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Adewale Johnson Alonge

Iowa State University

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An assessment of the impact of Farming Systems Research/Extension on the adoption of agricultural technologies in the Middle-Belt region of Nigeria

Alonge, Adewale Johnson, Ph.D.

Iowa State University, 1993
An assessment of the impact of Farming Systems Research/Extension on the adoption of agricultural technologies in the Middle-Belt region of Nigeria

by

Adewale Johnson Alonge

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY

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CHAPTER 1. INTRODUCTION

Background

The wide gap between technological production possibilities and the persistent low level of agricultural production in Sub-Saharan Africa has been an issue of concern in the agricultural development literature for decades. Despite many past attempts, such as the Green Revolution, aimed at improving the level of technological application in African agriculture, little success has been achieved (Feder et al., 1985). Food-production in the region is still largely dominated by subsistence, low technology-utilizing traditional producers. This is attested to by the fact that an estimated 90% of cultivated area in Sub-Saharan Africa does not receive any fertilizer, while improved seeds account for only 10% of all cereals planted (Food and Agricultural Organization (FAO), 1986), and only four percent (4%) of usable land in Sub-Saharan Africa is plowed (Yudelman, 1987). It is little wonder that Sub-Saharan Africa is reported to be the only region in the world where per capita food production has either stagnated or declined over the last two decades (Abatena, 1988; Yudelman, 1987; Delgado et al., 1985).

The persistent food-deficit problem confronting the region is now regarded as one of the most limiting factors to sustainable development (Okigbo, 1991). The widening population-land supply ratio and the consequent shortening of the traditional fallow period has made the traditional reliance on area expansion as the main source of increased agricultural production a non-sustainable approach to agricultural development. Hence technological intensification by the millions of resource-poor farm households who form the bulk of producers in Sub-Saharan Africa is now generally regarded as the most sustainable approach towards
agricultural development (Elliot, 1988). However, past attempts to induce resource-poor, small-holder producers in Africa to adopt modern agricultural technologies have recorded minimal success (Feder et al., 1985). This paradox in African agriculture has been the focus of many adoption studies for decades.

The conventional wisdom in the 1950s and early 1960s, was to lay the blame for the non-adoption of "improved" technologies on the perceived rigid adherence of peasant producers to tradition, their ignorance and their lack of education (Rogers, 1969; McClelland, 1961; Spicer, 1952). The solution to the problem of low agricultural productivity was, therefore, conceptualized within a trickle-down transfer of technology framework. Hence, most agricultural development activity in the developing countries focused on persuading the more progressive producers, termed innovators and early adopters, to adopt agricultural technology imported from the developed countries. It was then assumed that the demonstration effect of such adoption would trickle down to the tradition-bound, unprogressive producers, termed late adopters and laggards (Roger and Shoemaker, 1971). As a result of this pro-innovation bias of the modernization paradigm, studies of the adoption and diffusion of technologies in the 1950s and 1960s were predicated on the assumption that the available technologies were not only superior to farmers' traditional practices, but were directly applicable and transferable to the diverse agroecological and sociocultural milieu in which resource-poor operated (Rogers, 1983; Bengtson, 1983).

The fallacy of this Eurocentric paradigm of development when applied to Less-Developed countries (LDCs), is well documented in agricultural development literature (Hayami and Ruttan, 1971; Norman, 1969). For instance, Paul (1970), Helleiner (1971) and Chambers and Jiggins (1987) all concluded that the diffusion
paradigm is too simplistic a framework for explaining the adoption of innovation by resource-poor farmers, observing that the model excludes the complexity of the situational and individual factors in the whole innovation adoption process. In the same vein, Merrill-Sands and Kaimowitz (1989) blamed the failure of past transfer of technology approach on the failure to recognize the diversity of the agroecological and sociocultural conditions under which most resource-poor farmers in the third world operate.

This paradigm shift in agricultural development brought to question the individual-blame bias that has characterized the explanation for non-adoption of technologies in diffusion studies in the 1960s and 1970s (Rogers, 1983). It is now becoming increasingly clear that not only do peasant producers respond to incentives, but they continually experiment and modify their farming systems in line with agroecological and survival imperatives (Chambers and Jiggins, 1987; Richards, 1985; Schultz, 1964). Stevens (1983) observed that in examining the agricultural technology used by farmers in developing countries today, when we find that farmers continue to use traditional agricultural techniques, our hypothesis must be that these technologies are the most profitable available to them and that the cost and/or risk of changing to new, potentially more profitable technologies must be too great. This frustration with the modernization model of development led in the early 1970s to the adoption of an agriculture growth-led model of development, which had at its core the incorporation of resource-poor farmers into the development process (McNamara, 1973; World Conference on Agrarian Reform and Rural development, 1979). Such a model was expected to achieve the goal of growth with equity, by correcting the perceived negative distributional consequences of past development efforts.
Two approaches, the Integrated Agricultural Development Project approach (IADP), and the Farming Systems Research/Extension perspective (FSR/E), each under-girded by different assumptions about the root-cause of agricultural stagnation in the third world, became the vehicles for achieving rapid agricultural development. The FSR/E perspective, which was widely championed by the Consultative Group for International Agricultural Research (CGIAR), in the 1970s and 1980s, was predicated on the argument that conventional approach to agricultural technology development that relied solely on on-station research methodologies was inappropriate for resolving the complex socioeconomic and agroecological constraints with which resource-poor farmers are confronted (Aboyade 1991; Chambers and Ghildyal, 1985; Matlon and Spencer, 1984; Norman, 1969). Hence, a new approach to agricultural research which takes a holistic view of the opportunities and constraints of the farming systems of the resource-poor farmer, and which involves him/her in the development of agricultural technologies, was recommended as the most viable option for accelerating agricultural development in Sub-Saharan Africa (Merill-Sands, 1988; Chambers and Ghildyal, 1985; Collinson, 1981).

While many variants have emerged, such as the Farmer-First-Farmer-Last, Farmer-back-to-Farmer models, among others; the FSR/E approach to technology generation is characterized by the adoption of the following stepwise sequence of activities: (i) selection of target homogeneous recommendations domain and research area, (ii) identification of farming systems constraints and development of a research base, (iii) planning on-farm research, (iv) on-farm research and analysis, and, (v) extension of appropriate technologies. Each of these five activities involves the active participation of the farmers working with a
multi-disciplinary research team (Shaner et al., 1981).

The Integrated Agricultural Development Projects approach (IADP) which was implemented in many third world countries in the 1970s and 1980s with major funding from the World Bank, was under-girded by a structure-function theoretical argument. According to this perspective, the major obstacle to technology adoption by farmers in the developing countries could not be attributed to the non-availability of appropriate technologies but rather to the poor state of rural infrastructure and agricultural support facilities and services (Carr, 1989; World Bank, 1984). For instance, Carr (1989) differentiated between technological availability and practicability, contending that technologies are available to overcome many of the farmers' most pressing constraints in Sub-Saharan Africa, but all too often economic, institutional and financial factors render them impracticable for the small-holder in remote rural areas. This infrastructure-deficit argument under-girded most of the agricultural development projects funded by the World Bank in the late 1970s and 1980s in many sub-Saharan African countries. The IADP approach was anchored on a production-led rural development strategy based on the improvement of rural infrastructure and agricultural-support services such as the extension and input supply services, in order to facilitate farmers' adoption of Green Revolution-type package of technologies (Blackwood, 1988).

The implementation of the agricultural development projects in many Sub-Saharan African countries has, however, attracted serious criticism from many quarters. It is argued by some that the huge investment in rural infrastructure development was a misapplication of scarce resources because many of the developing countries lacked a dynamic agriculture and the appropriate technologies that are required to make use of the infrastructure (Lipton, 1985;
Aboyade, 1991). There was also serious concern regarding the sustainability of the projects after the withdrawal of foreign technical and financial assistance from the World Bank.

The Farming Systems Research/Extension approach which generated so much hope in agricultural development circles in the early 1970s and the 1980s, has also come under intense criticism. There is already widespread concern within the donor community, that the huge resources already committed to FSR/E projects might not have resulted in improved technological application by resource-poor farmers (Chapman and Castro, 1988; McArthur, 1984). Other critics observed that farmers' participation, the core of FSR/E, has received inadequate attention in many on-farm research projects. It is argued that many so-called FSR/E projects were nothing more than cosmetic changes to the conventional Transfer of Technology approach, as farmers' participation had in many cases been reduced to the farmers providing land and cheap labor for the validation and/or demonstration of technologies which most often have been fully developed and evaluated in experiment stations (Sumberg and Okali, 1988; Chambers and Jiggins, 1987; Hilderbrand and Poey, 1985). Oasa and Swanson (1986), in a critical assessment of the FSRE approach, concluded that like the classical transfer of technology model, FSR/E is under-girded by a technological deterministic philosophy, hence it is unlikely to succeed as a development strategy where the Green Revolution failed. Such criticisms question the viability of FSR/E as a vehicle for agricultural transformation in the third world. Hence, there is a need for a study of this nature that evaluated the impact of FSR/E and rural infrastructure development on the adoption of technology by resource-poor farmers.
Accountability has become the major issue for FSR/E in the decades of the 1980s and 1990s. In the words of one of the founding fathers of the FSR/E perspective, (Norman, 1989, p. 2), twenty-five years after the enthusiastic acceptance of the FSR/E approach, a measured withdrawal on the part of many donor agencies threatens the institutionalization of FSR/E within many national research systems. He concluded by observing that the dilemma of accountability has now become an important issue for FSR/E in the 1980s. Since the relevance of the Farming Systems Research/Extension approach to agricultural development is assessable in terms of the extent to which technologies and recommendations are adopted by the farmers; this study sought to assess the impact of a collaborative FSR project implemented by the International Institute of Tropical Agriculture on farmers' adoption of recommended technologies in the middle-belt region of Nigeria.

Statement of the Problem

The overall performance of the Nigerian agricultural sector since the advent of the oil-boom of the late 1970s and the early 1980s has been dismal. In 1960, the agricultural sector accounted for 80 per cent of total export, but by 1980 its share of total export amounted to only two per cent. Nigeria, which was almost food self-sufficient in the early 1960s, became a major importer of staple food by the early 1970s as per capita food production in 1981 fell 18% below that of 1967-70 (Hunt and D'Silva, 1981). As a result of the imbalance between population and food production growth rates, Nigeria's food import bill rose from less than N60 million in the 1970s to over N 400 million in 1976, to a billion Naira in 1980 and by 1984 it had reached an all-time high of N2.3 billion - (in 1980, $1=N 0.60; by 1992 the exchange rate was $1=N 20.00; (Mabawonku and Yoshida, 1990). Expressed
in per capita terms, Nigeria’s food imports rose from a value of about $2 in 1970 to a staggering $39 in 1980 (Pinto, 1987).

In order to reverse the decline in the agricultural sector, the Nigerian government in the late 1970s embarked on the implementation of integrated agricultural development projects in different parts of the countries with loans from the World Bank. This study was carried out in one of the earlier ADPs implemented in the middle-belt region of Nigeria (hereafter referred to as the Bida ADP). The project area covered 17,000 square miles and served a population estimated at 481,655 in 1985/86 (Wedderburn, 1986). It had as its major mandate to increase the output of the major staple crops of the area by 25%, through the development of rural infrastructure, and the reorganization of the extension and input supply services for prompt delivery of a package of technologies to the over 63,000 farming families within the project area. The project was unique in that in addition to its rural infrastructure development activities, it embarked in 1982, on a collaborative farming systems research project with the Inland Valley Research Group of the International Institute of Tropical Agriculture (IITA), a member of the Consultative Group for International Agricultural Research (CGIAR) located in Ibadan, southern Nigeria.

The aim of the FSR project was to develop a package of prototype technology for rice-production within the rice-based farming system of the inland valleys (Fadamas) spread across the project. Inland Valleys are numerous flat-floored and relatively shallow valleys that occur in undulating plains and plateaus of most African landscapes, whose potential for rice-production has long been recognized (Palada et al., 1987; Andriesse, 1986). The Bida project was selected by the IITA as a representative site for on-farm research into the development of
prototype technologies for rain-fed rice production in Inland Valleys farming systems of West Africa. The collaborative farming systems research project between the Bida ADP and the IITA placed emphasis on on-farm testing of technologies such as improved rice varieties, plant population, weed control, water management, and the use of external inputs such as fertilizer and herbicide (Ashraf and Sinner, 1983). The main focus of this study was to evaluate the impact of the FSR project described above, on the use of technologies by farm households within the project area.

The study of the adoption of agricultural innovations both within and outside Nigeria has attracted a lot of attention in the development literature for decades, because technologies have long been perceived as the key to rapid agricultural transformation in many third world countries. However, most of these past studies have focused on the adoption of technologies under the rubric of the transfer of technology approach and hence have been guided by the classical diffusion model (Atala and Abdullahi, 1988; Daramola, 1988; Brown, 1987; Majidadi and Njoku, 1986; Osuntogun and Adeyemo, 1986; Shiawoye et al., 1986; Balcet and Candler, 1982). The classical diffusion model has characteristically examined the stages through which an individual passes in the process of adopting a new idea, and the role of communication and demographic variables in this adoption-decision process (Rogers, 1983). However, the classical diffusion model has in recent years come under much criticism because of its inadequate modification to suit specific local conditions. Beltrans (1976) contends that the model does not make provision for including the social structure in which innovations are introduced, especially in developing countries.
Another weakness of the model is its assumption that the technologies are good and appropriate regardless of the diversity in farming system constraints facing different cadres of farmers (Chambers and Jiggins, 1987). Bordenave (1976) emphasized the need to understand the diversity of farmers, the economic consequences of innovations and the role of the media in the communication of innovations in developing countries. Chambers and Jiggins (1987) observed that diffusion strategies have focused on the minority, the more progressive, and easily reachable farmers, thus, ignoring the more deprived majority who are isolated and include the poorest of the poor. Hence, the classical model may be inappropriate for explaining the adoption of innovation by resource-poor farmers under the Farming System Research approach.

The literature on the adoption of technology under the FSR/E approach has been limited. McLean (1988), Horton (1986) and Anderson (1985) have all recognized the difficulty of conducting adoption studies under the rubric of the FSR/E approach, because the complex intervening institutional and policy variables that come to play in determining technology dissemination and adoption make it difficult to delineate the impact of FSR/E in the process. Hence most of the impact assessment done to date has concentrated on the institutionalization of FSR/E within the national agricultural research systems of selected countries (Merrill-Sand, Ewell, Biggs and McAllister, 1989).

Purpose of the Study

The main purpose of the study was to assess the impact of participation in Farming Systems Research, access to rural infrastructure and human capital endowment, on the adoption of agricultural innovations by farm-households in the middle-belt region of Nigeria. Specifically, the study set out to analyze the impact
of farm households' level of participation in FSR, their access to rural infrastructure and services, their human capital endowments, and other sociocultural and institutional factors on their adoption of technology in selected villages within a major Agricultural Development Project area in the middle-belt region of Nigeria. In addition, the study sought to evaluate the differential impact of rural infrastructure development and participatory technology development activities on the well-being of the farm-households.

The study was under-girded by the systems theory framework. The systems approach takes a holistic view of the different components (subsystems) that constitute the total farm system. These subsystems are classified as either exogenous or endogenous depending on the degree of control that the farmer has over them (FAO, 1989a). Farm household's technology adoption-decision is conceptualized to depend on the opportunities and constraints arising from the complex interaction among the various subsystems that make up the farming systems (FAO, 1989a; Leagans, 1985; Mosher, 1971). In line with this theoretical framework, the study developed a conceptual model which incorporated relevant elements of the Farm Household Systems model developed by the FAO (1989a) and the interdisciplinary behavioral differential model of farmer response to technological innovations developed by Leagans (1985).

Objectives

The following specific objectives were set for the study:

1. To analyze and describe the important sociocultural, agroecological and intra-household variables impacting the organization of the local farming systems in the area of study.
2. To determine farmers' perceptions regarding the appropriateness of the recommended package of technologies for their farming systems constraints and opportunities.

3. To determine the degree to which the recommended package of technologies for lowland rice, corn, cowpea and sorghum production has been adopted by the farm households within the project area.

4. To analyze and determine important sociocultural, institutional, human capital endowment, and technological variables influencing the level of technology adoption by the farm households.

5. To determine the impact of farmers' participation in FSR on their adoption of technologies for lowland rice production within the inland valleys of the original Bida ADP.

6. To assess the impact of the Bida ADP on the living standards of the farm-households within the project area.

**Research Questions**

1. What are the important sociocultural, agroecological and intra-household variables impacting the organization of the existing farming systems in the area of study?

2. What are the perceptions of the farm households regarding the appropriateness of the recommended package of technologies for resolving their farming systems constraints?

3. To what extent has the recommended package of technologies for rice, corn, cowpea and sorghum production been adopted by the farm households within the project area?
4. To what extent do classical diffusion, institutional constraint and technology-related models predict the levels of adoption of agricultural technologies by the farm-households within the Bida ADP area.

5. Are there any significant differences in the levels of technology adoption between FSR participants and non-participants?

6. To what extent has the implementation of the Bida ADP contributed to the improvement of the living standards of the farm-households within the project area?

General Hypotheses

On the basis of the overall purpose of the study which was to assess the impact of farmers' participation in FSR activities on their adoption of agricultural technologies in lowland rice production, the following general hypotheses were tested:

1. There are no significant differences in the level of adoption of recommended technologies between FSR participants and non-participants.

2. There are no significant differences in the material resource-base of the farm-households before and after the implementation of the Bida ADP.

3. The levels of technology adoption by the farm-households can not be predicted from the differences in their human capital endowment, their access to agricultural support services and perceptions of the innovations' relative advantage and constraints to adoption.

Need for the Study

Most of the past attempts at resolving the agrarian crisis facing Sub-Saharan Africa can be defined in three words "hit, miss and discard". Different models of agricultural development have been tried in the past, some worked and raised
hopes of a major breakthrough in African agricultural development, only to turn to illusion. Such models have then been discarded only to be replaced by another catch-phrase. Hence the pendulum of African agricultural development has been swinging from one extreme to another. The on-going debate in African agriculture concerning the more crucial of the two variables of rural infrastructure development, and the development of appropriate technologies is one that might be crucial in determining the direction in which the pendulum of agricultural development will swing in the 1990s and beyond. While the debate is not a question of a choice of one or the other, it is however imperative for the purpose of priority setting, to examine the issue very critically. Hence this study, by evaluating a major agricultural development project in middle-belt Nigeria, which incorporated both the infrastructure development and the Farming Systems Research/Extension components, provided such vital information.

The enthusiastic response that accompanied the introduction of the FSR/E approach in the early 1970s and 1980s is giving way to a measured withdraw of support from the donor community (Norman, 1989). Coming at a time when many national agricultural research systems (NARS) in the third world countries are just beginning the process of institutionalizing the approach (Merrill-Sands et al., 1989) such a development is likely to have a disruptive effect in many countries especially those with initially weak NARS. In the face of stiff competition for the limited resources available for agricultural development, funding agencies are demanding concrete evidence to justify resources already put into Farming Systems Research activities in order to determine its future direction (Chapman and Castro, 1988). Merrill-Sands et al. (1988) identified two principal ways of doing an impact assessment of FSR/E:
1. **Impact on production in the field**: measured in terms of the extent to which technologies and recommendations developed by FSR are adopted by extension and farmers; and

2. **Institutional impact**: measured in terms of the extent to which FSR has improved research systems' capacity to meet the needs of their clients more effectively and efficiently.

This study was, therefore, set up to meet the research need for an assessment of the impact of participatory research on the adoption of agricultural innovations by resource-poor farmers in the less developed countries.

The national research systems of many African countries are making slow but steady progress towards the institutionalization of the Farming Systems Research approach (Norman, 1989; Merill-Sands, 1988; Collinson, 1988). Concrete evidence justifying the appropriateness of the model for resolving the farming systems constraints facing resource-poor farmers is required to avoid a waste of very scarce research resources. Hence the findings of this study make a contribution towards supplying such information.

A recurring issue in the project approach to agricultural development is the concern with sustainability. Many have contended that the benefits accruable from most projects tend to cease with their completion and the withdrawal of technical personnel (Aboyade, 1990). This same concern has been expressed in connection with the World Bank-assisted ADPs in Nigeria. This concern with sustainability is one of the major foci of this study, hence its relevance to agricultural development in Nigeria.
Limitations to the Study

In interpreting the findings of the study, the following limitations should be borne in mind:

1. The study is subject to the methodological constraints characteristic of most descriptive social science studies: the impracticability of experimental control of relevant variables, and hence the inability to establish causal relationships between independent and dependent variables.

2. The use of a questionnaire as the instrument for data collection is subject to the problem of recall failure by respondents. Secondly, there is also the concern that such studies in reality focus on a static slice of reality with their inability to factor-in the time variable. The study attempted to minimize these limitations through the adoption of a triangulation data collection procedure which included non-participant observation, qualitative focus group interviews and the use of a quantitative interview schedule. The use of verifiable secondary data from the project reports compiled by the Bida ADP and the IITA was very helpful.

Delimitations to the Study

The study was limited to the following factors:

1. Data collection was limited to farm households within the original Bida project enclave and not the expanded Niger State ADP. This delimitation was necessitated by the need to monitor the sustainability impact of the project.

2. Because the IITA’s Farming Systems Research activities within the Inland Valleys were focused mainly on the development of up-stream prototype technology, and not the direct transfer of technology to farmers (Spencer, 1991) it was not the purpose of the study to blame the non-adoption of technologies
on the IITA. It should also be borne in mind that technology transfer usually involves a host of complex intervening variables and institutions (Anderson and Herdt, 1988) which makes it often impracticable to blame non-adoption on a particular institution.

Operational Definition of Terms

The study was conducted using the following operationally defined terms:

1. **Adoption**: Measured for continuous technologies, such as improved seeds and fertilizer, in the quantitative term of the quantities applied, and the proportion of cropped land on which the technologies are being applied. For discrete technologies such as water management, herbicides and insecticides, adoption was measured as a dichotomous variable- "adopted" or "not adopted".

2. **Continuous technologies**: Those innovations that produce a response over a range of values. e.g. fertilizers and improved seeds.

3. **Discrete or discontinuous technologies**: Innovations whose responses are either of the "none or all" type, e.g. water control channels, mechanization, herbicides etc.

4. **Appropriateness of technologies**: Measured subjectively from farmers rating of the comparative advantages of modern varieties over traditional varieties and/or the degree to which the farmers perceive the technologies to address their farming systems constraints.

5. **Age**: Age of farmers at the time of the survey.

6. **Education**: Defined as the number of years of formal education the farmers had at the time of the study.
7. **Farm size:** Defined as the total acreage of land cultivated by the farmer during the last cropping season.

8. **On-farm research participants:** Farm household heads who were directly involved as cooperating farmers in the Farming systems Research projects of the IITA, Bida ADP and the NCRI within the last ten years.

9. **"Efako" family unit:** An extended farm household unit in which the most senior male is the head, incorporating the household head's wives, his married sons and their families, his unmarried sons and daughters into an agricultural production and a consumption unit.

10. **"Gucha" unit:** An agricultural production unit in which individuals own and manage their individual farms to meet their individual and/or nuclear family needs. Some individuals may cultivate their own "Gucha" farm units while still maintaining their membership in an "Efako" unit.

11. **Inland valleys (Fadama):** Inland Valleys are numerous flat-floored and relatively shallow valleys that occur in undulating plains and plateaus of most African landscapes, with a lot of potential for lowland rice production.

12. **Extension contact:** The number of times during the last twelve months, when the respondents had contact with an extension agent to discuss their agricultural problems.

13. **Access to input:** The distance in miles between the respondents and the nearest functional farm service center for input distribution.

14. **Access to market:** The distance in miles between the respondents and the nearest agricultural produce market.

15. **Access to credit facilities:** The amount of credit (in Naira) obtained by the farm-households during the last twelve months.
16. **Accessibility**: The distance between the respondent's residence and the administrative headquarters.

17. **Access to irrigation**: Respondents who operated within one of the two major irrigation schemes within the project were designated as having access to irrigation facilities.

18. **Family size**: The number of individuals who constitute part of the consumption and production farm-household unit.

19. **Labor**: The proportion of the consumption components of a farm-household that is available for productive work on the family's farm.

20. **Income**: The annual income of the farm-household's head.

21. **Social participation**: The number of local farmer organizations to which the respondents belong and participate actively in, e.g., farm cooperatives, labor pool etc.

22. **Communication characteristics**: The frequency with which the respondents listen to agricultural programs through the radio, the television, extension bulletins and agricultural shows.

23. **Technology cost**: Respondents' perceptions regarding the degree to which cost was a constraint to the adoption of recommended technology.

24. **Availability**: Respondents' perceptions regarding their access to recommended agricultural innovations.

25. **Relative advantage**: Respondents' perceptions regarding the degree to which recommended modern varieties are superior or inferior to local varieties in terms of yield, taste, profitability, cooking quality, insect pests, disease and weed resistance.
26. **Complexity:** Respondents' perceptions regarding the degree of difficulty involved in implementing recommended innovations within their farming system.

27. **Compatibility:** Respondents' perceptions regarding the degree to which a recommended technology was adaptable to their farming systems constraints and opportunities.

28. **Farm-household's Welfare:** The welfare impact of the project on the farm households was measured using the proxy variables of changes in farm-households' possession of durable goods before and after the implementation of the project. The items included cars, motorcycles, bicycles, iron-roofing, watches, radios, televisions, milling machines, iron beds, wooden beds, wall clocks, granaries, farm machinery, sprayers, and livestock.

29. **International Institute of Tropical Agriculture (IITA):** A member of the Consultative Group of International Agricultural Research Centers (CGIAR), founded and located in Ibadan Nigeria since 1967, with global and regional mandates for the improvement of tropical crops such as cassava, lowland rice, cowpeas, corn, etc.

30. **Farming Systems Research/Extension:** A participatory approach to agricultural development in which agricultural scientists from different disciplines work together within an interdisciplinary team framework and in close collaboration with farmers, which the purpose to diagnose farmers' farming systems constraints and develop appropriate solutions.

31. **Systems-blame:** A process of blaming institutional failure rather than farmers' conservatism (individual-blame), for the non-adoption of recommended agricultural innovations.
CHAPTER II. LITERATURE REVIEW

The main purpose of the study was to determine the impact of farmers' participation in FSR, their access to rural infrastructure and agricultural support services, their human capital endowments, and other sociocultural and institutional factors on the adoption of a recommended package of technology by farm households in selected villages in the middle-belt region of Nigeria. The purpose of this chapter was to lay out the theoretical and empirical framework that undergirded the organization of the study. This review of literature is organized under the following sub-headings:

1. Analysis of the failure of the modernization paradigm of agricultural development among resource-poor farmers in the less developed countries of the world.


3. A review of past adoption studies under the rubric of the classical innovation-diffusion model and the need for an appropriate innovation adoption model for resource-poor farmers.

4. The development of the theoretical/conceptual model that undergirded the present study.

The Modernization Paradigm of Agricultural Development

Most of the agricultural development assistance in the 1960s was predicated on the assumption that the wide agricultural productivity gap between the developed and the less developed countries (LDCs) could be attributed to the low level of technology application, by what were then perceived, as irrational tradition-
bound peasant farmers in the latter (Hayami and Ruttan, 1971). Agricultural
development assistance in the 1960s and 1970s was therefore, conceptualized
within a dualistic theory of development which perceived the solution to the
problem of low agricultural productivity as depending on the direct transfer of
modern agricultural technologies from the developed countries to the LDCs. This
approach, as encapsulated in the Green Revolution of the late 1960s and early
1970s, brought tremendous yield increases among many resource-rich farmers in
Asia and Latin America (Chambers and Ghildyal, 1985). However, in most of Sub-
Saharan Africa and some parts of Asia and Latin America, where millions of
resource-poor farmers face harsh agro-ecological and institutional constraints
different from those that characterize the research stations in which the innovations
were developed, Green Revolution technologies were not only poorly adopted, but
led to serious distributional and social consequences (Chambers and Ghildyal,
1985; Evans et al., 1979).

For a long time the non-adoption of "improved" technologies by resource-
poor farmers was attributed by social scientists and other development experts, to
the low level of education of farmers, their penchant for traditionalism and their low
level of innovativeness. For instance, Manual (1960), observed that rural
development in the LDCs were doomed to failure from the beginning because the
peasant would resist any attempt to introduce innovations that interfered with
commonly accepted practices and procedures. Hence, most social science
research on the adoption and diffusion of innovations in the developing countries
in the 1960s assumed that the technologies were good and appropriate
(Chambers and Ghildyal, 1985). It was also assumed, in the tradition of the
classical diffusion paradigm, that the distribution of adopter categories followed the
normal bell-shape, and that with the demonstration effect of the benefits of innovation adoption by innovators and early adopters, technologies would trickle-down to the late majority and laggards whose psycho-social characteristics were perceived as the hindrance to innovative behavior (Rogers, 1983).

However, the failure of many agricultural development projects in the 1960s and 1970s to bring about this trickle-down technology transfer effect led to a reexamination of the appropriateness of the classical innovation-diffusion paradigm to the diverse and constrained agro-ecological conditions under which the majority of the agricultural producers in the LDCs operate (Chambers and Ghildyal, 1985). Another impetus for change came about when the experiences of many social scientists and agronomists involved in agricultural development in the LDCs began to demonstrate that resource-poor farmers were not only efficient allocators of resources, but were involved in continuous experimentation to improve their farming systems (Schultz, 1964; Hopper, 1965; Norman, 1969; Moseman, 1970; Biggs, 1980; Chambers and Ghildyal, 1985 and Richards 1985). For example, Biggs (1980), after extensive study in Bangladesh and Bihar concluded that the failure of farmers to adopt new technological “packages” entirely may be a sign of creativity rather than backwardness. He noted that in Bangladesh and Bihar, the traditional rice varieties and bamboo tubewells outperformed the new rice varieties and the steel tubewells introduced by change agents; hence, their non-adoption was a wise decision.

Norman (1969), also came to the same conclusion regarding the failure of cotton farmers in Northern Nigeria to adopt an “improved” cotton production package recommended by scientists. Although this cotton package gave a net return per acre that was 110 percent above the traditional practice, it required
inputs such as fertilizers, pesticides and a radical change in farmers' cropping patterns that were incompatible with the farmers' farming systems. Such experiences in many parts of the globe, especially in the late 1960s and early 1970s, demonstrated the inadequacy of the "individual-blame" approach of the classical diffusion model for the explanation of the innovation adoption process in the LDCs.

