack of resource flexibility in the development departments of the rural areas. It can be best solved by program implementation through a semi-autonomous organization that has more flexibility in operations, budgetary and personnel management that ministerial and R&D organization.

e) **Staffing requirements:** Reorientation of those who are currently working in agricultural development in new methodology as applied to field conditions and methods for working with farmers in their field will be required.

f) **Training:** The staff should be given an exposure to the objectives, process and methodologies of FSR in order to instill in them as appreciation of resources poor farmers as a useful source of information and as valuable partners in the research and technology implementation process; acquaint them with on-farm research and give them guidance and experience for working as an inter-disciplinary team.

g) **Professional competence:** The staff involved may not have a high professional competence in the field. Therefore, suitable training programs need to be conducted for training those personnel actively involved in the Farming System Research and Extension.

h) **Qualified staff:** Suitable persons in sufficient numbers especially technology managers and Extension scientist may not be available and efforts must be made to increase the number through training and providing incentives.

i) **Evaluation:** Who will do the evaluation of personnel involved in the implementation and on what basis the evaluation will be done is the problem. Therefore, the present performance appraisal system needs drastic change.

j) **Applicability of results:** Traditional approach, by its nature, often general and widely fitted. One the other hand, the FSR/E approach is designed to be more specific and unless sufficiently wide ranging environmental conditions and sufficiently large number in the target group is identified, it will become a problem under the rural area conditions.

k) **Timing:** It varies greatly. Change takes place comparatively lesser time in crop related improvement programs than the livestock systems. More fundamental changes in the farmers cropping patterns and management practices in their field normally takes longer time.

l) **Cost factor:** Since it emphasis working with farmers in their fields, it involves more money. At that time, it appears to be costly and taxing.

m) **Collaboration:** Effective collaboration of all the organizations closely associated with the needs of small farmers is very important and essential

n) **Government Support:** Since it involves extreme field work, finance and more than one organization, Government's support in terms of suitable policy, men and materials required for the work is very much essential.

In the North East India, the agricultural development could not achieve the desired impact, often because these technologies are not consistent with their circumstances. In the past, the problems of resource poor farmers were often not clear to the development specialists and policy makers. They failed to appreciate the existing farming system, their problems and farmers' needs, which led to develop and extend development that, were inappropriate to resource poor farmers and rural areas ecosystem. Since FSR stresses more on the understanding of the farming systems and the farmers' environment, it is more apt to design technologies that are appropriate and acceptable to resource poor farmers. It starts with farmers and learns about their environments, resources, methods of production, problems and opportunities, aspirations, and how they react to change. Then it moves on to the development of technologies through on-farm trials and finally evaluating them for their appropriateness by the farmers themselves. The adoption of FSR/E approach in place of the traditional approach to agricultural development poses a considerable challenge to the existing institutions and individuals involved in the development may resist for the change. However, the time has now come for all those really interested in the well being of the resource poor farmers of the rural areas and its ecosystem to appreciate the policy-parading shift and orient themselves to this new approach.

Farming system Research and Extension (FSR/E) in the broadest sense refers to any research and extension that views the farm in a holistic manner and considers interactions in the system (CGIAR, 1978). In 2001, an estimated 1.8 billion people across the world were suffering from poverty and hunger. For the vast majority of farm families, poverty and hunger are simply factors of everyday life. These people are caught in the poverty trap. For most of them the way out of the poverty trap is through a more productive agricultural sector. Development agencies have realized the importance of the agricultural sector and making every effort for the development of agriculture. Realizing its importance, our Government has made it as a national priority and launched different schemes for the development of agricultural sectors in the agency areas. Shrinking natural resources mainly in the hilly areas and incompetency of traditional production systems led to the failure in meeting the livelihood security of NE farmers. Therefore, planned technological interventions in the North East agriculture are very much essential to bring food security to them in a most sustainable way to their culture and natural resources. Since most of the KVK personnel have only formal agricultural training, they are often facing hardship in solving the problems related to NE farming. Therefore, it is very much essential for them to understand the various development approaches for a sustainable agriculture in the North East India. Farming System Research and Extension (FSR/E) is one of the important approaches and it is essential for the agricultural development professionals to have an understanding and clarity about the terms and concepts of Farming System Research and Extension. In this publication, an attempt is made to clarify the concepts for a better understanding about the farming system research and extension in the context of farming system research and extension oriented development in North East India (Hereafter mentioned as North East Region).

The book systematically presents the diverse research activities and development approaches commonly incorporated under the umbrella term of Farming Systems Research and Extension. An extensive district wise compilation of agricultural situation is provided in chapter 3. In chapter 4 the different farming systems identified are presented while chapter 5 and 6 presents the research priorities and strategies as well as development issues.