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FARMING SYSTEMS RESEARCH PROGRAMME

RESEARCH GUIDELINES AND PROCEDURES

FARMING SYSTEMS RESEARCH PROGRAMME
INSTITUTE FOR AGRICULTURAL RESEARCH
AHMADU BELLO UNIVERSITY, ZARIA

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I. INTRODUCTION

Agricultural research traditions at Samaru, Zaria, go back to 1922, when the town served as a regional research station and as the headquarters of the Department of Agriculture of the Northern Provinces. Actual research in Samaru started in 1924 with the appointment of technical staff (the first being a botanist). In 1957 agricultural research became the responsibility of the Research and Specialist Division of the Ministry of Agriculture of the Northern Region of Nigeria. The Institute for Agricultural Research (IAR) was established in 1962 with the transfer of this Division from the Ministry to Ahmadu Bello University (ABU).

Since then the focus of research at IAR has been moving gradually from multi-disciplinary undertakings to inter-disciplinary endeavours. In this respect, three distinct but interrelated stages can be identified.

The first stage emphasized multi-disciplinary research. Before the establishment of IAR, research was mainly concentrated on technical problems i.e. on the physical and biological aspects of farm problems within a multi-disciplinary framework with little or no coordination between the technical scientists and with a conspicous absence of the social science disciplines related to agriculture. An almost similar situation continued after the establishment of IAR in 1962 till 1965 when the Rural Economy Research Unit (RERU) was established.

The second stage involved a gradual appreciation of inter-disciplinary research. Originally, research at IAR was mainly organised on a department basis which served as a nucleus for both teaching (for the Faculty of Agriculture)

and research (for IAR). Staffing and funding both from the Faculty and IAR (which incidentally came from different sources) were merged at the departments level. Research priorities were mainly determined by the departments concerned while coordination and cooperation between the physical, biological and social scientists was limited and was mainly confined within the boundaries of individual disciplines. However, inter-disciplinary focus was not completely absent, but was provided in the form of an umbrella by the governing bodies of the Institute namely the Board of Governors, and the Professional and Academic Board. Research programmes are drawn up by the sub-committees of the Professional and Academic Board which are mainly organised on crop basis. These committees are inter-disciplinary in orientation and encouraged an inter-disciplinary approach to the solution of farm problems.

RERU (later the Agricultural Economics and Rural Sociology Department) was represented in all the above research committees, and this helped to provide a social science perspective to the understanding of the technical problems confronting each research committee. In addition this unit particularly used an inter-disciplinary approach in its research programme, drawing on the discipline of rural sociology, geography and agricultural economics. However, the technical scientists of the Institute did not often actively involve themselves in the research programmes of the Department and RERU. This was a serious gap which needed to be closed with the passage of time.

The third stage involved a major effort to reorganize research at IAR. In 1975 ABU was federalized. Correspondingly,

a new statute for IAR (1976) stressing the need for farming systems research following an inter-disciplinary approach defined the present role of IAR as follows: "To conduct research into the development of farming systems which involve crops of savannah ecological zones and result in in the maintenance or in improvement of the soil resources, and especially in the production and products of sorghum, millet, maize, wheat and barley; cowpeas and soybeans (in coordination with other Institutes); groundnut and sesame and other oilseeds of economic importance; cotton and other vegetable fibre of economic importance; tree and horticultural crops and shall in particular conduct research into....the technical social and economic integration of cultivation of the crops into farming systems in different ecological zones and their impact on the economy." Thus the new statute provided the necessary framework to reorganize and revitalized research along inter-disciplinary lines by removing the institute from a rigid departmental structure to more dynamic crop based programmes. The necessary inter-disciplinary communication between programmes was achieved through Research Review Committees (RRC's) identified for each programme. Each programme is headed by a Leader and the RRC which he presides over is comprised of at least a breeder, an agronomist, a soil scientist, a crop protectionist, an agricultural engineer, an agricultural economist/rural sociologist and an extension specialist. Attendance of RRC meetings is open to all IAR research staff. The RRC prepares research projects for the approval of the Professional and Academic Board and draws up research plans which reflect the priorities prescribed by the Governors.

The Farming Systems Research Programme (FSRP) is at the centre of this major reorganization at IAR as all the research activities of the other programmes have a direct bearing on its activities.

II. OBJECTIVES AND PROCEDURES OF THE FARMING SYSTEMS RESEARCH PROGRAMME

The overall objective of the FSRP of the institute is to provide a good understanding of the farmer, his farm, and the total environment in which he operates, as a system of interdependent parts with a view to evolving improved agricultural technologies which are relevant to his felt needs and problems.

This broad objective is being achieved through a number of sub-programmes operating within the following set of procedures:

* Identify the constraints operating to limit output of a particular farming system in the area of responsibility of the Institute.
* Evaluate, on the basis of existing information, possible technologies which might overcome the most important constraint(s) of farmers in the area.
* Test, usually on farmers' fields, the technologies which appear to be appropriate and then either;
  - reject the technologies and try something else, or
  - modify them and try again, or
  - accept them and propose the necessary institutional and social action to facilitate their adoption

(extension, input delivery, extension, marketing, social organization, etc).

* Hook up the successful technologies into an on-going Agricultural Development Project or Programme to achieve mass production.
* Monitor the adoption process and either;
  - continue to modify the technology as necessary, or
  - be prepared to try something else if despite the existing on-farm research results, the technology is not widely adopted or,
  - identify and propose solutions for the next most important constraint if the technology if being adopted.

III. SUB-PROGRAMMES

To facilitate the achievement of the general objective of the programme, its activities are being carried out under a number of sub-programmes, each with a coordinator. The present structure of the programme and its sub-programmes are as follows:

H: FARMING SYSTEMS RESEARCH PROGRAMME

H.I. Diagnostic Studies Sub-programme

<u>Projects H.I/1-3</u>

(1) Exploratory Surveys

(2) Other Surveys

(3) Data Systems

H.II. On-Station Studies Sub-programme

Projects H.II/1-4

(1) Mixed Cropping Systems

(2) Sole Cropping Systems

(3) Irrigated Cropping Systems

(4) Other Systems

H.III. On-Farm Studies Sub-programme

Projects H.III/1-4

(1) Improved Mixed Cropping Systems

(2) Improved Sole Cropping Systems

(3) Improved Irrigated Cropping Systems

(4) Mechanization Systems

H.IV. Village-level Studies Sub-programme

Projects H.IV/1-5

(1) Marketing

(2) Finance

(3) Input Delivery

(4) Extension

(5) Social Organization

IV. DIAGNOSTIC SURVEYS SUB-PROGRAMME

The activities of this sub-programme are aimed at providing an understanding of relevant farming systems and agricultural problem areas with a view to identifying the key constraints that must be removed if agricultural production in the area is to be significantly increased and the welfare of the farmers meaningfully improved.

