AGRICULTURAL SYSTEMS RESEARCH IN ASIA : A COMPARATIVE DISCUSSION OF HUMAN ECOLOGY, AGROECOSYSTEMS RESEARCH. FARMING SYSTEMS RESEARCH AND CROPPING SYSTEMS RESEARCH

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The purpose of this paper is to explore four areas of current research into agricultural systems in Asia in order to identify their similarities and differences and to promote discussion of how these research areas complement each other. The reason for making this exploration is based on the belief that: (1) all four areas of research show considerable parallelism in their approaches and findings; (2) all represent serious efforts to discover new knowledge about technologies for use directly or indirectly by Asian farm households; and (3) active participants in all four areas have contributions to make to, and lessons to learn from, each other.

In order to promote discussion this paper will be brief, and in order to be brief the paper will draw only a sketch of four very extensive research efforts. For these reasons it will be possible to find exceptions to many of the generalizations that are made here. However, the aim of the paper is to highlight the principal characteristics of different approaches to agricultural systems research, each valid but possessing different strengths.

Problem identification

'Inquiry starts when something is unsatisfactory... what one has at the begining of inquiry is merely the problem (Northrop

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1947)'. But what is unsatisfactory? What is the nature of the problem? Northrop identifies three principal types of research problem: (1) questions of logical consistency which can be answered by working out the logical consequences of a given set of assumptions; (2) questions of fact which require the formulation of a theory and testing with empirical evidence; and (3) questions of value which address what ought to be rather than what is. If we can classify problems into basic types we still need to understand how a problem is recognized, and among social scientists four approaches to problem identification are recognized: (1) a felt need by a individual or group; (2) a gap between a goal and achievement; (3) a significant deviation from an optimum defined by theory; and (4) an intellectual difficulty felt by a researcher (Hildreth and Castle 1966).

The importance of this discussion to agricultural systems research is that there are currently at least four very active sets of researchers attacking problems in very similar ways, whose work is distinct but highly complementary. These sets are distinct largely because of their disciplinary backgrounds and because they have chosen to difine their problems in different ways. Two sets, working in human ecology and agroecosystems research, have begun with an intellectual difficulty and are searching for a new body of theory, or combination of theories, to order and explain very complex phenomena. Two other sets, working in farming systems research and cropping systems research and cropping systems research, have begun with an existing body of theory but the perception of an important gap between goals and achievements. However, despite their different origins all four sets are working in teams, employing systems approaches to research on topics which form part of an important hierarchy of agricultural systems.

Human Ecology

The term human ecology (HE) is used here to define a research perspective that helps describe and explain in very broad terms the behavior and interactions of social systems with ecosystems. HE research employs a systems approach to understanding complex human ecosystems which can be represented graphically as in Figure 1. The components of the ecosystem and the social system are linked by flows of energy materials and information. The resulting conceptual framework assists man to understand the structure, function and dynamics of human interactions with ecosystems.