This paradigm shift of the early 1970s led to a search for new models of development in the LDCs. For instance, the World Bank embarked on a refocus of development assistance from purely industrial projects to an accommodation of integrated rural development projects geared towards meeting the development needs of the rural poor who had been left out of the development loop of past trickle-down models (McNamara, 1973). Other issues such as growth with equity, appropriate technology, sustainable development and participatory development began to attract greater attention in the development literature. There was also an increasing realization that the key to sustainable agriculture development in the LDCs lay in a small-holder development strategy.

Bergtsson (1983) identified three schools of thought that emerged in the 1970s in an effort to explain the failure of past development approaches and to develop new models of development. One school of thought, the Farming Systems Research/Extension perspective, contended that the failure of past development projects could be largely attributed to the inappropriateness of available technologies for the peculiar agroecological, socioeconomic and cultural environments in which resource-poor farmers operate. It was the contention of proponents of this model of agricultural development that technologies are not value-free, that they bear the imprint of the agroecological and socioeconomic
milieu from which they evolved, and are therefore adoptable mainly in environments that are similar to that in which they were developed (Aboyade, 1991; Chambers and Ghildyal, 1985; Matlon and Spencer, 1984; Biggs, 1980; Norman, 1969). Hence the solution to the problem of low technological application in the LDCs was conceptualized within a participatory approach to technology development, the Farming Systems Research/Extension, in which resource-poor farmers play an active role in the development process.

The second school of thought, which was predicated on a structure-function theoretical framework, argued that the major impediment to agricultural development in the LDCs is not so much the absence of appropriate technologies, but the absence of an enabling rural infrastructure and other agricultural support systems, necessary to stimulate rapid technology adoption (World Bank, 1986; Yudelman, 1987). This structure-function argument under-girded most of the integrated agricultural development projects implemented in many LDCs in the 1970s and 1980s, with major funding from the World Bank. These projects involved huge investment in rural infrastructure development, the reorganization of the extension systems along the Training and Visit (T & V) model and the diffusion of a Green Revolution-type package of agricultural technology (Blackwood, 1987).

The third school of thought, emanating from the political-economic perspective of dependency/critical theory, blamed the poor state of agricultural development in the LDCs on inequitable distribution of social and political power, and the incorporation of the rural economy into an unjust local and international market system (Stanvenhagen, 1969; de Janvry, 1977). The theory of unequal exchange was propounded to describe the exploitation of the "periphery" by the "center". The exploitation of the peasantry was identified to occur at international,
national and local levels. At the global level, they identified the extraction of surplus from the LDCs (the periphery) for transfer to the developed countries (the center). Government pricing policy which keeps food prices low for the urban elites (the center) to the detriment of the rural poor (the periphery) is also identified as a disincentive to increased production; while at the local level, similar levels of exploitation exist between the resource-poor farmers and the resource-rich absentee landlords who charge exorbitant rents. From this theoretical framework, de Janvry (1977) developed a structuralist model of technology transfer. The model posits that the supply of research is filtered through the socioeconomic structure, and as a result, produces specific pay-off for different social groups. This consists of particular interest groups in society—resource-rich commercial farmers and resource-poor subsistence producers—who derive income gains or losses from improved agricultural technology. He argued that the relative social power of different socioeconomic groups determines who participates in the technology development process and, as a consequence, whose constraints and concerns are addressed by agricultural research (de Janvry, 1977). Hence the non-adoption of technologies by resource-poor farmers is explained within an institutional/structural constraint model.

Although, the major focus of the study was to evaluate the impact of the FSR/E approach on technology adoption by farm-households, elements of the two other approaches, the infrastructure development and the critical perspectives were included. Because the study was carried out within a major Agricultural Development Project in middle-belt Nigeria, which had a major infrastructure development component, the study included an evaluation of the impact of differential access to rural infrastructure and other agricultural-support services, on
the adoption of agricultural technologies by the selected farm households. Also in line with the critical perspective, the distribution of the project's benefits and farmers' participation in FSR activities were disaggregated along socio-economic status and gender parameters.

An Analysis of Farming Systems Research/Extension Approach to Technology Transfer

The Farming Systems Research/Extension approach emerged in the 1970s, as a response to the perceived failure of the classical transfer of technology approach (TOT) to stimulate technology adoption among resource-poor farm households in the LDCs. The general feelings in agricultural development circles during the early 1970s and 1980s, was that conventional agricultural research methodology, which relied solely on on-station research, was producing agricultural technologies that were only appropriate for resource-rich farming systems that approximated the conditions under the research station (Chambers and Jiggins, 1987). Hence, it was contended that millions of resource-poor farmers who constitute the bulk of agricultural producers in the LDCs were being left out of the development loop. The resource-poor farmers, who Chambers and Ghildyal (1985) defined as those whose resources of land, water, labor and capital do not currently permit a decent and secure livelihood, constitute the majority of farmers in most developing countries. The FSR/E approach seeks, through on-farm research and associated extension activities, to test, adapt and integrate, and disseminate new technologies for adoption by resource-poor farm-households, whose interest had been poorly attended to under the Transfer of Technology model. The specific goals of FSR/E were stated by Dillon, Plucknett, and Vallaey (1979, p. 17); and Plucknett (1987) as follows:
- To understand better the problems and needs of farmers, especially farmers with small amounts of land or land located in marginal environments.
- To improve the efficiency of the agricultural research process by focusing research on the problems and needs of farmers, and by developing improved technology.
- To assess the interaction among technologies and between technologies and the environment, thereby improving the relevancy and appropriateness of new technologies.
- To facilitate communication among farmers, researchers, extension agents and representatives of other agricultural support institutions.

In his analysis of FSR/E, Brynes (1990, pp. 10-12), identified the following as its characteristics: it is farmer-oriented; involves the active participation of the clientele; a recognition of the location specificity of technical and human factors; a problem-solving and systems orientation; the involvement of an interdisciplinary team; and, an emphasis on research-extension-farmer linkages. While there exists many variants of the FSR/E approach, a typical FSR/E model is characterized by the following sequences of activities: (i) selection of target homogeneous recommendations domain and research area, (ii) identification of farming systems constraints and development of a research base, (iii) planning on-farm research, (iv) on-farm research and analysis, and, (v) extension of appropriate technologies. Each of these five activities should involve the active participation of the farm-households, working with a multi-disciplinary research team (Shaner et al., 1981).

The FSR/E approach generated so much confidence that by the mid 1980s, literally hundreds of projects purporting to be using the approach were being implemented in the LDCs. For instance, Anderson (1985) estimated that close to
15% of the total budget of the International Agricultural Research Centers (IARCs) was being devoted to FSR activities, while many National Agricultural Research Programs in the third world were also committing a substantial proportion of their budget towards FSR/E activities. The IARCs were in the forefront in promoting the institutionalization of the FSR/E perspective into the national agricultural research systems of the LDCs. In Sub-Saharan Africa, where resource-poor farmers are confronted with a myriad of socioeconomic, institutional and ecological constraints, and with most National Agricultural Research and Extension Systems both under-funded and ill-equipped in terms of manpower and material resources, efforts to institutionalize the FSR/E approach have proved an uphill task (Merrill-Sands et al., 1990, Jahnke et al., 1987). As a result of the low capacity of many National Agricultural Research Systems (NARS) to conduct down-stream adaptive on-farm research with the prototypes of technologies emanating from the IARCs, many IARCs had to get involved in these type of research activities (Jahnke et al., 1987).

The International Institute of Tropical Agriculture (IITA), located in Ibadan, Nigeria, was the first of the IARCs established in Africa. Its mandate includes worldwide research responsibility for cowpea, yam, cocoyam, and sweet potato improvement; and regional responsibility for cassava, rice, maize and soybean improvement in Africa. As part of its mandate for the development of technologies appropriate for rice-production in the lowland inland valley farming systems spread across West African landscape, the Inland Valley Farming Systems Research Group, at the IITA, set up two on-farm research sites, one located in Bida, in the middle-belt region of Nigeria and the other in Makeni in Sierra Leone, to carry out on-farm adaptive research. The IITA's Farming Systems Research activities in the inland valleys have focused on three broad objectives: (1) the development and
testing of on-farm research methods adapted to the farming systems of the humid and sub-humid regions of Africa; (2) dissemination of these methods through training and cooperation with on-farm research of national agricultural research centers; and (3) testing of IITA's technologies under farmers' conditions in a range of ecologies and systems, assessing their adaptability and identification of new research needs (Spencer, 1991; Palada et al., 1986). The study was carried out within the original Bida ADP where the IITA has been implementing a FSR project for the development of technology for lowland rice production in the inland valleys for over ten years. Hence, one of the objectives of the study was to assess differential innovation adoption between FSR participants and non-participants.

After two decades of the implementation of FSR/E projects and hundreds of millions of dollars in financial commitments, the approach has recently come under intense criticism from both theoretical and methodological perspectives. Norman (1989) observed that twenty-five years after its over-enthusiastic acceptance, the challenge to FSR/E in the 1980s was the dilemma of accountability, and the measured withdrawal on the part of donor agencies just when many national programs were in the process of institutionalizing the approach. In a strong criticism of the theoretical foundation of the FSR/E approach, Marcotte and Swanson (1987) noted that like the top-down Transfer of Technology approach FSR/E has its theoretical roots in structural functionalism and, hence, it is subject to the promise and limitations of the modernization approach. They condemned its technological deterministic orientation, observing that other past attempts, over the last three decades, that have attempted to offer purely technical solutions to fundamental socioeconomic and political problems have failed to reduce human misery, poverty, starvation and social inequalities (Marcotte and Swanson, 1987).
They, therefore, concluded that FSR by itself without proper articulation within the larger political economy fails as a development strategy. Similar opinions have been expressed by Davidson (1987), and Haverkort et al. (1988). For instance, Davidson (1987) contended that if FSR is to fully develop into a viable agricultural development strategy, it must incorporate policy issues that are informed by extension activities. He also observed that FSR/E needs to be undertaken not merely as a technical exercise, but as the social interactions and contradictions occurring between the various elements involved in the agricultural development process, namely, farm households, the state, regional research centers and international agencies. Failing this, Davidson (1987) contends that FSR runs the risk of joining other corpses of development acronyms.

The implementation of farmers' participation, the core of FSR/E, has received much criticism (Worman et al., 1991; Sumberg and Okali, 1988; Byerlee and Tripp, 1988; Haverkort et al., 1988; Farrington and Martin, 1987; Ashby, 1986; Heineman and Biggs, 1985; Chambers and Ghildyal, 1985). Sumberg and Okali (1988) observed that many FSR/E projects were nothing more than the on-farm validation and demonstration of technologies already developed and evaluated on experiment stations without farmers' input. Hence, farmers' participation in the technology-development process is often reduced to the supply of the plots and the labor for the validation of technologies.

Heineman and Biggs (1985) also observed that FSR/E is being adopted by both national and international research institutes as a universal panacea, and in the process many of its qualities have been lost, the most crucial being farmer participation. FSR/E has therefore become a technological package that is imposed upon existing informal and formal structure rather than being developed
within them. While, in principle, FSR/E is predicated on the active participation of farmers in the technology development process, the reality in many field experiences is the lack of congruence between the highly centralized, top-down institutional structure in many research-extension systems, and the bottom-up, decentralized structure germane to the implementation of FSR/E (Byerlee and Tripp, 1988). It is charged that, unless these institutional rigidities are overcome, the promise of FSR/E in facilitating sustainable agricultural development in developing countries will remain suspect.

Biggs (1989) summarized the four distinct modes of farmer participation observed during the ISNAR's nine-country case studies of the institutionalization of On-Farm Clientele-Oriented Research approaches as follows: (i) Contract participation, in which farmers are mostly passive, with their participation often limited to providing scientists with land, labor and services, while the researchers take the commanding role in the implementation of trials. (ii) Consultative participation, likened to a doctor-patient relationship. Emphasis is placed on the use of formal and informal surveys in order to diagnose farming systems constraints and possibilities, and to adapt technologies to farmers' socio-economic and agroecological situations. Farmers' participation is therefore often mainly confined to the diagnosis and technology evaluation phases. (iii) Collaborative participation involves collaborative activities between researchers and farmers in setting research priorities, developing and monitoring technological solutions on a continuous basis. (iv) Collegiate participation: Emphasis is on empowering farmers to carry out research on their own, feeding back to formal research systems for information and services. Based on the findings of the case studies,
Biggs (1989) concluded that the contract and consultative participation modes predominated in many FSR/E projects.

Another major issue that has attracted research attention is the role of extension in FSR/E (Ortiz and Meneses, 1991; Landeck, 1991; Ewell, 1989; McDermott, 1987; Johnson (III) and Claar, 1986; Kellogg et al., 1983). Kellogg et al. (1983) observed that the implicit assumption in many FSR programs is that once farmers play an active role in the development and validation of technology, that they will spontaneously adopt them with little or no extension intervention. Hence in many FSR programs, extension education activity is either perceived as dispensable or incorporated as an add-on program after on-farm validation of technology (Kellogg et al., 1983).

The fallacy of such an assumption of spontaneous adoption has, however, been recognized in past studies (Ortiz and Meneses, 1991; Ewell, 1989; Johnson and Claar, 1986; Kellogg et al., 1983). Ewell (1989) for instance, observed that while the direct link between farmers and researchers through on-farm research contributes to the development of relevant technology, it is not a substitute for technology transfer. He therefore concluded that for FSR to achieve its objective of facilitating technology adoption by resource-poor farmers it must establish three complementary and partially overlapping sets of links: between researcher and farmers; between on-farm and on-station researchers and, between researchers and technology transfer workers (extension). It is observed, that while many NARS in the LDCs are shifting towards a FSR approach with emphasis on participatory on-farm research, their extension organizations are still utilizing for the most part, a one-way technology centered mode of operation (Johnson and Claar, 1986).
In spite of numerous criticisms, the FSR/E approach has been credited with major successes in the LDCs. Otiz and Meneses (1991) credited a collaborative FSR/E project between the International Center for Tropical Agriculture (ICTA), and the Guatemalan extension system - the DIGESTA, with following positive results:

1. A total of 50,000 farmers from five regions reported using new technology transferred by the project within three years.
2. Over 21,000 farmers obtained new seed varieties from the seed production and distribution centers established by the extension system.
3. An estimated increase of 16,200 metric tons of food crops, enough to cover the annual needs of slightly over 26,000 farm families, was recorded in 1989.

In conclusion, Ortiz and Meneses (1991) observed that the Guatemala case-study demonstrates that the collaborative involvement of a national agricultural extension institution working with a research system in on-farm research is a positive strategy for stimulating rapid agricultural development. In another example, Worman et al. (1990) reported how a shift from researcher-dominated to a more collaborative researcher-farmer-extension participation mode in the Agricultural Technology Improvement Project - (ATIP), jointly funded by the United States Agency for International Development (USAID) and the Botswana government, yielded positive results. In a comparative analysis of the two modes of participation, researcher-dominated and research-extension-farmer collaborative participation modes, the latter was credited with the following positive results (Worman et al., 1990):

1. Increased group participation from just 12 in 1985-86 to 130 members in 1987-88.
2. Increase in number and variety of trials from 12 trials of one technology to over 150 trials of over 12 technologies in 1987-88.

3. In a 1989 survey of 165 farmers who had participated in trials over the last four years, 25.9% indicated at least adopting a new technology outside the project trial location. Such spontaneous adoption ranged from 17-42% of respondents in each village sampled.

4. Increased interest by on-station researchers in on-farm testing.

5. An increase in the number of extension-led farmer testing groups.

In conclusion, Worman et al. (1990) observed that participation for sustainability would have to involve farmers from the outset of research planning to the adaptation of this research to various ecological situations in which farmers operate.

In an evaluation of the USAID’s field experience with the implementation of the FSR/E approach, Brynes (1990) identified the following as constituting the major constraints limiting the contributions of FSR/E towards sustainable agricultural development in the LDCs: (1) Lack of a problem-solving approach; (2) Lack of effective collaboration across disciplines; (3) Weak research-extension-farmer linkages; (4) Lack of consensus on methodology for FSR/E; (5) Lack of stakeholder understanding of FSR/E; (6) Lack of agricultural policy and strategy defining FSR/E’s role in research and extension; (7) Lack of adequately trained manpower to implement FSR/E; and (8) Inadequate funding from government to meet recurrent costs of FSR/E.

The purpose of this study, therefore, was to evaluate the impact of FSR/E on the adoption of innovations by resource-poor farmers in Nigeria and on the improvement of their standard of living.
Review of Past Innovation-Adoption Studies in the LDCs

The study of the innovation-adoption process has attracted a lot of attention in agricultural development literature for decades, because improved technologies are expected to play a crucial role in the transformation of the third World's agriculture (Feder et al., 1985). As a result of this great interest, different disciplines have developed different models to explain the process through which agricultural innovations get adopted by farmers. For instance, while sociologists and geographers have focused on the impact of communication, sociocultural and psychological variables in explaining the pattern and rate of innovation diffusion over time and space (Rogers, 1983; Hagerstrand, 1967; Lionberger, 1960); economists have been concerned with the development of economic deterministic models, to analyze the impact of economic variables such as the cost and profitability of innovation, farmers' risk-averseness, availability of labor, and the general resource-base of the farm firm on the rate and intensity of technology adoption by farmers (Griliches, 1957; Ruttan and Hayami, 1971). Political-economists, on the other hand, have emphasized the role of class conflict, differential access to political and financial powers, and other institutional and structural constraints in determining the rate and pattern of innovation adoption (Busch et al., 1989; Shaw, 1987; de Janvry and Van Der Veen, 1983; de Janvry, 1977).

In their evaluation of past adoption studies in the LDCs, Herdt and Capule (1983) and Shaw (1987) observed that most past adoption studies have adopted the classical innovation-diffusion paradigm. The model defines adoption as the mental process an individual passes through from first becoming aware of an innovation until final adoption-decision is made (Rogers, 1983; Rogers and
According to Shaw (1987), the primary objective of the model has been to understand how sociocultural and economic characteristics of the adopters create a spectrum ranging from innovators to laggards, and how these characteristics determine the means of communication that are most effective in accelerating diffusion. Hence most studies about the innovation-adoption process in the 1960s and 70s were under-girded by the following assumptions: (1) that the innovations were good and appropriate for the receiving social system, and hence its adoption would enhance the socioeconomic well-being of the farmers; (2) that making people aware of innovations would lead to attitudinal change that was conducive to the acceptance of new ideas; (3) that non-adoption could be attributed to sociocultural and material constraints that prevented farmers from innovating, and subsequently from advancing socially and economically; and (4) that individuals had equal access to the innovations (Shaw, 1987). Three broad categories of adopters' characteristics have been identified in past studies, as being important to the innovation-adoption process; they include: socio-economic, personality, and communication variables.

Under the socioeconomic dimension most past studies have focused on such farmers' characteristics as level of education, farm size, extension contact, family size, tenure arrangement, and their resource base as crucial in determining where an individual falls along the innovator-laggards spectrum (Rogers, 1983). While some studies have reported contradictory findings, most past studies have found the following socio-economic differences between early adopters and late majority or laggards: early adopters tend to be more educated, have higher socio-economic status, farm larger holdings, own their land, and have access to more capital, than non-adopters (Hossian and Crouch, 1992; Polson and Spencer, 1990;
Igodan et al., 1988; Feder and Slade, 1984; Balcet and Candler, 1982). For instance, Ezeh and Unamma (1989), in their study of the adoption of cassava-maize production technology by small-holders in Southeastern Nigeria reported that adoption was related to farmers' age, level of education, membership in social organizations and access to production inputs.

Similar findings were reported by Hossian and Crouch (1992), in their study of the pattern and determinants of the adoption of ten recommended practices by opinion leaders and their followers in Bangladesh. Using a combination of chi-square, Pearsons correlation and multiple regression analysis, and measuring adoption as the proportion of the total recommended practices being used by the farmers, they reported that age, formal education, farm size, family background, social participation, exposure to mass media, and cosmopolitanism were all positively related to the level of adoption of the respondents (Hossian and Crouch, pp. 11-13). However, only three variables, farm income, cosmopolitanism and family background, were the best and significant predictors of adoption with a multiple regression analysis.

However, other studies of the role of socioeconomic variables in the adoption process have not always yielded consistent results (Schutjer and Van Der Veen, 1977; Schluter, 1971; Bohlen, 1967). For instance, Schluter (1971) reported an inverse relationship between farm size and proportion of acreage under high yielding varieties (HYV) in the case of rice, bajra, maize and jowar in India. Similar findings have been reported elsewhere. Muthiah (1971), Sharma (1972), and Van Der Veen (1975), all in India, reported similar findings. Alivar (1972) reported no significant difference in the adoption of tractor usage in the Philippines between small and large-scale producers. Polson and Spencer (1990) reported a negative
relationship between farm size and innovation adoption in Southwestern Nigeria. This inconsistency led Schutjer and Van Der Veen (1977) and Feder et al. (1985) to conclude that the relationship between farm size and technology adoption was complicated by the lumpiness (divisibility) of the technology, its labor requirement, the farmers' social status and human capital endowment, and their risk preference; all of which can act as intervening variables in determining the relationship between farm size and technology adoption.

Similar inconsistent findings have also been reported regarding the impact of tenure status and age on the adoption of innovation (Polson and Spencer, 1990; Osuntogun et al., 1986; Moock, 1981; Nulty, 1972; Muthiah, 1971). For instance, Osuntogun et al. (1986) concluded that the relationship between farmer's age and adoption was not clear cut; he observed that while on the one hand, older farmers because of their experience are expected to be better able to appreciate the benefits of improved technologies; on the hand, old age is often associated with increased conservatism, a characteristic not supportive of innovative behavior.

The application of the classical innovation-diffusion model to the study of agricultural technology transfer in the less developed countries has attracted a lot of criticism (Merrill-Sand, 1986; Shaw; 1987; Helleiner, 1977; Myren, 1974). It is contended that while the classical diffusion model has made great contribution to our knowledge about the innovation-adoption process, it is limited by its assumption of an individual-blame bias. The assumption is that the main constraint to innovation-adoption is neither within the technology itself nor within the system, but the psycho-social characteristics of the respondents which are regarded as not conducive to innovative behavior (Rogers, 1983). Little, if any emphasis, is placed on either the appropriateness of the technology or on institutional constraints as
major determinants of innovation-adoption. Beltrans (1976) contended that the model does not make provision for including the social structure in which innovations are introduced, especially in developing countries. Helleiner (1977) also concluded that empirical results of innovation adoption studies in Africa do not fit easily into the diffusion theoretical framework. Another weakness of the model is its assumption that the technologies are good and appropriate, regardless of the diversity in the farming system constraints facing different cadres of farmers. Hence, Bordenave (1976) recommended the need to understand the diversity of farmers, the economic consequences of innovations, and the role of the media in the communication of innovations in developing countries.

Chambers and Jiggins (1987) observed that diffusion strategies have focused on the minority, the more progressive, and easily reachable farmers, while it ignores the more deprived majority, which is isolated and include the poorest of the poor. Shaw (1987, p. 6) also concluded that the preoccupation of past innovation-adoption studies with individual modernization variables, along with mass communication exposure and various types of communication behavior, at the expense of institutional and structural variables, tend to show that a few privileged farmers who own large amounts of land, enjoy high socioeconomic status and are exposed to mass media and extension education most readily adopt new agricultural technologies. As a result of the perceived inadequacy of the classical diffusion paradigm for explaining the innovation-adoption process in the LDCs, Havens (1975, p. 105) recommended the development of alternative systems-blamed approaches in the analysis of the failure of past agricultural development efforts. He noted that:
The reason for the failure of technology to bring about widespread changes in the peasant societies is that the most important obstacles to rural change, e.g., the social structure of land tenure, of political participation, of economic segregation, inequitable distribution of wealth, of services, of legal privileges and of rights, have all too frequently been overlooked (Havens, 1975, p. 105).

This paradigm shift in the study of the adoption and diffusion of agricultural innovations in the LDCs became evident in the late 1970s and 1980s, when many studies began to reflect the infusion of a systems-blame approach to the explanation of the non-adoption of innovations (Shaw, 1984; Lipton, 1978; Schulter, 1974). Issues such as the appropriateness of recommended technology to the agroclimatic and socioeconomic conditions of the farmers, access to institutional support in terms of input supply, market, rural infrastructure, credit and extension services, began to be factored-in, in addition to traditional farmer-based variables, in the explanation of differential adoption of innovation in the third world countries.

Institutional and Structural Constraint Model of Innovation Adoption

Shaw (1985) in his study of the adoption of recommended rice production technologies in Guyana adopted an institutional constraints model which incorporated institutional, structural, and farmer's personal and communication characteristics. The primary source of data for the study came from a survey of 125 rice farmers in 24 villages along the Essequibo Coast of Guyana. In a multivariate adoption model, the level of adoption of recommended innovation was hypothesized to be dependent on the following variables: access to, and quality of water control facilities provided by government institutions, access to institutionalized credits, farmers perceptions regarding the sources of credits, amount of credit obtained in the past four years, farm size, level of income,
ownership of farm equipment. Also included were farmer's personal and communication characteristics including, age, number of years of farming experience, family size, level of education, number of visits to demonstrations, and number of contacts with extension agents (Shaw, 1985, p. 32). Using discriminant analyses, Shaw (1985) reported the following findings:

1. **On the impact of personal and communication variables on adoption:** While visits to demonstration plots and extension contacts positively influenced innovation adoption, other variables such as years of formal education, years of farming experience, farmer's age, and family size did not produce statistically significant relationships with the adoption of innovation.

2. **On institutional and structural variables:** The result of the study showed that these factors were more effective in distinguishing the three categories of cultivators, namely non-adopters, non-irrigated adopters and irrigated adopters. Four variables were found to be significantly and cumulatively linked to the adoption of new rice varieties. They included frequency of crop failures, amount of purchased inputs (a proxy for farm income), access to machinery and water control. Factors such as farm size, equipment owned by farmers, numbers of pairs of oxen owned and farm fragmentation were moderately related to adoption.

Similar findings have been reported in other parts of the LDCs (Shakya and Flinn, 1986 (Nepal); Jansen et al., 1990 (India); Tautho et al., 1985 (Philippines)). In their study of the spread of modern varieties of coarse cereals in ten states in India, Jansen et al. (1990) defined adoption as the proportion of total area of a given cereal planted to modern varieties. Using secondary data, the study sought to analyze the impact of infrastructure and agroclimatic variables in determining the
rate and intensity of variety adoption in ten states of India between 1966/67 and 1983/84. Infrastructure variables considered included use of irrigation, access to fertilizer, markets, credit, extension services and roads. Three models were developed, namely an infrastructure model, an agroclimatic model and a combined or mixed model consisting of both infrastructure and agroclimatic variables. They found that, while the infrastructure model was statistically significant within the single model frame, its impact faded into insignificance in the combined model, with the agroclimatic variables having higher explanatory power. Jansen et al. (1990) identified the problem of multicollinearity between agroclimatic and infrastructure as the probable cause of the result, because infrastructure investment tends to be biased towards areas with favorable agroclimatic conditions.

In another study of the technical and economic factors predictive of the adoption of rice-production technologies in the Philippines, Tautho et al. (1985), using a probit model and data collected from 174 farmers, reported that only institutional and structural variables such as farm size, landscape position, fertilizer availability, cooperative membership and extension contact were significantly related to the adoption of innovation at the 10% level of probability. However, human capital variables such as education, tenure and size of family labor force were not significant.

Few studies have been conducted in Nigeria using the institutional and structural constraint model to explain the adoption of innovation (Daramola, 1988; Osuntogun et al., 1986). In a study of 122 farmers, Daramola (1988) developed a multiple regression model to analyze the impact of farmers' socioeconomic characteristics and institutional variables on the adoption of food production technologies by participating and non-participating farm households in the Oyo
state Agricultural Development Project. The mean age for the sample was 51 years, mean years of schooling was 3.5 years with 62% of the respondents having zero year of formal education, mean household size was 10, mean farm size was 3.1 hectares, and mean farm income was N1,983 (approximately $100.00). Adoption of recommended practices was selective and partial, with only 31% of the respondents adopting up to 50% of the recommended practices. Agrochemicals such as insecticides and herbicides had low adoption rates. Of the 13 independent variables included in the regression model, only farm income, distance from source of farm inputs, amount of credit available and distance from produce markets were significant, while frequency of extension visits and membership in cooperative societies were not.

In another study of the adoption of recommended rice-production practices, among a sample of 150 selected farmers in Imo state of southeastern Nigeria, Osuntogun et al. (1985) developed both linear and logarithmic multiple regression models to assess the determinant of innovation adoption. They reported the following adoption rates for the technologies: 54% of the respondents adopted improved rice varieties; fertilizer (57%); correct crop spacing (65%); irrigation bunds (51%); insecticides (43%); and herbicides (46%). The most frequent reason for adoption was direct extension contact, while non-adoption was blamed on lack of awareness, high cost, lack of credit, lack of knowledge about technology and preference for traditional practices. The linear regression model predicted 43.95% of the variance in technology adoption, with extension contact accounting for 38.93% of the variance, use of mass media (4.44%), amount of credit (0.0049%), and age of farmer (0.0058%).
Both the classical diffusion and the institutional and structural constraint models to the study of innovation adoption are both under-girded by the basic assumption that recommended technologies are appropriate for the agroecological and sociocultural conditions in which the farmers operate. While the classical diffusion model blames farmers' ignorance and resistance to change for non-adoption of innovation, the institutional constraint model lays the blame on institutional and structural impediments. However neither of the two models devotes adequate attention to the impact of technology-related variables, and farmers' perceptions regarding the appropriateness of recommended technologies to their farming systems constraints and opportunities on the adoption of technologies.

However, the importance of technology's attributes and farmers' perception of them in determining the rate of adoption has long been recognized in the social science literature. Linton (1936) identified farmer perceptions of an innovation's attributes of utility and compatibility as being crucial in the innovation adoption process. Others, such as Barnett (1953), Rogers (1983), and Fliegel and Klvlin (1962), have also recognized the importance of innovation attributes of relative advantage, compatibility, complexity, observability and trialability as factors affecting the adoption rate. Linton (1936) was one of the earliest persons to describe the relationship between the perceived attributes of an innovation and its rate of acceptance. According to him innovations are accepted by potential adopters on the basis of the two attributes - utility and compatibility. He defined utility as what the innovation appears to be good for, and compatibility as the ease with which the innovation can fit into the existing culture configuration (Linton, 1936, p. 342). He concluded that although an innovation can be more useful than
the one it supersedes, if it requires a different kind of effort or is unpleasant to work with, then the innovation may be rejected.