The exploratory surveys have the following specific objectives

(1) Identify the important cropping systems in different ecological zones in northern Nigeria.

(2) Describe these systems with respect to:

(a) Crop composition and intensity.

(b) Cultural and agronomic rationality.

(c) Economic and social logic.

(3) Utilize the knowledge so obtained in shaping cropping systems work at IAR.

The relevant areas of emphasis include but are not necessarily limited to the following:

(1) Soil and rotational aspects: type of soil, length of cropping and fallow.

(2) The cropping patterns: arrangement of crops in time and space.

(3) Cultivation practices: power source, tools used, timing and phasing of farming operations.

(4) Fertility maintenance: manurial, fertilizer, and other practices used to maintain fertility.

(5) Labour use: source and profile, family or hired?, labour requirements in relation to the season, priorities for labour allocation.

(6) Other inputs: source and use.

(7) Harvesting practices: when, how, and why?

(8) Pests and diseases: types, occurence, effects and control measures applied

Although major emphasis should be placed on the above aspects in the surveys, serious consideration should also be given to other relevant items in the farming systems whenever possible. Items of importance in this regard include:

(1) Storage and utilization of crops and crop residues: subsistence requirements, marketable surplus, marketed surplus, utilization of residues, insect pest and disease problems in storage.

(2) Product and input prices.

(3) Institutional factors: agricultural development projects, extension programmes, credit facilities, input delivery systems, government policies, etc.

(4) Food consumption and preferences.

(5) Population: settlement pattern, population densities.

(6) Local industry and non-farm occupations.

Classification of Cropping System in Northern Nigeria[1]

There is a definite need for a framework into which the various exploratory surveys to be carried out should be fitted. However, any framework arrived at must of necessity be tentative, and subject to refinements and modification as more knowledge is gained from completed surveys.

Among the available descriptions of Nigerian farming systems, the village studies of Norman and his collaborators in the areas of Zaria, Sokoto and Bauchi are by far the most detailed sources available. Nevertheless, the rigorously quantitative approach of these studies does not always facilitate the extraction of what is needed for the present purpose : i.e. a more descriptive indication of what crops are grown and how they relate to each other in space and time. Although some of this information is already available, it is not always easy to extract. Besides, most of the available information defies formal classification. The addition some areas are not covered by known published material. These include Niger, Kwara and Gongola States.

1. This section draws freely from a report on the first exploratory survey carried out in the Gumel area of Kano State. In 1982 by researchers in the FSRP.

In a document with restricted circulation, Gosden[1] has described the farming systems of Central Nigeria, an area covering most of Kaduna, Plateau and Benue States and parts of Kano and Bauchi. While the detailed village information could conceivably be sensitive, there seems to be nothing to prevent their discussion and use. His categories of farming systems are based on the principal food crops grown and include the following (the dominant crop is always listed first, other crops are secondary):

1. Millet-sorghum system: found north of a line joining Musau and Dambatta. Gero millet is the dominant crop, cattle production is important and animal draft widespread. Cash crops are groundnut and cowpea.

2. Sorghum-millet-cowpea system: found in the southern parts of Kano and Bauchi States, cattle production is important, animal draft is locally important, cash crops are cotton and groundnut.

3. Sorghum-millet-maize-system: especially in Kaduna State, south of Dutsin Ma and north of Kaduna town. Cattle production is less important than in 2, animal draft is locally important, cash crops are cotton and groundnut, yam is grown.

4. Sorghum-maize-yam system: found south from Kaduna through the Jema'a area and continueing eastwards through Shendam and Yelwa. Cattle not very important, surplus food crops are sold for cash, gero millet is rare.

5. Sorghum-yam system: south west of Kaduna State. Few livestock, surplus food crops sold for cash.

6. Acha-millet system: confined mainly to the Jos Plateau. The millet is mainly 'dauro', cattle are important and groundnut is the important cash crop.

7. Yam-sorghum system: southern Plateau and eastern Benue States. Cash crops include groundnut and surplus food crops. Millet is rare.

8. Yam-cassava system: mainly in the western part of Benue State.

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1. For more details see Gosden, P.M. (1978). Land resources of central Nigeria. Present farming systems: Vol. 1 Introduction and description of the farming systems. Land resources paper 17, Land Resources Development Centre, Surbiton, Surrey, U.K.

From the point of view of crop improvement, this classification has much to recommend it and the present plan is to draw heavily on it. A number of criticisms can however be made:

1. The land use intensity is perhaps even more basic than the nature of the food crops and is internationally the basis of most classifications of tropical farming systems. Despite the rather limited range of land use intensity in Northern Nigeria today, the distinction between the predominantly permanently cultivated cropping systems of the north and the bush or grass fallow systems of the middle belt is fundamental.

2. The distinction between cash and food crops, though useful in the colonial era, would seem to be of decreasing and already minimal relevance. Cowpea is a cash crop in the Sudan savanna but predominantly a food crop elsewhere. Groundnut today is often more than a cash crop and maize, sorghum and yam are increasingly perceived by medium scale farmers as cash crops. Only for cotton is the postition not equivocal.

3. The classification has no vertical structure; it implies the differences between any two systems are about equal. In fact, this is not really so: for instance the differences between 2 and 3 and between 7 and 8 are minor compared with the differences between say 2 and 8. Likewise some distinction is needed between zonal systems to be found in bands running east-west across the study area and the intra-zonal systems such as no. 6 which are confined to localities with specific features and determined more by geomorphological or ethnic influences than by climate.

A Proposed Classification: zonal systems.

Zonal is defined here as the cropping systems which are largely determined by climate and therefore exist over large areas, usually oriented parallel to the rainfall or ecological zones, though not necessarily coinciding with their accepted boundaries. The intrazonal systems are more location-specific.