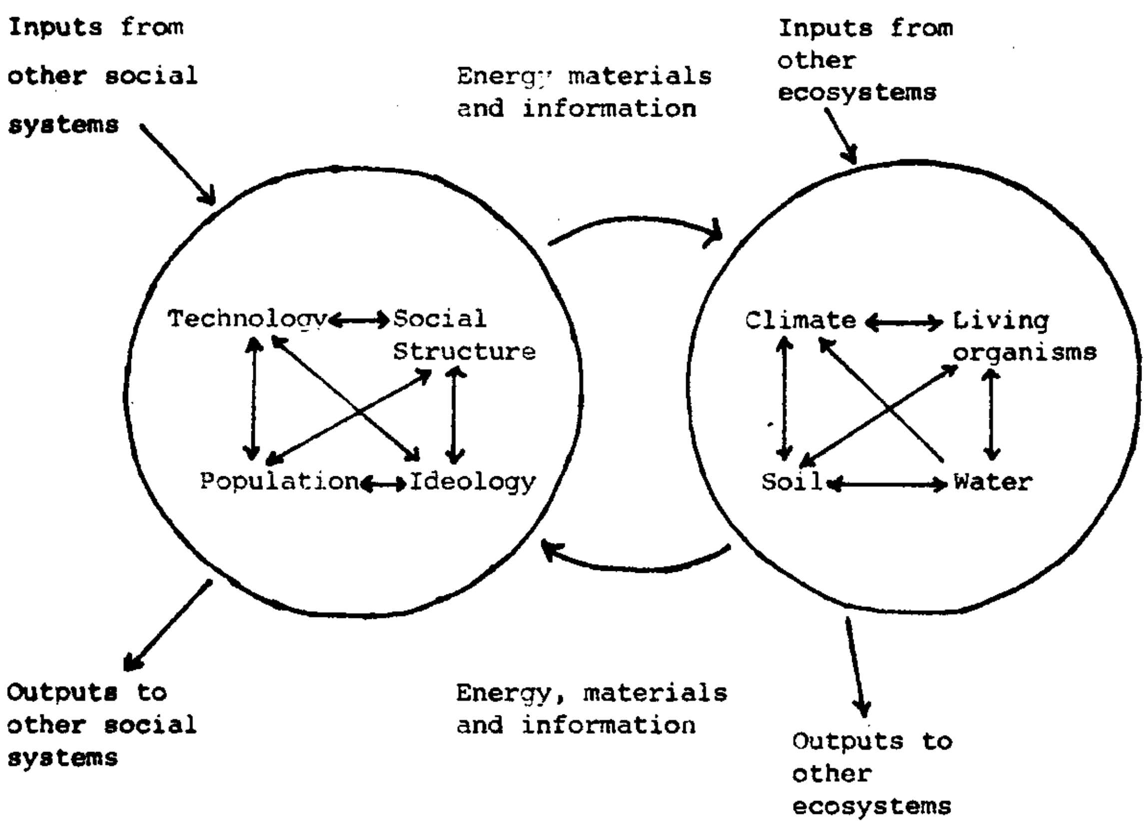
The common characteristic of studies employing a human ecological perspective is the concern with interactions between the natural world and the social world, which Western thought patterns normally keep separate (Rambo 1985). Natural scientists and social scientists normally work apart but if we want to understand the disappearance of tropical rain forests or the destruction of coastal fisheries, we must bridge the gaps between groups of disciplines. The systems model of HE provides a mechanism for linking didcipli- nary specialists in teams around complex problems, at the same time allowing individuals to pursue their own research in the areas of their own competence. HE permits and encourages communication across disciplinary boundaries and has been applied successfully in Asia in human ecological studies of tropical agroecosystems.

Agroecosystems Research

Agroecosystems are ecosystems with an agricultural purpose. An ecosystem is the biosystem of a particular area that includes both the communities of plants and animals and the non-living components of the environment with which they interact such as soil and water (Odum 1971). In an agroecosystem man has defined the boundaries and the purpose of the ecosystem and regulates the interaction within and between agroecosystems (Conway 1985).

Agroecosystems research describes and analyzes agroecosystems in-terms of their structure, function and dynamics (Rambo and Sajise 1985). Structurally agroecosystems are complex

Figure 1. A Systems Model of Human Ecology.



