PN-ABC-784

AGRICULTURAL RESEARCH CORPORATION

WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT

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ITS STRENGTHS AND WEAKNESSES AND THE NEED TO LINK FARM RESEARCH TO MACRO-ECONOMIC CIRCUMSTANCES

WSARP PUBLICATION No. 32

DECEMBER 1984

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THE GOVERNMENT OF SUDAN
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
THE WORLD BANK
CONSORTIUM FOR INTERNATIONAL DEVELOPMENT
WASHINGTON STATE UNIVERSITY

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THE WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT

is supported by

The Government of Sudan

The Agricultural Research Corporation

US Agency for International Development

The World Bank

The USAID portion of the project is being implemented by

The Consortium for International Development

Tucson, Arizona, USA

with

Washington State University, Pullman, Washington, USA

as the Lead University

Correct Citation:

WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT

Invited Paper, "Farming Systems Research Workshop,"
held at Ministry of Agriculture, Khartoum, April 2-4, 1983
Sponsored by Western Sudan Agricultural Research Project.
WSARP Publication No. 32
Khartoum, Sudan and Pullman, Washington, USA

FARMING SYSTEMS RESEARCH:
Its Strengths and Weaknesses and the Need to Link Farm Research to Macro-Economic Circumstances [1/]

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[1/] Invited Paper, "Farming Systems Research Workshop," held at Ministry of Agriculture, Khartoum, April 2-4, 1983 and sponsored by Western Sudan Agricultural Research Project. The views expressed are solely those of the author and do not necessarily reflect the views of the USAID Mission.

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INTRODUCTION

Before discussing the strengths and weaknesses of Farming Systems Research (FSR), it is useful to describe briefly how FSR came about and the methodological approach of FSR so that its strengths and weaknesses are discussed in light of a generally accepted conceptual framework for FSR.

HISTORICAL DEVELOPMENT OF FSR

The roots of FSR can be traced to the early work in Farm Management Research in U.S. Colleges of Agriculture in early 1900s. In those days the study of farm management was a multidisciplinary approach which investigated the entire range of factors involved in operating a family farm, with the view to develop principles for improved farm management. Professor Stanley Warren's (Cornell University) classic text on farm management includes topics on soil types, agronic considerations, conventional factors of production (e.g., land, labor and capital) and farm accounts. In addition, political and philosophical considerations as they influence farming, particularly the business aspects, were included in his text published in 1913.

Early leadership in farm management research came from the physical sciences, however, by the 1920s a move in the direction of economic analysis came about. This trend continued and eventually farm management as a discipline moved from the departments of agronomy to departments of agricultural economics. Today, at least in American Colleges of Agriculture, the mainstream of farm management has become increasingly identified with production economics which places greater emphasis on what farmers ought to do and less emphasis on what, how and why farmers do what they do.

In Africa the interest in farm management research can be traced to Michael Collinson's monumental text, "Farm Management in Peasant Agriculture: A Handbook for Rural Development Planning in Africa," originally published in 1972. One can also trace much of the current FSR methodology to Collinson's work, particularly with regard to the approach to investigate farmers' circumstances including motivations, farm attributes and organization and the approach to defining research and extension domains.

More recently important methodological contributions for farming systems research have come from Collinson, Norman, Hildebrand, Ruthenberg, Zandstra, and Gilbert et al. The most comprehensive document on the subject is W. W. Shaner, et al., "Farming Systems Research and Development: Guidelines for Developing Countries," a Consortium for International Development study published in 1982.

There are several reasons for the development and popularity of FSR. Probably the more important are:

1. Evidence that the needs of small or low resource farmers have not been adequately addressed by development projects and programs;

2. Many development projects and much agricultural research have been designed and undertaken without sufficient understanding of the environment in which small farmers operate;

3. Existing weak links between research organizations and small farmers: An interaction which should have been facilitated by extension workers but for a host of reasons has rarely taken place;

4. Top-down research prescriptions from researchers to extension workers, to farmers, rather than the other way around.

As a result, development practitioners and agricultural researchers have sought more efficient ways to develop relevant research programs for the large number of low resource farmers in developing countries. Out of this experience came the development of FSR and the view that the approach, which starts with the farmer, holds a hope for low resource farmers in the developing world.

CONCEPT OF A FARMING SYSTEM

A system is defined conceptually as any set of elements or components that are interrelated and interact among themselves. Thus, a farming system is the result of interactions among several interdependent components. At the center of the interactions are the farmers themselves, whose families and means of livelihood are intimately linked and cannot be separated. The level of performance of a farming system is determined by how the farming family allocates the resources - land, labor, capital, and management - to which it has access, to crop, livestock and off-farm enterprises in a manner which given the knowledge and experience they possess will create the greatest possible attainment of the goals they are striving to achieve.