Among the zonal systems (Table 1), a distinction is made between fallow systems and permanent cropping. The former is defined as systems where farmers either perceive a fallow period as being essential to the

systems as they have traditionally practised it or where farmers choose periodically to crop fallow land when this is freely available. The permanent cropping systems are those where farmers either choose or are forced to crop most of the land every year. It is important to note that this distinction is based on farmer practice and not on the proportion of land which is cultivated. For example, the proportion of land cultivated in a densely-populated, yam-farming part of Benue State might be about the same as millet-farming in Northern Kano State. However, the uncropped land in Benue would be land consciously fallowed in order to give good yam crop when returned to cultivation. The uncropped land in Kano State would be recognised grazing areas, cropped only occasionally or not at all, since the farmers in this environment have little preference for cultivating fallow land as compared with cropped land. Despite the comparable equality of the proportion of land cultivated, the Benue situation would be classified as a fallow system and the Kano one as permanent cropping.

Table 1. A proposed classification of the zonal cropping systems of northern Nigeria.

Land use pattern	1. Fallow systems	2. Permanent cropping
Most important Crop:		
1. Yam	1.1 Fallow systems with yam.	not important
2. Sorghum	1.2 Fallow systems with sorghum	2.2 Permanent cropping with sorghum
3. Gero (early) millet	not important	2.3 Permanent cropping with millet

For the purpose of this classification, the most important crop is not viewed as necessarily the one occupying the greatest land area. The problems of defining land area by crop have not been satisfactorily solved for land predominantly cropped to mixtures. It is [illegible] better

to rely on the perception of the typical farmer who knows for which crop he feels the greatest obligation to supply enough for his family, the one to which he will give preference when his labour supply is inadequate or when a disasterous cropping season appears to be developing.

The fallow systems with yam (1.1 in Table 1, Gosden's categories 7,8) are obligate fallow systems in the sense that if populations grew to such an extent that fallowing was no longer possible, then probably cassava would replace yam as has happened in the highly populated areas of south eastern Nigeria. It is an open question whether fertilizer or other modern methods could prevent this involution but cassava-dominated systems in the northern States are rare at present. When they occur, they seem to be based on a localised specialisation in "gari" production for cash and could therefore be regarded as intra-zonal systems.

Fallow systems with sorghum (1.2 and Gosden's categories 5 and part of 4) are mostly found in the southern Guinea savanna where land pressure is low. The second most important crop is often yam so that the dangers of involution still exist, though they are less imminent than for fallow systems with yam.

The permanent systems with sorghum (2.2) occupy most of the northern Guinea savanna and some of the Sudan savanna. All of categories 2 and 3 and probably much of category 4 of Gosden's classification is included. This is a large category and quite diverse in some respects but Gosden's attempt to sub-divide it on the basis of the second most important crop(s) would seem to create as many problems as it solves and in particular confuses the basic similarity of the cropping patterns along the same line of latitude east and west of the Jos Plateau. It would therefore be prefereable to leave permanent systems with sorghum as a single cropping system and to define the cropping patterns to be found within the basic system, noting the geographic differences which certainly exist in their frequency of occurrence.

farmhunt systems with millet (2.2, Gosden's 1) are found in the northern part of the Sudan savanna and in the Sahel zone. An effort has already been made to define the southern boundary of this cropping system in the pioneer exploratory survey carried out in the FSRP in 1982. From east to west, the boundary is found just south of Bama passing west-north-westwards to Damaturu, follows approximately the Maiduguri-Kano road to Kari, west-north-west again to pass about 20km north of Kano and reaching its most northerly point somewhere near Mani in Kaduna State. Turning west-southwest it passess north of Gusau and crossed the western border at about the same point as the Niger river. Whatever may have been the situation before the Sahelian drought, there is no doubt that millet is now dominant in these areas and that the boundary of the millet zone is well on the Nigerian side of the border with the Niger Republic throughout it length.

Intrazonal Cropping Systems

Intrazonal cropping systems are distinctive cropping systems which exist within the broad zonal systems, usually associated with some geomorphological feature, strong ethnic preference or a "modern" agricultural development. The following Intrazonal Systems are noted but the list is not necessarily complete:

1. The Acha-dauro millet system of the Jos plateau (Gosden's category 6) which are probably determined by low temperatures favouring acha (Digitaria exilis) over millet and sorghum and partly by the ethnic preference for this cereal. Maize may be taking over as the dominant food crop in many parts of this zone.
2. Traditional swamp rice cropping systems of the river valleys, especially along the Sokoto, Rima and Jamaare rivers and along the Niger between Jebba and Lokoja. Often these may be integrated into upland cropping systems but would be considered a separate system wherever rice is the most important crop.

3. "Masakwa" sorghum production systems on land which is flooded in the wet season, especially on vertisols (black soils) around Lake Chad. The sorghum is transplanted as the floods recede and uses residual moisture to grow during the dry season. Again the system may be integrated with upland cultivation and would be considered a separate system where Masakwa sorghum was the sominant crop.

4. Fadama (valley bottom) farming systems throughout the northern States, growing sugar cane and dry season vegetables or traditional wheat. Many villages have access to small fadamas which are farmed along with the upland but on the more extensive fadamas, whole villages may be found whose primary agricultural activity is centred in the fadama. It is these which constitute a distinct cropping system.

5. Modern irrigation developments made possible by building large dams and extensive water distribution works. Usually the traditional crops are grown in the wet season and double-cropped with a dry season crop su such as wheat.

6. Large scale, mechanised farming systems. These may be government sponsored or privately owned developments. They tend to have large fields which are tractor-cultivated and sown to sble crops. Weeding and harvesting may only be partially mechanised.

Other Diagnostic Surveys

From time to time there would be demand for fairly restricted types of surveys to identify and provide answers to specific constraints and problem areas. For example a particular weed problem or insect problem could arise on which very little documented knowledge exists. It would therefore be most expeditious to embark on a quick survey on the problem to produce the required knowledge on which subsequent research work would be based. While the general procedures to be followed on these types of surveys would be quite similar to those used on the more orthodox exploratory surveys discussed earlier, the precise procedures to be followed will vary depending on the particular problem area under consideration.

Another area is which a broad based research strategy that cuts across the whole programme is needed is in the development of appropriate methods of data collection, processing, and analysis. Because farming systems

research is a relatively new type of research strategy, there is need to evolve relevant and effective procedures of data collection, processing and analysis in support of the overall objective of the programme. Appropriate procedures on data collection, processing and analysis need to be developed and standardized. To this end, a project area concentrating on evolving appropriate data computing systems has also been built into the diagnostic sub-programme.