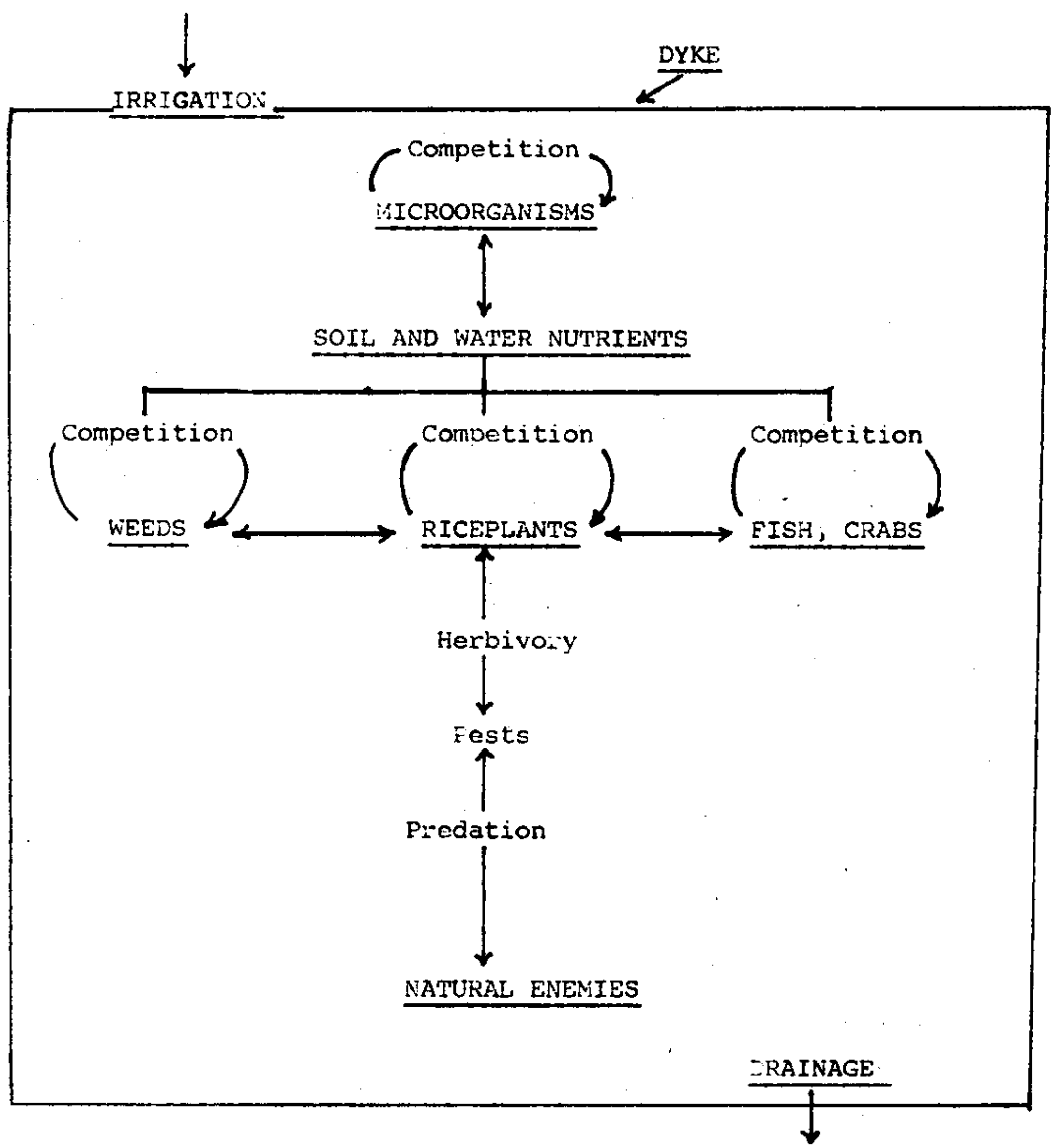
[Based on Rambo, Dixon and Wu Tsechin, 1984] exhibiting emergent properties, i.e., the whole is more than the sum of the parts. Functional emergent properties of special significance for applied research are productivity, stability, and sustainability. Productivity refers to the level of output of a system, stability refers the capacity for minimizing short-term variations in output, and sustainability refers to the ability to withstand repeated stress or major perturbation over the long-term (Conway 1985). Employing an HE perspective, agroecosystems are seen to function through exchanges of energy, materials and information, and are dynamic, changing their structure and function over time. Agroecosystems research (AER) in Asia has tended to focus on either broad regional topics, such as rain-fed agricultural systems in Northeastern Thailand, or very specific topics, such as the rice field represented graphically in Figure 2.

Farming Systems Research

Farming systems research (FSR) analyzes the farm and the behavior of the farm householder as a unit in order to identify ways in which the welfare of the farm family can be improved by increasing the productivity of the farming system (Gilbert, Norman and Winch 1980). FSR priorities reflect a holistic view of the farm as a socioeconomic and biophysical entity but research on components of whole farm systems are also considered to be legitimate parts of FSR. Graphically a farm system can be represented as in Figure 3.