The total environment in which farming households operate can be divided into two parts following Norman's schematic representation: namely, the technical element and the human element. The types and physical potentials of livestock and crop enterprises will be determined by the technical element which reflects what the potential farming system can be. The technical element has typically received the most attention by agricultural researchers. They have within limits been able to modify the technical element and thereby improve the potential farming system by developing technologies that partially alleviate the deficiencies and constraints inherent in the technical element.

The technical element is divided into two factors - the physical and biological. Physical factors are soil, water, temperature, etc. Technical scientists, for example, enhance water availability through irrigation or soil quality, through improved rotations or fertilizer application. Biological factors are crop and animal physiology, disease, pest attack, etc. Examples of limited interventions by technical scientists would include disease resistant crop varieties, breeding cultivars and varying physiological maturities, etc.

The farming system that actually evolves, however, is something less than what is potentially possible as determined by the technical element. The determinant that provides the sufficient condition for the presence of a particular farming system is the human element. The human element is also characterized by two types of actors - exogenous and endogenous.

The exogenous human factors that influence the farming systems in any given community are the social, economic and political institutions in the area. These factors are largely outside the control of the individual farming household. However, these exogenous factors all directly influence what the farming household or individual members can and cannot do. These exogenous factors include:

1. Community structures, norms and beliefs which often reflect the acceptability of development strategies and products of research.

2. External institutions, such as input delivery systems (which influence input supplies, availability of credit, quality of the extension service) and commodity markets. The number of these institutions available to farmers, the actual ease of access farmers have to them and the quality of services offered will largely reflect government policies and have a direct influence on the prices farmers receive;

3. Other influences such as population density and the availability of social amenities such as rural water supplies and health services.

On the other hand, individual farming households have some degree of control over the endogenous factors. These are land, labor, capital and management. One of the tasks of FS researchers is to determine to what extent the quantity and quality of these resources vary among households and farming areas within the target region. This is important because the quantity and quality of these resources influence the performance and potential of the farming system. In addition these resources may not be entirely owned by the household and access to them may be on another basis of use, thereby affecting the goals and performance of the farm family.

Farmer goals and motivations are key endogenous factors that can significantly influence the nature and level of productivity of the farming system. Farmer goals, views and motivations are in large measure the factors which drive the farming system. Even where changes in the technical element (e.g. late rains or drought) and exogenous factors (e.g. new commodity prices) force adjustment in the farming system, farmers still have options, so the resulting choices are invariably influenced by individual goals and motivations.

A point to be stressed is that farming systems are complex even among low resource farmers operating in dryland farming areas. This complexity explains why some new technologies which were considered to be relevant often are not adopted, or why the degree of adoption frequently varies widely. In sum, by not considering the human element, agricultural research has produced new so-called "improved" technologies which often turned out to be irrelevant to the farmer.

DEFINITION OF FARMING SYSTEMS RESEARCH

The primary aim of the FSR approach to research and extension is to increase the productivity of the farming system in the context of the entire range of private (farmer) and societal goals, given the constraints and potentials of existing farming systems. It is the view of FS researchers that productivity can be improved by the development of relevant technology and complementary agricultural policies which increase the welfare of farm families in ways that are beneficial and acceptable to both farmers and society as a whole. Given this philosophical view, FSR has the following characteristics:

1. FSR views the farm as both a production and consumption unit. By viewing the farm in this comprehensive manner FS researchers have to recognize the interdependencies and interrelationships between the bio-physical and human environments. The research process devotes explicit attention to the goals of the whole farm household and the constraints on the achievement of these goals;

2. Priorities for research reflect the holistic perspective of the farm household, including both the bio-physical and human factors;

3. Research on a sub-system can be considered part of the FSR process if the interrelationships with other sub-systems or components are recognized and accounted for;

4. FSR is evaluated in terms of individual sub-systems and the farming system as a whole;

5. The approach concentrates on the farm family. It necessitates a multidisciplinary team of researchers, farmers and extension workers working in a interdisciplinary manner at the local level. Thus, the goals and objectives of the farming household tend to take precedence in the process of designing farm level interventions.

6. Although FSR is holistic in its orientation, the degree of comprehensiveness in practice is tempered by the state of the methodology, the quantity and quality of resources that can be devoted to the process and often the limited base data that can be drawn upon.

7. FSR usually has its institutional roots in agricultural research institutions and thus usually has a bias toward bio-technical modification in farming systems, although increasingly many researchers and development practitioners recognize that changes in non-technical factors such as markets, price policy, institutions and infrastructure are often necessary to make the bio-physical products of research attractive and adoptable.

"UPSTREAM" AND "DOWNSTREAM" FSR

In a review and critical appraisal of FSR, Gilbert, Norman and Winch identified and classified two types of FSR programs. We labelled these as "upstream" and "downstream."