Diagnostic Surveys Sub-Programme:

Summary of On-Going Projects (1984/85)

Below is a summary of on-going projects in the diagnostic surveys sub-programme for the 1984/85 growing season. It is expected that any new projects to be added to list below would fit as neatly as possible into the proposed frame-work and philosophy of the sub-programme outlined above.

H.I. Diagnostic Surveys Sub-Programme.

New No.	Old No.		
H.I.1	-	PROJECT:	Exploratory Surveys
H.I.1.1	H.V.1	SUB-PROJECT:	Identification and Description of Important Cropping Systems in Different Ecological Zones of Northern Nigeria: Ilorin Area
		OBJECTIVES:	To identify the important cropping systems in different ecological zones, to describe the systems with respect to crop composition and to the rationality of the practices employed and to utilize this knwoledge in shapping cropping systems research at the Institute.
		STARTING DATE:	1982.
		RESEARCHERS:	Fisher, Abalu, Voh, Ogungbile, Ajayi, Elemo, Bello.

H.I.2 - PROJECT: Other Surveys

(No On-going Projects)

H.I.3 - PROJECT: Data Systems

H.I.3.1 H.II.2.2 SUB-PROJECT: The Collection and Retrieval of Data for Evolving Farm Plans

OBJECTIVES:
(a) To initiate a continuous and consistent monitoring of a selected group of farmers.
(b) To collect specific information on the whole farm as one system - i.e. data relating to soils, plants, the farmers, machineries, fertilizer, socio-economic variable etc.
(c) To evolve an effective Farm Records System.

STARTING DATE: 1983

RESEARCHERS: Agori-Iwe, Nwasike, Owonubi, Nwagbo, Ogungbile and Olukosi.

H.I.3.2 H.V.2 SUB-PROJECT: Estimation of Optimum Plot Size, Shape and Number of Replications.

OBJECTIVES:
(1) To estimate optimum plot sizes and shapes for the different crops.
(2) To estimate number of replications required to detect specific differences between treatment means at prescribed levels of significance.

STARTING DATE: 1984

RESEARCHER: ABED

H.I.3.3 H.V.3 SUB-PROJECT: Relative Efficiency of Experimental Designs.

OBJECTIVES: To estimate the relative efficiency of some experimental designs.

STARTING DATE: 1984

RESEARCHER: ABED.

H.I.3.4 H.V.4

SUB-PROJECT: Statistical Validity and Improvement of Methods of Assessing Yield Advantages of Intercropping.

OBJECTIVES: To improve the follwing methods of assessment.

(a) Bivariate - LER method

(b) Use of individual sole crop values for calculating LER

STARTING DATE: 1984

RESEARCHERS: Oyejola & Fisher

H.I.3.5 H.V.5

SUB-PROJECT: Development of a Computing System for Storing and Retrieving Information from Experiments carried out at IAR.

OBJECTIVES: To provide easy access to essential information on experiments carried out in IAR.

STARTING DATE: 1984

RESEARCHERS: OYEJOLA & ABED

H.I.3.6 H.V.6

SUB-PROJECT: Development of Basic Programs for the Micro-computer.

OBJECTIVES: To develop programs suitable for use on the M-20 micro-computer in I.A.R's Data Processing Unit.

STARTING DATE: 1984

RESEARCHERS: Oyejola and Abed.

V. ON-STATION STUDIES SUB-PROGRAMME

Studies carried out in this sub-programme are designed to examine the range of strategies that are thought to be relevant in dealing with the constraints identified in the diagnostics studies sub-programme as well as other constraints which may have made themselves known through other processes.

Ideally most of the basic information needed in this sub-programme should be available from the body of existing knowledge. It is however quite reasonable to expect that there may exists situations where the needed knowledge would have to be generated from scratch. In any case, the major emphasis of studies in this sub-programme is centred around testing possible improved cropping systems into which productive technologies can be fitted. The systems of direct relevance to this sub-programme include but are not necessarily limited to; mixed-cropping systems, sole cropping systems, and Irrigated Cropping Systems.

Concerning future research emphasis on crop mixtures, there is as of now, abundant evidence from I.A.R. research to show that a mixture of two crops which differ in the time at which the individual crop growth rate is maximal almost invariably shows a yield advantage from mixing, irrespective of the level of management. This difference in the timing of maximal growth may arise through differences in maturity length of crops sown at approximately the same time (millet with sorghum, millet or maize with cotton, groundnut with sorghum) or because of differences in sowing dates ("gicci" mixtures and early cereals with late cowpea). Mixture including legumes may show advantages at low N fertility even if they have synchronous growth patterns but this advantage is likely to disappear with high N fertilizer inputs. All these advantages may, however, be short-lived because there is some evidence that land carrying mixed crops supports lower yields in the subsequent year.

The future plan is for all new cropping trials in this sub-programme to primarily aim at optimising some aspect of management of the mixed crops. The demonstration of a yield advantage in these studies would constitute a secondary objective if the required sole crop comparisons did not greatly increase the size or complexity of the experiment. In view of possible residual effects, more trials would be planned on a longer time scale than one year, either by accumulating the treatments on the same plot over several years or by test-cropping the land used for mixed crops of possible residual effects.

Priority should be given to the testing of imputs which are not traditional in mixed crop farming systems such as new varieties, fertilizers, and herbicides.

In general, improvement efforts should be focussed on two-crop mixtures except (a) for herbicides where it would be important to ascertain whether or not farmers could add minor crops to the basic mixture and (b) where interactive testing of packages clearly indicated a farmer preference for a third crop to be added.

Taking note of the information available for the northern Guinea savanna from village studies and evaluation studies in the Agricultural Development Projects (ADP's) and the yield advantages and improvement prospects of the mixtures, the following five priority mixtures for studies at Samaru would be empnasized in the future:

1. millet-sorghum
2. maize-sorghum
3. maize-cotton
4. sorghum-groundnut
5. maize-cowpea

Studies on mixtures of cereals with vegetable crops would also be supported.

For each of these mixtures, the aim of all on-station research should be to work towards or improve the "package" to be offered for or subjected to on-farm testing. Proposals for work on other mixtures are not necessary precluded but would be very fully justified.