FSR addresses each of the farm's enterprises, their interrelationships and relationships to the farm environment (Zandstra, Price, Litsinger and Morris 1981). FSR analyzes the farm in terms of both production and consumption but focuses on efficient utilization of the factors of production under the control of the farm household to achieve the farm household's goals. These goals may be expressed either in terms of subsistence, the production of a margin of safety beyond subsistence, production of an agricultural surplus, or in terms of profit maximization (Day

Figure 2.A Systems Model of Ricefield Agroecosystem.



[Based on KEPAS, 1984]

and Singh 1977). At the same time, FSR is an effective mechanism for communicating the needs and constraints of small-scale farmers to agricultural researchers.

Cropping Systems Research

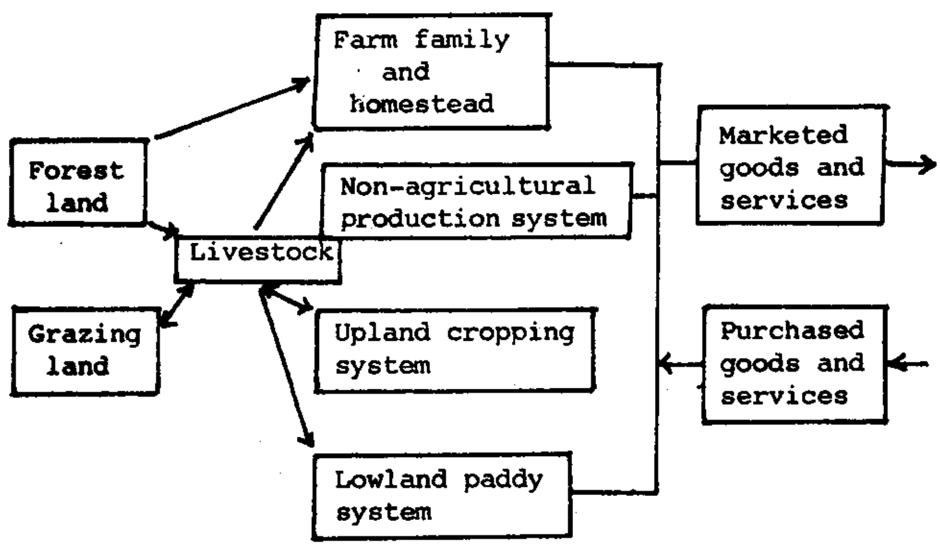
Cropping systems research (CSR) is a subset of farming systems research designed to increase food production through the introduction of additional crops or improved management practices into existing crop production systems (Zandstra 1982). Like FSR, CSR requires a systems approach but CSR is typically disciplinary and commodity-oriented with emphasis on increasing the annual output of food per hectare by increasing yields per crop and crops per year, and by improving cropping patterns. CSR has recognized the importance of multiple cropping in developing country farming systems and has focused on the problem of fitting crops together in space or time often in response to farm labor or soil moisture constraints. CSR seeks to modify either the characteristics of the crop, such as time to maturity or disease resistance, or the characteristics of the crop environment, through spacing, tillage irrigation or other practices.

The design of CSR is based on recognition of both the socioeconomic environment of the farmer and the physical biological characteristics of farmers' fields. CSR incorporates important elements of on-farm testing of innovations and tends to emphasize crop management and the environment at a particular site. However, environmental factors in CSR may be defined relatively broadly to include physical resources, economic resources, and socioeconomic conditions affecting the farm household. A systems model of CSR is provided in Figure 4.