Barnett (1953) identified the cost of acquiring and using an innovation and its compatibility or incompatibility with tradition as factors affecting the rate of adoption. Others, such as Lionberger (1960), mentioned an innovation's required capital outlay for adoption, its compatibility with existing practices, its communicability and the extent to which it can be adopted first on a small-scale as crucial to the innovation-decision process. In one of the first attempts at collecting empirical data on the relationship between farmers' perception of innovation attributes and the rate of adoption, Fliegel and Kivlin (1962) arrived at findings that confirmed the existence of such a relationship. The study covered 43 dairy practices introduced among farmers in Pennsylvania and tested 11 attributes for their relationship with the rate of adoption. Using data collected from 229 dairy farmers and a panel of 20 judges, farm practices' characteristics of complexity, compatibility, time-saving attribute and relative advantage showed significant relationships at the 95 percent confidence interval, with rate of adoption.

In spite of the long established tradition regarding the importance of technology-related variables in the innovation decision-making process, few studies have been carried out in the LDCs to analyze the relationship between farmers' perceptions regarding innovation characteristics and the rate of adoption of innovations. In one of the few studies on this subject, Zinnah and Compton (1992) evaluated the relative impact of technology-specific factors and farmers perceptions of these factors, and farmers' human capital and personal characteristics, on farm household's adoption of technologies in mangrove rice
production in Sierra Leone and Guinea in West Africa. Using a stochastic tobit model to analyze data collected from 234 farmers, Zinnah and Compton (1992, 8-9) reported that varietal-specific variables such as yield, threshing, and cooking qualities were associated with the rate and intensity of adoption of improved mangrove rice varieties. None of the farm and farmer-specific variables such as age, family size, and participation in on-farm research was statistically significant. They, therefore, concluded that greater attention needed to be devoted to technology-specific variables, in the study of innovation-adoption among resource-poor farm families. Hence, in the present study, data were collected on farmers' perceptions of the comparative advantages of recommended technologies over their traditional practices.

Conceptual Model for the Study

In the previous section of this literature review, emphasis was placed on analyzing past approaches to the study of the innovation-adoption process in the LDCs. The main emphasis was placed on the methods adopted and the major findings of past studies. The main purpose of this section is to analyze the theoretical and conceptual models that have under-girded these past studies, in the hope to lay a theoretical and conceptual foundation for the present study. Leagans (1979, p. 17) defined a model as a framework for integrating and explaining the major elements in a process, as parts of a larger concept, and their relationship to each other and to the problem, the solution for which they are designed.

Most of the past approaches to the study of the innovation-adoption process have been conceptualized within narrow disciplinary frameworks. Leagans (1979, p. 17) summarized the main elements of some of these past studies as follows:
1. Technology model: The thesis of this model is that the demonstration effect of the attractiveness of a powerful technology is strong enough to induce its widespread adoption and diffusion by farmers. This model under-girded the development of Green Revolution technology of the 1960s and 70s when it was assumed that the dramatic yield-enhancing capacity of the new seed-fertilizer package of technology would be strong enough to stimulate its widespread adoption by farmers in the LDCs.

2. Economic model: Under-girded by an economic deterministic assumption that resource-poor farmers' production behaviors are motivated by a rational profit-maximizing goal. Hence, the demonstration of the profitability of a new technology was expected to induce its wide adoption and diffusion by farmers.

3. Communication model: The most widely adopted model in the study of the innovation-adoption diffusion process. The model posits that the interaction between an individual's psycho-social characteristics and communication variables determines the rate and intensity with which innovation is adopted.

4. Institution-building model: The model emphasizes the primary role of societal institutions in determining who has access to innovations and also the rates and intensity with which they are adopted.

While each of these approaches emphasizes different elements in the innovation-adoption process, they all share a common thread of being under-girded by the dualistic modernization theory of agricultural development. The main proposition of the theory is that the solution to the problem of agricultural stagnation in the LDCs lay within a technological deterministic framework involving the direct transfer of modern agricultural technologies from the developed countries to the
LDCs, the so-called 'Transfer of Technology' approach (Hayami and Ruttan, 1971). This theoretical framework is under-girded by the following assumptions:

1. that agricultural technologies are value-free and are therefore adoptable under widely varying sociocultural and agroecological systems.

2. that modern technologies are superior and more economical than traditional practices and hence its adoption would contribute to the socio-economic well-being of the receiving system.

3. that non-adoption of innovations could be attributed to sociocultural and material constraints that prevent farmers from innovating, and subsequently from advancing socially and economically.

4. that individuals had equal access to modern technologies and hence could benefit equally from its adoption, irrespective of socio-economic status differences (Shaw, 1987).

The fallacy of the assumptions that under-girded the modernization paradigm, when applied to the LDCs, is now widely recognized in the agricultural development literature (Hayami and Ruttam, 1971; Schultz, 1964; Rogers, 1983; Shaw, 1987). For instance, it is now recognized that technologies are not value-free and are therefore not adoptable across varying sociocultural and agroecological environments (Biggs, 1980; Ashby, 1986); that not only is access to technology not evenly distributed, but that they produce different payoffs across different socioeconomic status and gender boundaries (de Janvry, 1977), and that some of the so-called improved technologies perform worse than the traditional practices they are supposed to replace (Norman, 1969; Biggs, 1980). Finally, past discipline-oriented theories and models that have been developed for the study of the innovation-adoptions diffusion process, most of which have largely ignored the
multivariate nature of the process, have proved inadequate (Shaw, 1987; Rogers, 1983; Leagans, 1979). Writing on the need for the development of new broad-based models in the study of the process of innovation-adoption, Coughenour (1968) noted that past narrow and simplistic disciplinary approaches to research on innovation diffusion have often ignored or glossed over critical elements involved in the process. He therefore recommended that adoption should be conceptualized as a complex set of processes rather than as a single or unitary one (Coughenour, 1968, p. 5).

Because the FSR/E approach to agricultural development evolved in response to the perceived failure of the modernization theory in the LDCs, past narrow disciplinary adoption models were deemed inappropriate for the present study. Hence, a conceptual model that incorporated relevant elements of the interdisciplinary behavioral differential model for the adoption of agricultural technologies developed by Leagans (1979) and the Farm-Household model developed by the FAO (1989a) was developed for the study.

From a theoretical perspective, this study was rooted in the systems perspective. The main characteristics of the systems approach as espoused by the FAO (1989a), included the following:

1. Emphasis on the need to view a situation as a whole and not as separate parts.
2. Recognition of the interactions of components inside (endogenous) and outside (exogenous) the system, in the process of transforming inputs into outputs.
3. Emphasis on systems hierarchy, whereby every system is part of a larger system and itself consists of subsystems.

On the basis of this theoretical framework, the FAO (1989a) developed the Farm-Household Systems model for the study agricultural households. At the
center of the model is the farm-household with its multiple goals and objectives, and its endowments in human capital and material resources. This is the endogenous subsystem within the model. Impinging on the farm management decision of the farm-household, including technology adoption-decision, is an array of other major exogenous subsystems which include the agroecological, the sociocultural and the policy/institutional components or subsystems. The agroecological environment includes variables such as climate, soils, topography, water, vegetation and infrastructure. The sociocultural environment consists of the community, culture and values and tradition. The policy/institutional environment consists of policy decisions, research, extension and other agricultural support services, e.g. input distribution, credit, marketing, etc. (FAO, 1989a, pp. 15-17). It is the interaction within these various subsystems that determines the opportunities and constraints for developing the farm-household systems. This conceptual model formed the core of the approach adopted for the present study.

The interdisciplinary behavioral differential model was developed by Leagans (1979) in order to meet the need for a more interdisciplinary construct that could accommodate a wider range of the significant variables associated with the adoption of innovation. Hence, the model was an attempt to synthesize into a functional theoretical framework the large body of information available from the various disciplines regarding the nature of the innovation-adoption process. The model identifies five major components relevant to the innovation-adoption process. They include:

- General environmental factors related to adoption of agricultural technologies: technological, economic, social, physical, institutional, communicational, educational, and cultural variables.
-Primary environmental factors related to adoption of innovations by farmers: economic, social and communication

-Primary dimensions of farmers' mental set factors (intervening variables) related to the adoption of innovations: incentives and disincentives.

-Adoption behavior-change (the dependent variable): categorized into three phases as follows: static, dynamic and semidynamic.

-Adoption/ non-adoption: the observable results of adoption behavior change.

The central core of the model is the proposition that the adoption behavior of farmers can be explained by an understanding of the cumulative differential valence of incentives and disincentives perceived by farmers with regards to a specific technical innovation. An incentive is defined as a factor that promotes innovative behavior, while a disincentive is a factor that inhibits it. The valence of an incentive or disincentive refers to its strength or force to either facilitate or inhibit innovative behavior. It is hypothesized that depending on which of these two opposing forces (incentive or disincentive) has the stronger valence, three adoption behavioral patterns are discernible, namely: static, dynamic and semi-dynamic phases (Leagans, 1979).

1. The static phase: occurs when the cluster of incentives and disincentives are seen as exerting equal amounts of valence, force or importance, or when the cumulative differential valence of incentives and disincentives is near zero. Hence the adoption behavioral pattern is either in a passive or status quo state.

2. The dynamic phase: occurs when a state of disequilibrium is triggered off between the valences of disincentive and incentives due to a technological or educational intervention that is strong enough to tilt the scale in favor of incentives. Leagans (1979) identified four kinds of action that can create and
sustain this disequilibrium: introduction of forceful new incentives; strengthening existing incentives, improving the complementarity of incentives; and weakening or removing the forces of disincentives. The dynamic phase is characterized by a net positive cumulative valence differential in favor of incentives, and hence farmers exhibit innovative behavior.

3. Semi-dynamic phase: This phase is reached when a given cluster of incentives have attained their optimum power to cause innovative behavior. At this point the slant of the innovative behavioral curve tends to decline, though it is still higher than during the static phase. According to Leagans (1979), new and more advanced incentives are required to redynamize this phase.

The interdisciplinary behavioral differential model posits that behavior change, conditions and is in turn conditioned by patterned relationships in economic, social and political realms, such as institutional structures, available technology, economic resources, and allocation of resources which make change possible and valuable (Leagans, 1979). In other words the interaction between the general and specific environmental factors surrounding farmers, such as technological, social, economic, communication, educational, political, and cultural variables, could represent either incentives or disincentives in the three progressive behavioral phases (static, dynamic and semidynamic) enumerated above. The consequent perceptions of the respondents of a cumulative valence differential between the opposing force of change incentives and change inhibitors (disincentives) constitute the central dynamics of their behavior change related to technical innovations. Hence to change the balance or valence of cumulative internal (human) and environmental forces toward innovative behavioral change requires intervention from without or the introduction of new forces for change, such
as new technology, new social institutions, extension systems, or production requisites, designed to influence change in the desirable directions (Leagans, 1979).

On the basis of the two models discussed above, the conceptual model graphically represented in Figure 1 was developed for the present study.
Figure 1. An interdisciplinary conceptual model of innovation adoption by farm-households in the Middle-Belt region of Nigeria.
CHAPTER III. METHODOLOGY

The main purpose of the study was to assess how participation in on-farm research, access to rural infrastructure and agricultural support services, and differences in human capital endowments, impact farm-household adoption of recommended agricultural technologies in selected villages in the middle-belt region of Nigeria.

This chapter presents a detailed description of the procedures and methods adopted in collecting and analyzing the data used for the study. The chapter starts with a brief description of the location, the agroclimatic and sociocultural settings of the area in which the study was carried out. This is followed by a description of the procedures adopted in sample selection, data collection and analysis.

The Research Setting

The study was carried out within one of the major Agricultural Development Projects implemented by the Federal Government of Nigeria in the mid 1980s, with a loan from the World Bank. The Bida Agricultural Development Project (BADP) belonged to the second generation of integrated agricultural development projects implemented in the mid-1970s and 1980s by the Federal Government of Nigeria, with loans from the World Bank. The Agricultural Development Projects (ADPs) were set up in all of the 30 states in Nigeria with the goal to improve the well-being of the rural populace, through the introduction of agricultural productivity-enhancing technologies. In order to achieve these objectives the ADPs adopted the integrated rural development approach which placed great emphasis on the development of rural infrastructure and other agricultural support services, such as the extension system.
The Bida ADP, the site of this study commenced operation as an enclave project in 1980 and completed its life cycle in 1986. At the end of its six years of operation, a total sum of $64.4 million (US) had been committed, with the Federal Government, Niger State Government and World Bank, respectively, providing 25%, 39% and 36% of the cost (Project Completion Report, 1987). The original project area has now been incorporated into a larger state-wide project known as the Niger State ADP. The Bida ADP was set up with the mandate to achieve a 25% increase in the output of the staple crops of the area, which include sorghum, rice, yam, cassava, millet, groundnut, melon, corn, and cowpea (Project Baseline Report, 1979). In an effort to achieve this objective the project introduced packages of technologies, which included improved varieties, fertilizer, herbicides, insecticides and other agronomic practices, for adoption by the farm-households. The goal of this study, therefore was to assess the degree to which these technologies had been adopted by the farm-households.

The Bida ADP area is situated in the southern part of Niger State and includes Lavun, Gbako, Agaie and Lapai Local Government Areas (LGAs). Niger State, carved out of the former North Western State in 1976, is bordered to the North by Sokoto and Kaduna States, to the South and West by the Niger River, across which is Kwara State, and to the east by the Federal Capital Territory (see project map on Figure 2). The project area lies entirely within the Southern Guinea Savanna ecological zone, and has a sub-humid climate. Rainfall distribution is monomodal, averaging 1100 mm. per annum, and distributed over a seven-month period extending from April to October (Palada et al., 1987).
Figure 2. A Map of Nigeria showing the location of the Bida Agricultural Development Project Area
The project area has a large expanse of flat-floored lowland inland valleys or fadamas which contain rich hydromorphic soils suitable for rice cultivation. Hence, the project area is one of the major rice-producing regions in Nigeria, a fact attested to by the location of the major rice-research institute in the country, the National Cereal Research Institute (NCRI), within the project area. The project area covers an area estimated at 17,000 sq. km, representing 26% of total land mass of Niger State. Population estimates for the area are shrouded in the controversy and inconsistency that have characterized census data for the whole country. While the official population projection for the area was put at 700,000 in 1979, the World Bank's population estimate of 405,200 at the commencement of the Bida ADP in 1978/79 is considered more realistic (Project Baseline Report, 1979). The project was expected to serve a total of 63,000 farm-households. The area can aptly be described as land-abundant due to its low population density which ranges from the highest of 28.9 persons per square kilometer in Agaie L.G.A. to between 14-17 per square kilometer elsewhere in the project area (APMEPU, 1980).

The Nupes are the dominant ethnic group in the project area, accounting for over 90% of the population. Other minor ethnic groups in the area include the Gwaris, the Hausas, the Fulanis and the Yorubas (BADP, 1980). Islam is the dominant religion in the area. Farming is the primary occupation of the majority of the population, while fishing, trading and handicrafts, are reported as secondary occupations.

Sorghum is the dominant food crop in the area, and is cultivated either sole or inter-cropped with other upland crops such as melon, millet, corn, peanuts, or bambara nuts, in the upland fields. In the lowland fadama fields, rice is the dominant crop. It is very common for most farm-households to cultivate both
upland and lowland crops, though the upland farming system, which is more important for food crops, is the most widespread. However, most of the FSR/E activities within the project area were focused on the development of appropriate technologies for the rice-based farming systems of the inland valleys or fadamas. Hence, the main focus of this study was on the assessment of technology adoption within the rice-based inland valley farming systems.

In the upland sorghum-based cropping system, sorghum (sole and or intercropped with melons) and early millet are planted at the onset of the rains between mid-April and May. Groundnut (peanuts) and late millet usually inter-cropped with melons are planted in June. Between June and July, maize, bambara nut and cassava are planted. Planting in the lowland rice-based fadamas usually begins in June and extends to August. This procedure usually coincides with three months after the onset of the rainy season, when the first weeding of the upland fields must have been completed. The cropping system is predominantly mixed, in which two or more crops are grown on the same plot. As described elsewhere in the far northern region of Nigeria (Hill, 1972; Norman, 1974 and Atala, 1980), most farm-households usually cultivate multiple fields, in order to meet their subsistence needs.

Household Structure and Intra-Household Analysis

The household structure in the area consists of a combination of large extended and nuclear family types. The "Efako", the large extended family type, encompassing a father, (the household head) his wives, his married sons and their families, and his unmarried sons and daughters, is the fundamental household structure among the Nupe people, who constitute over 90% of the people found in the survey area.
This "Efako" household unit constitutes the decision-making unit for the choice of agricultural enterprise, the consumption and marketing of farm produce and the distribution of farmland among its constituent members for their individual cultivation. It also takes major responsibility for the distribution of labor and time between group's ("Efako") and individuals' cultivation. The "efako' family structure is very similar to the 'Gandu" family structure described among the Hausa ethnic group in northern Nigeria (Hill, 1972; Norman, 1974 and Atala, 1980). Family members who are non-residents in the villages and/ or are unable to make their labor available for work on the family's farms are expected to make up for this, through cash payment, in order to derive benefits from the harvest. In most of the villages, specific days and times of the week are earmarked for work by members on the households' ("Efako") farms. The proceeds from the family farms usually go towards meeting the family's food needs and for meeting the marriage obligations of family members when they reach marriageable age.

However, outside of the "Efako" family structure, there is the individual "Gucha" family structure. The "Gucha" family structure constitutes the nuclear family type in which a married son with his family pulls out of the "Efako" farm to set up his own independent farm with little or no obligation to the "Efako" family structure. Another form of the "Gucha" systems may involve individual members, who while still maintaining their link with the "Efako" family structure, decide to own their private farms in order to meet some personal financial needs not normally covered by the large "Efako" family structure. Males begin to engage in individual "Gucha" cultivation from the age of fifteen. The "Efako" unit is, however, still responsible for meeting their marriage obligations to their brides' families.
The "Gucha" household structure of individual agricultural production unit is reported to be gaining increasing prominence (see Appendix C). This trend is attributed to the out-migration of young men from the villages, and to the transition of agricultural production from being mainly subsistence, to a more market-oriented production system. This development is perceived as a potential source of threat to the survival of the "Efako" system.

At the "Efako" household level, decision-making powers in the areas of agricultural production and investment and allocation of resources are vested in the family head, usually the eldest male in the family. These powers are either directly exercised by the family head, or may sometimes be delegated to the most senior son, when the family head either becomes too old or is unable to take part in the day-to-day management of the family farm. The Nupe society is patrilinear and male-dominated, hence, a woman's access to land is usually through her husband. In the same vein a woman's role in intra-household agricultural production decision-making is mainly secondary and consultative at best. However, women are very active in the post-harvest phases of processing and marketing.

The FSR project, the evaluation of which constituted the major purpose of the study, began in 1982, when the International Institute of Tropical Agriculture (IITA) in collaboration with the Bida ADP, established on-farm research project sites in selected villages within the project area. The goal of the FSR project was to develop and test appropriate soil, water and crop management technologies for rice-production in the inland valley or fadamas (Palada et al., 1987). The FSR project included a major on-farm testing of available technologies from the research station, in order to assess their suitability for the existing farming systems opportunities and constraint confronting the farmers (Palada et al., p. 4).
In addition to the IITA's FSR activities, other research and extension organizations, such as the National Cereal research Institute, (NCRI) and the Bida ADP have also implemented other forms of participatory technology development activities within the project area. Hence, one of the major objectives of the study was to compare the levels of adoption of lowland rice-production technologies by farm-households within and outside the FSR project sites. In addition the study sought to assess the impact of access to rural infrastructure and other agricultural support services, and differential human capital endowment on the adoption of technologies. Finally the study analyzed the impact of the project on the living standards of the farm-households.

Research Design

The study adopted a descriptive survey design. It was also under-girded by an interdisciplinary conceptual model. It adopted a triangulation data collection approach involving qualitative non-participant observation, unstructured focus group interviews and structured individual interviews with selected farm-households. In addition, secondary data were collected from past project reports and studies, and through informal interviews with the management and extension staffs of the Niger State ADP, the National Cereal Research Institute (NCRI), and IITA's field staff involved in the FSR project.

Population and Sampling Procedures

In line with the study's conceptual model which recognized the centrality of the farm-household to agricultural production in the developing countries (FAO 1989b and 1983; Merrill-Sands, 1986), the population of interest for this study consisted of all farm-households within the original Bida Agricultural Development Project area. For instance, the FAO (1983), noted that farm-households are both
production and consumption units in the LDCs, hence collecting data on traditional agriculture is equivalent to collecting data on agricultural households. The project area was estimated to contain 63,000 farm-households in 1983. Using the World Bank's estimated population figure of 405,200 for the project area in 1978/79 and the widely applied annual growth rate of 2.5%, the area in 1990/91 was projected to contain a population of 544,948. The subjects for this study consisted mainly of male household heads. However, in order to explore a gender angle to the organization of the farming system and also because of the recognized inherent danger of assuming the farm-household unit as having non-conflicting homogeneous production and consumption goals (Fapohunda, 1987; Guyer and Peters, 1987) women farmers were included in both the group and individual interviews. However, because of sociocultural constraints which created a communication barrier between a male stranger and local women, the bulk of the data for the study came from male-headed farm-households. It was almost impossible to identify any female-headed households within the project area.

During the first phase of data collection, which involved qualitative semi-structured focus group interviews, a three-stage cluster sampling procedure was adopted. The primary sampling frame consisted of the geo-political parameter of local government areas, which are equivalent to county areas (see Figure 3 showing the detailed map of the project area). The plan at the preparatory stage to use agro-ecological zones as the sampling frame had to be discarded when it was discovered that the characterization of agro-ecological zones was based on doubtful criteria (Keith, 1983, p. 6). Each local government area, except Gbako, the administrative headquarters, which had four, was divided into two extension administrative blocks, by the ADP management, giving a total of ten blocks.
Figure 3. A map of the Original Bida Agricultural Development Project Area
From each extension block, one village was randomly selected, giving a total of ten villages. During this phase of data collection, the researcher worked closely with the ADP's extension staff, in order to legitimize the study both with the ADP and the local farm-households, and also to get acquainted with the area. The IITA's research assistant, who had worked closely with the ADP in the implementation of the on-farm research project, also played an active role in introducing the researcher to the ADP's management and extension staff. This was very crucial in allaying possible resentment of the ADP's staff towards what might be misconstrued as an external evaluation of their project. Working in close collaboration with the ADP's extension staff, it was also easy to get the permission of the local leadership hierarchy in the selected villages to conduct the group interview. With the assistance of the respective Block Extension Officers, and the village leadership, a purposive representative sample of 8-10 farmers was selected from each village for the group interviews. Because of cultural norms which prevented a joint interview with both men and women, a special group interview was conducted with a women's group in one of the villages which had a well established women's extension program. The interview was conducted by women interviewers who worked with the researcher.

The group interviews which were conducted by a three-person interview team composed of the researcher and two interpreters, took place mostly in the late afternoons and evenings, when all farm activities must have been completed. The interviews, carried out in the local Nupe language, were semi-structured, thus allowing for the flexibility required for extensive follow-up questioning and unobtrusive exchange of information between the informants and the interview team. The exploratory survey was completed in late September, 1990. The
collected data was analyzed using content analysis and some basic descriptive statistics. A report of the exploratory survey was completed in October and reviewed by the study’s field supervisor at IITA, Nigeria, and by the research supervisor in the USA (see appendix B). On the basis of the report, the second phase of data collection was prepared. The second phase of data collection involved individual structured interviews with farm-households in selected villages within the project area.

Since there was no existing sampling frame containing a list of all the farm-households operating within the project area, and because of the impracticality of developing one, a multistage cluster sampling frame was adopted using a list developed by the project’s extension service which contained all the villages and wards located within the project area. All the villages and wards were sub-divided into the following descending hierarchical clusters: areas, blocks, cells, and sub-cells. An area constitutes the largest cluster, with the whole project area being sub-divided into four extension areas, each equivalent to a Local Government Area. Each area was then sub-divided into extension blocks. In all, the four areas were divided into 10 blocks. Each block was further divided into eight cells, each of which was in turn divided into eight sub-cells. Hence the cells, which were either equivalent to villages or wards depending on size and population, were the smallest cluster within the hierarchical arrangement. From these hierarchical clusters, a multistage random cluster sampling, first of blocks and then cells, and finally of sub-cells resulted in the sampling of twenty villages/subcells- two from each block (see Table 1).
Table 1. Sampling frame for data collection within the Bida ADP area

<table>
<thead>
<tr>
<th>Local Govt. Area</th>
<th>District</th>
<th>Village</th>
<th>Ward</th>
<th># Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gbako</td>
<td>Baddegi</td>
<td>Kataeregi</td>
<td>Mantutu</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Same</td>
<td>Bishe Tiawogi</td>
<td>Emu Egba</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Katcha</td>
<td>Katcha</td>
<td>Anguwar Gabas</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Katcha</td>
<td>Dzwafu</td>
<td>Potungi</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Ekugi</td>
<td>Ndaba</td>
<td>Efu Lima</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Edozhigi</td>
<td>Edozhigi</td>
<td>Efu Ndalima</td>
<td>37</td>
</tr>
<tr>
<td>Lavun</td>
<td>Kudu</td>
<td>Chiji</td>
<td>Efu Tsowa</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Kudu</td>
<td>Labozhi</td>
<td>Emi Tifin</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Kede</td>
<td>Wuya Kede</td>
<td>Wuya Kede</td>
<td>09</td>
</tr>
<tr>
<td></td>
<td>Gonagi</td>
<td>Gata Wodata</td>
<td>Gata Lele</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Kutigi</td>
<td>Nagya</td>
<td>Nagya</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Doko</td>
<td>Shaba Maliki</td>
<td>Gadza</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Batati</td>
<td>Batati</td>
<td>Emi Ndaji</td>
<td>18</td>
</tr>
<tr>
<td>Agaie</td>
<td>Central</td>
<td>Ndamaza</td>
<td>Ndamaza</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Kintako</td>
<td>Nagenu</td>
<td>Nagemu</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Kintifin</td>
<td>Ndamaraki</td>
<td>Ndamaraki</td>
<td>13</td>
</tr>
<tr>
<td>Lapai</td>
<td>Central</td>
<td>Evuti</td>
<td>Tumigi</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>Muye</td>
<td>Muye</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Cece Wadata</td>
<td>Wadata</td>
<td>Wadata</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>364</td>
</tr>
</tbody>
</table>
Because the study sought to analyze the impact of access to irrigation facilities on farm-households' adoption of technologies, one of the two villages with access to formal irrigation facilities, was randomly selected as part of the twenty selected villages. With the assistance of the local village or ward head and the extension agent, a census of all farm-households was conducted in each of the selected villages. From this list, a random sample of twenty farm-households was drawn for each village, to participate in the individual interview. In all 400 respondents were selected. However, either because some of the respondents declined to participate in the interview or due to incomplete information, only 364 respondents (337 males and 27 females), provided data for the first phase of structured interview, representing a 91% response rate. Two female respondents were included in the sample for each of the selected villages. However, it was not possible to find female respondents in some of the villages, either because of strong cultural barriers or because of low level of women involved in individual crop cultivation.

The third and final phase of data collection focused specifically on farm-households who had been involved in the FSR/E projects conducted within the project area. Because of the limited number of villages and farm-households involved in on-farm research, no formal sampling was necessary. All of the 149 OFAR participating farm households in five villages were included in the survey. Because the main focus of the FSR activities was on the development of appropriate technologies for rice-production within the inland valleys systems, data collection focused exclusively on fadama rice production. In all, a total of 513 farm-households' heads were interviewed from 25 selected villages within the project area.
Data Collection

The study adopted a triangulation data collection approach which involved qualitative non-participant observation, semi-structured exploratory group survey methods and quantitative structured individual interviews. All of the interviews, both group and individual, were conducted in the local Nupe language. The first two months of on-site research extending from July to August, 1990 were devoted to getting acquainted with the workings of the project, exploring secondary data and visiting and discussing with farmers in different villages. Between August and October, exploratory group interviews were conducted in ten villages randomly selected from across the four local government area covered by the project. The focus group interviews involved both male and female groups. During the non-participant observation and qualitative semi-structure focus group interview phases of data collection, two research assistants, one male, one female, were recruited to travel around the project area with the researcher in order to facilitate communication. The research assistants were recruited, not only because they spoke both the local Nupe language and English fluently, but also because of their past experience with conducting farmers' surveys and familiarity with the project area.

Because the goal of the exploratory survey was to gain an insight into the general organization of the farming systems, including its opportunities and constraints, a semi-structured, loose interview guide was prepared, only for the purpose to give some order to the interview process. The interview guide contained items which sought information on the following issues: the sequencing of cropping patterns; farming systems constraints and opportunities; intra-household agricultural decision-making process and division of labor; sociocultural
norms and traditions regarding land tenure, access to labor and other productive resources; the local leadership structure; and farmers' perceptions of the welfare implications of the implementation of the project. A sample of 8-10 farmers was purposively selected in each village with the assistance of the village head and the local extension agent. It was clearly emphasized that the selected farmers should represent, as closely as possible, a cross-section of the different cadres of the farmers operating within each village. In line with the cultural and religious norms among the Nupes, a separate interview was conducted with the women's group. Group interviews were conducted mostly in the evening when farmers must have completed the day's work on their farms and had adequate rest. This also provided an opportunity for the interview team to stay overnight in some of the villages. Given its flexibility and broad objectives, the group interviews lasted from 90 to 150 minutes, depending on the need for follow-up questioning and the level of enthusiasm shown by each group. The exploratory survey was probably the most productive phase of the study because its unobtrusive nature permitted free exchange of ideas between the farmers and the interview team.

On the basis of the findings of the exploratory survey, the final schedule for the structured individual interviews was developed. The final schedule, as well as the use of human subjects were approved by the Iowa State University Human Subject Review Committee. Because the study was conceptualized within an interdisciplinary research framework, which sought to analyze the impact of institutional, structural, demographic and human capital endowment variables, on the adoption of recommended technologies, the interview schedule was rather detailed. The interview schedule consisted of the following seven sections (see Appendix A).
Section I: The identifier section which requested the enumerator to identify him/herself, the names of the LGA, districts, village and ward in which the interview was conducted.