There is a fundamental difference between the objectives and the nature of the activities of these two types of FSR programs. "Upstream" FSR seeks to generate prototype solutions which will facilitate major shifts in the potential productivity of farming systems. "Upstream" research often involves several years of research both on and off the research station and is particularly the concern of the International Agricultural Research Centers and some regional and national research programs.

"Downstream" or site-specific FSR programs are designed to identify rapidly and subsequently test possible innovations which can be readily integrated into existing farming systems. "Downstream" FSR focuses on close interaction with farmers via on-farm trials and draws selectively upon results from commodity or discipline oriented research or "upstream" programs.

I will focus upon what we have classified as "downstream" research since I believe it is the downstream farming systems approach to research and extension which is most relevant to the Western Sudan Agricultural Research Project (WSARP) and its target area. However, I am troubled as no doubt you are that the Nile does not enter the Kordofans or Darfurs! Therefore, for this audience perhaps it would be better to call what I am going to describe simple adaptive FSR.

FRAMEWORK FOR ADAPTIVE FSR

There are four generally recognized stages involved in adaptive FSR which can be delineated as follows:

1. The diagnostic stage in which the actual farming system is examined in the context of the "total" environment. The purpose of this stage is to identify constraints farmers face and to determine the potential flexibility in the farming system in terms of timing of field practices, slack resources, etc. An effort is also made to understand the goals and motivation of farmers that may affect or influence efforts to improve the farming system.

2. The design stage in which a range of research strategies are identified that are thought to be relevant and potentially attractive from the farmers' point of view in dealing with the constraints delineated in the diagnostic stage.

3. The testing stage in which selected promising strategies arising from the design stage are examined and evaluated under farm conditions to ascertain their suitability for achieving desirable and acceptable changes in the existing farming system. This stage consists of two parts: initial trials on farmers' fields with joint participation of both the research team and the farmer; then testing totally under the control of the farmers themselves.

4. The extension stage in which the strategies that were identified and screened during the design and testing stages are adopted by target farmers.

In practice there may not be clear boundaries between these stages of research. Design activities, for example, may begin before the diagnostic stage is completed and may continue into the testing stages, as promising alternatives emerge during the trials on farmers' fields.

THE STRENGTHS OF FSR

The potential strengths of adaptive FSR are imbedded in its methodological attributes. Some of the important attributes of adaptive FSR are:

1. Explicit Consideration of Farm Household Objectives

The production, consumption and off-farm objectives of the farmer are explicitly incorporated into research design and testing strategies. This comes about as the FSR team investigates and attempts to understand the farmer's objective function in the initial diagnostic stage. The target farmer participates directly in all research stages except the design stage. This ensures evaluation criteria relevant to the farmer rather than simply physical yield or conventional returns to factors of production.

2. Incorporating Community and Society Goals

The FSR approach views farmers both as individuals and as members of the larger community and society. Thus, the approach links the micro or farm level perspective with broader considerations of society in the process of designing development strategies. These strategies may involve single innovations proposed for adoption by farmers such as improved seeds, or policy changes which improve product prices or farmers' access to markets.

Societal goals on the other hand might include maintaining or building up soil fertility to enable the land resource to be used by future generations, increasing the availability of a domestic food supply, or avoiding an increase in inequality of income distribution. But it is likely that such goals are not going to be achieved simply through the development of improved bio-physical technologies. For example, farmers with better quality resources and easier access to external institutional support systems will probably progress more rapidly than those farmers who are less well endowed.

3. Tapping the Pool of Knowledge of Society

FSR recognizes that the potential beneficiary, the farmer, must be an integral part of the research process. The methodology explicitly recognizes the value of the farmer's experience and his traditional experimentation as inputs into the design of research strategies.

Many interventions envisioned by adaptive FSR involve modest adjustments rather than complete changes in the farming system. In addition, greater reality is encouraged in the research process by way of maximizing research under actual farm conditions as opposed to heavy supervisory inputs and unrealistic field support as if often the case on the experiment station. When testing improved technologies, the managerial input is initially provided by the research worker via trials on farmers' fields and then by the farmer himself, thereby giving the farmer an important role in the FSR process.

The link with extension workers in the FSR research process is vital. Extension workers' knowledge of the farmers' circumstances and the responsibilities they will eventually have for the transfer of technology (the products of FSR) make it imperative that extension workers be involved at each stage of the FSR process.

Research workers, however, have often cut themselves off from such knowledge and wisdom. Consequently researchers often spend considerable time "rediscovering the wheel" rather than building on the knowledge that farmers and, where they exist, extension workers already possess.