For the Kano area, four priority mixtures areas are being proposed for the future:

1. millet-sorghum
2. sorghum-groundnut
3. millet-groundnut
4. millet-cowpea

For Mokwa, it is felt that it would be difficult to suggest firm priorities at present. However, studies of the two-year system of melon-cereal mixtures, followed by yam grown on the sorghum straw trellis appears to be of high priority. The emphasis for mixtures with yam would probably be on their fertilizer response.

For Yandev published information on the cropping systems of eastern Benue suggest that a complex mixed-multiple system of cereals, cassava and legumes usually followed a mixture dominated by yam. As at Mokwa, fertilizer studies on the yam based mixture would be emphasized as well as more general improvement studies on a simplified version of the "mixture without yam" phase of the rotation. A possible starting point would be early-sown groundnut, intersown later with sorghum and with soybean replacing the groundnut as it was lifted.

The research being carried out in the Diagnostic Surveys Duo-Programme should eventually provide more definitive suggestions or areas for action.

With regards future research on cropping systems which do not involve crop mixture, emphasis would be placed on studies involving rotation and crop sequences as well as studies on various cultural practices and crop management systems.

With regard to studies on rotation and sequences, the former Experimental Cropping Systems Programme included a number of crop sequence and rotational studies which had been laid down at Samaru and the sub-stations. About 1972, the decision was made to wind these up. Although a number of brief summaries have appeared, mainly as Miscellaneous Papers, the information gleaned has been disproportionately small relative to the cost of mounting these experiments. Whether this is an intrinsic property of this sort of experimentation or whether it resulted from staff discontinuities during the life of the experiments is debatable. The result is that the programme currently contains little on crop sequence or rotation except in relation to irrigated agriculture.

The absence of rotational studies at Samaru, an environment situated among farming systems dominated by annual cultivation and in which fallows are known to be of very limited efficacy in restoring fertility and where double cropping without irrigation is not feasible, is defensible. However, at Kano, even though most of these same arguments apply, a case could be made for cropping systems studies aimed at protecting the soil from erosion by wind. For Mokwa and Yandev, situated in areas where the traditional fallow systems are already or could soon be under pressure from growing populations, the case for a fresh look at rotational studies could be made. Areas of enquiry might be alternatives to fallows as means of maintaining both fertility and manageable weed populations and at methods of intensifying the cropping within the arable phase, particularly the means of enabling the more demanding crops such as yam and maize to be grown perhaps once in two years withou recourse to fallow.

Another area of cropping studies not related to mixed cropping has to do with cultural practices and weed management systems. There is need to carry out research on cultural practices and weed control. Particularly since cultivations for land preparation are being studied under the Soil and Crop Environment Programme but little note is taken of the effects on subsequent weed growth. The Weed Scientists have made an important

contribution in evaluating herbicides for use on tractor-prepared seedbeds and some work has been done on post-sowing tillage for weed control under the Mechanization Programme. Except to a limited extent for sole crop groundnut no attempt has been made to integrate these components into a cultivation and weed management system for any one of the types of cultivation currently used in northern Nigeria: hand, animal or tractor.

There is thus need to encourage projects on integrated cultivation and weed management systems by which herbicides might be incorporated into indigenous hoe cultivation systems. At the same time, there is need for other Research Programmes to pursue an integrated approach to animal- and tractor-powered cultivation and weed management research which encompasses the whole growing season.

On-Station Studies Sub-Programme:

On-Going Projects (1984-85)

The on-going projects in the sub-programme for the 1984/85 growing season are outlined below.

H.II On-Station Studies Sub Programme

New No.	Old No.		
-	H:II.1	PROJECT:	Mixed Cropping Systems
H:II.I.1	H.I.1.1	SUB-PROJECT:	Genotypic comparisons in groundnut cereal mixtures.
		OBJECTIVES:	To test the effects of length of growing period for both millet and groundnuts in a 2:1 row mixture of both crops.
		STARTING DATE:	1982
		RESEARCHERS:	Odion.

H.I.1.2	H.I.1.3	SUB-PROJECT:	Evaluation of sorghum genotypes in intercropping.
		OBJECTIVES:	(1) To assess the performance of promising new sorghum genotypes under sorghum-cereal and sorghum-legume mixtures of West Africa.

(2) To explore the possibilities of developing alternate productive cropping systems with improved promising sorghum genotypes.

STARTING DATE: 1983

RESEARCHERS: Shetty, (SAFGRAD/ICRISAT), Fisher, Abalu, Bello, Obilana and ICRISAT-breeder.

H.I.2.2.1 SUB-PROJECT: Fertilizer response in a mixed crop sequence.

OBJECTIVES: To evaluate fertilizer response in a sequence of mixed crops as used by local farmers and to compare the response of the sole crops of the component species.

STARTING DATE: 1979

RESEARCHERS: Fisher, Sachan, and Elemo

H.I.1.4 H.I.2.2.7 SUB-PROJECT: Fertilizer response of maize-cowpea-cassava.

OBJECTIVES: To determine the effects of fertilizer application on the yields of maize-cowpea-cassava mixed crop, maize-cowpea relay crop and the sole crops.

STARTING DATE: 1982

RESEARCHERS: Bello

H.I.1.5 H.I.2.3.2 SUB-PROJECT: Populations, proportions and crop arrangement in cereal-groundnut mixtures for the Sudan savanna.

OBJECTIVES: To determine the best proportions, populations, and arrangements in various mixtures of cereals with groundnuts for the Sudan savanna.

STARTING DATE: 1980

RESEARCHER: Odion

H.I.1.6 H.I.2.3.3 SUB-PROJECT: Planting arrangement in maize-legume mixtures.

OBJECTIVES: (a) To observe if an adjustment in the present recommended maize spacings could decrease the depressing effect of maize on the accompanying legumes when both are interplanted.

(b) To determine the optimum density combinations for intercropping cowpea and maize.

(c) To compare different planting pattern and crop proportions for a maize-cowpea mixture.

STARTING DATE: 1983

RESEARCHERS: Olufajo, Ologunde, Bello and Raheja

H.I.1.7 H.I.2.3.4 SUB-PROJECT: Population density of cotton-maize mixtures.

OBJECTIVES: To study the response of cotton-maize mixtures to varying plant population densities.

STARTING DATE: 1983

RESEARCHERS: Kumar and Ogunlela

H.I.1.8 H.I.2.6.1 SUB-PROJECT: Weed control in millet-sorghum and maize-sorghum mixtures.

OBJECTIVES: : To develop weed control recommendations for millet-sorghum and maize-sorghum mixtures.