Section II: Consisted of items requesting information of the cropping practices and patterns adopted by the respondents in the cultivation of guinea corn, upland rice, fadama/ lowland rice, corn and cowpea during the 1989/90 cropping season.

Section III: Contained items requesting information on the stages the respondents were in, with regards to the adoption of recommended technologies.

Section IV: Consisted of items on farmers perceptions regarding the appropriateness of the package of technologies for their peculiar farming systems possibilities and constraints.

Section V: Contained questions on the demographic and other psycho-social characteristics of the respondents and their levels of social participation.

Section VI: Contained items on the socioeconomic characteristics of the farm-households, with particular emphasis on their farm firm characteristics such as access to labor, farm size, farm income, family size, their resource base and land tenure status.

Section VII: Focused on the relevant institutional and structural variables influencing the adoption of innovations. This section dealt with the households' access to rural infrastructure, information, extension services and other agricultural support services and their perceptions of the quality and the sustainability of these infrastructure and services.
The validation of the interview schedule was carried out in two stages. The first phase involved using existing instruments that had been developed and used in related past studies, to validate the instrument used in the study. The second phase of instrument validation was carried out during the on-site visit of Dr. Martin to Nigeria. The validation process was carried out by social scientists from the IITA, the University of Ibadan and the Iowa State University, who have had considerable experience with conducting rural surveys both within and outside Nigeria. The validated instrument was then field-tested in three villages not included in the final sample. The data collected from this field testing were then analyzed for their reliability. Based on this analysis, items that were not well understood by the respondents, or deemed to reduce the instrument's reliability, were either rephrased or discarded.

In order to conduct the structured interviews, four enumerators who had previous experience conducting rural surveys were recruited. Because of past concerns regarding the validity and reliability problems with rural surveys (Dommen, 1988) careful recruitment of enumerators was determined to be very crucial to the success of the study. A three-day training session on the instrument was conducted in both English and the local Nupe language with ten invited potential enumerators. The Senior planning and evaluation officer, who was in charge of conducting rural surveys for the Bida ADP, was appointed as the resource person for the training session. Four enumerators, including a woman, were finally selected to participate in the survey on the basis of their performance during the training session. Detailed explanatory notes, written in both English and the local Nupe language were included along with the interview schedule to assist
the enumerators. These four enumerators participated in the two phases of structured interviews with the selected farm-households.

Interviews were conducted in the local Nupe language during the evening hours when farmers must have been fully rested after the day's work on the farm. During the interviews, test-retest reliability tests were calculated for each enumerator in order to assess the quality of their interviews. This was done by randomly selecting some of the respondents already interviewed by each of the enumerators and re-interviewing them. Pearson correlation coefficients were then calculated using the data collected from both interviews, in order to test their reliability. On the basis of these results, corrective instructions were given to the enumerators in order to improve the quality of the collected data. It is, however, pertinent to note that each of the enumerators recorded reliability coefficients ranging from 0.90-0.95.

Analysis of Data

The analysis of qualitative data involved content analysis of taped information and general descriptive statistical analysis such as distributions and percentages. The data obtained through the quantitative individual interviews were coded and loaded into the SAS statistical package on the computer main frame first at the IITA, and later at the Iowa State University computation Center. The following descriptive statistical treatments were applied to the data: distributions, percentages, means, standard deviations and variances. In addition inferential statistical treatments such as chi-square, paired and non-paired t-tests, and multiple regression analysis were applied for hypotheses testing.
CHAPTER IV. ANALYSIS AND FINDINGS

This chapter presents the major findings of the study in line with the major objectives and hypotheses that provided the basis for the collection of data for the study. The main purpose of the study was to assess the impact of farmers' participation in farming systems research, their access to rural infrastructure and agricultural support services, and their human capital endowments on the adoption of agricultural innovations in sorghum, rice, corn and cowpea production, by farm-households within the original Bida Agricultural Development Project area in the middle-belt region of Nigeria. Specifically, the study set out to determine how participation in the Farming Systems Research projects implemented by the International Institute of Tropical Agriculture and the National Cereal Research Institute within the original Bida ADP area impacted farm-households' adoption of a package of recommended agricultural technologies. In addition, the study sought to analyze the impact of the implementation of the ADP on the living standards of farm-households in selected villages in the middle-belt region of Nigeria.

The chapter is divided into the following sections: (1) Results of post-hoc reliability tests of instrument, (2) Description of the important sociocultural, personal, intra-household and institutional factors impacting the organization of the farming systems within the survey area, (3) An analysis of the respondents' perceptions regarding the appropriateness of the recommended technologies to their farming systems and of the constraints to their adoption, (4) Analysis of the farm-households' adoption of the recommended package of technologies for sorghum, lowland rice, cowpea and corn production, (5) A comparative analysis of differential adoption of lowland rice production technologies by participants and
non-participants in the Farming Systems Research projects implemented by the IITA and the NCRI, within the Bida ADP area, (6) Multiple regression analysis of the relevance of classical diffusion, institutional constraints and technological models' variables to the prediction of technology adoption by farm-households within the Bida ADP area, and (7) Assessment of the impact of the Bida ADP on the living standard of the farm-households, using the proxy variable of change in the material resources of the respondents before and after the project.

Reliability Tests

In addition to the validation and reliability tests carried out during instrument development, the Cronbach's alpha post-hoc reliability test procedure was conducted in order to ascertain the reliability of collected data. The procedure produced an overall alpha coefficient of 0.91 for the data, a strong testament to the high degree of reliability of collected data.

Analysis of the Personal Characteristics of the Farm-Households

The first objective of the study was to determine the sociocultural, intra-household, farm-firm and personal characteristics of the selected farm-households, in order to gain an understanding of the organization of the existing farming systems. In order to achieve this objective, information concerning the age, level of education, family size, degree of social participation and the farm firm characteristics of the respondents were collected, both during the exploratory and individual interviews conducted within the survey area. The distribution of the respondents according to age groups is shown in Figure 4. Of the 364 respondents interviewed during the first phase of qualitative data collection, 13.6% fell within the 20-29 age category, while the modal age group, constituting 29.6% of the sample was the age group 30-39. The distribution across other age categories
Figure 4. Distribution of respondents according to their age groups was as follows: 40-49 years (22%), 50-59 (12.5), 60-69 (10.1%), 70-79 (7.8%), while the respondents within the age group 80 and above accounted for 4.5% of the sample. The mean age for the sample was 44.37 years.

The distribution of the respondents according to their level of formal education is found in Figure 5. Of the 364 respondents interviewed during the first phase of data collection, 297, representing 81.6%, had no formal education. The distribution of the remaining respondents according to their number of years of formal education were as follows: 1-3 years (1.65%), 4-6 years (7.4%), 7-9 years (2.75%), 10-12 years (4.95%), and 13-15 years (1.65%) of respondents.
Figure 5. Distribution of respondents according to their years of formal education

In order to gain insight into the structural variables impacting the organization of the existing farming systems, respondents were asked to provide information regarding their farm firm characteristics such as family size, farm size, the types of crops cultivated, land tenure arrangements, income from different crops, and the intra-household distribution of agricultural responsibilities. The distribution of the respondents according to their family sizes is shown in Figure 6. The modal family size, which accounted for 36% of the respondents was 6-10. The distribution along other family size groupings was as follows: families with 1-5 members accounted for 26.9% of respondents, 11-15 (26.4%), 16-20 (6.3%), 21-25
Figure 6. Distribution of respondents according to their family size

(1.9%) and 26-30 (1.9%), while 0.3% of the sample had family sizes containing more than 30 members. Respondents from the “Efako” family structure tended to have large family sizes. The average family size for the sample was 9.4.

In terms of the distribution of the respondents according to their family structure, the data in Figure 7 show that 65.7% classified themselves as operating within the extended “Efako” family structure, while the remaining 34.3% belonged to the independent “Gucha” family unit.

The distribution of the sample according to gender as revealed in Figure 8 shows that males constituted 92.6% of the respondents, while female respondents constituted only 7.4% of the sample. As was mentioned earlier, sociocultural norms not only tended to limit women access to agricultural production resources such as land and labor, but also their contact with men from outside the area, hence the seeming under-representation of women in the sample.
Figure 7. Distribution of respondents according to their family structure

Figure 8. Distribution of respondents according to their gender
Analysis of the Farm Firm Characteristics of Respondents

The distribution according to the proportion of respondents who cultivated the four crops evaluated in the present study is shown in Figure 9. It shows that sorghum, the major food crop of the area, was the most widely cultivated, with 96.7% of the farm-households growing the crop. This was followed by corn cultivated by 83.5% of the sample, fadama rice with 73.3%, while cowpea with 39.3% of respondents was the least widely cultivated of the four crops.

![Figure 9. Distribution of respondents according to the percent cultivating crops](image)

The mean size distribution of the holdings for each of the four crops is shown in Table 2. It is, however, pertinent to indicate that the data on the size of farm holdings was based on the farmers' estimation. Time and resource constraints, coupled with the fragmentation of the respondents' fields made it impossible to measure the areas cultivated by each of the 513 respondents interviewed for the study. However, in order to enhance the reliability of farmers' size estimation, information on the quantities of planting materials, measured in local measuring
scale of numbers of "mudus", used by the farmers for each crop during the year was collected. This information, in addition to the data collected from the local extension agents and the tractor hire unit of the Bida ADP, was used to validate the data on farm sizes. Sorghum, with a mean farm size of 2.54 acres, still maintained the lead, followed in descending order, by fadama rice with a mean size of 2.51 acres, corn with 1.59 acres and lastly by cowpea with a mean farm size of 1.08 acres. An analysis of the data on table 2 shows that the distribution of size of holdings for the crops exhibited a high degree of skewness as shown by the wide gap between the smallest and largest farm sizes and the high values of the standard deviation scores.

Table 2. Distribution of means farm size for sorghum, corn, rice and cowpea (acre)

<table>
<thead>
<tr>
<th>Crops</th>
<th>Mean size</th>
<th>standard deviation</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>2.54</td>
<td>2.33</td>
<td>.417</td>
<td>20.80</td>
</tr>
<tr>
<td>Rice</td>
<td>2.51</td>
<td>2.67</td>
<td>.417</td>
<td>20.80</td>
</tr>
<tr>
<td>Corn</td>
<td>1.59</td>
<td>1.56</td>
<td>.417</td>
<td>10.40</td>
</tr>
<tr>
<td>Cowpea</td>
<td>1.08</td>
<td>0.96</td>
<td>.417</td>
<td>06.25</td>
</tr>
</tbody>
</table>

The distribution of the respondents according to their tenure arrangements is shown in Figure 10. Most of the respondents, 75.68%, indicated that they have inheritance rights over their cultivated fields, followed by 15.5% who indicated renting their cultivated field, 7.0% who mentioned family usufruct right tenure arrangements, 1.2 % through communal land tenure arrangements, while a negligible 0.6% indicated share-cropping as the source of their cultivated land.
Figure 10. Distribution of respondents according to land tenure type

It was observed during the first phase of exploratory group interview and non-participant observation that cooperative associations were very critical to the organization of the production systems within the project area. Group farming, in which a whole community or sub-section thereof engaged in collective farming was observed in most of the villages visited during data collection. In the same vein, labor associations and other kinds of reciprocal labor exchange were observed during data collection. Palada et al. (1987) reported similar findings during their exploratory survey of the area. The "Efako" family unit in which members of an extended family pool their labor for collectively crop production is an example of such labor pools. Other forms of reciprocal labor pools were engaged in such labor intensive tasks as land preparation, planting and harvesting in members' fields. The importance of group solidarity within the area was underscored by the fact that the newly instituted women in agriculture unit of agricultural extension division of the ADP worked mainly through women's farming groups.
Hence, in order to assess the degree of social participation of the respondents, they were asked to indicate their membership in the different farmers cooperative associations found in the area. The bar chart in Figure 11 shows the percent of respondents who belonged to different farmers cooperative associations. It shows that a vast majority of the respondents belonged to cooperative associations. For instance 88.9%, 81.4% and 65.4% of the respondents, respectively, belonged to cooperative group farming, cooperative labor pools and saving associations.

![Figure 11. Distribution of respondents according to percent that belonged to different farmers cooperative associations](image)

In order to assess the degree of commercialization of the production of each crop, data were collected on the average income derived by respondents from each of the four crops during the past cropping year. The analysis of these data is shown in Table 3. In terms of the proportion of the respondents who obtained
income from the crops, and the mean income derived, it can be concluded that a vast majority of the respondents could be classified as subsistence producers. For instance, only 196 (51.5%) of the 352 respondents who indicated growing sorghum received any income from the crop. The mean income from sorghum, which also showed very wide variability, was N 1254 ($62.7). Fadama rice, in which 81.3% of its cultivators indicated obtaining income, was the most commercialized crop. It also produced the highest mean income of N 2181 ($109.05). Corn and cowpea with mean income earnings of only N625 ($31.25) and N711 ($35.55), respectively, were the least commercialized of the four crops involved in the study.

Table 3. Distribution of respondents according to mean income (N) from crops

<table>
<thead>
<tr>
<th>Crops</th>
<th>Mean (N)</th>
<th>SD</th>
<th>Min.</th>
<th>Max.</th>
<th>No.</th>
<th>% of growers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>1254.32</td>
<td>1528.72</td>
<td>50</td>
<td>12,000</td>
<td>196</td>
<td>55.7</td>
</tr>
<tr>
<td>Rice</td>
<td>2181.53</td>
<td>2335.36</td>
<td>50</td>
<td>20,000</td>
<td>217</td>
<td>81.3</td>
</tr>
<tr>
<td>Corn</td>
<td>0625.71</td>
<td>0708.02</td>
<td>20</td>
<td>04,000</td>
<td>162</td>
<td>53.3</td>
</tr>
<tr>
<td>Cowpea</td>
<td>0711.78</td>
<td>0751.88</td>
<td>40</td>
<td>03740</td>
<td>73</td>
<td>51.0</td>
</tr>
</tbody>
</table>

Intra-Household Distribution of Agricultural Tasks

One of the major objectives of the study was to analyze the intra-household distribution of agricultural tasks in the production of the different crops, with special emphasis on gender differentiation in the performance of agricultural activities. The data in Table 4 show the distribution of agricultural tasks between male and female members of the farm-households. The analysis shows that the allocation of agricultural tasks between male and female members followed the same pattern for
the four crops analyzed in this study. It is observed that while men were responsible for most of the labor inputs for land preparation, planting, weeding, input application and harvesting, women were responsible for most of the labor input for post-harvest tasks such as processing and marketing of farm produce. Using the data on fadama rice as an example, men accounted for 97.86% of the labor input for land preparation, 92.27% of planting, 97.03% of weeding, 89.95% of agricultural input applications and 89.96% of the labor input for harvesting. Women, on the other hand provided 88.83% of the labor input for fadama rice processing and 71.43% of marketing.

Table 4. Distribution of the percent of labor input for different agricultural tasks provided by male and female members of the farm-household

<table>
<thead>
<tr>
<th>Activities</th>
<th>Sorghum</th>
<th>Fadama Rice</th>
<th>Corn</th>
<th>Cowpea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Land Prep</td>
<td>93.87</td>
<td>6.13</td>
<td>97.86</td>
<td>2.14</td>
</tr>
<tr>
<td>Planting</td>
<td>85.02</td>
<td>14.98</td>
<td>92.27</td>
<td>7.73</td>
</tr>
<tr>
<td>Weeding</td>
<td>93.30</td>
<td>6.70</td>
<td>97.03</td>
<td>2.97</td>
</tr>
<tr>
<td>Input appl.</td>
<td>86.93</td>
<td>13.07</td>
<td>89.95</td>
<td>10.05</td>
</tr>
<tr>
<td>Harvesting</td>
<td>88.78</td>
<td>11.21</td>
<td>89.96</td>
<td>10.04</td>
</tr>
<tr>
<td>Processing</td>
<td>6.10</td>
<td>93.90</td>
<td>11.17</td>
<td>88.83</td>
</tr>
<tr>
<td>Marketing</td>
<td>30.76</td>
<td>69.24</td>
<td>28.57</td>
<td>71.43</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It was discovered, through non-participant observation and during the exploratory group interviews conducted during the first phase of the study, that there were specific sociocultural norms regarding the marketing of farm produce. It was reported that it was customary among the Nupes to have intra-household marketing of farm produce in which the female members of the farm-households buy farm produce from their husbands at below farm-gate prices and subsequently sell them in the market at a profit. The purpose of this intra-household marketing was explained during informal and group interviews with the farmers, as a mechanism for compensating women for their labor input during the post-harvest phase of crop production. The level of intra-household marketing of farm produce was also reported to depend on how much input the wives had in the post-harvest phases. For instance, a wife who was very active during post-harvest activities was allowed a higher profit margin, whereas a husband might decide to market his produce directly to the market if the wife refused to participate actively in the processing of the harvest, thus denying her access to the extra cash she needed to meet some of her personal and domestic obligations. Hence intra-household marketing of farm produce is regarded as a sociocultural mechanism to incorporate women's labor into the agricultural production system.

Analysis of Respondents' Access to Agricultural Support Services

One of the major objectives of the study was to analyze the impact of institutional and structural constraints and opportunities within the project area, on the farm-households' adoption of a recommended package of agricultural technologies. In order to achieve this objective, data were collected on farmers' access to agricultural support services, and also on their perceptions regarding the institutional and structural constraints impacting their adoption of technologies. An
analysis of the respondents' access to rural infrastructure and agricultural services is presented in Table 5. A general overview of the data in the table indicates that many of the respondents have had moderate access to some agricultural support systems available within the project area. For instance, 75.8% of the respondents indicated having had some contact with an agricultural extension agent during the past twelve month period. The reported average numbers of extension contacts during the twelve month period was 4.56.

Table 5. Distribution of respondents according to the mean access and proportion of respondents having access to agricultural infrastructure and services within the last twelve months

<table>
<thead>
<tr>
<th>Services</th>
<th>Mean</th>
<th>SD</th>
<th>Min.</th>
<th>Max.</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agric-shows</td>
<td>2.35</td>
<td>0.21</td>
<td>1</td>
<td>20</td>
<td>241</td>
<td>66.20</td>
</tr>
<tr>
<td>Extension agent</td>
<td>4.56</td>
<td>0.88</td>
<td>1</td>
<td>52</td>
<td>276</td>
<td>75.80</td>
</tr>
<tr>
<td>Demo. Plots</td>
<td>3.25</td>
<td>0.54</td>
<td>1</td>
<td>52</td>
<td>189</td>
<td>51.90</td>
</tr>
<tr>
<td>Input depot</td>
<td>2.72</td>
<td>0.18</td>
<td>1</td>
<td>12</td>
<td>173</td>
<td>47.50</td>
</tr>
<tr>
<td>Radio program</td>
<td>44.05</td>
<td>1.23</td>
<td>1</td>
<td>52</td>
<td>306</td>
<td>84.06</td>
</tr>
<tr>
<td>Television shows</td>
<td>8.74</td>
<td>1.02</td>
<td>1</td>
<td>52</td>
<td>72</td>
<td>19.78</td>
</tr>
<tr>
<td>Extension Bulletin</td>
<td>4.56</td>
<td>0.65</td>
<td>1</td>
<td>40</td>
<td>101</td>
<td>27.75</td>
</tr>
</tbody>
</table>

In the same vein, 84.06% of the respondents indicated that they regularly listened to the weekly radio agricultural program presented by the project. When asked how frequently they listened to the radio agricultural program, an average of 44.05 radio programs per year was reported. The percentage of respondents who reported having contact with other agricultural support services were: agricultural
 Farmers' Perceptions of the Opportunities and Constraints Confronting their Adoption of Recommended Agricultural Technologies

One of the major objectives of the study was to determine the perceptions of the respondents with regards to the appropriateness of the recommended technologies to their farming systems and of the structural and institutional constraints to their adoption. For instance, respondents were asked to compare the recommended modern varieties of sorghum, rice, corn and cowpea to traditional varieties on such qualities as, yield, pest resistance, profitability, weed tolerance, labor requirement, maturity rate, and availability. They were expected to rate the recommended varieties on a five-point Likert scale as follows: much lower, lower, equal, higher or much higher in quality than traditional varieties. Table 6 presents the analysis of the data collected for this question.

The data in Table 6 show that the majority of the respondents had positive perceptions with regards to the comparative advantage of improved rice varieties over traditional varieties in the area of yield, cooking quality, profitability and early maturity. For instance, 46.8% of the respondents rated modern rice varieties (MV) higher in yield quality than the traditional varieties (TV), while 28.8% of respondents felt that there was no comparative yield difference between improved and local rice varieties. However, 24.5% of respondents rated the MV of rice as giving either lower or much lower yield than traditional varieties. In the same vein, 67%, 45.7% and 42.1% of respondents, respectively, expressed the opinion that the introduced modern varieties exhibited comparative advantage over the local varieties in the areas of early maturity, profitability and cooking quality. However, in
such characteristics as weed and pest tolerance, storage quality, and availability, modern varieties were rated lower than traditional varieties by the respondents. For instance, 40.5% of respondents expressed the opinion that the introduced modern rice varieties were lower in weed tolerance than local varieties, while only 24.3% expressed a counter opinion that they were more weed tolerant than local varieties, while 35.7% said there was no difference between the two.

Table 6. Percent distribution of respondents according to their perceptions of the quality of recommended modern varieties of fadama rice

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Much lower</th>
<th>Lower</th>
<th>Equal</th>
<th>Higher</th>
<th>Much Higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>05.5</td>
<td>19.0</td>
<td>28.8</td>
<td>29.6</td>
<td>17.2</td>
</tr>
<tr>
<td>Cooking quality</td>
<td>10.5</td>
<td>19.2</td>
<td>28.2</td>
<td>25.5</td>
<td>16.6</td>
</tr>
<tr>
<td>Pest resistance</td>
<td>11.7</td>
<td>28.8</td>
<td>30.4</td>
<td>21.9</td>
<td>07.2</td>
</tr>
<tr>
<td>Profitability</td>
<td>06.7</td>
<td>18.7</td>
<td>28.9</td>
<td>27.8</td>
<td>17.9</td>
</tr>
<tr>
<td>Weed tolerance</td>
<td>13.1</td>
<td>26.9</td>
<td>35.7</td>
<td>16.3</td>
<td>08.0</td>
</tr>
<tr>
<td>Labor Required</td>
<td>08.2</td>
<td>19.7</td>
<td>42.6</td>
<td>17.3</td>
<td>12.2</td>
</tr>
<tr>
<td>Storage Quality</td>
<td>11.7</td>
<td>26.9</td>
<td>37.8</td>
<td>14.9</td>
<td>08.8</td>
</tr>
<tr>
<td>Maturity rate</td>
<td>02.2</td>
<td>18.0</td>
<td>12.8</td>
<td>31.2</td>
<td>35.8</td>
</tr>
<tr>
<td>Availability</td>
<td>18.2</td>
<td>22.2</td>
<td>20.7</td>
<td>28.2</td>
<td>10.7</td>
</tr>
</tbody>
</table>

Similar findings were reported for pest tolerance, where 40.5% of the respondents rated modern varieties lower than local varieties, compared to 30.4% who rated MV and TV of rice equal in pest tolerance and 29.1% who rated modern rice varieties higher then traditional varieties. From the data in table 6, it is observed that the analysis of respondents' perceptions of the comparative
advantage of MV over TV of rice yielded mixed results with the recommended rice MV not showing clear-cut advantage over traditional varieties in such qualities as weed and pest tolerance, storage and cooking qualities, which are often more important factors in farmers' adoption decision.

In order to identify the structural and institutional constraints that confronted the farm-households in their adoption of recommended complementary external inputs, such as fertilizer, herbicides and pesticides, the respondents were asked to rate the degree to which they were confronted by institutional and structural constraints in their innovation adoption decision. The findings regarding this objective are laid out in Tables 7 through 11.

Table 7. Distribution of respondents according to the percent holding different perceptions regarding the constraints to the adoption of fertilizer

<table>
<thead>
<tr>
<th>Constraints</th>
<th>No problem</th>
<th>Minor</th>
<th>Serious</th>
<th>Very Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cost</td>
<td>27.31</td>
<td>36.4</td>
<td>12.4</td>
<td>23.7</td>
</tr>
<tr>
<td>Compatibility</td>
<td>25.3</td>
<td>43.2</td>
<td>18.5</td>
<td>13.0</td>
</tr>
<tr>
<td>Labor input</td>
<td>34.8</td>
<td>38.8</td>
<td>13.5</td>
<td>12.9</td>
</tr>
<tr>
<td>Complexity</td>
<td>31.4</td>
<td>45.4</td>
<td>12.9</td>
<td>10.3</td>
</tr>
<tr>
<td>Availability</td>
<td>19.3</td>
<td>42.0</td>
<td>12.8</td>
<td>25.9</td>
</tr>
<tr>
<td>Information</td>
<td>34.9</td>
<td>39.4</td>
<td>10.7</td>
<td>14.9</td>
</tr>
</tbody>
</table>

It is observed from the data in Table 7 that the majority of the respondents, over 60%, did not perceive such institutional and structural variables as technology's compatibility, complexity, labor requirement, and lack of information as serious constraints to the adoption of fertilizer. However, 36.1% and 38.7% of
the respondents, respectively, regarded high cost and non-availability as either serious or very serious constraints to fertilizer adoption.

Similar patterns as those recorded for fertilizer, were observed regarding farmers' perceptions of constraints to the adoption of seed dressing as shown in Table 8. For instance, 43.4%, 43.3% and 46.2% of respondents, respectively, rated high cost, non-compatibility and non-availability of seed dressing as constituting either serious or very serious constraints. Labor requirements, complexity and lack of information about technology were not considered as constituting serious problems by a majority of the respondents.

Table 8. Distribution of respondents according to the percent holding different perceptions regarding the constraints to the adoption of seed dressing

<table>
<thead>
<tr>
<th>Constraints</th>
<th>No problem</th>
<th>Minor</th>
<th>Serious</th>
<th>Very Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cost</td>
<td>18.2</td>
<td>38.5</td>
<td>18.2</td>
<td>25.2</td>
</tr>
<tr>
<td>Compatibility</td>
<td>15.0</td>
<td>41.7</td>
<td>27.7</td>
<td>15.6</td>
</tr>
<tr>
<td>Labor input</td>
<td>30.5</td>
<td>34.0</td>
<td>17.3</td>
<td>18.2</td>
</tr>
<tr>
<td>Complexity</td>
<td>24.9</td>
<td>37.7</td>
<td>17.9</td>
<td>19.5</td>
</tr>
<tr>
<td>Availability</td>
<td>13.9</td>
<td>39.9</td>
<td>16.8</td>
<td>29.4</td>
</tr>
<tr>
<td>Information</td>
<td>31.8</td>
<td>34.0</td>
<td>15.4</td>
<td>18.9</td>
</tr>
</tbody>
</table>

However, when farmers were asked to rate the constraints with which they were confronted in the adoption of insecticides, herbicides and mechanization, a sharp change in response pattern was observed. On the constraints facing the adoption of insecticide, the data in Table 9 show that a vast majority of the
respondents regarded all the itemized structural and institutional variables as constituting serious or very serious constraints to its adoption. For instance, 78.2% of the respondents regarded non-availability of insecticides as a serious constraint to its adoption. In the same vein, high cost, incompatibility with farming systems, high labor requirement, complexity and lack of adequate information about technology, each rated by 75.3%, 73.5%, 64.4%, 63.6% and 59.1% of respondents, respectively, were considered as either serious or very serious barriers to the adoption of insecticide.

Table 9. Distribution of respondents according to the percent having different perceptions regarding the constraints to the adoption of insecticides

<table>
<thead>
<tr>
<th>Constraints</th>
<th>No problem</th>
<th>Minor</th>
<th>Serious</th>
<th>Very Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cost</td>
<td>8.5</td>
<td>16.1</td>
<td>27.2</td>
<td>48.1</td>
</tr>
<tr>
<td>Compatibility</td>
<td>7.7</td>
<td>18.7</td>
<td>37.7</td>
<td>35.8</td>
</tr>
<tr>
<td>Labor input</td>
<td>16.7</td>
<td>18.9</td>
<td>34.6</td>
<td>29.8</td>
</tr>
<tr>
<td>Complexity</td>
<td>15.8</td>
<td>20.6</td>
<td>31.3</td>
<td>32.3</td>
</tr>
<tr>
<td>Availability</td>
<td>04.4</td>
<td>17.4</td>
<td>31.5</td>
<td>46.7</td>
</tr>
<tr>
<td>Information</td>
<td>20.9</td>
<td>19.9</td>
<td>25.9</td>
<td>33.2</td>
</tr>
</tbody>
</table>

Herbicide, which was promoted as a technology to alleviate the labor bottleneck arising from high weed infestation within the project area, appeared to have been most constrained by structural and institutional barriers. The data in Table 10 show that 89.1% of the respondents considered non-availability as either a serious or very serious constraint to its adoption. Other constraints such as incompatibility
with the farming system, rated by 86.1% of respondents, high cost- 85.5%, technology's complexity rated by 77% and high labor requirement with 74.8% of respondents were each identified as constituting serious constraints to the adoption of herbicides by the farm-households within the project area.