Relationships between Research Approaches

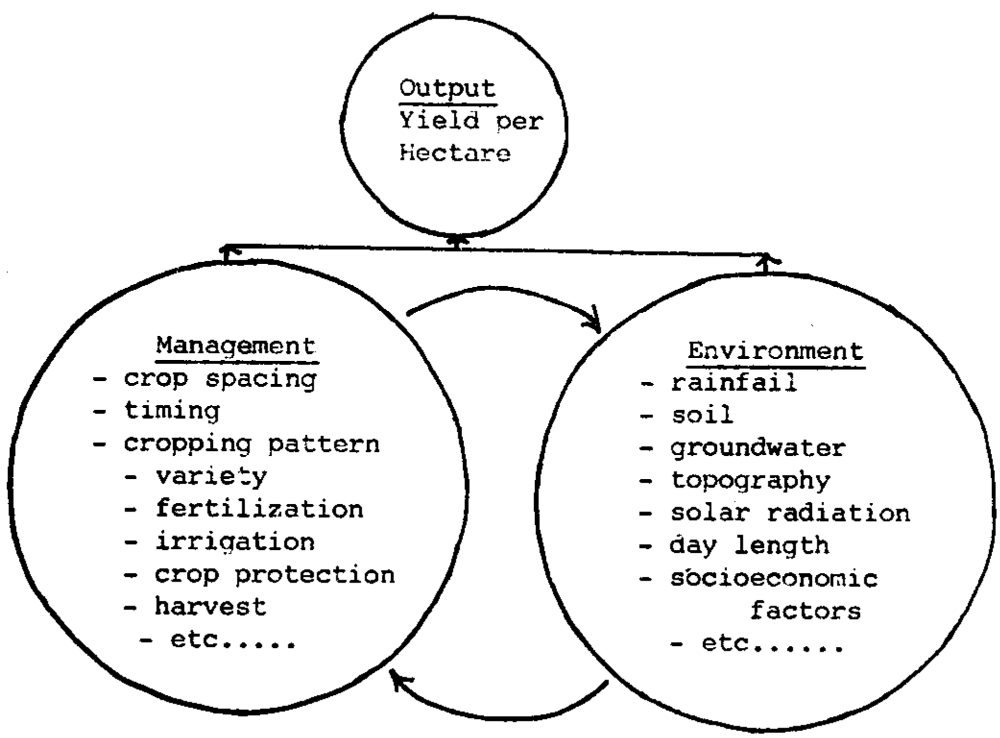
If we consider simultaneously the four research approaches outlined above and compare their principal characteristics, as in Figure 5, it is possible to identify numerous similarities. Combining these characteristics with the descriptions of the research

Figure 3.A Systems Model of a Nepalese Hill Farming System.



[Based on Harwood, 1979]

Figure 4.A Systems Model of a Cropping System.



[Based on Zandstra, Price, Litsinger and Morris, 1981]

Figure 5. The Principal Characteristics of Four Approaches to Agricultural System Research

	Human Ecology	Agroecosystems Research	Farming Systems Research	Cropping Systems Research
Origins	Prompted by concern for the lack of a paradigm for explaining social and environmental consequences of agricultural expansion and intensification.	Prompted by recognition of high external costs of specialization in agricultural production, high energy use, and use of agrochemicals.	Prompted by recognition of the gap in adoption of new technology between 'progressive' and 'less progressive' farmers.	Prompted by recognition of a yield gap between experiment station results and results in farmers' fields.
Leadership	Anthropologists and ecologists.	Ecologists.	Agricultural Economists.	Agricultural scientists and agricultural economists.
Focus	Focus at a conceptual level on social system and ecosystem interactions to facillitate communication across disciplines.	Focus at an analytical level on the structure, properties, and dynamics of traditional agroecosystems and natural systems as sources of change for contemporary agricultural systems.	Focus at an operational levâl on farmer knowledge and decision-making as a starting point for, and a constraint to, incremental changes to farming systems.	Focus on intensification of existing cropping systems through a combination of research station experimentation and testing in farmers' fields.
Link to Policymakers	Weak	Moderate	Very strong	Very strong
Level of Resources	Very few	Some	Very high	Very high

Figure 5. (Cont'd)