STARTING DATE: 1981

RESEARCHERS: Choudhary, Ndahi and Shebayan

H.I.1.9 H.I.2.6.3 SUB-PROJECT: Weed control in cereal-groundnut mixture.

OBJECTIVES: To develop weed control recommendation for cereal-groundnut mixtures.

STARTING DATE: 1982

RESEARCHERS: Gworgwor, Choudhary and Lagoke

H.I.1.10 H.I.2.6.4

SUB-PROJECT: Melon-maize-sorghum intercropping with herbicides.

OBJECTIVES: To observe the depressive effect of intercropping melon-maize and melon-sorghum on the yields of component crops as compared to sole crops. To evaluate the effectiveness of some chemical herbicides in melon-maize mixture.

STARTING DATE: 1977

RESEARCHERS: Ologunde and Lagoke

H.I.1.11 H.I.2.2.8

SUB-PROJECT: Rate and Time of Inorganic Nitrogen Fertilization in Sorghum/Millet Mixture.

OBJECTIVE: To determine the optimum rate and time of inorganic nitrogen fertilization of sorghum/millet mixture.

STARTING DATE: 1984

RESEARCHERS: Elemo and Singh

H.I.1.12 H.I.1.4.1

SUB-PROJECT: Performance of cowpea (Vigna unguiculata (L) Walp cultivars in maize/cowpea and milet/cowpea mixtures.

OBJECTIVE: To investigate the competitive ability of cowpea cultivars in maize/cowpea and millet/cowpea mixtures, with a view to identifying cowpea varieties/lines adaptable to intercropping.

STARTING DATE: 1984

RESEARCHER: Elemo

H.I.1.13 H.I.3.2.3

SUB-PROJECT: Efficiency of insecticide application methods in maize-cotton mixture.

OBJECTIVES: To compare different methods of spray application for control of insect-pests of cotton in cotton/maize mixture.

STARTING DATE: 1984

RESEARCHERS: Kumar and Raheja

VI ON-FARM STUDIES SUB-PROGRAMME

This sub-programme concerns itself primarily with evaluating promising strategies arising from the work of researchers in the on-station studies sub-programme, other programmes of the institute and other research institutes in and outside the country. Research in the sub-programme is designed to test recommendations originating from all these sources. Particular attention is payed to those recommendations and strategies which may be useful in removing the constraints faced by farmers under the jurisdiction of the institute. It is expected that by removing these constraints, desireable and acceptable changes would be produced in the existing farming systems in the area.

The recommendations and improvements being subjected to evaluation should have been arrived at as a result of a careful evaluation of the range of constraints and problems actually facing farmers. In other words, on-farm studies carried out in this sub-program should, whenever possible, be based on previous research efforts in the design stage in the on-station sub-program. Furthermore, on farm studies researchers should as much as possible, discuss suggested improvements and strategies with the farmers themselves and with the relevant extension agents operating in the area.

The research projects in this sub-programme could be researcher-managed or farmer-managed depending on the level of farmer involvement in carrying it out.

Researcher Managed Studies

Researcher managed on-farm studies, as the name implies, are usually located on a representative piece of land on a cooperating farmer's field but are managed entirely by the researchers themselves. These types of studies would usually involve suggested improvements or recommendations with demonstrated potential but with a too high a enough risk level which would be unreasonable for the farmer to bear. A good example here would be a

study involving the use of a new herbicide which if improperly used may damage farmers' crops and for which information about farmers' ability to handle it is not available.

Once the necessary information has been obtained from the researchers managed trials, this information is then used to formulate the farmer managed trials. The design and analysis of the researcher managed studies would normally be quite similar to those carried out in the on-station sub-program.

Farmer-Managed Studies

These types of on-farm studies bring the farmer directly into the research process. The main objective of these farmer-managed trials is to screen and evaluate new technologies and strategies under actual farmer circumstances and to analyse the research results in light of these farmer circumstances for further improvements of the new technologies and strategies.

Of considerable importance in the design of the studies here is adequate accounting of non-experimental variables which are useful in measuring the effects of the individual technologies on the farming system as a whole as well as the effects of various aspects of the farming system on the adoption of the recommendations and strategies.

Procedures for Farmer Managed Trials*

Possible choices for farmer managed tests and trials include:

1. Single component trials, comparable to pre-minikits but carried out on-farm and considered appropriate where:

   (a) The diagnostic survey revealed an indigenous cropping system which was basically sound but had clearly defined constraints which could be addressed by the components to be researched.

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* This section draws freely the outcome of a workshop on On-Farm Adaptive Research in the Nigerian Savanna. For more details see Farming Systems Research Programme, On-Farm Adaptive Research in the Nigerian savanna, Summary Proceedings of a Workshop held on April 3-4 1984, at the Institute for Agricultural Research, Ahmadu Bello University, Zaria.

(b) Rapid progress to an extension phase was required.

(c) The component in question can only be effectively evaluated by including the farmer reaction.

2. Diamond trials, very simple factoriabs with two components (or groups of components). The components need to be chosen or grouped with care to avoid absurd comparisons (e.g high population densities on unfertilised plots). Very careful researcher control is necessary.

3. Progressive technology increement trials with the farmers' existing practice at one extreme, the complete package at the other and one or two intermediate treatments incorporating some but not all elements of the package.

4. Feasibility studies of complete packages, probably with an "unimproved" comparison. They can be made to yield useful information about elements of the package if carefully monitored with this aim in view.

5. Monitored demonstrations on farmers' own fields.

Farmer involvement

The initial degree of farmer involvement in all these tests and trials will obviously vary with technologies to be tested but will normally increase with time until the farmer is managing and executing all aspects of the trial or study.

Plot number and size.

For trials with a high level of farmer involvement, plot numbers should not exceed four or five and the best experimental plot size will usually be that which fully utilises the field which the farmer makes available. Large plots are required where the information to be collected on labour inputs is an important part of the evaluation.

Records.

Yield results are important and obtaining them should not present insurmountable problems. Ideally the whole plot should be harvested but where piecemeal harvesting or other farmer practice make this impossible,

a suitable sampling technique has to be worked out. Everything depends on a good working relationship between farmer and enumerator.

A minimum list of desireable records should include the following:

1. Measured plot size and description of position in the toposequence, land history, especially the time elapsing since the last fallow in bush-fallow systems.