Table 10. Distribution of respondents according to the percent having different perceptions regarding the constraints to the adoption of herbicide

<table>
<thead>
<tr>
<th>Constraints</th>
<th>No problem</th>
<th>Minor</th>
<th>Serious</th>
<th>Very Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cost</td>
<td>04.5</td>
<td>10.0</td>
<td>24.1</td>
<td>61.4</td>
</tr>
<tr>
<td>Compatibility</td>
<td>02.6</td>
<td>11.3</td>
<td>38.1</td>
<td>48.0</td>
</tr>
<tr>
<td>Labor input</td>
<td>13.4</td>
<td>11.8</td>
<td>33.0</td>
<td>41.8</td>
</tr>
<tr>
<td>Complexity</td>
<td>12.2</td>
<td>10.9</td>
<td>30.9</td>
<td>46.1</td>
</tr>
<tr>
<td>Availability</td>
<td>01.9</td>
<td>09.0</td>
<td>32.2</td>
<td>56.9</td>
</tr>
<tr>
<td>Information</td>
<td>18.1</td>
<td>12.9</td>
<td>22.6</td>
<td>46.5</td>
</tr>
</tbody>
</table>

The major constraints against the adoption of mechanization as shown in Table 11, included non-availability (74.3%), high cost (70.1%) and incompatibility with farming systems (63.9%). Over 50% of respondents also regarded lack of information, high labor requirement and the complexity of technology, as constituting serious structural and institutional constraints to the adoption of mechanization.
Table 11. Distribution of respondents according to the percent having different perceptions regarding the constraints to the adoption of mechanization

<table>
<thead>
<tr>
<th>Constraints</th>
<th>No problem</th>
<th>Minor</th>
<th>Serious</th>
<th>Very Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cost</td>
<td>11.5</td>
<td>18.4</td>
<td>23.9</td>
<td>46.2</td>
</tr>
<tr>
<td>Compatibility</td>
<td>09.5</td>
<td>26.6</td>
<td>28.4</td>
<td>35.5</td>
</tr>
<tr>
<td>Labor input</td>
<td>19.5</td>
<td>20.7</td>
<td>26.7</td>
<td>33.1</td>
</tr>
<tr>
<td>Complexity</td>
<td>18.5</td>
<td>23.1</td>
<td>25.5</td>
<td>32.9</td>
</tr>
<tr>
<td>Availability</td>
<td>07.3</td>
<td>18.3</td>
<td>26.6</td>
<td>47.7</td>
</tr>
<tr>
<td>Information</td>
<td>25.7</td>
<td>16.9</td>
<td>24.2</td>
<td>33.2</td>
</tr>
</tbody>
</table>

Sustainability of the Quality of Agricultural Support Services during and after the Implementation of the Bida ADP

In order to analyze the degree to which the agricultural support services provided during the implementation of the Bida ADP as an enclave project have been sustained since its expansion into the Niger state ADP, respondents were asked to rate the qualities of these services during the two periods.

The data in Figure 12 presents a comparative analysis of the quality of extension services during the implementation of the enclave project and now. An analysis of the chart will tend to suggest a decline in the quality of extension service between the two periods under investigation. For example, while only 16.2% of respondents rated extension quality as poor during the enclave project, the percent has now risen to 31.7%. In the same vein, while 54.1% rated extension quality then as good, the percent rating extension service under the expanded project as good has declined to 40.8%.
Figure 12. Farmers' perceptions of change in the quality of extension services during and after the Bida ADP.

Similar findings as reported above emerged for the evaluation of the quality of fertilizer distribution during the enclave project and now as revealed in Figure 13. While only 9.0% of the respondents rated the service as poor during the enclave project, the percentage of respondents with similar opinions now has risen to 34.9%. Conversely, 31.6% now compared to 51.1% during the enclave project rated the service as good, signifying a marked decline in quality.

The data in Figure 14 presents a comparative analysis of the quality of insecticide supply services during the implementation of the enclave project and after. An analysis of the chart shows that while the quality of services was poor for both periods, the trend is towards a further deterioration in quality. For example, while 48.9% of respondents rated the facilities for insecticides distribution to be poor in quality during the enclave project, the percentage has now risen to 63.4%. In the same vein, while 25.2% of respondents rated the facilities then as of good quality the percentage with a similar rating now has dropped to 21.6%.
Figure 13. Farmers' perceptions of change in the quality of fertilizer supply services during and after Bida ADP

Figure 14. Perceptions of respondents regarding change in the quality of insecticide supply services during and after Bida ADP

Similar decline in the quality of the tractor hire service was recorded between the two periods as shown in Figure 15. The proportion of respondents who rated the service as good has declined from 38.6% during the enclave project to only 21% now. There was also an increase in the percentage of respondents
Figure 15. Distribution of respondents according to their perceptions of change in the quality of tractor hire services during and after Bida ADP who rated the quality poor from 28% during the enclave project to 51% under the expanded project.

The data in Figure 16 with regards to farmers' perceptions of the quality of road networks at the time of the survey compared to the quality during Bida ADP, showed a marked departure from previously observed pattern.
While there was a slight increase in the percentage of respondents with negative ratings during the two periods, a higher percentage of respondents rated the quality of road networks now as good when compared to the enclave project. This suggests that the quality of road networks in the area has been sustained during the two periods.

The data in Figure 17 show the perceptions of farmers regarding the quality of credit facilities during and after the Bida ADP. An analysis of the chart presented in Figure 17 shows that the quality of credit facilities was poor during the two periods. For instance, only 26.5% of respondents rated the quality of credit services as good during the enclave project, compared to just 20% who expressed similar opinions with regards to the period after the project. There was also an increase in the percentage of the respondents who expressed negative opinions about the quality of service from 44.8% during the enclave project to 56.9% who at the time of the study rated the quality negatively.

![Figure 17. Distribution of respondents according to their perceptions of change in the quality of agricultural credit facilities during and after Bida ADP](image-url)
Analysis of Respondents' Awareness and Adoption of Recommended Agricultural Innovations

The primary goal of this study was to determine the impact of rural infrastructure development and the farming systems research activities carried out within the Bida ADP, on the adoption of agricultural innovations by resource-poor farm-households within the project area. The analysis of data for this objective was done in two stages. The first stage involved the determination of the impact of farmers' access to rural infrastructure and other agricultural support services on the adoption of a recommended package of technologies in sorghum, corn and cowpea production by farm-households within the project area. The analysis of technology adoption for lowland fadama rice involved a comparative analysis of differential innovation adoption by participant and non-participant farm-households in the FSR project implemented by the IITA and the NCRI for development and testing of improved technologies for the rice-based inland valley farming systems.

In order to ascertain the impact of the Bida ADP on farmers' awareness of technologies, farmers were asked when they first became aware of the recommended package of agricultural innovations. The graph in Figure 18 shows the distribution of respondents according to the year they first gained an awareness of or first tried fertilizer on their farm. It shows that over 60% of the respondents were already aware of fertilizer by the time the project started in 1980. However, there seemed to a surge in the proportion of respondents who became aware of fertilizer with the beginning of the project, to the point where almost all the respondents are now well aware of the agronomic importance of fertilizer. In the same vein, the graph also shows that many respondents (38.7%) had tried fertilizer before the commencement of the project. However, since the implementation of
the project over 85% of the respondents have now adopted fertilizer. It was clear during data collection that fertilizer application has become a routine practice among the farm-families, and hence the major research issue in fertilizer adoption within the Bida project area goes beyond the traditional classification of respondents as adopter/non-adopters, to the question of intensity of fertilizer use and correct application.

![Distribution of respondents according to the proportion that were aware of, or had tried fertilizer before and after the implementation of the Bida ADP](image)

Figure 18. Distribution of respondents according to the proportion that were aware of, or had tried fertilizer before and after the implementation of the Bida ADP

The data in Figure 19 show the various agencies and media indicated by the respondents as their sources of information about fertilizer. An analysis of the figure shows that radio was the most popular source with over 60% of the respondents mentioning it as their primary source of information, followed by the
extension service, which was mentioned by 26% of the respondents. Other sources mentioned included the IITA and other farmers.

The data in Figure 20 show the proportions of the respondents that were aware of herbicides, insecticides and seed dressing, before and after the Bida ADP. The figure shows that many respondents became aware of these inputs only after the implementation of the project. For instance, 77.7%, 82.5% and 78.9% of the respondents, respectively, only became aware of seed dressings herbicides and insecticides after the commencement of the project. Conversely, only 16.8%, 6.0%, and 6.3% of the respondents were aware of seed dressings, herbicides and insecticides before the project. However, 5.5%, 11.5% and 14.8% of respondents, respectively, were still unaware of the agricultural importance of seed dressings, herbicides and insecticides at the time of data collection.
Adoption of Innovations

One of the major objectives of the study was to assess the impact of the project on the farm-households' adoption of a recommended package of innovations for sorghum, rice, corn and cowpea production. The technology package included improved crop varieties, fertilizer, herbicide, insecticides and seed dressing. The data in Table 12 represent the level of innovation adoption by the selected farm-households in the production of sorghum, rice, corn and cowpea. The data show that fertilizer was the most widely adopted innovation within the project area. It is also revealed that lowland rice was the most fertilized crop, with 93.3% of all the farm-households cultivating lowland rice applying fertilizer. Sorghum, the major staple crop for the area came second with 85.8% of those cultivating it applying fertilizer. Corn with 81.3% of respondents came next, followed by cowpea with 56.60% of cultivating households applying fertilizer. The use of seed dressing, is another agricultural innovation which seemed to have
Table 12. Distribution of respondents according to the percent that have adopted different agricultural technologies for different crops.

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Sorghum</th>
<th>Rice</th>
<th>Corn</th>
<th>Cowpea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>85.8</td>
<td>93.3</td>
<td>81.3</td>
<td>56.60</td>
</tr>
<tr>
<td>Modern Variety</td>
<td>03.0</td>
<td>19.0</td>
<td>23.0</td>
<td>31.00</td>
</tr>
<tr>
<td>Herbicide</td>
<td>04.5</td>
<td>05.6</td>
<td>03.6</td>
<td>07.00</td>
</tr>
<tr>
<td>Seed Dressing</td>
<td>41.0</td>
<td>33.7</td>
<td>38.9</td>
<td>38.50</td>
</tr>
<tr>
<td>Insecticides</td>
<td>05.4</td>
<td>03.4</td>
<td>03.9</td>
<td>21.68</td>
</tr>
</tbody>
</table>

achieved considerable adoption by the farm-households. For instance, 41% of the respondents used it on their sorghum seeds before sowing. The adoption rates for seed dressing for other crops, ranged from 38.9% for corn, 38.5% for cowpea, to 33.7% for fadama rice. Apart from fertilizer and seed dressing which have both achieved substantial adoption rates, other recommended agricultural innovations such as improved varieties, herbicides, insecticides and water management for lowland rice, seemed to have attracted a low level of adoption among the farm-households within the Bida ADP. For instance, only 3% of the farm-households have adopted the recommended modern varieties of sorghum. The adoption rates for other crops included 31% for cowpea, 23% for corn and 19% adoption rate for modern rice varieties within the non-FSR project sites. Herbicides and insecticides were the most poorly adopted innovations. For instance, only 4.5% of the farm-households growing sorghum had adopted herbicides. The figures for other crops were equally poor with 7% for cowpea, 5.6% for fadama rice and 3.6% for corn.
Apart from cowpea in which 21.68% of farm-households applied insecticides, most other crops had attracted a low level of insecticide application, 5.4% for sorghum, 3.4% for rice and 3.9% for corn. It is, however, pertinent to indicate that the adoption rate for modern varieties of rice was very difficult to measure with utmost certainty. This was attested to by the fact that during data collection it was observed that respondents who mentioned growing the same varieties in terms of their local names, tended to differ in their classification of the same varieties as either modern or traditional varieties.

In the same vein, the same varieties tended to have different names in different localities. It was generally observed that respondents who obtained their seeds from other farmers, as opposed to those who obtained theirs directly from government agents tended to classify their seeds as traditional varieties. This problem was more serious with fadama rice, which had experienced widespread diffusion among farmers. Attempts to clarify the confusion in farmers' classification of rice varieties, with the NCRI which has the mandate to release new rice varieties, did not help in resolving the problem. It was discovered that most of the locally grown varieties had lost their genetic purity as a result of being mixed up with other varieties by the farmers during harvesting. Hence, most of the so-called local varieties of fadama rice, were probably products of such variety mixture. Similar problem in differentiating improved from local crop varieties had been reported by Balcet and Candler (1982).

In order to analyze fertilizer adoption in terms of the intensity and the appropriateness of the application methods adopted, respondents were asked to indicate the types, quantities and fertilizer application methods they adopted for sorghum, fadama rice, corn and cowpea. The distribution of respondents
according to quantities of fertilizer (50kg. bags/ha) they applied to the different crops is shown in Table 13. An hectare is equivalent to 2.5 acres. Fadama rice with an average input of 3.77 fertilizer bags per hectare, received the highest dose of fertilizer. This was followed by corn with an average of 2.99 bags per hectare. Cowpea and sorghum each, with an average input per hectare of 2.78 and 2.76 fertilizer bags (50 kg.), respectively, received the lowest fertilizer dosage.

Table 13. Distribution of the mean fertilizer application rates adopted by the respondents (# of 50 kg. fertilizer bags/ hectare)

<table>
<thead>
<tr>
<th>Crops</th>
<th>Mean fertilizer rate (Bag/Ha.)</th>
<th>Standard Deviation</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>2.76</td>
<td>2.46</td>
<td>0.12</td>
<td>26.40</td>
</tr>
<tr>
<td>Rice</td>
<td>3.77</td>
<td>2.76</td>
<td>0.24</td>
<td>16.00</td>
</tr>
<tr>
<td>Corn</td>
<td>2.99</td>
<td>3.13</td>
<td>0.24</td>
<td>24.00</td>
</tr>
<tr>
<td>Cowpea</td>
<td>2.78</td>
<td>2.27</td>
<td>0.32</td>
<td>12.00</td>
</tr>
</tbody>
</table>

It is, however, instructive to note that the average fertilizer input for all the crops, with the exception of sorghum which exceeded the recommended input, was very much below the recommended fertilizer input per hectare for each of the crops, given below: (Bida ADP extension crop husbandry recommendations, 1990).

1. Sorghum- one 50 kg. bag of fertilizer as basal application, followed by a side-dressing application of one 50 kg. bag of fertilizer.
2. Fadama rice-basal application of 4 bags of single ammonia and three bags of single super-phosphate, followed by side-dressing of two 50 kg. bags of CAN (calcium ammonium nitrate), giving a total of nine 50 kg. bags of fertilizer.

3. Corn-basal application of four bags of NPK 15-15-15 (nitrogen, phosphorus and potassium), one-and-a-half bags of double ammonium-phosphate and one bag of CAN; followed by two side-dressing applications each of one bag of CAN.

4. Cowpea- one time basal application of four bags of single super-phosphate plus two bags of single ammonia.

The data in Tables 14 and 15 present the type and methods of fertilizer application adopted by the respondents. The data in Table 14 indicate that most respondents did not follow the recommended fertilizer type. For instance, while the recommended fertilizer types for fadama rice were mainly urea and single super-phosphate, most of the respondents (60.2%) used compound NPK, while only 31.5% and 2.8%, respectively, adopted urea and single super phosphate.

Table 14. Distribution of respondents according to the percent using different fertilizer types on each crop

<table>
<thead>
<tr>
<th>Fertilizer type</th>
<th>Sorghum</th>
<th>Fadama rice</th>
<th>Corn</th>
<th>Cowpea</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPK</td>
<td>83.6</td>
<td>60.2</td>
<td>80.5</td>
<td>79.1</td>
</tr>
<tr>
<td>Urea</td>
<td>10.2</td>
<td>31.5</td>
<td>12.1</td>
<td>8.8</td>
</tr>
<tr>
<td>Super phosphate</td>
<td>5.3</td>
<td>2.8</td>
<td>5.8</td>
<td>9.9</td>
</tr>
<tr>
<td>CAN</td>
<td>-----</td>
<td>-----</td>
<td>0.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Combination</td>
<td>1.0</td>
<td>5.6</td>
<td>1.2</td>
<td>1.1</td>
</tr>
</tbody>
</table>
The data in Table 15 show the percentage of respondents that adopted the recommended fertilizer application methods for the different crops. While the recommended method of application was a combination of basal and side dressing for all the crops, most of the respondents as shown in Table 15 only adopted the side-dressing fertilizer application method. Fadama rice with only 15% of the farm-households adopting both basal and side-dressing received the highest score, while the proportion of farm-households that adopted the recommended fertilizer application methods ranged from 7.2% for sorghum, 6.9% for corn to 6.6% for cowpea.

Table 15. Distribution of respondents according to the percentage of fertilizer adopters who practiced the recommended application methods.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Basal</th>
<th>Side-dressing</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>1.0</td>
<td>91.8</td>
<td>07.2</td>
</tr>
<tr>
<td>Rice</td>
<td>0.4</td>
<td>84.6</td>
<td>15.0</td>
</tr>
<tr>
<td>Corn</td>
<td>1.2</td>
<td>91.9</td>
<td>06.9</td>
</tr>
<tr>
<td>Cowpea</td>
<td>3.3</td>
<td>90.1</td>
<td>06.6</td>
</tr>
</tbody>
</table>

Differential Innovation Adoption between FSR Participants and Non-Participants

One of the major objectives of the study was to analyze the impact of farm-households' participation in the FSR projects implemented by the International Institute of Tropical Agriculture (IITA) and the National Cereal Research Institute (NCRI), within the rice-based inland valley systems, on the adoption of agricultural technologies. The second phase of data collection focused exclusively on the
participants in the FSR projects, as a way to compare their levels of innovation adoption in fadama rice production, with those of non-participants. The FSR participants consisted of 149 respondents who had taken part as cooperating farmers either with the IITA or the NCRI in the development and testing of innovations appropriate for the rice-based inland valley farming systems. Hence, the analysis of differences in technology adoption between FSR participants and non-participants involved a total of 413 farm-households consisting of 264 FSR non-participants who were interviewed during the first phase of data collection, and the 149 FSR participants who were interviewed during the second phase of data collection.

**Demographic and Farm Firm Characteristics of FSR Participants and Non-Participants:** In order to ascertain the comparability of these two groups of respondents, data regarding their personal and farm firm characteristics, and their access to agricultural support services, were analyzed using unpaired t-test and chi-square analyses in order to test for significant differences between the two groups.

The data in Table 16 show the result of the chi-square analysis of the differences in the proportion of FSR participants and non-participants who had access to agricultural support services. An analysis of the data in Table 16 shows that there were no statistically significant differences between FSR participants and non-participants, in terms of their access to agricultural extension services, farm service centers, and agricultural credit. For instance, while a greater proportion of FSR participants than non-participants (50.34% versus 45.83%) had access to extension services, the difference was however, not statistically significant at the .05 confidence level. There were, however, statistically significant differences between
FSR participants and non-participants in terms of the proportion that had access to agricultural radio and television programs, agricultural shows and irrigation facilities. The data in the table also show that a greater proportion of non-FSR respondents had access to agricultural shows, agricultural programs on television and irrigation facilities than farm-households within the FSR project villages. For instance, while 12.12% of FSR non-participants had access to irrigation, only 5.41% of FSR participants had access to irrigation facilities.

Table 16. Chi-square analysis of the differences in access to agricultural support services between FSR participants and non-participants

<table>
<thead>
<tr>
<th>Services</th>
<th>Percent FSR Participants</th>
<th>Percent FSR non-participants</th>
<th>Chi-square Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension Services</td>
<td>50.34</td>
<td>45.83</td>
<td>0.774 NS</td>
</tr>
<tr>
<td>Farm Service center</td>
<td>29.53</td>
<td>31.82</td>
<td>0.239 NS</td>
</tr>
<tr>
<td>Agricultural Shows</td>
<td>27.52</td>
<td>39.39</td>
<td>5.897*</td>
</tr>
<tr>
<td>Agricultural Radio program</td>
<td>96.64</td>
<td>84.09</td>
<td>14.883***</td>
</tr>
<tr>
<td>Agricultural credit</td>
<td>10.74</td>
<td>6.06</td>
<td>2.916 NS</td>
</tr>
<tr>
<td>Agric. Television program</td>
<td>9.40</td>
<td>18.94</td>
<td>6.624**</td>
</tr>
<tr>
<td>Access to irrigation</td>
<td>5.41</td>
<td>12.12</td>
<td>4.879*</td>
</tr>
</tbody>
</table>

NS=Not significant at .05 level
*** Significant at 0.001 level
** Significant at 0.01 level
* Significant at 0.05 level
In the same vein, while 39.39% of FSR non-participants indicated attending agricultural shows, only 27.52% of FSR participants have had access to this service, a difference that was statistically significant. However, a greater proportion of FSR participants (96.64% versus 84.09%) listened to agricultural radio programs than non-participants. In summary, it can be concluded from an analysis of the data in the table that FSR participants and non-participants did not differ substantially from one another in terms of access to agricultural support services, and hence the two groups are fairly comparable. Finally, it can be deduced from the data in Table 16 that the majority of the farm-households did not have access to adequate agricultural support services, necessary to stimulate widespread adoption of agricultural technologies. For example, only 10.74% and 6.06% of FSR participants and non-participants, respectively, had access to agricultural credit.

The data presented in Table 17 show the non-paired t-test analysis of differences in the resource base and personal characteristics of participating and non-participating farm-households in the FSR project. An analysis of the data in the Table 17 reveals that there were statistically significant differences in the farm firm characteristics of FSR participants and non-participants. While the mean farm size of lowland rice cultivated by non-participants was 2.34 acres, FSR participants only averaged 1.34 acres, a difference that is statistically significant at the .001 confidence level. However, FSR participants were statistically higher than non-participants in terms of total farm income and income from fadama rice and the average amount of agricultural loans they received. For instance, while the mean total farm income obtained by FSR participants was N5,970 ($298.5), the average for non-participants was N3885.75 ($194.3), a difference that was statistically significant at .001 confidence level.
Table 17. Non-paired t-test analysis of differences in the resource-base of FSR participants and non-participants

<table>
<thead>
<tr>
<th>Factors</th>
<th>Group Mean FSR</th>
<th>SD</th>
<th>Group Mean Non-FSR</th>
<th>SD</th>
<th>T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size (acres)</td>
<td>1.66</td>
<td>1.32</td>
<td>2.42</td>
<td>2.56</td>
<td>-3.33***</td>
</tr>
<tr>
<td>Age</td>
<td>43.31</td>
<td>13.57</td>
<td>45.88</td>
<td>16.72</td>
<td>-1.60 NS</td>
</tr>
<tr>
<td>Total income</td>
<td>5970.00</td>
<td>6291.94</td>
<td>3885.75</td>
<td>5386.37</td>
<td>3.36***</td>
</tr>
<tr>
<td>Agric. credit</td>
<td>343.60</td>
<td>1131.40</td>
<td>28.41</td>
<td>130.00</td>
<td>4.48***</td>
</tr>
<tr>
<td>Income from rice</td>
<td>3394.72</td>
<td>3438.83</td>
<td>2156.33</td>
<td>2318.70</td>
<td>4.06***</td>
</tr>
<tr>
<td>Years in school</td>
<td>1.56</td>
<td>3.72</td>
<td>1.30</td>
<td>3.26</td>
<td>0.72 NS</td>
</tr>
<tr>
<td>Family size</td>
<td>8.52</td>
<td>4.52</td>
<td>9.70</td>
<td>6.04</td>
<td>-1.49 NS</td>
</tr>
<tr>
<td>Cost of Hired labor</td>
<td>695.43</td>
<td>835.86</td>
<td>707.54</td>
<td>982.64</td>
<td>-0.13 NS</td>
</tr>
</tbody>
</table>

**** Significant at 0.0001 level  
*** Significant at 0.001 level  
**  Significant at 0.01 level  
*   Significant at 0.05 level  
NS  Not Significant at .05 level

There was, however, no statistically significant difference between FSR participants and non-participants in such personal characteristics as age, family size, years of formal education and amount of money spent on hired labor.

In order to assess the impact of the FSR activities conducted within the project area by the IITA and NCRI, a chi-square analysis was applied to determine differences in the proportions of FSR participants and non-participants who had adopted the recommended innovations. The result is presented in Table 18.
Table 18. Summary of chi-square analysis of the differences in the proportion of FSR participants and non-participants who have adopted different technologies in fadama rice production

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Percent adopters FSR participants</th>
<th>Percent adopters Non-FSR</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>93.96</td>
<td>98.18</td>
<td>00.09 NS</td>
</tr>
<tr>
<td>Insecticides</td>
<td>11.41</td>
<td>03.41</td>
<td>10.33***</td>
</tr>
<tr>
<td>Seed dressing</td>
<td>18.12</td>
<td>33.71</td>
<td>11.46***</td>
</tr>
<tr>
<td>Herbicide</td>
<td>04.03</td>
<td>05.68</td>
<td>00.54 NS</td>
</tr>
<tr>
<td>MV fadama rice</td>
<td>73.15</td>
<td>18.94</td>
<td>118.24***</td>
</tr>
<tr>
<td>Water control</td>
<td>81.88</td>
<td>64.02</td>
<td>14.60***</td>
</tr>
</tbody>
</table>

*** Significant at .001 confidence level
NS Not Statistically Significant at the .05 level

The data in the table show that while a higher proportion of non-participants than participants had adopted fertilizer (98.18% versus 93.96%) and herbicides (5.68% versus 4.03%), the differences were not statistically significant, and hence could have been due to sampling error. However, the difference in the proportion of FSR non-participants and participants who had adopted seed dressing, 33.71% and 18.12% respectively, was statistically significant. In the same vein, a statistically higher proportion of FSR participants than non-participants had adopted improved fadama rice varieties, insecticides, and water control measures along their fadama fields. For instance, while 73.15% of FSR participants had adopted improved varieties of fadama rice, only 18.94% of non-participants had done the same. In the same vein, while 81.88% of participants had adopted water control measures along
their fadama fields, only 64.02% of non-participants had adopted similar technologies. From the above, it can be concluded that the difference in the proportion of FSR participants and non-participants who had adopted different technologies was mixed and not clear-cut. Hence it was difficult to make conclusive statements on the hypothesis that there were significant differences in adoption of recommended technologies for lowland rice production between FSR participants and non-participants, in terms of the proportion adopting different practices.

In order to further test the hypothesis that there were significant differences between FSR participants and non-participants in terms of technology adoption, differences in the intensity of their adoption of recommended rice-production technologies were analyzed using t-test statistical analysis. The data presented in Table 19 show that there were statistically significant differences between FSR participants and non-participants in terms of the intensity of technology adoption.

In terms of the intensity of rice MV adoption, the data in Table 19 also show that mean coverage of .52 or 52% of total fadama rice holdings for FSR participants was statistically higher at the .001 confidence interval than the mean area coverage for non-participants of .15 or 15% of total area cultivated. In the same vein, the average fertilizer input of 4.91 bags of fertilizer per hectare for FSR participants, was statistically higher than the mean fertilizer input of 3.61 bags reported by non-participants. There was, however, no statistically significant differences between the two groups in terms of the proportion of the technological package they had adopted (i.e. overall adoption index). The hypothesis that there was no significant difference between FSR participants and non-participants in terms of innovation adoption was therefore, rejected.
Table 19. Unpaired t-test analysis of differences in the intensity of technology adoption between FSR participants and non-participants

<table>
<thead>
<tr>
<th>Innovations</th>
<th>MEANS FSR</th>
<th>MEANS NON-FSR</th>
<th>STD. DEV. FSR</th>
<th>STD. DEV. NON-FSR</th>
<th>T-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of MV coverage</td>
<td>0.52</td>
<td>0.15</td>
<td>0.43</td>
<td>0.34</td>
<td>9.56***</td>
</tr>
<tr>
<td>Fertilizer input Intensity</td>
<td>4.91</td>
<td>3.61</td>
<td>2.98</td>
<td>2.89</td>
<td>4.31***</td>
</tr>
<tr>
<td>Number of Innovations used</td>
<td>2.82</td>
<td>2.78</td>
<td>0.85</td>
<td>1.01</td>
<td>0.50 NS</td>
</tr>
</tbody>
</table>

*** Significant at .001 confidence level
NS Not Significant at the .05 confidence level

The data in Figure 21 presents the percent distribution of FSR participants and non-participants according to the proportion of the six recommended technologies for lowland rice production they had already adopted. The figure shows that, while the technologies were recommended as a total package, their adoption by respondents has been sequential and piece-meal. For instance, only 1.34% of all FSR participants have adopted the total package of recommended technologies, while none of the FSR non-participants had adopted the whole package. The distribution of FSR participants and non-participants, respectively, according to the number of technologies they adopted were as follows: one technology- 0.67% versus 12.12%; two technologies-36.91% versus 24.24%; three technologies-47.65% versus 40.91%; four technologies-10.07% versus 19.32%, while, 3.36% of FSR participants compared to 3.41% of non-participants had adopted five of the six recommended technologies.
Figure 21. Percent distribution of FSR participants and non-participants according to the proportion of the recommended package of technologies they had adopted.

Analysis of Variables Predictive of Technology Adoption

One of the major objectives of the study was to analyze the relevance of variables characteristic of the classical diffusion model, the institutional constraint and technological models to the prediction of the levels of technology adoption by farm-households within the Bida ADP. On the basis of the interdisciplinary conceptual model developed for the study (Figure 1), the following variables
representative of classical diffusion, the institutional constraint and technological models were included in the multiple regression models that were developed to predict the adoption intensity for fertilizer and modern rice varieties, and the proportion of total technological package adopted by the farm-households:

1. **Classical diffusion variables:** age, level of education, farm size, social participation, family size, income, access to information and years of farming experience.

2. **Institutional constraints model variables:** access to agricultural credits, extension services, agricultural input, and irrigation facilities; participation in technology development, proximity to rural infrastructure and facilities such as roads and market.

3. **Technology-related variables:** farmers' perceptions of the relative advantage of introduced technologies over traditional practices. These included for modern varieties such qualities as their yield, profitability, compatibility, pest and weed resistance, cooking quality, and maturity rate. For agricultural inputs, such as fertilizer, seed dressing, herbicides and insecticides, the following variables were included: cost, compatibility, complexity and availability.

The results of the multiple regression analyses are presented in Tables 20-22. The data in Table 20 show the variables that were statistically significant in predicting the intensity of modern rice varieties adoption by the farm-households. Adoption intensity for modern varieties was defined as the proportion of the farm-household's rice holding that was planted with modern varieties. Using a stepwise entry procedure, the multiple regression model produced 12 statistically significant predictors which collectively predicted 46.20% of the variance in the adoption of
rice MV. The single most important predictor of farmers' adoption of the recommended modern varieties of rice was their level of participation in the FSR projects implemented by the IITA and NCRI within the Bida ADP. The variable accounted for 22.98% of the variance in adoption of rice MV. The next most important predictor of MV adoption was the farmers' perceptions of the comparative profit advantage of MV over traditional rice varieties. This factor accounted for 8.23% of the variance in adoption.