4. Recognition of the Locational Specifity of the Technical Element and Endogenous and Exogenous Factors

The FSR approach involves delineating area and farming heterogeneity into homogenous subgroups and developing strategies appropriate to each. The disaggregation into homogenous subgroups is first done according to ecological systems or differences in the technical element; then, if further disaggregation is necessary, on the basis of differences in the human element. The aim of such disaggregation is that the variance between or among subgroups be maximized and within them minimized, and that the classification be useful as a guide to developing research strategies. The constraint(s) most limiting in the farming system of each subgroup as revealed during the diagnostic stage then becomes the focus of FSR efforts. This approach helps to insure that the products of research will be relevant for the technical and human elements in the target area.

5. Dynamic and Iterative Nature

The iterative nature of FSR is illustrated by the process by which the research team begins by acting on partial information about the farming system, gains insight through studies and experimentation and modifies its strategies. The process continues until research and extension staff are satisfied that changes can be broadly implemented by the target groups. This approach encourages the FSR team to begin working within a whole farm framework at the start, rather than waiting for excessive precision before initiating on-farm trials. In this way better solutions to farmers' conditions are sought, not necessarily the "best" solutions.

FSR is dynamic in that strategies for future work can be adjusted in light of accomplishments. For example, FSR might initially work with only minor modifications in the farmers' existing cropping and livestock patterns. After initial on-farm changes, greater modifications to their farming systems can be tried.

6. The Integrative and Multidisciplinary Nature

Most past agricultural research in developing countries has been characterized by narrow disciplinary approaches, which left farmers with the difficult task of integrating new information and technologies into their farming system.

FSR, on the other hand, provides a means by which multidisciplinary researchers can examine problems of the farming system including complementary and supplementary relationships between resources, enterprises, and the external environment. Such interactions have rarely been exploited in the conventional reductionist approaches to developing new technology. If researchers overlook these interactions there may well be important adverse effects on specific enterprises. The necessity of recognizing and focusing on the interactions between the technical and human elements and fully appreciating the multiple use of farm resources requires a multidisciplinary team working in an interdisciplinary manner.

7. Flexibility in Accommodating Both Technical and Non-Technical Improvements

In the past, agricultural research has often been rather narrowly focused on yield increasing technical innovations for specific commodities. Since FSR is concerned about the productivity of the entire farming system, it will also examine non-technical changes that are exogenous to the farming system such as improving marketing policies, price policies or physical infrastructure. The flexibility inherent in the FSR approach also assists in linking macro and micro perspectives to design research and development strategies more effectively for specific farming areas or groups of farmers. Changes

in pricing and trade policies which have a direct influence on farming decisions and performance may be the most critical factors in efforts to improve the productivity and welfare of low resource farmers. In my view the FSR approach increases the probability that such exogenous factors will be taken into account.

8. Complementing Conventional Research Approaches

The FSR approach is not intended to replace basic or applied research or what is often described as the "body of knowledge." In fact, the body of knowledge can be augmented by FSR. For example, the results of the FSR approach in a specific area may be applicable with some modification to other areas with similar bio-physical and human environments.

The complementarity between FSR and the more conventional commodity oriented research when designing adaptive research can probably best be underlined by the necessity of adaptive FSR to draw upon the experience and results of upstream research undertaken at selected international agricultural research centers, as well as the long history of commodity oriented research undertaken in the Sudan.

9. Potential for Short-Term Solutions

Possibly one of the greatest potential strengths of FSR is its farm-level, problem-solving orientation and the influence this can have on designing interventions which are relevant and adoptable in the short to intermediate term. By working closely and continuously with the target group FS researchers become sensitized to the farmer's environment, his constraints and the potential for change within the farming system. Also, this research strategy has a greater probability of addressing the farmer's pressing real problems while at the same time ensuring that the research results are within the technical, financial and managerial capacity of the target group(s).

In fact, the FSR team should be charged with the responsibility to design short-term modifications in existing farming systems in addition to the longer term, possibly more productive solutions to prevailing systems constraints.

This suggestion, however, immediately raises important issues for research leadership and the FSR team. For example:

1. How should the bundle of resources available for FSR over the next 3-5 years be allocated between short- vs. intermediate term solutions?

2. Among the multidisciplinary team of researchers, which disciplines or problem-solving areas have the greatest potential to generate short-term research results which can make the greatest impact on the productivity of existing farming systems?

3. What is the appropriate composition of the critical mass of researchers to be included in the multi-disciplinary teams that will address these problem-solving areas?

4. How many cropping seasons will it likely take to generate productive interventions which will be attractive to target farmers?