Human Ecology	Agroecosystems Research	Farming Systems Research	Cropping Systems Research
Orientation Oriented to cross-disciplinary research programs, perspectives and approaches.	Oriented predominantly to researchers, as individuals or teams, and to the researchers' capacity and knowledge.	Oriented primarily to the farm household, as the researchers' client, its capacity and knowledge, and secondarily to the research station program.	Oriented primarity to the research specialist (plant breeder, entomologist, agronomist) and secondarily to the farmer.
Emphasis Human ecosystem productivity, sustainability and stability and the social consequences of environmental change.	Agroecosystem productivity, sustainability and stability.	Overall farming system productivity.	Annual crop yield improvement per hectare.
System boundary Social boundary-the community or the tribe.	Biophysical boundary-ecological zone or field-but recognizing political boundaries.	Social and biophysical boundary-the farm.	Predominantly biophysical boundary-the crop association.
Scope Spatially broad, at village or county level, temporally short-or long-term.	Spatially either very broad or very narrow: temporally short-or long-term.	Spatially focussed temporally short-term.	Spatially highly focussed: temporally very short-term.

Figure 5. (Cont'd)

Human Ecology	Agroecosystems Research	Farming Systems Research	Cropping System Research
Primary Product			
A new paradigm for cross disciplinary understanding.	Scientific disciplinary knowledge of agroeco-system functioning.	Improved welfare of the farm household through increased farm produc-tivity.	Efficient increase in crop yield per crop, per year, and per hectare.
Analysis			
Mainly conceptual and descriptive.	Descriptive and empirical.	Descriptive and empirical.	Mainly empirical.
Farmer Participation			
Active farmer parti-cipation not essen-tial but social actions closely observed.	Farmer participation-a possible consequence.	Farmer and farm household participation are central, i.e. both as starting and ending points of FSR.	Testing innovation in farmers' fields essential component of the research process.
Polyculture			
Interprets polycul-ture as a product of co-evolution between man and his ecosystem.	Recognizes polyculture as a desirable agro-ecosystem form that mimics natural ecosys-tems.	Promotes polyculture as a strategy for improving labor utilization, increasing soil fertility and reducing risk, etc.	Promotes polyculture as a tool of crop inten-sification.

approaches creates the possibility of an hierarchical relationship between HE, AER, FSR and CSR that can be represented graphically as in Figure 6. HE, FSR and CSR all represent research approaches that attempt to link social phenomena and biophysical phenomena functionally. As we move from HE to FSR to CSR the object of investigation becomes much more sharply defined both spatially and temporally, the results sought become more specific and more measurable, the research approach becomes more narrowly disciplinary and reductionist, and research becomes more analytical and less descriptive. Broad concerns for several significant systems properties in HE and AER become narrower in FSR and CSR, with growing emphasis on crop productivity per unit area and per unit time. Concerns for stability and sustainability are not lost completely but appear to be suppressed operationally.

Because it is capable of being applied either broadly to a major agroclimatic zone or specifically to a farmer's field. AER with its concern for productivity, stability and sustain - ability has been depicted to one side in Figure 6. However, experience suggests that short-term gains in productivity have become the major concern of FSR as it has evolved, and the major emphasis of CSR.