Other technology-related variables that emerged as significant predictors of MV adoption, were the respondents' perceptions of the accessibility of rice MV (1.27%), early maturity (0.95%), yield (0.95%), and overall comparative advantage of MV of rice over traditional varieties which accounted for 2.59% of the variance in MV adoption. Other significant variables included access to irrigation facilities (2.44%), membership of village council, a proxy variable for access to political power, which accounted for 2.74% of variance in varietal adoption, total income (0.73%). Other significant variables, but which had negative regression coefficients included distance from farm service center which accounted for 0.77% of variance in MV adoption, farmers' age (2.15%), and access to radio programs (1.14%). An analysis of all the significant predictors of MV adoption reveals that only technology-related variables and the variables usually included in the institutional constraint model were significant. Variables characteristically included in the classical diffusion model were not significant. The two exceptions were farmers' age and farm size, which while being statistically significant, both had negative regression coefficients. Hence, age and farm size are both negatively related to rice MV adoption.
Table 20. Multiple regression analysis of variables predictive of the proportion of total rice acreage covered by improved varieties

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Multiple R</th>
<th>Cumulative R²</th>
<th>Partial R²</th>
<th>% Variance</th>
<th>F-VALUE</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in on-farm testing of MV of rice</td>
<td>29.27</td>
<td>0.2298</td>
<td>22.98</td>
<td></td>
<td>120.24***</td>
<td></td>
</tr>
<tr>
<td>Perceptions of the profitability of MV of rice.</td>
<td>12.00</td>
<td>0.3121</td>
<td>28.23</td>
<td></td>
<td>48.11***</td>
<td></td>
</tr>
<tr>
<td>Access to irrigation facilities</td>
<td>6.10</td>
<td>0.3365</td>
<td>02.44</td>
<td></td>
<td>14.72***</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.41</td>
<td>0.3580</td>
<td>02.15</td>
<td></td>
<td>13.41***</td>
<td></td>
</tr>
<tr>
<td>Membership of village council</td>
<td>15.33</td>
<td>0.3854</td>
<td>2.74</td>
<td></td>
<td>17.78***</td>
<td></td>
</tr>
<tr>
<td>Perceptions of availability of MV of rice</td>
<td>7.73</td>
<td>0.3980</td>
<td>01.27</td>
<td></td>
<td>8.37**</td>
<td></td>
</tr>
<tr>
<td>Perception of overall relative advantage of MV</td>
<td>2.28</td>
<td>0.4239</td>
<td>02.59</td>
<td></td>
<td>17.85***</td>
<td></td>
</tr>
<tr>
<td>Perception of yield advantage of MV of rice</td>
<td>5.50</td>
<td>0.4334</td>
<td>0.95</td>
<td></td>
<td>6.64*</td>
<td></td>
</tr>
<tr>
<td>Perception of comparative maturity advantage of MV</td>
<td>3.86</td>
<td>0.4429</td>
<td>0.95</td>
<td></td>
<td>6.72**</td>
<td></td>
</tr>
<tr>
<td>Access to ag. radio program</td>
<td>-0.18</td>
<td>0.4543</td>
<td>1.14</td>
<td></td>
<td>8.22**</td>
<td></td>
</tr>
<tr>
<td>Distance from farm service center</td>
<td>-0.48</td>
<td>0.4620</td>
<td>0.77</td>
<td></td>
<td>5.60*</td>
<td></td>
</tr>
<tr>
<td>Farm size</td>
<td>-1.75</td>
<td>0.4662</td>
<td>0.42</td>
<td></td>
<td>3.10NS</td>
<td></td>
</tr>
<tr>
<td>Total income</td>
<td>0.68⁻³</td>
<td>0.4735</td>
<td>0.73</td>
<td></td>
<td>5.41*</td>
<td></td>
</tr>
<tr>
<td>Distance from extension</td>
<td>0.34</td>
<td>0.4773</td>
<td>0.38</td>
<td></td>
<td>2.86NS</td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at 0.001 level  
** Significant at 0.01 level  
* Significant at 0.05 level  
NS Not significant at the .05 level
The result of the multiple regression analysis for fertilizer adoption intensity is shown in Table 21. An analysis of the data in the table shows that eight variables, most of them falling under the rubric of the institutional constraint model, emerged as significant predictors at the .05 confidence level. These eight variables, taken together predicted only 37.8% of the variance in fertilizer adoption intensity. Two variables, distance from farm service center and farm size, both with negative regression coefficients, accounted for most of the variance in fertilizer adoption. They each accounted for 9.06% and 9.53%, respectively, of the variance in fertilizer adoption intensity. Other statistically significant variables included the level of commercialization of rice production, which accounted for 4.21% of the variance in fertilizer adoption; access to irrigation facilities (3.28%), distance from agricultural extension services (4.06%), collaboration with the National Cereal Research Institute (2.88%), contact with agricultural inputs dealers (2.27%) and total farm income (2.5%). As was the case with the prediction of MV adoption, most variables characteristic of the classical diffusion model did not emerge as statistically significant predictors of fertilizer adoption intensity. Farm size which was the only exception also had a negative regression coefficient.

Finally, a multiple regression model was developed to analyze the variables predictive of the proportion of the total technological package adopted by the farm-households. These practices included modern rice varieties, fertilizer, insecticides, herbicide, seed dressing and water control practices along the fadama. The result of the analysis is presented in Table 22.

An analysis of the data in Table 22 reveals a similar trend as was recorded in Tables 20 and 21, with variables closely related to the institutional constraints model being statistically significant at the .05 confidence level, in predicting the
Table 21. Multiple regression analysis of variables predictive of the intensity of fertilizer input adopted by the respondents

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Multiple R</th>
<th>Cumulative R²</th>
<th>Partial R²</th>
<th>% Variance</th>
<th>F-VALUE</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from farm service center</td>
<td>-0.099</td>
<td>0.0906</td>
<td>09.06</td>
<td>12.20***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of fadama rice holding</td>
<td>-0.824</td>
<td>0.1859</td>
<td>09.53</td>
<td>14.64***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of commercialization (Proportion of harvest sold)</td>
<td>0.042</td>
<td>0.228</td>
<td>04.21</td>
<td>6.76**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to irrigation facilities</td>
<td>3.201</td>
<td>0.268</td>
<td>03.28</td>
<td>5.46*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration with NCRI</td>
<td>-2.311</td>
<td>0.2896</td>
<td>02.88</td>
<td>4.95*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance from extension service</td>
<td>-0.207</td>
<td>0.3302</td>
<td>04.06</td>
<td>7.33*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact with chemical dealers</td>
<td>0.164</td>
<td>0.353</td>
<td>02.27</td>
<td>4.21*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income for fadama rice</td>
<td>0.0001</td>
<td>0.378</td>
<td>02.50</td>
<td>4.82*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration with ADP</td>
<td>-0.877</td>
<td>0.391</td>
<td>01.29</td>
<td>2.502NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household structure</td>
<td>1.238</td>
<td>0.405</td>
<td>01.4</td>
<td>2.820NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of fertilizer</td>
<td>-0.007</td>
<td>0.417</td>
<td>01.2</td>
<td>2.290NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration with IITA</td>
<td>-0.833</td>
<td>0.427</td>
<td>01.5</td>
<td>2.109NS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at 0.001 level  
**  Significant at 0.01 level  
*   Significant at 0.05 level  
NS  Not Statistically Significant
farm-household's composite adoption index. The nine variables together explained 49.04% of the variance in composite technology adoption. The most important predictor of the proportion of technological package adopted by the farmers was the adoption of improved rice varieties. In other words, a farmer was likely to adopt other complementary technological inputs if he/she adopted modern rice varieties. This variable accounted for 27.01% of the variance in composite technology adoption index.

Other significant predictor variables at the .05 confidence interval included access to irrigation facilities which predicted 6.14% of the variance in technology adoption, farmers' participation in on-farm adaptive research (3.98%), farmers' perceptions of the structural/institutional constraints to the adoption of agricultural input (3.31%). Others included variables such as household structure (0.75%), membership of agricultural cooperative society (0.91%), frequency of visits to agricultural input depot (0.59%), participation in fertilizer trial (0.38%) and dependency ratio, defined as the ratio of consumers:producers within each farm-household, which accounted for 0.98% of variance in technology adoption.

Analysis of Welfare Implications of the Bida ADP on the Farm-Households

The last objective of the study was to analyze the impact of the implementation of the Bida ADP on the living standards of the resident farm-households. Changes in the living standards of the respondents were estimated using a proxy variable of change in the family's wealth since the implementation of the Bida ADP. Family wealth was measured using the proxy variable of change in material possessions of the farm-households before and after the implementation of the Bida ADP. The use of income and other economic analysis such as consumer or producer surplus or cost-benefit analysis was discarded because it
Table 22. Multiple regression analysis of variables predictive of the proportion of technological package (e.g. fertilizer, herbicide, improved varieties, etc.) adopted by respondents.

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Multiple R</th>
<th>Cumulative R²</th>
<th>Partial R²</th>
<th>% Variance</th>
<th>F-VALUE</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of MV rice coverage</td>
<td>0.0451</td>
<td>0.2701</td>
<td>27.01</td>
<td>91.02***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to irrigation facilities</td>
<td>0.0443</td>
<td>0.3315</td>
<td>06.14</td>
<td>22.51***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participation in FSR</td>
<td>0.2365</td>
<td>0.3713</td>
<td>03.98</td>
<td>15.46****</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceptions of constraints to the adoption of ag. inputs.</td>
<td>-0.1858</td>
<td>0.4044</td>
<td>03.31</td>
<td>13.49***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>House hold structure (Dummy variable)</td>
<td>-0.3769</td>
<td>0.4318</td>
<td>02.75</td>
<td>11.70***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Membership of farm coop.</td>
<td>0.3563</td>
<td>0.4510</td>
<td>01.91</td>
<td>8.41**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of visits to farm service center.</td>
<td>0.0166</td>
<td>0.4669</td>
<td>01.59</td>
<td>7.17**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participation in fertilizer trial</td>
<td>0.3831</td>
<td>0.4807</td>
<td>01.38</td>
<td>6.33*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependency ratio</td>
<td>0.0217</td>
<td>0.4904</td>
<td>00.98</td>
<td>4.55*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm size</td>
<td>0.1143</td>
<td>0.4971</td>
<td>00.67</td>
<td>3.16NS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at 0.001 level
**  Significant at 0.01 level
*   Significant at 0.05 level
NS  Not significant at the .05 level
was felt that they might not necessarily reflect the social realities of the respondents. Hence, changes in respondents' possessions of locally prized material resources such as buildings, bicycles, motor-bikes, granaries, cars, milling machines etc., were used as the proxy measure for change in living standards of the farm-households.

The dependent t-test analysis of changes in the material possessions of the respondents before and after the implementation of the project is found in Table 23. The data in Table 23 show that there had been substantial and positive changes in the material resource endowment of the respondents since the implementation of the Bida ADP. For instance, material resources such as the mean possession of wrist watches, buildings with metal roofing, livestock, granaries, radio, television, wooden and iron beds, wall clocks, bicycles and motor-bikes have shown statistically significant positive growth since the implementation of the project. The remarkable changes registered with three items, namely granaries, thatched and metal roofed buildings, clearly demonstrated positive impact of the project. The positive growth in the average number of granaries per farm-family from 1.74 before the project to a new average of 2.96 was indicative of expanded production, because granaries are locally constructed storage for excess farm produce. In the same vein, the statistically significant increase in the number of buildings with metal roofing per farm-household's head from 2.13 before the project to a new average of 3.87 also indicated an improvement in living standards. Ownership of buildings with metal as opposed to thatched roofing represents an upward movement along the socioeconomic status continuum. A decrease in the mean number of thatched-roofed buildings, per farm-household from 1.29 before the project to .60 at the time of the survey, also lent support to the conclusion of an
Table 23. Paired t-test analysis of change in the resource-base (agricultural and household equipment) of farmers before and after the Bida ADP

<table>
<thead>
<tr>
<th>Resources</th>
<th>Group Mean Before ADP</th>
<th>Group Mean After ADP</th>
<th>Mean Diff</th>
<th>T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrist Watches</td>
<td>0.57</td>
<td>1.01</td>
<td>0.44</td>
<td>7.83***</td>
</tr>
<tr>
<td>Metal-roofed houses</td>
<td>2.13</td>
<td>3.87</td>
<td>1.74</td>
<td>13.30***</td>
</tr>
<tr>
<td>Thatched-roof houses</td>
<td>1.29</td>
<td>0.60</td>
<td>-0.69</td>
<td>06.23***</td>
</tr>
<tr>
<td>Cattle</td>
<td>0.06</td>
<td>0.13</td>
<td>0.07</td>
<td>1.74NS</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.60</td>
<td>1.42</td>
<td>0.82</td>
<td>5.04***</td>
</tr>
<tr>
<td>Goats</td>
<td>1.41</td>
<td>2.72</td>
<td>1.31</td>
<td>7.41***</td>
</tr>
<tr>
<td>Chicken</td>
<td>3.09</td>
<td>5.69</td>
<td>2.60</td>
<td>6.19***</td>
</tr>
<tr>
<td>Spraying equipment</td>
<td>0.01</td>
<td>0.04</td>
<td>0.33</td>
<td>2.71**</td>
</tr>
<tr>
<td>Granary</td>
<td>1.74</td>
<td>2.96</td>
<td>1.21</td>
<td>9.84***</td>
</tr>
<tr>
<td>Lorries</td>
<td>0.01</td>
<td>0.00</td>
<td>-0.005</td>
<td>-1.42NS</td>
</tr>
<tr>
<td>Car</td>
<td>0.01</td>
<td>0.01</td>
<td>0.003</td>
<td>0.45NS</td>
</tr>
<tr>
<td>Motor-bike</td>
<td>0.39</td>
<td>0.52</td>
<td>0.13</td>
<td>4.92***</td>
</tr>
<tr>
<td>Bicycle</td>
<td>0.60</td>
<td>0.73</td>
<td>0.13</td>
<td>3.40**</td>
</tr>
<tr>
<td>Radio</td>
<td>0.60</td>
<td>0.90</td>
<td>0.30</td>
<td>7.50***</td>
</tr>
<tr>
<td>Television</td>
<td>0.03</td>
<td>0.06</td>
<td>0.03</td>
<td>2.20*</td>
</tr>
<tr>
<td>Iron bed</td>
<td>0.77</td>
<td>1.11</td>
<td>0.34</td>
<td>7.9***</td>
</tr>
<tr>
<td>Wooden bed</td>
<td>0.30</td>
<td>0.36</td>
<td>0.06</td>
<td>2.17*</td>
</tr>
<tr>
<td>Mattresses</td>
<td>0.94</td>
<td>1.23</td>
<td>0.29</td>
<td>7.02***</td>
</tr>
<tr>
<td>Wall Clock</td>
<td>0.29</td>
<td>0.43</td>
<td>0.15</td>
<td>5.62***</td>
</tr>
</tbody>
</table>

*** Significant at 0.001 level  
** Significant at 0.01 level  
* Significant at 0.05 level  
NS Not Significant
improvement in the respondents' standard of living.

A further chi-square analysis of the proportion of the respondents who owned different household and agricultural equipment compared with the baseline data collected before the implementation of the Bida ADP produced similar results as those reported in Table 23. The findings as presented in Table 24 show a marked increase in the proportion of respondents who owned different equipment such as wrist watches, metal-roofed houses, agrochemical spraying equipment, granaries, motor-bikes, radio, iron-beds and livestock, compared to the proportion before the implementation of the project. When the data in Tables 23 and 24 are taken together, it can be concluded that not only has there been an increase in mean possession of household and agricultural equipment per household, but a greater proportion of the households who never used to own these equipment before the project, owned them after the project. On the basis of these findings, it can be concluded that there has been a marked increase in the households' wealth since the implementation of the Bida ADP.
Table 24. A percent and chi-square comparison of the proportion of farm-households who owned different household and agricultural equipment before and after the Bida ADP

<table>
<thead>
<tr>
<th>Resources</th>
<th>Percent Before ADP*</th>
<th>Percent After ADP</th>
<th>Percent Diff</th>
<th>Chi-Square.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrist Watches</td>
<td>55.3</td>
<td>70.6</td>
<td>15.3</td>
<td>4.83***</td>
</tr>
<tr>
<td>Metal-roofed houses</td>
<td>66.2</td>
<td>90.1</td>
<td>23.9</td>
<td>15.40***</td>
</tr>
<tr>
<td>Thatched-roof houses</td>
<td>36.8</td>
<td>26.6</td>
<td>-10.2</td>
<td>1.86**</td>
</tr>
<tr>
<td>Cattle</td>
<td>2.7</td>
<td>5.2</td>
<td>2.5</td>
<td>0.13NS</td>
</tr>
<tr>
<td>Sheep</td>
<td>16.9</td>
<td>32.4</td>
<td>15.5</td>
<td>5.30***</td>
</tr>
<tr>
<td>Goats</td>
<td>32.7</td>
<td>55.8</td>
<td>23.1</td>
<td>12.58***</td>
</tr>
<tr>
<td>Chicken</td>
<td>44.1</td>
<td>61.8</td>
<td>17.7</td>
<td>5.80***</td>
</tr>
<tr>
<td>Spraying equipment</td>
<td>&lt;0.5</td>
<td>3.0</td>
<td>2.5</td>
<td>1.35**</td>
</tr>
<tr>
<td>Granary</td>
<td>66.0</td>
<td>83.0</td>
<td>17.0</td>
<td>6.74***</td>
</tr>
<tr>
<td>Tractor</td>
<td>&lt;0.5</td>
<td>0.5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Milling machine</td>
<td>1.0</td>
<td>1.9</td>
<td>0.9</td>
<td>0.00NS</td>
</tr>
<tr>
<td>Grinder</td>
<td>1.0</td>
<td>2.5</td>
<td>1.5</td>
<td>0.26NS</td>
</tr>
<tr>
<td>Car</td>
<td>2.4</td>
<td>1.4</td>
<td>-1.0</td>
<td>0.00NS</td>
</tr>
<tr>
<td>Motor-bike</td>
<td>36.05</td>
<td>48.4</td>
<td>12.35</td>
<td>2.48**</td>
</tr>
<tr>
<td>Bicycle</td>
<td>62.8</td>
<td>60.4</td>
<td>-2.40</td>
<td>0.08NS</td>
</tr>
<tr>
<td>Radio</td>
<td>46.05</td>
<td>73.1</td>
<td>27.05</td>
<td>14.03***</td>
</tr>
<tr>
<td>Television</td>
<td>NA</td>
<td>2.7</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Iron bed</td>
<td>56.05</td>
<td>75.5</td>
<td>19.95</td>
<td>8.04***</td>
</tr>
<tr>
<td>Wooden bed</td>
<td>44.5</td>
<td>26.4</td>
<td>-18.1</td>
<td>7.08***</td>
</tr>
<tr>
<td>Wall Clock</td>
<td>37.04</td>
<td>33.2</td>
<td>-4.84</td>
<td>0.20NS</td>
</tr>
</tbody>
</table>

*** Significant at .001 level  
** Significant at .01 level  
NS Not statistically significant at .05 level

CHAPTER V. DISCUSSION

In the preceding chapter, the major findings of the study were presented. The purpose of this chapter is to discuss and elaborate on these findings. The discussion will be organized along the study's major objectives that were set out in chapter one. The main purpose of the study was to assess the impact of participation in Farming Systems Research, access to rural infrastructure and agricultural support services, and human capital endowment on the adoption of agricultural innovations by farm-households within the original Bida ADP located in the middle-belt region of Nigeria. The former Bida ADP, having incorporated both elements of the integrated rural development project model and the Farming Systems Research/Extension perspective, presented a unique opportunity for evaluating the two approaches to agricultural development. The project which was funded with a loan from the World Bank, implemented large-scale investment in the development of rural roads, irrigation facilities, the extension service and input distribution. In addition, the International Institute of Tropical Agriculture (IITA) and the National Cereal Research Institute implemented FSR projects within the inland valleys farming systems spread across the project area.

Hence, the specific purpose of the study was to evaluate how farm-households' access to these agricultural support services, their participation in on-farm adaptive research, and their human capital endowment impact their adoption of recommended agricultural technologies. The discussion of the major findings of the study will be organized along the following specific objectives of the study:

1. Discussion of the findings related to the personal, farm firm, sociocultural, and intra-household variables impacting the organization of the local farming systems in the area of study.
2. Discussion of the findings on farmers' perceptions of the appropriateness of the recommended package of technologies for their farming systems constraints and opportunities.

3. Discussion of the findings on the farmers' adoption of the recommended package of technologies.

4. Discussion related to the study's findings on the variables predictive of the level of innovation adoption by the farm households.

5. Discussion of the findings on the impact of farmers' participation in FSR on their adoption of recommended technologies for fadama rice.

6. Discussion related to the impact of the project on the living standards of the selected farm-households.

**Personal, Farm Firm, Sociocultural, and Intra-household Characteristics of the Respondents**

One of the major objectives of the study was to analyze and describe the important personal, farm firm and intra-household variables that under-girded the organization of the farming systems within the project area. Included in the survey were the respondents' personal characteristics, such as age, family size, level of formal education, social participation, family structure and gender. The respondents varied widely in their age distribution, from a minimum of twenty years to over 80 years. The modal age group was 30-39 years, while the mean age was 44.37 years. However, 34.9% of the respondents were aged 50 years or older. On education, it was found that a vast majority of the respondents were illiterate, with 81.6% not having had any form of formal education. Of the remaining 18.4% of the respondents, only 9% had any form of post-primary education. It was, however, observed during data collection that the majority of the respondents who indicated
having had formal education often had other primary occupations besides farming. Most were government employees working and living in the villages. In terms of family size and structure, most of the respondents had large families with 65.7% operating within the extended "Efako" family units.

The family size distribution for the respondents ranged from between 1-5 to over 30 members, with the mean family size being 9.4 per respondent. It was observed that there was a high degree of social participation within the population. Not only was agricultural production organized along the extended family structure, the majority of the respondents belonged to more than one agricultural cooperative associations. For instance, over 80% of the respondents belonged to cooperative group farming society and exchange labor pools, while over 65% belonged to a cooperative saving association. It was, however, observed during field research that past agricultural development efforts have largely ignored the potential of these local institutions to act as the vehicle for agricultural development within the area. This has a lot of implications for agricultural development policy both nationally and locally. Local institutions have sometimes been known to resist change to the status quo, however, when given appropriate external support such as educational programs, they have been recognized as one of the most cost-effective vehicles for bringing about sustainable participatory agricultural development in many third world countries.

While the mean age reported in the study seemed to be lower than those reported elsewhere in Nigeria (Daramoia, 1988), a critical analysis of the personal characteristics of the respondents would reveal that they were typical of most resource-poor farm-households elsewhere in Nigeria. The lower mean age for the sample could well have been due to the increasing reverse migration of young
people, who had moved into the urban area during the Nigerian oil-boom era of the 1970s and 1980s, back to the rural agricultural economy. Secondly, it was observed during data collection that some of the older farm-households' heads were represented by their eldest sons who had taken over the management of the family's farms, due to the old age of the household's head.

An analysis of the findings of the study with regards to the farm firm characteristics of the respondents, shows that most of the respondents were resource-poor small-holder producers. Agricultural production was organized along the family structure, with the members providing the bulk of the labor input. The distribution of agricultural tasks among male and female members of the households were similar to those reported elsewhere in Northern Nigeria, with the males providing the bulk of the labor for pre-harvest tasks, while females had major responsibility for post-harvest activities (Atala and Abdullahi, 1988; Balcet and Candler, 1982, and Norman, 1969). The household head, who almost always was the most senior male within the family, took most of the agricultural production decisions after consultation with key members of the family. The findings of the study also revealed that the agricultural production systems within the area were dominated by small-scale subsistence producers. Most households cultivated three or more different crops, either sole or inter-cropped, in order to meet the food and cash needs of their members. The reported mean farm sizes for the four crops evaluated in the study ranged from the highest of 2.54 acres for sorghum, 2.51 acres for fadama rice, 1.59 acres for corn, to the lowest mean farm size of 1.08 acres for cowpea.

The dominant land tenure arrangement for most of the respondents was inheritance. Over 75.68% of respondents reported to have inheritance right over
their cultivated fields, while only 15.5% rented their fields. It is, however, pertinent to note that the traditional norms regarding inheritance rights were biased against women, who had no land inheritance rights, and hence relied on their husbands for land for farming. This gender bias in resource distribution also extended to the distribution of access to family labor where the male household heads have almost absolute control. Hence, most of the few women involved in individual cultivation tended to farm smaller holdings and relied more on hired labor. This factor, in concert with other sociocultural norms such as the dominant Islam religion, could explain why very few women were involved in individual crop production.

An analysis of the study's findings with regards to the personal and farm firm characteristics of the respondents, reveals that they are typical of most resource-poor subsistence producers who dominate agricultural production in many less developed countries, including Nigeria (Chambers and Ghildyal, 1985; Dommen, 1988). While, on one hand, they had been incorporated into the modern cash economy, their primary agricultural production goal still remains to meet the subsistence needs of their farm-households. This sometimes creates a disarticulation between national agricultural development objectives, which more often than not, are geared towards meeting broad national economic objectives, and the narrow production goals and needs of the farmers. Such a disarticulation could be observed in the original Bida ADP, where most of the FSR activities were geared towards developing technologies for the rice-based inland valley farming systems, while, sorghum, the staple food crop of the area still remains the most widely cultivated crop and is accorded top priority in the farm-households' production agenda.
While, the ban imposed on rice importation by the federal government of Nigeria in the mid-1980s, had accelerated the need for national self-sufficiency in rice production in order to meet the high demand in the urban centers, most of the farm-households living within the project area regarded rice only as a secondary food crop. As a result, although rice has become an important cash crop, most of the farmers would commence farm operations on their fadama rice field only after completing the first weeding in their more important upland fields, where the major food crops, such as sorghum, are cultivated. This explains why all past efforts to encourage early planting of fadama rice have achieved little success. This disarticulation between farmers' goals and national agricultural policy goals has a lot of implications for future agricultural development initiatives. Hence, it is concluded from the findings of the study, that the minimization of this disarticulation between national and producers' goals is critical to the achievement of sustainable agricultural development in the third world countries. In order to achieve this goal, a greater involvement of farmers in setting national priorities for agricultural development is imperative.

Farmers' Perceptions of the Appropriateness of Recommended Technologies and of the Constraints to their Adoption

In deference to the classical diffusion model of technology transfer which posits that the major constraint to technology transfer in the developing countries is the non-innovative personality disposition of the resource-poor farmers, the study included variables characteristic of the institutional constraint model in its overall conceptual model. The thesis of the model is that the individual-blame bias of the diffusion paradigm does not provide an adequate explanation for the non-adoption of technology by resource-poor farmers, but rather that resource-poor producers
face insurmountable institutional and structural constraints which make innovative behavior impossible (Shaw, 1985 and 1987; Chambers and Jiggins, 1987 and Leagans, 1979). Hence, one of the major objectives of the study was to determine possible institutional and structural constraints which inhibited the adoption of innovations by the farm-households. Among variables included in the model were access to services such as agricultural extension, agricultural inputs, information, credit and irrigation facilities. In addition, respondents were requested to assess the appropriateness of the recommended technology package in terms of cost, availability, comparative advantage over traditional practices, compatibility with their farming systems, complexity, profitability and labor requirement.

The findings of the study on the respondents' access to agricultural support services show that a large proportion did not have access to critical services such as agricultural extension services, credit, input supply and irrigation facilities. For instance, when respondents were classified on the basis of their participation in the FSR project, it was found that as many as 49.66% of participants and 54.17% of non-participants did not have access to extension services. A much bigger percent of the respondents did not have access to agricultural credit, input supply and irrigation facilities. For instance, 70% of FSR participants and a little less than 70% of non-participants did not have access to input supply centers, while over 90% of all respondents did not have access to agricultural credit and irrigation facilities. Women respondents were worse off, with none of them being involved in the FSR project implemented in the inland valleys. The major service to which a majority of the respondents (over 90%) had access, was the weekly agricultural radio talk produced by the ADP. From the findings discussed above, it could be concluded that while the major focus of the ADP was the development of agricultural
infrastructure and support services, most of the respondents did not have access to these infrastructure and services.

The findings of the study with regard to the degree to which the now expanded state-wide NSADP has been able to sustain the quality of the agricultural support services during the original Bida ADP also supported the findings reported above. Most of the respondents rated the quality of extension services, input distribution, credit and tractor hire services as poorer after the project than they were during the implementation of the ADP as an enclave project. For instance, while only 16.2% of the respondents rated the quality of extension services during the enclave project as poor, the percent of respondents who rated the quality of extension service after the project as poor has risen to 31.7%. In the same vein, the proportion of respondents who rated the quality of input supply services as good has dropped from 51.1% during the enclave project to only 31.6% under the new dispensation. The only exception was the quality of rural roads which was considered slightly better after the project than during the enclave project. It can therefore, be concluded from the above that there had been a marked decline in the quality of agricultural support services since the expansion of the Bida ADP from an enclave project to an expanded state-wide project.

A discussion with the project's staff revealed that some of the services which were, hitherto, provided by the ADP have since either been canceled or transferred to the local government authorities. For instance, the tractor hire service which was a major component of the ADP had now been canceled and the tractors, most of which were in a dilapidated state, sold. In the same vein, fertilizer distribution has been transferred from the ADP to the local government authority (Niger State Agricultural Development Project, 1990).
This decline in the quality of the agricultural support services was further confirmed by the study's findings regarding farmers' perceptions of the institutional constraints to the adoption of recommended technologies. Over 40% of the respondents mentioned inadequate facilities for input distribution, high cost and inaccessibility as the major constraints to the adoption of fertilizer and seed dressing. Over 70% of the respondents mentioned high cost, lack of access, incompatibility with farming systems, technology complexity, high labor requirement and lack of information, as serious constraints to the adoption of insecticides, herbicides, and mechanization. It is little wonder that these inputs attracted low levels of adoption by the farm-households. This contrasts with seed dressing, and especially, fertilizer, which have attracted a high level of adoption by the respondents. The findings reported above, all point to the fact that institutional and structural constraints were major factors in determining which of the recommended technologies were adopted.

An analysis of the findings regarding the respondents' perceptions of the comparative advantage of the recommended modern varieties over traditional fadama rice varieties, revealed that the former did not possess a clear-cut advantage over the latter. While modern varieties were perceived by a majority of the respondents as being superior in such characteristics as yield, early maturity, taste, and profitability, a similar majority however, rated them inferior to traditional varieties in terms of pest resistance, weed tolerance, storage quality and accessibility. Similar findings were reported by Keith (1983), who in his mid-term progress report for the Bida ADP, observed that most farmers were planting their own seeds because the superiority of the "improved" planting materials being distributed by the project was not supported by adequate adaptive research. Given
the widely recognized low risk-absorbing capacity of resource-poor farmers (Feder et al., 1985), and hence their tendency to value stability of yield and adaptability to local conditions over short term yield and profitability gains, it is little wonder that a majority of the respondents have resisted the move towards the recommended varieties.