POTENTIAL WEAKNESSES OF FSR

The FSR approach to agricultural research and farm-level development has a number of appealing attributes. However, a critical appraisal of the FSR concept and the potential to apply or implement FSR forces one to look at the possible dangers or shortcoming of the approach. These may include:

1. Lack of Clear Strategy and Mandate

Since FSR is holistic in its approach, taking account of technical and human elements and endogenous and exogenous factors, there is concern among some that a FSR project may attempt to take on more than it can effectively handle. This raises the issue of research efficiency. Since efficiency is an input/output relationship one must consider if the FSR program has adequate resources in terms of scientific and technical manpower, research funds, and supporting infrastructure to carry out the task (i.e. output) it is expected to achieve. This depends upon the range of problems to be addressed, the geographical area to be covered, the ease of getting around in the target environment(s), and the composition of multidisciplinary FSR teams.

To insure both a productive and efficient program of FSR, it is imperative that a clear research strategy and mandate be developed and agreed upon by both the research leadership and the FSR team.

To achieve this aim it is critical that sufficient resources are applied to the diagnostic stage so that efficient and high payoff areas of research are undertaken. Good diagnostic field research will also have important implications for the composition of multidisciplinary research teams, the identification of priority areas of research, an indication of the time frame necessary to carry out the research, and the likely problems that are to be encountered during the design and testing of the products of research.

2. Team Composition and Working Relationships

Both the composition of the multidisciplinary research team and how it functions in an interdisciplinary fashion are potential problem areas of FSR. To address the real problems effectively will require not only accurate problem identification but also the correct or appropriate disciplinary expertise on the FSR team. This further implies that flexibility must be maintained in the composition of the team as the research process continues, problems are solved, and new problems identified and addressed.

Since FSR requires the various disciplines to work together in an interdisciplinary manner, working relationships on the team and between the research team and project leadership become extremely important. Let it be said that within a FSR effort there is no room for the researcher who wants to do "his own thing," that is, work independently of either farmers or other members of the research team!

Functioning in an interdisciplinary manner required discipline, patience and appreciation of the role of professional disciplines other than one's own. It requires an ability to work together, often over longer periods of time than if independent research were pursued. However, the methodological approach requires an interdisciplinary effort and the research leadership, as well as team members themselves, must constantly strive for this goal, particularly in the beginning until it becomes the mode of operation for the researchers.

3. Long-Term Strategies

There is a danger that highly trained agricultural scientists will strive for the major breakthroughs, the highest possible yields, the elegant solutions and in striving to achieve such results, will consider major if not wholesale changes in existing farming systems. The dangers in this approach are the time required to design and test the products of the research as well as the real possibility that technology will not be relevant or attractive to all but a few progressive, high resource farmers. Of course this approach is inconsistent with adaptive (downstream) FSR. But the potential for this type of strategy exists when highly trained scientists are involved in agricultural research.

To insure that the above kinds of solutions are not pursued, FS researchers must have as an important part of their research strategy the design of short-term interventions. The team must seek to identify and diagnose those farm level and/or off-farm constraints which lend themselves to short-term solutions which target farmers can readily adopt.

Often these types of solutions will not be those which are suitable for write-up in professional journals, however, we must keep in mind the target group - the farmer working in a varied, complex and difficult dryland farming environment.

4. Lack of Credibility

Since the FS approach to research and development is relatively new, despite its roots, we do not have a significant body of empirical evidence to demonstrate its validity and potential results. There is, however, a fairly voluminous body of literature which indicates that much of the past conventional agricultural research has failed to trickle down to small, low resources farmers. There are exceptions of course, such as some of the products of the green revolution research undertaken at IIRI, CIMMYT and selected Indian research stations. But even here the impact has been limited largely to selected areas of Asia, and to a lesser extent, South America.

Thus, FSR as a research methodology still must establish its credibility. Turning to the Sudan and the WSARP, the project and research team must establish their credibility through products of research. To do this will require demonstrated results in terms of farmer adoption on a fairly wide scale. The research strategy over the next few years must have a heavy short-term focus if this credibility is to be achieved in the near future.

5. Over-Extending

Given the holistic approach to research, FSR leadership and researchers must take care not to be over-extended or spread too thinly. This possibility exists in terms of the target area to be covered, the number of research domains to be included in the short-term strategy, the number of farmers to work with and the number of technical and human elements to address in the short and intermediate term.

To avoid or minimize this potential danger, good initial diagnostic research and analysis throughout the research process are necessary. Further, because of the vast size of the Kordofans and Darfurs it will require, particularly in the short run, a focusing of effort on a geographical basis (selected number of farming areas) as well as a concentration on selected farming systems and farmers. In addition it will require good choices of which aspects of the technical and human element to focus upon in the short and intermediate term.

If the research program becomes spread too thinly then the probability increases that research results will be delayed and that credibility becomes an issue. Most important, it means that Sudan's investment of scarce resources will not achieve the results required by the present state of the economy.