2. Daily rainfall from a rainguage located in each study village.

3. Establishment counts on a whole plot or sample basis.
   Growth vigour at midseason for each crop present.
   Dates of flowering (tasseling, heading) and maturity.
   Simple scores for major pests and diseases.
   Number of yield units where appropriate (e.g. yam tubers, sorghum heads).
   Weight of product, subdividing if necessary (e.g. seed yams, v. processing yams v. ware yams).

4. Quantities of all inputs including labour.
   Dates of all operations.

5. Farmer assessment of each treatment or the whole package. To be obtained by a combination of direct researcher-farmer interaction and questionnaires administered by enumerators. Questions for both methods should be simple and concrete. For package studies, the farmer should be asked to comment on each element separately (variety, land preparation, spacing, weed control, fertilizer, pest control). If he deviated from the recommendation in any respect, why? Did the fertilizer/herbicide/spray have the effect he expected?

Reporting.

Reports of on-farm trials should include tabulated yields and tabulated responses to questions asked. If mean yields are presented, some indication of the distribution is also required. The subjective impressions resulting from the researchers own conversations are also important.

Relationships with enumerators and extension workers.

Feed-back of the analysed trial results by the researcher to enumerator and field staff is an important means of boosting their morale.

As indicated earlier, extension agents should be in the on-farm research process. To be effect we, the more senior staff should be involve all along in the entire FSR process starting from the diagnostic to the technology design teams to the on-farm teams. Arrangements should always be made for lower grade extension agents to visit on-farm trials when it is expected that they will be promoting the technologies under test in a subsequent year.

Programme Based On-Farm Adoption Studies.

On-farm technology adoption studies are also housed in each of the crop based research programmes of the institute. The reason for housing them there is to provide a more direct link between the research activities in each crop based programme and the farmers who would eventually adopt the recommendations that these programmes put out on the individual sole crops.

These On-farm adoption studies deal mainly with the development of prototype improved technologies for the individual sole crops. The studies are meant to emphasize both ex-ante and ex-post evaluation of the individual sole crop technologies so as to facilitate major shifts in the productivity of the farming system as a whole. They are also expected to be continuously on-going with a built in feed-back system of research information to programme researchers.

While the on-farm studies based in the crop programmes center around the development of prototype improved technologies for the individual sole crops, their counterparts projects in this sub-programme are designed to focus on immediate solutions for specific sitautions and conditions on the basis of an understanting of whole farming systems and the constraints operating in them.

On-Farm Studies Sub-Programme:

Summary of On-Going Projects (1984/85)

H.III On-Farm Studies Sub-Programme.

New No	Old No.	
H.III.1		**Project:** Improved Mixed Cropping Systems
H.III.1	H.II.1.1	**Sub-Project:** On-Farm Testing of Improved Cotton/Maize Mixtures.

Objectives:
(a) To put together an improved package for cotton and maize.
(b) To test this improved package on farmers' plots.
(c) To use the test results to further improve the package.

Starting Date: 1983.

Researchers: Bbuyemusoke, Fisher, Choudhary, Kumar, Elemo, Ogungbile, Etuk and Ologunde.

H.III.2		**Project:** Improved Sole Cropping Systems
H.III.2.1	H.II.2.1	**Sub-Project:** Farm level tests of farm plans involving promising improved IAR technological packages.

Objective:
(a) To delineate common farm plans used by small farmers in the area.

(b) To identify promising sets of improved crop technologies developed at the institute that may be utilized to improve upon these plans.

(c) To identify the preference of farmers of these improved farm plans and the constraints they face in adoting them as well as the implications that would be associated with their widespread adoption.

Starting Date: 1982.

Researchers: Abalu, Lagoke, Fisher, Raheja, Isitor.

'H.III.2.2. H.II.3 Sub-Project Block Production pf Improved Maize by Village Farmers.

Objectives: The objectives of the project are as follows:

(1) To organize individual small farm holdings in a village setting into large production products for improve maize production.

(2) To block produce the improved maize following recommended practices, and exploiting the economics of scale and institutional and social advantages associated with this type of a collective utilization of land and group effort.

(3) To keep up to date data on the costs of production and organizational problems with a view to enlarging the block and ensuring its successful replication elswhere.

Researchers: Abalu, Chuke, Ogungbile, Ingawa, Musa, Lagoke, Olukosi.

Starting Date: 1984.

H.III.3 PROJECT: Improved Irrigated Cropping Systems

H.III.3.1 H.II.3.1 SUB-PROJECT: Efficiency of resource use under large scale irrigation farming in Nigeria.

OBJECTIVES: (1) To examine the economics of resource use by farmers in large scale irrigation projects in northern Nigeria.

(3) To identify agricultural and soci-economic constrainats faced by farmers operating in the projects with a view to making recommendations about how to make better use of resources invested in large scale irrigation project.

STARTING DATE: 1983.

RESEARCHERS: Erhabor, Mayaki and Voh.

H.III.4 PROJECT: Machanization Systems.

H.III.4.1 H.II.3.2 SUB-PROJECT: Machaninery performance of selected farm equipments under field conditions.

OBJECTIVES:

1. Determination of machinery field performance in Kaduna and Kano State.

2. Determination of machinery performance in post-harvest processing equipment in Kaduna and Kano States.

3. Determination of machinery performance of irrigated agricultural equipment in Kaduna and Kano States.

4. Supply data onannual machinery usage, field capacities, processing capacities, operating costs and constraints in the use field, processing and irrigated equipment in fed and irrigated agriculture.

RESEARCHERS: Musa, Braide, Olokosi, Yiljep, and Ogugua.

STARTING DATE: 1984.

VII VILLAGE LEVEL STUDIES SUB-PROGRAMME

The farming systems is influenced by institutions and structures. These institutions and structures which are established to support or influence the farming system, usually consist of collective action which control, limit or liberate the actions of farmers. These include marketing, credit, input delivery, extension, and social organization. To be effective these institutions and structures must be so organized and structured that they are capable of responding adequately to improvements in the farming system. Marketing channels, for example, must operate in such a way that they do not restrict inter-farm and inter-regional exchange of the increased production forthcoming from an improved farming system. Credit institutions must be responsive to the increased cash flow needs of farmers who are willing to adopt improved technologies. Ready access to the improved inputs that have been recommeded is a crucial requirement for the adoption and maintenance of high productivity. Effective social organization would ensure that the benefits accruble from improvements in the farming system are not concentrated in a few hands but reach a large number of farmers, thus ensuring widespread development.