The findings of the study as they relate to the institutional and structural constraints to the adoption of agricultural technologies seem to lend support to the institutional constraints model of innovation adoption (Shaw, 1987 and 1985). Similar findings regarding the impact of institutional constraints on discouraging innovative behavior among resource-poor farmers have been reported elsewhere in Nigeria. In a study of the adoption of recommended technologies by rice farmers in Imo state in south-eastern Nigeria, institutional constraints such as lack of information and credit, and high costs were mentioned as factors inhibiting the adoption of innovations (Osuntogun et al., 1986). Past studies have also reported that the modernization of traditional agriculture in most third world countries often lead to farmers' dependence on inefficient bureaucracies (Weisenborn, 1990). While the integrated agricultural development approach implemented in many third world countries in the 1970s and 1980s were geared towards making these bureaucracies more efficient, past studies have raised questions regarding the sustainability of such projects once foreign technical and financial assistance are withdrawn (Aboyade, 1990; Lipton, 1987). This concern with sustainability has cast serious doubts on the relevance of the integrated agricultural development project approach for bringing about sustainable agricultural development in the third world countries. While the findings of this study raised some concerns regarding the sustainability of the services and infrastructure provided by the original Bida ADP, it
is not tantamount to a condemnation of the Nigerian ADP. Whatever, its shortcomings, the Nigerian ADP has become one of the cornerstones of the country's agricultural development policy. Not only have the ADPs contributed in improving the state of rural infrastructure in the country, the ADP framework has been adopted under local management in all the thirty states.

Respondents' Adoption of the Recommended Innovations

One of the major objectives of the study was to determine the impact of the rural infrastructure development and the Farming Systems Research activities conducted within the original Bida ADP, on the adoption of agricultural technologies by the farm-households operating within the project area. Specifically, the study sought to analyze the impact on the FSR projects implemented by the IITA and the NCRI within the rice-based inland valley farming systems on the adoption of technologies by the farmers. The recommended package of technologies included improved varieties, fertilizer, herbicides, seed dressing, insecticides and water control techniques along the fadama field. The findings of the study provided evidence that the implementation of the Bida ADP had a positive impact both on the farm-households' awareness and adoption of new agricultural technologies. Over 50% of the respondents became aware of the agricultural importance of agricultural inputs such as herbicides, insecticides, seed dressing and improved crop varieties after the commencement of the project.

Over 80% of the respondents reported using fertilizer in sorghum, fadama rice, and corn, compared to just over 45% who reported using different types of fertilizer at the beginning of the project in 1980 (Agricultural Project Monitoring, Evaluation and Planning Unit, 1980). However, when fertilizer adoption was analyzed on the basis of intensity of use, appropriate types of fertilizer and the
methods of application, it was observed that most of the respondents did not follow the recommended practices. The failure of the respondents to follow the recommended practices for fertilizer application has implications for fertilizer efficiency. The possibility for fertilizer losses through erosion and leaching in a humid tropical environment is great if proper application methods are not adopted.

The findings of the study revealed that the adoption of other recommended agricultural innovations, such as improved varieties, seed dressing, herbicides, and insecticides have been very minimal. For instance, only 3% of all farm-households which cultivated sorghum had adopted any improved varieties. The adoption rate for other crops included 19% for fadama rice among the FSR non-participants, 23% for corn and 31% for cowpea. While, the adoption rates for improved varieties were generally low, it was nonetheless, a marked improvement over the 3% adoption rate reported at the beginning of the project (Agricultural Project Monitoring, Evaluation and Planning Unit, 1980).

The findings of the study with regard to the adoption of herbicides and insecticides were more dismal, with less than 10% adoption rates for all the crops, with the exception of cowpea, for which 21.68% of respondents adopted the use of insecticides. When it is recognized that it is almost impossible to grow a good crop of cowpea in the area without insecticides due to high insect infestation, it becomes obvious why only a small percent of the respondents reported growing the crop. This was despite the massive campaign launched by the ADP management in collaboration with the IITA, to promote the cultivation of cowpea, a rich source of protein, as a catch crop in the fadama field after the harvest of rice. The low adoption rates achieved for insecticides and herbicides within the project area were typical of the findings of past studies in different parts of Nigeria, most of
which have also reported poor adoption rates for these inputs (Daramola, 1988 and Balcet and Candler, 1982).

The possible explanations for the general low adoption rates for agrochemicals among Nigerian farmers are many and varied. Among these, one could include such factors as their high cost, the need for very expensive complementary spraying equipment, complexity of technology and incompatibility with the local farming systems which is often characterized by mixed cropping. Mixed cropping, a system in which farmers grow two or more crops on the same plot, often makes the adoption of agrochemicals such as herbicides, very risky. Agrochemicals such as herbicides and insecticides also have the potential for constituting great health dangers in an environment where many farm-households and their livestock get their drinking water from local streams and rivers. One other possible explanation for the low levels of agrochemical adoption is the government subsidies policy which is biased against herbicides and insecticides. Most of the government's subsidies on agricultural inputs have been devoted to fertilizer, to the detriment of other agrochemicals which as a result, are often priced beyond the reach of most resource-poor farmers.

The findings of the study with regards to the proportion of the recommended package of technologies adopted by the respondents revealed that while the technologies were promoted as a package, the respondents took a different perspective in their adoption decision. The respondents were not only selective in their adoption decision, they tended to adopt the technologies in a step-wise and piece-meal manner, adopting only those components they considered very critical to their farming systems. On the basis of this analysis, fertilizer was likely to be the first technological component to be adopted, followed by improved varieties.
Farmers seemed, however, to have recognized the high demand of improved varieties for nutrients, hence the adoption of modern varieties seemed to be accompanied by the adoption of fertilizer. However, with the other technological components such as herbicides, seed dressing, insecticides and water control, such as a packaged adoption was absent. This finding is in consonance with the findings of other similar studies in different parts of the third world, where similar piece-meal, stepwise adoption has been reported (Byerlee and de Polanco, 1986; Merrill-Sands, 1986; Ryan and Subrahmanyam, 1975).

Based on the findings discussed above, it is concluded that while the implementation of the original Bida ADP had contributed to increased technology adoption among the farm-households, it is arguable whether the level of achievement is commensurate with the huge human and financial investment that was committed to the project. The project seemed to have been under-girded by a structuralist theoretical assumption that there were available locally adapted technologies, and that their non-adoption could be attributed to the poor state of the rural infrastructure and other agricultural support services within the area. The findings of the study, however, seemed to suggest that such an assumption may have been misguided. For instance, while the improved varieties of fadama rice promoted by the project were superior to the traditional varieties in terms of yield, they were however inferior in terms of weed and pest resistance. The situation as it applied to sorghum, the staple food crop of the area, was even worse, because most of the so-called improved varieties were not locally adapted, hence their rejection by the farmers. It is therefore, the conclusion of the study that, given the short supply of locally adapted technologies, some of the project's investment in rural infrastructure development could have been put to better use in adaptive
research in order to adapt available technologies to the local environment. Similar conclusions have been made by other past researchers who had evaluated the integrated agricultural development project approach (Aboyade, 1990; Lipton, 1987).

Impact of FSR on Technology Adoption

One of the major goals of the study was to determine the impact of the FSR projects implemented by the IITA and the NCRI within the inland valley systems of original Bida ADP, on the adoption of rice-production technologies by the farm-households. It was hypothesized that there was a significant difference between FSR participants and non-participants, in their levels of innovation adoption. When FSR participants and non-participants were compared in terms of the proportion that have adopted different technologies, the findings of the study were not clear-cut. While a higher proportion of FSR participants had adopted insecticides, improved rice varieties, and water control techniques; non-participants on the other hand had achieved a higher adoption rate for seed dressing than FSR participants. FSR participants and non-participants were, however, not different in terms of the proportion that had adopted fertilizer and herbicides and their overall adoption index. The most significant difference was in terms of the adoption of improved rice varieties where 73.15% of FSR participants compared to 18.94% of non-participants had adopted improved rice varieties. In the same vein, while 81.88% of participants have adopted water control measures along their fadama fields, only 64.02% of non-participants had adopted similar practices.

However, when FSR participants and non-participants were compared in terms of the intensity of technology adoption, the former showed a clear advantage over the latter. For instance, while modern rice varieties accounted for 52% of the
total holding for FSR participants, the coverage for non-participants was just 15%. Similarly, the average fertilizer input of 4.91 bags per hectare for FSR participants was statistically higher than the mean fertilizer input of 3.61 bags recorded for non-participants. Hence, when everything is taken into consideration, it can be concluded that farmers who had participated in the FSR projects within the inland valleys achieved a higher technology adoption rate than non-participants.

The findings of the study with regards to the impact of farmers' participation in FSR on technology adoption have some implications for the future direction of the FSR perspective. Over the past few years, there seemed to have been a gradual waning of the initial enthusiasm that accompanied the implementation of FSR projects in many third world countries in the 1970s and 1980s. This enthusiasm has been replaced in many quarters by serious doubts regarding the comparative advantage of the approach over traditional transfer of technology approaches (Chambers and Jiggins, 1987; Marcotte and Swanson, 1987 and Heineman and Biggs, 1985). When it is recognized that the FSR project implemented by the IITA did not have a technology transfer objective, and that the project implemented by the NCRI was still in its infancy, the projects should be commended for even making such an impact on farmers' adoption of technology.

The on-farm adaptive research activities of the IITA within the Bida inland valleys were essentially devoted to the testing the adaptability of prototypes of fadama rice technologies within the local agroecology, hence farmers' participation were often limited to either the contract or the consultative modes described by Biggs (1980). Hence most of the on-farm adaptive research (OFAR) consisted of either researcher-implemented-researcher-managed or researcher-implemented-farmer-managed trials. As a result, the level of farmers' participation was limited
mostly to the contract and consultative participation modes described by Biggs (1989). The situation was further complicated by the low level of interface between the IITA’s adaptive research team and the ADP’s agricultural extension service. It was observed during data collection that, while the FSR project in the Bida inland valleys began as a collaborative endeavor between the IITA and the Bida ADP (Ashraf and Sinner, 1983), this collaboration was all but gone. It was also observed during data collection that while many of the respondents showed a lot of enthusiasm for IITA’s technologies, they however, expressed frustration that the institute’s activities within the area did not include a technology transfer component. Hence, the fact that the FSR participants were still able to achieve higher technology adoption than non-participants, despite the deficiencies highlighted above, was a clear testament to the positive impact of farmers’ involvement in technology development. It goes to show that the FSR/E perspective could be a strong vehicle for stimulating technology adoption by resource-poor farmers, if proper interface with agricultural extension and other support services could be established and maintained.

Given the result of other studies, which reported similar occurrence of spontaneous adoption (Worman et al., 1990), it is contended that rather than discard the FSR/E approach, its present mode of implementation should be reevaluated with special emphasis on the need for greater farmers’ participation and the development of institutional linkages between FSR, agricultural extension and other support services. It has now become clear that some of the initial high expectations, such as FSR/E as a panacea, and that with direct researcher-farmer contact the need for extension interface would be minimized, have all been proven to be totally misguided (Ortiz and Meneses, 1991; Landeck, 1991; Ewell, 1989;
McDermott, 1987; Johnson (III) and Claar, 1986; Kellogg et al., 1983). To the contrary, based on the findings of the study, it is concluded that the FSR/E approach will be successful as a vehicle for stimulating agricultural development in proportion as it establishes and maintains close contact with the extension and other agricultural support services. Failing this, the approach might end up being discarded like many other failed development acronyms.

**Significant Variables Predictive of Innovation Adoption**

One of the overarching objectives of the study was to determine the relevance of variables characteristic of the classical diffusion, the institutional constraint and the technology-related models, to the explanation of technology adoption by resource-poor farm-households within the original Bida ADP. Hence, the study was under-girded by an interdisciplinary conceptual model which incorporated variables related to the respondents' human capital and resource endowment, their access to agricultural support services and their perceptions of the comparative advantages of recommended technology. In comparison with most other past social science studies using multiple regression analysis, the models used in the present study were effective in predicting farmers' adoption of innovation. For instance, the regression model for predicting farmers' adoption of improved rice varieties accounted for over 46 percent of the variance, a fairly high prediction for a social science study.

The findings of this study on the relevance of classical diffusion variables in predicting the respondents' adoption of fertilizer, modern rice varieties and their overall adoption index, produced negative results. Variables characteristic of the classical diffusion paradigm such as respondents' personal and farm firm characteristics and their communication behavior were poor predictors of the level
of innovation adoption. For instance, the findings of the study using a multiple regression analysis of the variables predictive of the intensity of rice MV adoption showed that institutional constraints variables and farmers' perceptions of the relative advantage of rice MV were the best predictors of farmers' adoption. The single most important predictor of the intensity of MV rice adoption was the farmer's participation in the FSR projects. The variable accounted for 22.98% of the variance in adoption of rice MV. The next most important predictor of MV adoption was the farmers' perceptions of the comparative profit advantage of MV over traditional rice varieties. This factor accounted for 8.23% of the variance in adoption. The only variable usually included under the classical diffusion paradigm which yielded a significant prediction was the respondents' age which, in addition to having a negative coefficient, only accounted for a small proportion of the variance in MV adoption. However, variables associated with the institutional constraint and technology models, such as access to input supply, irrigation facilities, total income, perceptions of comparative yield, accessibility, early maturity, and profitability advantages of MV over local varieties, emerged as significant predictors.

The study also arrived at similar findings on variables predictive of fertilizer adoption intensity, and the overall adoption index of the respondents. Only variables characteristic of the institutional constraint model, such as access to input supply depot, irrigation facilities, extension services, level of participation in adaptive research and level of commercialization, emerged as statistically significant predictors. The respondents' personal and farm firm characteristics, with the exception of farm size which had a negative regression coefficient, were not significant predictors of fertilizer adoption. The findings of the study seemed to
provide support for current argument within the innovation adoption literature, which contends that the classical diffusion paradigm might be inappropriate for explaining innovation adoption in the third world (Shaw; 1987; Merrill-Sand, 1986; Ashby, 1980; Myren, 1974).

It is contended that while the classical diffusion model has made great contributions to our knowledge about the innovation-adoption process, its application in third world countries is limited by its assumption that the main constraint to innovation-adoption is the psycho-social inadequacies of the farmers, which are perceived as not being conducive to innovative behavior (Rogers, 1983). The findings of the study suggested that the non-adoption of the recommended technologies by the farm-households within the original Bida ADP, could not be attributed to any personality inadequacies, but to the institutional and structural constraints which made innovation adoption non-achievable for the farm-households. Among these constraints were lack of or inadequate access to agricultural support services such as extension, input supply, irrigation facilities, and agricultural credit, and the inappropriateness of some of the recommended technologies for the farming systems constraint and opportunities that confronted the farmers.

Similar findings, which raise doubts about the relevance of the classical diffusion paradigm to the study of innovation adoption in the third world, have been reported in many past studies, (Jansen et al., 1990; Daramola, 1988; Shakya and Flinn, 1986; Shaw, 1985; Tautho et al., 1985). In a study of the technical and economic factors predictive of the adoption of rice-production technologies in the Philippines, Tautho et al. (1985), reported that only institutional and structural variables such as farm size, landscape position, fertilizer availability, cooperative
membership and extension contact were significantly related to the adoption of innovation at the 10% level of probability. However, human capital variables such as education, tenure and size of family labor force were not significant. In another study conducted in Oyo State, in southwestern Nigeria, Daramola (1988) reported that only institutional and structural variables such as farm income, distance from source of farm inputs, amount of credit available and distance from produce market were significant, while frequency of extension visits and membership in a cooperative society were not.

On the basis of the findings of this study regarding the variables predictive of farmers' adoption of recommended agricultural innovations, a modified conceptual model, graphically presented in Figure 22, is recommended for future study of innovation adoption among resource-poor farmers. One of the implications that could be drawn from this study is the need to explore the impact of the interaction among and between the sociocultural, technological and institutional sub-systems, in determining farmers' adoption of innovations. For instance, farmers' perceptions of the appropriateness of recommended technologies is often dependent on institutional factors such as participation in technology development, and access to agricultural extension, input and rural infrastructure.

Secondly, the definition of classical diffusion variables such as farmers' education should reflect local sociocultural realities. For instance, in an area dominated by the Islamic religion, the operational definition of farmers' education in terms of years of formal western education may not be appropriate. Instead, the use of indigenous educational variables such as years of exposure to Koranic education or other relevant indigenous knowledge systems may be more appropriate.
Figure 22. Modified conceptual model for the study of innovation adoption by resource-poor farmers.
Impact of Project on the Living Standards of the Farm-households

In order to evaluate the impact of the original Bida ADP on the farm-households, an analysis of changes in pre-project material resources of the households and their material possessions during the survey was carried out. The study found that there was a marked positive change in the households' wealth between the period before the implementation of the Bida ADP and now. For instance, the households' wealth measured in terms of their possession of household and agricultural equipment such as wrist watches, buildings with metal roofing, radios, televisions, iron beds, wall clocks, bicycles and motor-bikes, livestock, granaries, milling machines, grinders and tractors, showed a significant positive growth since the implementation of the project. The positive growth in the average number of granaries per farm-family from 1.74 before the project to a new average of 2.96, was especially significant, because it signified increased crop production, because granaries are indigenous storage facilities for storing excess farm produce. Similarly, the concurrent increase both in the proportion of households owning metal-roofed buildings and the mean possessions per household, is indicative of an improvement in household living standards. This conclusion is based on the fact that the conversion from thatched-roof buildings to iron-sheet roofing is regarded within the area to represent an upward movement along the socioeconomic status continuum. This was further attested to by the decrease in the proportion of households who owned thatched-roof buildings. While, it is difficult to establish a direct cause and effect relationship between the implementation of the Bida ADP and the improvement in the living standard of the farm-households, it is safe to conclude that the period marking the implementation
of the project was accompanied by a significant positive change in the living standard of the farm-households residing within the project area.

Implications of the Findings of the Study for Agricultural and Extension Education

The findings of the study have several implications for agricultural development in general, and agricultural extension education specifically. The study was carried out within the back-drop of the continuing search for appropriate models for achieving sustainable agricultural development in the third world countries. Over the last three decades, different models of agricultural development, including the Green Revolution, the integrated rural development and the FSR/E approach, have been adopted, with mixed results. The study evaluated a major agricultural development project in the middle-belt region of Nigeria, which incorporated both the integrated agricultural development and the FSR perspectives. The findings of the study revealed that, while the implementation of the two approaches within the project differed in form, both were under-girded by a similar technological deterministic orientation. The technological deterministic perspective is characterized by the assumption that the solution to the problem of agricultural underdevelopment in the third world countries lies in the introduction of productivity-enhancing technologies into their agricultural production systems. While technological stagnation is a major factor in the agricultural underdevelopment of many third world countries, it only represents a piece of the puzzle in the whole agricultural development process. While, the project evaluated in this study placed a lot of emphasis on the development and testing of productivity enhancing technologies, its failure to pay adequate attention to the other institutional constraints confronting the farmers, such as inadequate infrastructure for technology delivery, constituted a major setback to its success.
The implication of this conclusion is that the present approach in many agricultural development projects, of attempting technological-fixes to the complex and multifaceted problems of agricultural underdevelopment in the LDCs, is unlikely to achieve substantial success. Achieving agricultural development in the LDCs will involve a holistic perspective, incorporating all the critical factors germane to the achievement of sustainable development. In addition to the development and dissemination of appropriate technologies, attention needs to be focused on the institutional, the policy, sociocultural and agroecological sub-systems involved in the organization of the agricultural production system.

One of the major findings of this study, with several implications for agricultural development, relates to the low level of farmers' participation in the FSR project. In many instances, most of the OFAR activities were researcher-dominated, with the farmers having very minimal input into the setting of research agenda. For instance, the FSR projects implemented within the project area focused mainly on lowland rice, a largely commercial, male-dominated crop, while the major staple of the area, sorghum, received little attention, thus constituting a possible disarticulation between farmers' production objectives and the research agenda. Because, similar findings have been reported elsewhere (Sumberg and Okali, 1988; Chambers and Jiggins, 1987; Hilderbrand and Poey, 1985) there is a great need for developing appropriate modalities for enhancing farmer participation in the agricultural development process. Agricultural extension service, which works more closely with farmers, should be actively involved in setting research agenda for FSR/E. FSR/E ought to move beyond testing technologies on farmers' field to include farmers' involvement as active participants in the whole development process.
While it is easy to implement changes in methodologies, it is much more difficult to bring about changes in institutional philosophy and management. Merely incorporating a FSR/E model into the existing system, without a concomitantly restructuring of the top-down organizational structure of many national agricultural research and extension systems in many less developed countries has little chance for achieving sustainable agricultural development. Agricultural development should move beyond mere farmers' involvement to include empowerment. As long as the locus of control of agricultural development continues to reside within bureaucratic and political institutions, so long will the attainment of the goal of participatory sustainable development remain an illusion. Farmers should be empowered through education and decentralization to enable them take control of their development, while government and its institutions act as catalysts. The attainment of this goal of organizational restructuring and empowerment is a major challenge for agricultural and extension education.

The findings of the study on the poor linkages among the adaptive research unit, the extension services and other agricultural support components, such as input distribution, has several implications. The road to sustainable agricultural development in the less developed countries must necessarily involve a multi-faceted and multi-institutional approach. A mere change from top-down on-station research to a participatory on-farm adaptive research approach, without a concomitant change to a bottom-up agricultural extension and input distribution systems and the development of strong interface among these sub-systems will never bring about sustainable development in third world countries. This finding of the study supports the notion that the FSR/E approach would be a vehicle for achieving sustainable agricultural development in the third world countries only in
proportion to which it is accompanied by changes in other agricultural institutions and services, and to the extent that a strong linkage is maintained among these sub-systems. In order to achieve this goal, a lot of effort will need to be devoted to enhancing the institutional capacities of the National Agricultural Research and Extension Systems of third world countries. The achievement of this objective requires a major investment in agricultural education and training.

The finding of the study with regards to the inability of the now expanded Niger State Agricultural Development Project to sustain the quality of the agricultural support services provided during the Bida enclave project has several implications for agricultural extension. One of the major fall-outs of the implementation of the Training and Visits extension model in many third world countries was to divest extension personnel from their traditional agricultural input procurement and distribution responsibilities. However, the findings of the study revealed that the structure for input distribution within the project area was dysfunctional. Since the effectiveness of agricultural extension personnel depends to a great extent on the proper functioning of other agricultural support services, the issue of the relationship between the extension service and these other services demands further examination.

One of the most significant findings of the study, which also has implications for future studies of innovation adoption in the less developed countries, was the failure of respondents' personal and farm firm characteristics which are characteristically included in the classical diffusion paradigm to emerge as significant predictor variables for innovation adoption. One of the implications to be drawn from the findings of the study relates to the operational definition of some of the classical diffusion variables. For instance, the operational definition of farmers'
level of education may have to reflect local realities. In an area where Islam is the
dominant religion and where formal western education is minimal, proxy variables
such as years of Islamic education, or other relevant indigenous knowledge
systems may be more appropriate.

The debate over the relevance of the classical diffusion paradigm to the
prediction of innovation adoption among resource-poor farmers in the less
developed countries has remained a subject of great controversy in the agricultural
development literature for decades (Shaw, 1987; Chambers and Jiggins, 1987;
Merrill-Sand, 1986; Beltrans, 1976). The findings of the study would seem to
support the conclusions of people such as Chambers and Jiggins (1987);
Bordenave (1976) all of whom have argued that the classical diffusion model may
be inappropriate for explaining why agricultural innovations are adopted or
rejected in the less developed countries, because of its failure to focus on the
peculiar sociocultural, agroecological, and institutional conditions impinging on the
innovation adoption-decision of resource-poor farm-households who dominate
agricultural production in the third world countries.

The findings of the study related to the selective and sequential adoption of
technology package by farm-households has a lot of implication for technology
transfer in the less developed countries. Many past technology transfer efforts in
the LDCs have been a package of agricultural innovations usually including
improved varieties, fertilizer and other complimentary agrochemical input. In most
cases, there is a synergistic interaction among the different technological
components, and hence the adoption of one component without the others often
means the loss of comparative advantage over traditional practices. However,
many past studies, including the present, have shown that rarely do resource-poor
farmers adopt innovations as a package (Byerlee and Polanco, 1986), hence the package of technology approach may be inappropriate for resource-poor farm-households. Hence, "the basket of choice" approach as espoused by Chambers (1989, p. 182), in which resource-poor farmers can choose appropriate technologies from multiple technological options, is deemed a more appropriate approach to technology transfer in the LDCs. This not only calls for major investment in adaptive research, but a new approach to technology development in which farmers are not just mere recipients of packaged technologies, but become active participants in the whole technology development process. For this to happen demands major institutional and structural changes within the various subsystems (research-extension-farmers and public policy) involved in the whole agricultural development process.

Finally, the findings of the study regarding the decline in the quality of agricultural support services between the periods when the ADP was an enclave project and after the project under an expanded locally managed state-wide project raises questions regarding project sustainability. The findings of the study also revealed that agricultural services such as input distribution, and tractor hire services have been transferred to the political institutions of local government authorities. The implications of such findings are many and varied. First and foremost the recent emphasis in agricultural development on large-scale complex projects may not be sustainable. Secondly, the role of local institutions in project conceptualization and implementation deserves greater attention in future agricultural development effort. The findings of the study revealed that farm-households do not operate in isolation, in fact they often operate within locally adaptive clusters such as extended families, as members of labor pools and other
cooperatives societies that could be harnessed as partners in the agricultural development effort. Past development efforts haven't seemed to have tapped these resources to the fullest.
CHAPTER VI. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This purpose of this chapter is to give a general overview of the objectives, the methodology and major findings of the study. The chapter is organized along the following sub-sections: (1) Brief summary of the background to the study (2) Summary of the study's methodology (3) Summary of the major findings and conclusions (4) Recommendations for future agricultural development in the LDCs and (5) Recommendations for further studies.

Background to the Study

The study was carried out against the back-drop of the continuing search for appropriate models for achieving sustainable agricultural development in the third world. An analysis of agricultural development efforts in the third world over the last three decades would reveal that, while significant progress has been made, the overall picture is one of movement in a circle of hope and despair. In the 1960s, when the modernization theory was the dominant paradigm of development, there was a general feeling of optimism that the Green Revolution technological break-through within the CGIAR network of international research centers would bring about the transformation of traditional agricultural systems in the third world countries in line with those of the developed countries. Hence, agricultural development was conceptualized within the classical transfer of technology model, in which high yielding crop varieties and other complimentary external inputs such as fertilizer were transferred mainly from the developed countries, for adoption by innovators and early adopters, in the hope that the demonstration effect would result in a trickle-down transfer of technology to the resource-poor farmers. The fallacy of such a trickle-down effect has become part of history, as results of past studies have revealed that not only was practically the
whole of sub-Saharan Africa left out of the development loop, but even in Asia and
Latin America where the Green Revolution technology had remarkable impact,
many resource-poor farmers were left out in the cold (Chambers and Jiggins, 1987,
Chambers and Ghildyal, 1985).

The concern with the negative distributional consequences of the classical
modernization theory of agricultural development in the third world countries
(Feder, 1983) led to the emergence of the structuralist theory of agricultural
development, which contended that the major impediment to technology transfer in
the third world countries was the absence of appropriate rural infrastructure and
institutional support. It was, therefore, argued that a huge investment in the
development of these rural infrastructure and other institutional support services,
such as agricultural extension services, irrigation and input distribution facilities,
was the key to rapid agricultural development. This formed the basis for the
massive integrated agricultural development projects (IADP) funded by the World
Bank in many third world countries in the 1970s and 1980s (Blackwood, 1988).

While the IADPs were still being implemented in many developing countries,
the FSR/E perspective emerged as a bottom-up alternative to what was then
termed the prevalent top-down approaches to agricultural development. Brynes
(1990) identified the followings as the characteristics of the FSR/E approach: it is
farmer-oriented; involves the active participation of the clientele; a recognition of
the location specificity of technical and human factors; a problem-solving and
systems orientation; the involvement of an interdisciplinary team; and, an emphasis
on research-extension-farmer linkages. However, like other past models of
agricultural development, the FSR/E perspective which generated so much hope in
the mid 1970s and 1980s, is in the process of being jettisoned for other newly
emerging models of agricultural development. For instance, Norman (1989), one of the founding fathers of the FSR/E, observed that the enthusiastic response that accompanied the introduction of the approach in the early 1970s and 1980s is giving way to a measured withdrawal of support from the donor community.

It was against this background that the study was set up to evaluate the impact of the rural infrastructure development and the FSR approach on technology adoption by resource-poor farmers in the middle-belt region of Nigeria. The specific purpose of the study, therefore, was to assess the impact of farmers' participation in farming systems research, and their access to rural infrastructure and agricultural support services, on the adoption of agricultural innovations by farm-households within the original Bida agricultural development project area, located in the middle-belt region of Nigeria.

Summary of Research Procedures

The study adopted a descriptive research design. It was also conceptualized along the systems approach espoused by the FAO (1989a). Hence, the study was under-girded by the following principles:

1. Emphasis on an holistic view of the farming systems.
2. Recognition of the interactions of components inside (endogenous) and outside (exogenous) the farming system, and their impact on the farm-households.
3. Emphasis on systems hierarchy, whereby every system is part of a larger system and itself consists of subsystems.

On the basis of this theoretical framework, data collection was under-girded by an interdisciplinary conceptual model which incorporated relevant variables from the Farm-Household Systems model (FAO, 1989a) and the interdisciplinary behavioral differential model developed by Leagans (1979). At the center of the
model is the farm-household with its multiple goals and objectives, its endowments in human capital and material resources. This is the endogenous subsystem within the model. Impinging on the farm management decision of the farm-household, including technology adoption-decision, is an array of other major exogenous subsystems which include the agroecological, the sociocultural and the policy/institutional components or subsystems. The agroecological environment includes variables such as climate, soils, topography, water, vegetation and infrastructure. The sociocultural environment consists of the social norms, the cultural values and the intra-household variables that impact the organization of the local farming systems. The policy/institutional environment consists of policy decisions, research, extension and other agricultural support services, e.g. input distribution, credit, marketing, etc. (FAO, 1989a:15-17). It is the interaction within and among these different subsystems that determine the opportunities and constraints for developing the farm-household systems.