6. Neglecting Important Areas of Research

Given the holistic nature of FSR, the possibility that FS researchers will neglect important areas of research that may not be considered an issue or potential danger. This should be the case for the technical element and to a lesser extent for the endogenous human element. This is probably true because of the natural technical bias of agricultural researchers and the built-in feature of the FSR methodology which requires FSR teams to interact with the target group once it is identified.

It appears to me, however, that the greatest potential neglect is in the area of the exogenous factors. I wish to suggest that exogenous factors are very important and must influence the research strategy in the Sudan, particularly in the short and intermediate term.

LINK TO MACRO-ECONOMIC CIRCUMSTANCES

Research leadership at both the national and project levels, as well as FS researchers themselves, must not only understand the farmer's circumstances (goals, resources, constraints, performance), but also the present circumstances of the Sudan's economy and what the likelihood of change may be over the remainder of the decade. An appreciation of the macro-economic situation should influence research strategies, the design of all aspects of research, the ability of the economy and institutions to support the transfer of technology, as well as the attractiveness of the products of research to the target group. An appreciation of economic parameters is important, as they will influence:

1. Ability of the economy to produce and/or import agricultural inputs and equipment, particularly, but not limited to, heavy agricultural equipment, spare parts, fuel, and chemicals.

2. Availability of trained manpower to support research, technology transfer, marketing services, etc.

3. Ability of the economy to absorb increased marketable surpluses by generating new markets, expanding domestic processing of agricultural commodities, and improving infrastructure to handle increased domestic and export trade.

4. Necessary budget allocations to support scientists' and technicians' salaries, the operational research budget, technology transfer systems and infrastructural development.

5. Planning and implementation of rural based investment programs in the field of transport systems, water supplies, market development and social amenities.

6. The degree of growth in effective demand for agricultural commodities and consequently the financial incentives farmers will face for increases in farm output.

KEY ECONOMIC PARAMETERS

What are the key economic parameters of the Sudan's economy that agricultural researchers need to consider?

First of all, one must mention the external debt situation. Currently Sudan's external debt is estimated to be about $7 billion which is equivalent to 11 years of export earnings based upon present estimates of this year's exports, valued at slightly less than $700 million.

Second, the gap in the domestic budget, prior to the recent exchange rate, was estimated to be just over 400 million pounds. Since the exchange rate adjustment, the gap is estimated to be within the neighborhood of 600-700 million pounds. This deficit is financed largely from external sources in the form of loans and grants from other countries. The implication of this is that without external financing, a good share of it donor assistance, there would be virtually no development expenditures.

Third, the Sudan's foreign exchange reserves have over the past year been insufficient to finance more than several weeks of imports. This means that current foreign exchange earnings are targeted for critical imports, often before the earnings are received by the Bank of Sudan. In fact, crops have been mortgaged to pay for some imports this past year. A lack of foreign exchange or problems with the timing of the flow of foreign exchange often means delays in importation, or imports not being available when they are needed or could give the greatest possible return. This further means that very difficult decisions are made on import priorities which are often for imports to keep existing industries, production schemes and public services running, and not for investments which could lead to growth and economic recovery. Unfortunately the foreign exchange crisis may

not be solved within the next few years. Consequently there will be continued pressure on the donor community to provide balance of payments support, thereby reducing the amount of funds available for development oriented projects.

The above has the following implications for agricultural research, particularly for research and development of the rainfed sector:

1. There will be a severe limit on the availability of foreign exchange for import of inputs and equipment to support technological innovations and increased production;

2. Products of research cannot be capital intensive in the short or intermediate term but rather must rely upon improved biological technology, and improved labor and agronomic practices;

3. Consequently, in the foreseeable future, research must be directed toward farm level interventions that do not require major changes in the farming system or high import content, but rather should be based upon changes or modifications which have the potential to increase the productivity of the farming system based on targeted commodities (crops and livestock) and targeted practices. Targeted crops or livestock units must be those for which good markets are readily available and where marginal returns to investment or change are the greatest. Targeted practices must be those which do not require major capital investments but which will increase the productivity or response to new planting materials and improved farm labor practices and/or management.

IMPORTANT ECONOMIC POLICY ISSUES FOR AGRICULTURAL RESEARCH

Keeping the above in mind, it appears to me that the most important macro economic policy issues for the design of research strategies for the rainfed sector are the following:

1. Choice of Commodity Focus

A commodity focus may appear to be inconsistent or at odds with the philosophy of FSR. However, I do not believe this is so. Farming systems in Western Sudan tend to be based on one or two major commodities such as groundnuts, sorghum, sesame and/or livestock, depending on the farming location. This is not to say that farming systems do not involve combinations of enterprises; certainly FSR must take account of systems components and the linkages among these components for reasons explained earlier.