Conclusion

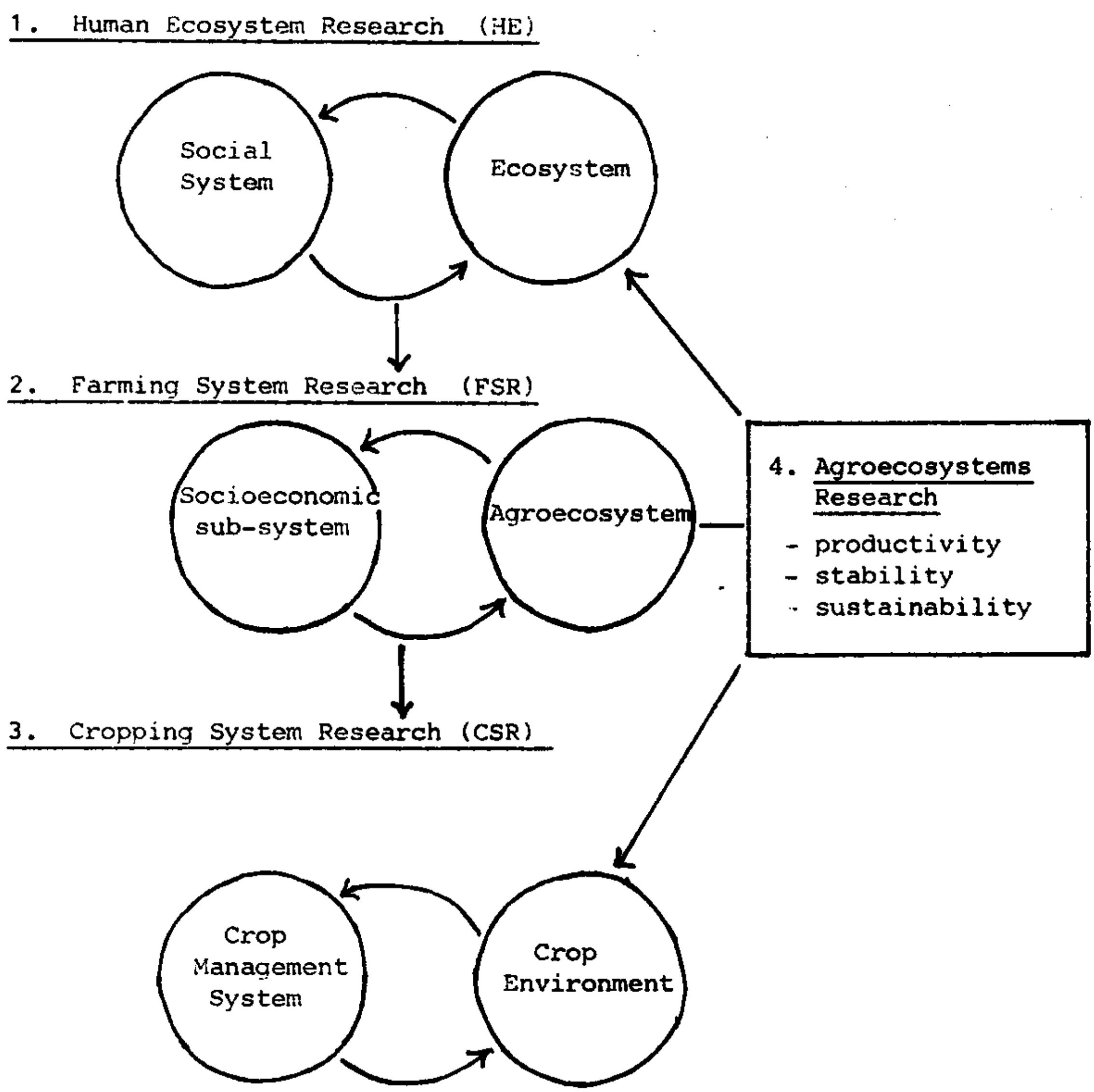
Agricultural systems research in Asia is being actively pursued in a variety of centers in a variety of ways. Different groups with different origins and concerns are engaged in research at a number of levels. In analyzing these activities an observer could be led to stress their differences and the benefits of diversity, or to highlight their similarities and potential complementarity. For several reasons, my conclusion is that there is much to be gained from comparative exchange both within and between the groups practicing HE, AER, FSR and CSR.

(1) Human Ecology and Agroecosystems Research. In HE and AER small groups of scientists, led by social scientists and ecologists, are searching for a new body of theory to explain very complex social and ecological phenomena. Human ecological approaches to agroecosystems research emphasise ecosystem productivity, stability and sustainability and the social consequences of ecosystem change. However, because of the breadth of these objectives much of the research in Asia remains descriptive and analysis has been minimal. As mechanisms for communication across disciplines HE and AER have been very successful but unless the volume and level of analysis undertaken increases significantly in the near-term, HE and AER research will fail to produce a body of tested generalizations capable of influencing policy-makers.