Whether or not food production and the welfare of farmers can be improved through improved technologies will depend on the establishment of a whole range of effective institutions and social structures or the reform of existing ones to support improved farming systems.

Since the studies in this sub-programme involve institutions and structures, they would normally cut access farms located in different parts of an area. They can be said to be village or country wide since their impact wide permeates the rest of society.

Because these studies deal mainly with policies and structured changes, they are usually macro-oriented and involve more social scientists than technicial scientists.

The studies carried out in this sub-programme are principally aimed at identifying institutional and social constraints operating in the farming system in area and finding solutions to these constraints. The results of the studies carried out in this sub-programme are therefore, meant to provide information to policy markers, managers of services and infrastructures, and other administrative representatives who are in a position to initiate the institutional and structural reform which are considered nêcessary for the successful incorporation of improved farming systems. In this regard, prototype institutional and social arrangements would need to be experimented with, usually on a small, and the results and implications of these results submitted to the appropriate authorities. For example, different extension methods, input delivery systems, credit scheme, etc, should be subjected to experimentation with the aim of evolving an appropriate set for the prevailing circumstances and situations faced by farmers.

The appropriate methodology to use here would be similar to those discussed earlier could normally include surveys aids at providing a farming systems perspective for predicting and guerding farmer responses to different policy stimuli.

Village - Level studies sub-programme:

On-going Projects (1984/85)

H. IV Village Level Studies Sub-Programme.

H.IV.1 H.IV.1. Project: Marketing

H.IV.1.1 H.III.1.1 Sub-Project: Marketing of crops by farmers adoption improved technologies

Objectives: (1) To assess the effect of diffusioon and adoption of improved packages of production of crops and development of market production.

(2) To identify posible market constfants to increased crop production and finding possible solutions to those constrints.

Starting Date: 1982

Researchers: Labura, Abdullahi, Ogungbile.

H.IV.1.2 H.III. 1.2. SUB-PROJECT: Problems and prospects of soybean marketing in Benue State, Nigeria.

OBJECTIVES:

(1) To identify and describe the problems in the marking system for soybeans in the study area, as seen through the marketing channels, the institutions, the intermediaries, and facilities for storage and transportation which exist in the system.

(2) To determine the marketable and market surpluses of soybeansamong the selected farmers.

(3) To determine the factors that affect both types of surpluses among the selected farmers.

(4) To assess the prospects for animproved soybean marketing system in the state.

STARTING DATE: 1982.

RESEARCHERS: Chuke, Abalu, Voh.

H.IV.1.3. H.III.1.3. SUB-PROJECT: An analysis of cotton marketing systems in northern Nigeria.

OBJECTIVES:

(1) To analyse the structure, conduct and performance of the cotton marketing system.

(2) To examine the procedure of cotton procurement and disposal by the Board.

(3) To identify marking problems facing the cotton farmers and the Board and to recommend ways of aleviating these problems.

(4) To examine to what extent the existing marketing system for cotton stimulates cotton production in the major producing ear.

RESEARCHERS: Isitor, Libura, Agori-Iwe, Abdullahi.

STARTING DATE: December, 1983.

H.IV.2 H.III.2. PROJECT: Finance

H.IV.2.1 H.III.2.1 SUB-PROJECT: Designing appropriate credit systems for different categories of farmers in northern Nigeria.

OBJECTIVES:

(1) To study the socio-economic characteristics of the farm population with a view to categorizing farmers according to their needs and access to agricultural credits.

(2) To evaluate, the efficiency of credit institutions and the availability and adequacy of credits with respect to different categories of farmers.

(3) To use the information obtained in 1 and 2 above to develop new strategies for action capable of relaxing credit constraints faced by differnt categories of farmers and to subjett these strategies to testing.

STARTING DATE: August 1983.

RESEARCHERS: Awolola, Raza, Krishnaswamy, Abdullahi, Ingawa, Libura, Banta.

H.IV.3 H.III.3 PROJECT: Input Delivery

H.IV.3.1 H.III.3.1 SUB-PROJECT: Designing appropriate input delivery systems for differnt categories of farmers in northern Nigeria.

OBJECTIVES:

(1) To study the socio-economic characteristics of the farm population with a view to categorizing them according the their need and access to the services of input delivery systems.

(2) To evaluate the efficiency of existing input delivery systems and the availability and adequacy of their services to different categories of farmers.

(3) To use the information obtained in 1 and 2 above to develop new strategies for action capable of relaxing input delivery constraints faced by different categories of farmers and to test these strategies.

STARTING DATE: August 1983

RESEARCHERS: Abdullahi, Ingawa, Awolola, Raza, Krishnaswamy, Libura, Banta.

H.IV.4 H.III.4 PROJECT: Extension

H.IV.4.1 H.III.4.1 SUB-PROJECT: Designing appropriate extension systems for different categories of farmers in northern Nigeria.

OBJECTIVES: (1) To study socio-economic characteristics of the farm population with a view to categorising them according to their needs and access to extension services.

(2) To evaluate the efficiency of the various extension systems vis-a-vis different categories of farmers.

(3) To use the information obtained in 1 and 2 above to develop and test improved extension prototype systems suitable for the various categories of farmers.

STARTING DATE: 1983.

RESEARCHERS: Abdullahi, Ingawa, Awolola, Raza, Krishnaswamy, Libura, Barta.

H.I.V.5 H.IV.2 PROJECT: Social organization

H.I.V.5.1 H.IV.1.1 SUB-PROJECT: Determination of village structures and analysis of farm characteristics of representative target farmers.

OBJECTIVES: (a) To develop a typology (typologies) for farms and villages in the area.

(b) To determine the nature and characteristics of representative farmers and villages in order to gain an understanding of the systematic characteristics and constraints of each group of farmers and village.

(c) Within each group of farmers and villages, to study farmers' decision-making process, particularly of their goals and attitudes in regards to risk and uncertainty, work relative to leisure, consumption vs saving, the use, availability and adoption of agricultural technology.

(d) To evaluate the specific technology and socio-economic needs of each group of farmers and villages.

(e) To specify the constraints facing each group of farmers and villages.

(f) To explore ways for removing the constraints facing each group of farmers and villages.

STARTING DATE: 1982.

RESEARCHERS: Raza, Voh, Abalu, Ituk, Fisher, Kaul, Abdullahi, [illegible] and Abdulsalami.