However, if one of the objectives is to design interventions in the short term, the FSR team's tasks will be made easier if it does not invest time and resources designing new farming systems or testing comprehensive packages of inputs and practices on a systems-wide basis in the target area.

The choice of commodity focus will depend upon whether the target area is El Nouhood in which case the commodity focus will be groundnuts or Delling in which case the focus will be sorghum based farming systems.

In order to insure that there will be at least adequate financial incentives for target farmers to increase production for the market, the FSR team must be certain that good local, regional, national and/or export markets exist for the commodity focus and that farmers have sufficient access to these commodity markets. In addition price policies for the commodity focus must be such that remuneration will be at the level that induces technological change, an increased marketable surplus and producer incentives.

2. Export Promotion or Reliable Domestic Food Supplies

The Sudan's economic crisis dictates that products of agricultural research at least within the short to intermediate term must lead to greater output on agricultural exports. However, this objective must be tempered to the point that food supplies for domestic consumption and processing are forthcoming in the quantities necessary to ensure reliable food supplies at reasonable prices. Despite this necessary second objective, FSR and the rainfed sector will be better off and can make greater claims on the national budget and foreign exchange reserves to the extent it achieves a demonstrated increase in Sudan's export earnings.

3. Choice of Production Techniques

Here the issue revolves around tradeables vs. non-tradeables required by new production technology. But clearly in the foreseeable future important requirements must be minimized since the Sudan will not overcome its foreign exchange crisis in the near future.

However, this is not to say that imported inputs should be excluded in the design of technology. But what it does mean for Sudan and WSARP is that the returns to those capital inputs used in dryland agriculture must be at least as great as they would be in other sectors of the economy. Otherwise, particularly in the present macro economic circumstances, such capital (machinery, fuel, chemicals and the like) allocations to the rainfed sector are difficult to justify. The point is that presently it does not make sense for FSR and agricultural development in Western Sudan to be based upon a medium to high import dependence.

4. Comparative Advantage Issues

Agricultural researchers and policy makers should focus on farming systems and agricultural commodities which have the greatest short and long-term production and farm income potential. To do so, FS researchers must utilize the concept of comparative advantage.

Simply put, a farmer, region or country engages in an activity in which it has a comparative advantage if the opportunity costs involved in production are low.

From on international perspective, Western Sudan has a comparative advantage in the production of gum arabic; on a national basis Western Sudan has a relative (possibly absolute) comparative advantage in livestock production, as well as millet. On a national basis Western Sudan has a relative comparative advantage in the production of groundnuts.

One point to be made here is the need for FSR to exploit these comparative advantages in order to achieve the greatest possible returns to agricultural research and in order to achieve the greatest possible increases in production and income of the target group in the near term.

A question, however, must be raised about comparative advantage. Do the Western Region, the rainfed sector and the irrigated sector have today the same comparative advantages as they did in the 1960s and 1970s? Will they be the same over the next decade or so? The answers to these questions have important implications for research strategies in Western Sudan and elsewhere.

5. Crop Choices and Rotation systems in the Gezira Scheme

The real comparative advantage of dryland farming systems in Western Sudan will in part depend on crop choices and land allocations among crops in the 2 million feddan Gezira Scheme. For example, consider the impact on the domestic market if Gezira authorities doubled or drastically reduced the acreage of sorghum or groundnuts, or decided to include large areas of fodder in the rotation system. What would be the subsequent impact on livestock production on or near the scheme; or the impact on the demand for beef, sorghum and groundnuts from Western Sudan?

6. Devaluation

Since there is a significant divergence between the present official foreign exchange rate and the open market rate, one is forced to consider the implications for agriculture, and particularly agricultural research in the dryland farming areas if there were further adjustments in the exchange rate.

Clearly, this possibility reinforces the point made earlier regarding the need to minimize imported inputs in research strategies. In fact, traditional rainfed agriculture is relatively insulated from the negative consequences of a devaluation since few if any imported inputs are used. At the same time traditional or semi-traditional agriculture can benefit from a devaluation to the extent that marketable surpluses are increased, and commodity prices in terms of Sudanese pounds are increased to reflect parity at the new exchange rate.

7. Agricultural Price Policies

It is clear that prevailing market prices of agricultural commodities and the level and structure of the costs of production influence financial incentives and the supply responses of farmers in both the irrigated and rainfed sectors.

Administered or official commodity prices can have a negative impact on production. Take, for example, the present situation with regard to gum arabic, an important export commodity in Western Sudan. It has been reported by many that farmers in the Darfurs and Kordofans are finding that Ac Senegal fetches greater income if used for charcoal and firewood. Thus, the producers' opportunity costs under the present marketing arrangement and pricing policy are too high for some farmers to undertake the laborious gathering of gum. The

consequent of this negative pricing policy is a destruction of capital stock in the form of Ac Senegal, negative environmental impacts due to the reduction in the number of leguminous trees and the consequent acceleration of desertification. Added to this, the potential for foreign exchange earnings is reduced at a time when Sudan is in critical need of foreign exchange.