Why is this a real danger? One part of the problem is that HE and AER involve difficult and creative work that requires time, resources, leadership and great scientific maturity on the part of the research teams. Agroecosystems are very complex: how are the critical relationships that govern the behavior of a system identified, disentangled and experimented with? Are these key relationships, once understood, capable of manipulation as instruments of policy? Unless HE and AER move quickly to develop a body of generalizations about resource management issues of critical importance to policy-makers, continued support for these activities is likely to fall away (Romm, 1984)

(2) Farming Systems and Cropping Systems Research. In FSR and CSR relatively large groups of researchers led by agricultural economists and agronomists are applying known bodies of theory to complex problems of small farm development. FSR and CSR both have their origins in an appreciation of social and ecological interactions but as they have evolved emphasis has been placed almost exclusively on system productivity in the short-term. By applying known bodies of theory from farm management and the agricultural sciences, very complex problems have been made tractable. As a consequence FSR and CSR have moved ahead rapidly

Figure 6. A Hierarchy of Agricultural Systems Approaches.



but there are growing signs that these research approaches are spreading more than they are deepening.

FSR and CSR have grown rapidly in part because they apply recognizable disciplinary tools and in part because of a somewhat uncritical acceptance of a great range of activities under these labels. FSR and CSR are described as holistic and systematic approaches to research but in practice much of the research is superficial, commodity oriented and focused on what are believed to be separable components of farming systems. Despite the apparent recognition of the farm household, FSR and CSR focus on farm enterprises or the field, largely neglecting the social, cultural and institutional setting of the farm. It is assumed in much of FSR and CSR that productivity gains in the field translate into welfare gains for the household, and that short-term increases in productivity per hectare per year are stable and sustainable after only one or two years of testing. The only defense against this being wrong seems to be rejection of recommendations by farmers themselves. However, because FSR and CSR produce findings that can be directly applied to critical agricultural policy issues and are capable of being understood by decision-makers in terms of familiar paradigms, their spread and acceptance have been very high.

(3) Bridging the Gap? There appears to be a considerable gap between HE and AER, on the one hand, and FSR and CSR, on the other. I have attempted to depict HE, FSR and CSR as related points on a hierarchy of research approaches all aimed at unerstanding social interactions with ecosystems, and AER as an approach that can be applied at any level of this hierarchy. The question is that of whether or not the gap between these approaches can be bridged in practice? Can HE and AER propositions be scientifically tested to produce generalizations of direct value to policy-makers? Alternatively, can FSR and CSR methods be broadened to take explicit account of ecosystem stability and sustainability and the social consequences of ecosystem change? Certainly the

need for movement in these two mutually reinforcing directions is apparent and should be supported for several reasons.

First, with respect to primary agricultural areas, including the major hydraulic core areas of Asia, the success of 'Green Revolution' technology has been enormous. However, the side-effects of agricultural intensification, with very high levels of energy use and management, have become very costly. Maintenance of high levels of productivity will require even closer attention in the future to aspects of agroecosystem stability and sustainability. Similarly, rapidly rising real energy costs and balance of payments difficulties are forcing Asians governments to look for dependable farming systems that employ a minimum of imported energy factors in production.

Equally important, Asian agriculture is continuing to expand and intensify on marginal lands in secondary agricultural regions. In the rain-fed uplands, hilly lands, on tidal swamplands and elsewhere new agricultural enterprises are being promoted with an inadequate prior understanding of the prevailing socioeconomic and ecological factors and their interactions. In these regions the development of new and productive farming and cropping systems is vital but unless they are dependable and environmentally stable their success will be short-lived and costs will be felt beyond the boundary of the farm or the field and into the future.

For these reasons agricultural systems research must continue to move ahead at a number of levels and we must communicate between levels in order to turn lessons learned into workable solutions. However, for researchers on agricultural systems problems there are important trade-offs to be made in choosing the appropriate research approach. Does he or she want scope or precision? Quick results or the long haul? Recognition and reward within the conventional professional structure or outside? Difficult work entails tough choices but it is clear that a growing number of Asian scientists are prepared to look beyond the boundaries of their chosen fields for lessons from their neighbor's experience.

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