FS researchers need to be aware of the supply and demand situation for agricultural commodities produced in the target area. They also need to have an appreciation of commodity supply and demand projections in order to know the projected effective demand for these commodities and consequently the relative prices farmers are likely to receive for future increases in output which in turn will influence their incentives to produce.

The above policy issues raise some important other issues:

1. At what level or where should these issues be addressed?

   - Council of Ministers
   - Ministry of Finance and Economic Planning
   - Ministry of Agriculture
   - Agricultural Research Corporation (ARC)
   - Western Sudan Agricultural Research Project
     * Project Leadership
     * FS Researchers
     * FS Researchers in collaboration with target farmers

2. To what extent are the policy issues already addressed and/or which onces have not been, but should be?

3. To what extent do we have sufficient knowledge to make appropriate research policy decisions; or, to put it in another way, to what extent or in which areas do we require more research experience before these issues can be addressed and appropriate policies established?

ROLE OF AGRICULTURE IN THE ECONOMIC CRISIS

As pointed out above, the present economic crisis will not be short-term in nature and unfortunately has important implications for the agricultural sector, particularly the rainfed sector and agricultural research directed toward improving the productivity of the rainfed sector.

However, it must be noted that it is largely agriculture where the solutions to the present economic crisis lie waiting to be identified, designed, disseminated, adopted, and publicly and privately supported. While it is not the purpose of this discussion, one could also argue that within agriculture it is the vast rainfed sector which holds the key to the longer term economic development of the Sudan.

For this goal to become a reality, however, agricultural research and particularly FSR, must be designed in such a way that for the remainder of the decade, and possibly into the 1990s, the products of research will:

1. Require a minimum of imported inputs;

2. Substantially increase the return to labor and management;

3. Be within the financial, technical and managerial capability of large number of farmers operating in the target area;

4. Be financially attractive to farmers, thereby encouraging widespread adoption;

5. Be within the capacity of the public and private sector to provide infrastructural and policy support;

6. Be technologies that generate marketable surpluses for which the effective demand is strong and likely to remain so over the decade;

7. Reduce the risk of dryland farming;

8. Not require unreasonable internal household savings and/or off-farm credit;

9. Not require intensive extension services to introduce and disseminate the products of research on a wide scale.

In addition to the above research product oriented characteristics, which admittedly include trade-offs, there will also be important choices to be made between rainfed and irrigated sector research and development by national policy makers. It is important that these trade-offs and, in some cases, conflicts be recognized by those who are involved in dryland farming systems research.

SUGGESTED ROLE OF ECONOMIC POLICY IN THE DESIGN OF FARMING SYSTEMS RESEARCH

Macro economic policy and agriculture policy (both micro and macro) need to be considered in:

- designing a research strategy
- developing the research work plan for the FSR team
- designing technology and on-farm trials
- evaluating research results in terms of private and social costs and returns

IMPLICATIONS FOR FSR ECONOMISTS

To what extent have I overplayed the role of macro-economists in FSR? To what extent can or should the project FS economists handle these issues? What are the trade-offs between investigating and analyzing the farmer's circumstances vs. the macro-economic circumstances and the latter's implications for the design of FSR?

These are important issues. If forced to decide between the two areas of investigation, I would decide in favor of the farmer's circumstances. But one need not be forced to make the either/or decision. I admit that given the number of FS economists involved in the WSARP and their very important primary role as part of the multidisciplinary FSR team, not much time can be devoted to these exogenous macro-economic considerations, despite their importance.

However, this is not to say that others cannot assist, undertake much of the analysis, provide the information and guidance to FSR economists which is relevant to their work as part of the FSR team. By establishing linkages between the FS economists and "the others", FS economists can obtain the necessary information and analysis regarding Sudan's macro-economic circumstances.

Who are "the others"? They include:

1. The Planning and Agricultural Economics Administration of the Ministry of Agriculture

2. The Ministry of Finance and Economic Planning, and

3. The Departments of Rural Economy and Economics of the University of Khartoum

Within these institutions one will find dedicated professionals and civil servants who can and are willing to provide guidance, studies, reports and information which can be reviewed and synthesized and incorporated into the diagnostic body of knowledge used to develop research strategies and design on-farm research.

FSR purports to be holistic in nature by the fact that both endogenous and exogenous factors are to be taken into account. How holistic FSR should be may be a legitimate issue, particularly given a limited number of economists with the FSR team, but under the present economic circumstances in the Sudan, I believe these considerations are essential.