The population for the study consisted of all the farm-households operating within the original Bida ADP, which has now been incorporated within the expanded Niger State ADP. The project area was estimated to contain 63,000 farm-households in 1983. Using the World Bank's estimated population figure of 405,200 for the project area in 1978/79, and the widely applied annual growth rate of 2.5%, the area in 1990/91 was projected to contain a population of 544,948. The subjects for this study consisted mainly of male household heads. However, in order to explore the gender angle to the organization of the farming system and also because of the recognized inherent danger of assuming the farm-household unit as having non-conflicting homogeneous production and consumption goals (Fapohunda, 1987; Guyer and Peters, 1987); women farmers were included in both
the group and individual interviews. However, because of sociocultural constraints which created a communication barrier between male stranger and local women, the bulk of the data for the study came from male-headed farm-households. It was almost impossible to identify any female-headed households in some of the selected villages.

Data collection was carried out in the following three stages: (1) Exploratory qualitative non-structured focus group interviews in ten randomly selected villages within the project area. (2) The second phase of data collection which focused on the evaluation of the rural infrastructure development activities of the Bida ADP, involved individual structured interviews with 364 farm-households' heads selected from twenty randomly selected villages. (3) The third phase of data collection involved structured interviews with 149 farm-households' heads who had participated in the FSR projects implemented by the IITA and NCRI within the rice-based inland valleys located within the Bida ADP area.

During the first phase of data collection, a three-stage cluster-sampling procedure was adopted. The primary sampling frame consisted of the geo-political parameter of local government areas (equivalent to county area). Each local government area, except Gbako, the administrative headquarters, which had four, was divided into two extension administrative blocks, by the ADP management, giving a total of ten blocks. From each extension block, one village was randomly selected, giving a total of ten villages. With the assistance of the respective Block Extension Officers, and the village leadership, a purposive representative sample of 8-10 farmers was selected from each village for the group interviews. Because of cultural norms which prevented joint interview with both men and women, a
special group interview was conducted with a women's group in one of the villages that had a well established women's extension program.

Since there was no existing sampling frame containing a list of all the farm-households operating within the project area, and because of the impracticality of developing one, a multistage cluster-sampling frame was also adopted during the second phase of data collection. The project management's master list in which all the villages and wards were classified into hierarchical clusters of areas, blocks, cells, and sub-cells was used for cluster sampling. An area constituted the largest cluster, with the whole project area consisting of four extension areas, each equivalent to a Local Government Area. Each area was sub-divided into extension blocks. In all, the four areas were divided into 10 blocks. Each block was further divided into eight cells, each of which was in turn divided into eight sub-cells. Hence the cells, which were either equivalent to villages or wards, depending on size and population, were the smallest clusters within the hierarchical arrangement.

From these hierarchical clusters, a multistage random cluster sampling, first of blocks and then cells, and finally of sub-cells resulted in the sampling of twenty villages/subcells - two from each block. Because the study sought to analyze the impact of access to irrigation facilities on farm-households' adoption of technologies, one of the two villages with access to formal irrigation facilities was randomly selected as part of the twenty selected villages. With the assistance of the local village or ward head and the extension agent, a census of all farm-households was conducted in each of the selected villages. From this list, a random sample of twenty farm-households was drawn for each village, to participate in the individual interview. In all 400 respondents were selected.
However, either because some of the respondents declined to participate in the interview or due to incomplete information, only 364 respondents (337 males and 27 females), provided data for the first phase of structured interview, representing a 91% response rate.

Because of the limited number of FSR participants, all of the 149 farm households in five villages who had participated in the on-farm adaptive research implemented by the IITA and the NCRI, were included in the third phase of data collection. Because the main focus of the FSR activities was on the development of appropriate technologies for rice-production within the inland valleys systems, data collection focused exclusively on fadama rice production. In all, a total of 513 farm-households' heads were interviewed from 25 selected villages within the project area, in addition to the ten group interviews conducted in ten villages. In addition to the primary data discussed above, secondary data were collected from past project's reports and through informal discussions and interviews with key personnel within the project's management.

The instruments used in data collection consisted of an unstructured interview guide used for group interview and the two interview schedules (questionnaires) used during the second and third phases of data collection. The content analysis approach was adopted in the analysis of the qualitative data collected during group interviews. The data collected during the two phases of structured interviews were coded and loaded onto the SAS statistical package on the computer main frame for analysis. The data were then analyzed using a combination of both descriptive and inferential statistical treatments such as frequencies distribution, percentages, means, standard deviations variances, chi-square, t-test, and multiple regression analysis.
Summary of Findings and Conclusions

1. **The human capital characteristics of the respondents:**
   The respondents varied widely in their age distribution, from a minimum of twenty years to over 80 years. The modal age group was 30-39 years, while the mean age was 44.37 years. However, 34.9% of the respondents were aged 50 years and older. On education, it was found that a vast majority of the respondents (81.6%) were illiterate. In terms of family size and structure, most of the respondents had large families with 65.7% operating within the extended “Efako” family units. The mean family size per household was 9.4 members. On social participation, it was observed that there was a high degree of social integration within the population. Not only was agricultural production organized along the extended family units, the majority of the respondents belonged to more than one agricultural cooperative association. For instance, over 80% of the respondents belonged to a cooperative group farming society and exchange labor pools, while over 65% belonged to a cooperative saving association.

2. **Farm firm characteristics of the respondents:**
   The respondents consisted mainly of resource-poor farm-households' heads whose agricultural production was organized within family units, with the members providing most of the labor. Each of the farm-households cultivated small holdings of different crops, each averaging just over two acres in size. The distribution of agricultural tasks among family members showed gender sensitivity, with the males providing the bulk of the labor for pre-harvest tasks, while females had major responsibility for post-harvest activities. The household head, who almost always was the most senior male within the family,
took most of the agricultural production decisions after consultation with key members of the family. The dominant land tenure arrangement for most of the respondents was inheritance. Over 75.68% of respondents reported to have inheritance rights over their cultivated fields, while only 15.5% rented their fields. It is, however, pertinent to note that the traditional norms regarding inheritance rights were biased against women, who had no land inheritance rights, and hence relied on their husbands for land for farming. This gender bias in resource distribution also extended to the distribution of access to family labor where the male household heads have almost absolute control. Hence, most of the few women involved in individual cultivation tended to farm smaller holdings and relied more on hired labor. This factor, in concert with other sociocultural norms such as the dominant Islam religion, could explain why very few women were involved in individual crop production.

3. Farmers' access to agricultural support services:
A large proportion of the farm-households did not have access to critical agricultural support services such as agricultural extension, credit, input supply and irrigation facilities. Over 50% of the respondents did not have access to extension services, while a much bigger percent, over 70% did not have access to input supply centers, and over 90% of all respondents did not have access to agricultural credit and irrigation facilities. Women respondents were worse off, with none of them being involved in the FSR project implemented in the inland valleys. On sustainability of project' services since its expansion to a state-wide project, most of the respondents rated the quality of extension services, input distribution, credit and tractor hire services as lower now, than they were during the implementation of the ADP as an enclave project. For
instance, while only 16.2% of the respondents rated the quality of extension services during the enclave project as poor, the percent who rated the quality of extension service as poor has risen to 31.7%.

4. Farmers' perceptions of constraints to innovation adoption and the appropriateness of recommended technologies:

While the major focus of the project was on the development of rural infrastructure and agricultural support services, still over 40% of the respondents mentioned inadequate facilities for input distribution, high cost and inaccessibility as the major constraints to the adoption of fertilizer and seed dressing. Over 70% of respondents mentioned high cost, lack of access, incompatibility with farming systems, technology complexity, high labor requirement and lack of information, as serious constraints to the adoption of insecticides, herbicides, and mechanization. An analysis of the findings regarding the respondents' perceptions of the comparative advantage of the recommended modern varieties over traditional fadama rice varieties, revealed that the former did not possess a clear-cut advantage over the latter. While MV were perceived by a majority of the respondents as being superior in such characteristics as yield, early maturity, taste, and profitability, a similar majority however, rated them inferior to traditional varieties in terms of pest resistance, weed tolerance, storage quality and accessibility.

5. The adoption of the recommended innovations:

The recommended package of technologies included improved varieties of rice, sorghum, cowpea and corn and complimentary inputs such as fertilizer, herbicides, seed dressing, insecticides and water control techniques along the fadama field. The findings of the study provided evidence that the
implementation of the Bida ADP had a positive impact both on the farm-households' awareness and adoption of new agricultural technologies. Over 80% of the respondents reported using fertilizer in sorghum, fadama rice, and corn, compared to just over 45% who reported using different types of fertilizer at the beginning of the project in 1980. However, when fertilizer adoption was analyzed on the basis of intensity of use (appropriate fertilizer types and methods of application) it was observed that most of the respondents did not follow the recommended practices. The adoption rates for other recommended agricultural innovations, such as improved varieties, seed dressing, herbicides, and insecticides were very minimal. For instance, only 3% of all farm-households who cultivated sorghum had adopted any improved varieties. The adoption rates for the MV of other crops included 19% for fadama rice among the FSR non-participants, 23% for corn and 31% for cowpea. The adoption rate for herbicides and insecticides were more dismal, with less than 10% adoption rate for all the crops, with the exception of cowpea, in which 21.68% of respondents adopted insecticides. On the proportion of the recommended package of technologies adopted by the respondents, it was observed that while the technologies were promoted as a package, the respondents took a different perspective in their adoption decision. The respondents were not only selective in their adoption decision, they tended to adopt the technologies in a step-wise and piece-meal manner, adopting only those components they considered very critical to their farming systems. Based on the findings discussed above, it is concluded that while, the implementation of the original Bida ADP had contributed to increased technology adoption among the farm-households, it is arguable whether the level of achievement is
6. **The impact of farmers' participation in FSR on technology adoption:**

When FSR participants and non-participants were compared in terms of the proportion that have adopted different technologies, the findings of the study were not clear-cut. While a higher proportion of FSR participants had adopted insecticides, improved rice varieties, and water control techniques, non-participants on the other hand had achieved higher adoption rate for seed dressing than FSR participants. FSR participants and non-participants were, however, not different in terms of the proportion that had adopted fertilizer and herbicides and their overall adoption index. The most significant difference was in terms of the adoption of improved rice varieties where 73.15% of FSR participants compared to 18.94% of non-participants had adopted improved rice varieties. However, when FSR participants and non-participants were compared in terms of the intensity of technology adoption, the former showed a clear advantage over the latter. For instance, while modern rice varieties accounted for 52% of the total holding for FSR participants, the coverage for non-participants was just 15%. Similarly, the average fertilizer input of 4.91 bags per hectare for FSR participants was statistically higher than the mean fertilizer input of 3.61 bags recorded for non-participants. Hence, when everything is taken into consideration, the findings of this study provided support for the hypothesis that there was a significant difference in the adoption of recommended agricultural innovations between FSR participants and non-participants. It was therefore, concluded that farmers who had
participated in the FSR projects within the inland valleys, achieved higher technology adoption rate than non-participants.

7. The variables predictive of innovation adoption

Of all the variables included in the interdisciplinary conceptual model developed to predict the farm-households' adoption of innovation, only those related to the institutional constraint and technology-related models were significant. On the contrary, most variables characteristic of the classical diffusion model such as respondents' personal and farm firm characteristics such as age, level of education, farm size, income, and family size were not significant in predicting differential level of innovation adoption. For example, a multiple regression model developed to predict respondents' adoption of improved fadama rice varieties showed that farmers' participation in FSR, their perceptions of the comparative yield, accessibility, early maturity, and profitability advantages of MV over local varieties, their access to input supply, irrigation facilities, and total income, were the significant predictors. It can therefore, be concluded that the classical diffusion model might not be appropriate for explaining why farmers did not adopt the recommended technologies within the original Bida ADP. Variables characteristic of the institutional constraint model, and technology-related variables, however, emerged as the best predictors of innovation adoption. The findings of this study, therefore, provided support for the hypotheses that institutional constraint and technology-related variables were good predictors of farm-household's adoption of agricultural innovation. However, the hypothesis regarding the impact of classical diffusion variables such as farm size, age, education and family size, on innovation adoption was not supported.
8. The impact of the project on the living standards of the farm-households:

The study found that there was a marked positive change in the households' material possessions between the period before the implementation of the Bida ADP and now. For instance, the households' wealth, measured in terms of their possession of household and agricultural equipment such as wrist watches, buildings with metal roofing, radios, televisions, iron beds, wall clocks, bicycles and motor-bike, livestock, granaries, milling machine, grinders and tractors, showed a significant positive growth when compared to the baseline data collected just before the commencement of the project in 1980. While, it is difficult to establish a direct cause and effect relationship between the implementation of the Bida ADP, and the improvement in the living standard of the farm-households, it is safe to conclude that the period marking the implementation of the project was accompanied by a significant positive change in the living standards of the farm-households residing within the project area.

Recommendations for Actions

On the basis of the findings of the study, the following recommendations for future action are put forward.

1. The rapidity with which new models of agricultural development are propounded, only to be discarded, seems disruptive of long-range agricultural development planning in many third world countries. With the ever-changing dominant paradigms of agricultural development, many NARS in the third world countries are often constantly struggling to keep up with the demands of implementing the continuous stream of newly emerging models. For instance, while many third world countries are just in the process of institutionalizing the FSR/E approach within their national research/extension systems (Merrill-
Sands et al., 1990), the approach is slowly being de-emphasized by the major international agricultural development institutions. Past agricultural development efforts seemed to have been too concerned with short-term solutions to long-term problems of agricultural stagnation in the LDCs. It is however, the researcher's contention that the road to sustainable agricultural development in the third world countries will entail more long-range development planning. The present practice of attempting quick-fixes through the development of new models of agricultural development, only to be discarded after few years, is counterproductive. Hence, rather than discard the FSR/E approach in search of a new quick-fix model, it is recommended that what needs to be done is to re-evaluate the approach as it is presently being implemented, in order to make it more responsive to the needs of resource-poor farmers in the third world. Issues that ought to attract high priority include strengthening linkage between FSR and the agricultural extension and other agricultural support services; and greater involvement of farmers in the whole technology development process. The development of the institutional capacity of the National Agricultural Research and Extension Systems of third world countries is a sine qua non to sustainable agricultural development.

2. There is need to reevaluate the present trend in agricultural development in the third world which often puts heavy emphasis on large-scale agricultural development projects which often end up being non-sustainable when external financial and technical support is withdrawn. It is therefore recommended that greater emphasis should be devoted to small-scale projects with greater local input and control. This will not only ensure increased sustainability, but it will
also go a long way in ensuring that problems relevant to meeting local needs are addressed.

3. Past experience with centralized and government-controlled distribution of agricultural inputs in Nigeria have often resulted, not only in inequitable distribution, but also lack of access at the critical times of need. Hence, while the present arrangement in which local government authorities are involved in input distribution may be a move towards increased decentralization, it is contended that such an arrangement is still subject to past abuses. Because of government subsidies policy on agricultural input, and because the market mechanism for agricultural input is highly imperfect and hence subject to predatory monopoly and profiteering, full privatization might be premature under the present dispensation in Nigeria. It is therefore, recommended that a sort of managed privatization policy should be implemented for agricultural input distribution in Nigeria. The details of such a mechanism is beyond the scope of this study and will require more detailed analysis. It is however, obvious that the present mechanism for input distribution in Nigeria is counterproductive to the national goal of increased technology application by traditional producers.

4. One of the most revealing findings of the study was the lack of an adequate linkage between the IITA and the management of the ADP that is critical to ensuring that the technologies developed by the international institute get to the farmers. Because similar findings had been reported by other researchers, (Jahnke et al., 1985; Lipton and Longhurst, 1985), it is hereby recommended that in order for the international research centers to have greater impact in the developing countries, there may be a need for the creation of liaison or
extension programs within these international centers in order to facilitate
linkages between them and the NARS of the developing countries.

5. The finding of the study with regards to the inappropriateness of the classical
diffusion model for predicting the adoption of technologies by the farm-
households, has several implications for the prevailing progressive-farmer
approach to extension programming in Nigeria and many other third world
countries. The progressive-farmer approach to agricultural extension
programming, such as the Training and Visit model, is rooted in the classical
diffusion model's trickle-down transfer of technology from the progressive
farmers to resource-poor, late adopters. However, the findings of this study
showed that the key determinants of the rate at which farmers adopted
technologies was more about their differential access to institutional support,
and not their psycho-social characteristics. It is therefore, recommended that
the key to enhancing farmers' use of technologies lies more in ensuring
equitable access to institutional support rather than the trickle-down approach.

6. An analysis of the project evaluated in the present study seems to reveal that
while in principle, it purported to be implementing a participatory technology
development perspective, in practice, however, it would appear that the project
still suffered from the hang-over of the classical top-down development
approach. For instance, the package of technology approach was still very
feasible in the technology transfer activities of the project. However, given the
poor performance of the project in terms of input distribution and the fact that the
respondents were essentially resource-poor farmers, it is doubtful if such a
package of technology approach was appropriate. It is therefore recommended
that long-term technology development and transfer activities should focus on
the development of technologies appropriate for the resource-poor, low external input farming systems that are prevalent in many third world countries. For instance, emphasis ought to be focused on the development of crop varieties that are not only pest and weed resistant, but that would also give high yield response under the conditions of low external input. The emerging field of biotechnology seems to offer a lot of promise in this direction.

Recommendations for Future Research

1. The findings of the study did not provide conclusive evidence on the comparative advantage of the FSR/E approach over conventional transfer of technology model, hence there is a need for future research on this subject, with specific emphasis on the comparative cost-benefit analyses of the two approaches.

2. The findings of the study seemed to suggest that the classical innovation diffusion model may be inappropriate for explaining the innovation adoption process among resource-poor farmers. Because such a finding has several implications for the way in which agricultural extension programs are organized in developing countries, further studies need to be carried out in other areas in order to ascertain the replicability of this finding.

3. The issue of linkage between agricultural extension and FSR emerged in the findings of the study, and of many other studies before it, as being crucial to the success of the FSR/E approach. However, not many studies have been carried out to work out the modalities for strengthening such a linkage. This is an issue that demands future research attention. Questions such as the modality for ensuring better interface between the International Agricultural
Research Centers and the National Agricultural Research Systems of third world countries should attract very high priority.

Finally, the study should be replicated on a much broader population, preferably in non-project environments.


ACKNOWLEDGMENTS

First and foremost, I wish to give honor and glory to the Almighty God through whose blessing and grace my academic goal has now become a reality. Next, I would like to extend my great sense of indebtedness to the Rockefeller Foundation and the International Institute of Tropical Agriculture (IITA) in Ibadan for providing the financial and logistic support which made this project a possibility. My major professor, Dr. Robert A. Martin played a major role right from the conception of the project to its completion. His academic and financial support during my five years of academic sojourn at Iowa State University is greatly acknowledged. Other members of my academic committee, including Drs. David Williams, Mike Warren, Julia Gamon and John Tait deserve special thanks for their support and suggestions.

The study could not have been completed without the immeasurable support of many people at the International Institute of Tropical Agriculture. First and foremost, Dr. Dunstan Spencer, the Director of the Resource and Crop Management Program and my in-country supervisor deserves special praise for his research and logistic support. Others, such as Dr. Gasser, Olu Ajayi, Sunday Afolayan, Rotimi Fashola, Moshood and all the staff of the IITA’s RCMP and Training program played invaluable roles in making the project a success. Special thank is also extended the management and staff of the Niger state Agricultural Development Project, especially the Director of Planning, the Bida zonal manager and Mallam Edozhigi for their support.

All my family members, especially my parents and parents-in-law Mr and Mrs Alonge and Mr and Mrs O. Z. Ojo, Mr Femi Olajoyegbe, Prince Adewale Adediran and all my other brothers and sisters deserve special thanks for their
support and prayers. I also remember all our family friends both in Nigeria and here in Ames, Iowa for their love and encouragement. Finally, the joys of my life, my wife Arike Funmilayo and my daughter Adedolapo Ayodamola deserve all the praise and honor for making this a reality. Without their love, support, perseverance and self-denial, this would have remained merely a dream.
APPENDIX A

QUESTIONNAIRE FOR PHASE II DATA COLLECTION
THE ADOPTION OF AGRICULTURAL TECHNOLOGIES IN THE BIDA AGRICULTURAL DEVELOPMENT PROJECT AREA.

QUESTIONNAIRE

1.0: IDENTIFIERS

Name of enumerator: ..............................................

Local Government area: ...........................................

District: ..............................................................

Name of village: ......................................................

Ward .................................................................

2.1. CROPPING PATTERN:

We are interested in finding out some information about the cropping practices you adopted in the cultivation of the following crops during your last cropping season. Kindly supply the following information.

<table>
<thead>
<tr>
<th></th>
<th>Guinea corn</th>
<th>Fadama Rice</th>
<th>Maize</th>
<th>Cowpea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area cultivated (Acres)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local name(s) of planting material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source of planting material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of planting material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of planting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mudus of total seeds planted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mudus of improved seeds planted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name other crops intercropped/planted with each crop.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methods of land preparation:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 3.0 ADOPTION OF TECHNOLOGIES:

For each of the following technologies, indicate how many years ago you **first heard about**, and **first tried it** on your farm. What was your source of information and when last did you use it?

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Year 1st awared</th>
<th>Source</th>
<th>Year 1st tried</th>
<th>Year last used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved seed</td>
<td>Guinea com</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fadama rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cowpea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Technologies

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Year 1st awarded</th>
<th>Source</th>
<th>Year 1st tried</th>
<th>Year last used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed dressing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbicides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insecticides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water control in fadama</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.0: CHARACTERISTICS OF TECHNOLOGIES

4.0.1. RELATIVE ADVANTAGE

On the five-step ladder described below, how would you rate the qualities of modern varieties of the following crops compared with your traditional local varieties.

```
1 2 3 4 5
Much lower Lower Equal Higher Much Higher
```

<table>
<thead>
<tr>
<th></th>
<th>Fadama Rice</th>
<th>Guinea corn</th>
<th>Maize</th>
<th>Cowpea</th>
</tr>
</thead>
<tbody>
<tr>
<td>a). Yield of modern versus local varieties</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>b). Cooking qualities of modern versus local varieties</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>c). Resistance to pests</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>d). Profitability</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>e). Tolerance to weeds</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>f). Storage quality</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>g). Labor requirement</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td>Fadama Rice</td>
<td>Guinea corn</td>
<td>Maize</td>
<td>Cowpea</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>h). Tolerance to low fertilizer</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>i). Marketability</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>j). Earliness to mature</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>k). Availability of seeds</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>l). Germination rate</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

### 4.0.2. COMPATIBILITY:

Using the five-step ladder described below, how would you rate the appropriateness of the following inputs/practices for your farms when you consider the factors described below. (Circle appropriate number)

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The cost of inputs compared to the benefits.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>b) How well it fits into your cropping system.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>c) Impact of its adoption on available labor.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>d) The level of difficulty of using technology.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>e) The level of difficulty of obtaining the technology</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>f) Access to information on how to use the technology</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>
5.0. PSYCHOSOCIAL VARIABLES

a. Age ..........; Religion.................; Tribe...............; Sex: M / F (circle)

b. Main Occupation:......... ; Percentage contribution to total income:....(0-100)

Other sources of income (list ) .................................................................
Percentage contribution to annual income.........(0-100%).

c). Total income from crop sales last year. .................

d). Number of years of formal education completed .........years

Certificate/Diploma obtained if any: .........................

e) Social Integration: Please (tick) against any of the following associations in which you are either a member or an officer .

<table>
<thead>
<tr>
<th>Organization</th>
<th>Membership</th>
<th>Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative Group Farm</td>
<td>...........</td>
<td>..........</td>
</tr>
<tr>
<td>Cooperative Saving/credit</td>
<td>...........</td>
<td>..........</td>
</tr>
<tr>
<td>Cooperative Exchange Labor Pool</td>
<td>...........</td>
<td>..........</td>
</tr>
<tr>
<td>Village Council</td>
<td>...........</td>
<td>..........</td>
</tr>
<tr>
<td>Ward Council</td>
<td>...........</td>
<td>..........</td>
</tr>
<tr>
<td>Emirate Council</td>
<td>...........</td>
<td>..........</td>
</tr>
<tr>
<td>Extension Committee</td>
<td>...........</td>
<td>..........</td>
</tr>
</tbody>
</table>

Others please indicate ..............................................................

(g). Level of participation in technology development:

(i) Are you an extension contact farmer? (Circle) Yes/ No

If yes, how long have you held the position? ............years
(ii) Have you ever acted as a farmer demonstrator for any of the following technologies? (Tick, if yes)

Technologies

1. Fertilizer application (......) name crops
2. Improved seeds (......) name crops
3. Seed dressing (......) name crops
4. Herbicides (......) name crops
5. Insecticides (......) name crops
6. Crop spacing (......) name crops
7. Water control in fadama (......)

6.0: SOCIOECONOMIC VARIABLES

6.0.1: HOUSEHOLD STRUCTURE

a). What is your status within the village? (Tick): Native _____ Migrant _____

b). Is your household an (tick): (i) "Efako" ....or (ii) "Gucha" .....production unit.

c). What is your status within the house hold? Tick.

i. Household head ...............; ii. Eldest son ..........;

iii. Married son ...............; iv Wife to the household head ..........;

iv. Wife to a married son ......; (v) Unmarried son ..........
6.0.2: ANALYSIS OF HOUSEHOLD CONSUMPTION & PRODUCTION UNIT.

Indicate the total number of persons in the following household membership categories who depend on the household's farms for their food and other support. Of this total number indicate how many members of the different categories are available full time, half time, quarter time or completely unavailable for work on the household's farm.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Total Number</th>
<th>Full-time</th>
<th>Half-time</th>
<th>Quarter time</th>
<th>Unavailable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head's wives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married sons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sons' wives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried sons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried daughters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.0.4: DISTRIBUTION OF LABOR ACCORDING TO TASK & GENDER

For each of the following crops, indicate the proportion (%) of the labor for the following agricultural tasks that is supplied by male and female members of the household.

<table>
<thead>
<tr>
<th>Task</th>
<th>Guinea corn</th>
<th>Rice fadama</th>
<th>Maize</th>
<th>Cowpea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male Female</td>
<td>Male Female</td>
<td>Male Female</td>
<td>Male Female</td>
</tr>
<tr>
<td>Land Preparation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weeding</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>agro-Chemical application</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvesting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.0.5: RESOURCE BASE

Indicate how many of the following items you had (or owned) before the Bida ADP (earlier than 10 years ago); during BADP (5 years ago) and now.

<table>
<thead>
<tr>
<th>Items</th>
<th>Earlier than 10 years ago</th>
<th>5 years ago</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milling Machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grinder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Sprayers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granaries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck/Lorry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorcycle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radio/ Cassette Player</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron Bed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wooden Bed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mattresses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Houses (iron roofs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Houses (thatched roofs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Items</td>
<td>Earlier than 10 years ago</td>
<td>5 years ago</td>
<td>Now</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------</td>
<td>-------------</td>
<td>-----</td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.0.6. Land Tenure:

i. (a) How many acres of upland field do you have? .................. acres.
   (b) Of these how many acres did you cultivate last year? ............acres.

ii. (a) How many acres of fadama field do you have? ............... acres
   (b) Of these how many acres did you cultivate last year? ............acres.

iii. How did you gain access to:
   a. Your upland field?: (Tick): i) Inheritance ...., ii. Rent ....,
      iii. Share-cropping .......; iv. family usufruct right ......;
      v. Communual usufruct right ........,

      Others, please indicate...................................................

   b. Your fadama field?: (Tick): i) Inheritance ...., ii. Rent ....,
      iii. Share-cropping .......; iv. family usufruct right ......;
      v. Communual usufruct right ........,

      Others, please indicate...................................................

iv. How much did you spend on Hired labor last cropping season?
    N........................
7.0: POLITICO-BUREACRATIC VARIABLES

7.0.1. INFRASTRUCTURE

Indicate how many kilometers you have to travel to gain access to the following services and facilities.

<table>
<thead>
<tr>
<th>Service facilities</th>
<th>Distance</th>
<th>Services/ Facilities</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Village extension</td>
<td></td>
<td>6. Banking facilities</td>
<td></td>
</tr>
<tr>
<td>2. Block Extension</td>
<td></td>
<td>7. Motorable road</td>
<td></td>
</tr>
<tr>
<td>3. Input supply depot</td>
<td></td>
<td>8. Local Govt. Hq.</td>
<td></td>
</tr>
<tr>
<td>4. Farm produce market</td>
<td></td>
<td>9. Research Demostra-</td>
<td></td>
</tr>
<tr>
<td>5. Agroservice Centre</td>
<td></td>
<td>tion sites</td>
<td></td>
</tr>
</tbody>
</table>

7.0.2. EVALUATION OF FACILITIES AND SERVICES

Please, think back to the quality of the following facilities and services earlier than 10 years ago (before Bida ADP); 5-10 years ago (during the Bida ADP) and now. How would you rate the quality of the following facilities and services during these three periods. Use the rating scale below.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Services/Facilities</th>
<th>Before BADP</th>
<th>During BADP</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Extension services</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. Fertilizer supply</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>3. Supply of insecticides</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>4. Tractor Hiring</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>5. Road network</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>6. Credit Facilities</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>
7. Price of fertilizers

<table>
<thead>
<tr>
<th>Before</th>
<th>During</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>BADP</td>
<td>BADP</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

8. Price of insecticides

<table>
<thead>
<tr>
<th>Before</th>
<th>During</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>BADP</td>
<td>BADP</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

7.0.3 (a) ACCESS TO FACILITIES AND SERVICES

Please indicate how many times within the last twelve months, you have contacted the following sources of information and services for new ideas or problem on your farm.

<table>
<thead>
<tr>
<th>Once</th>
<th>Twice</th>
<th>Thrice</th>
<th>Four times</th>
<th>Five times</th>
<th>Others indicate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Village extension worker

2. Block extension officer

3. Area extension officer

4. Attend extension meeting

5. Visit demonstration plots

6. Visit farm service center

7. Visit research station

8. Attend agric. show

9. Agricultural chemical dealer

10. Listen to agric talks on radio

11. Watch agric. talks on television

12. Read extension bulletins

Others please indicate
For each of the following services and facilities, tick (Yes) for the ones you had access to during the last cropping season. If yes, indicate level of access.

i. Tractor hire for land clearing ............Yes/No.
   If yes, how many acres? ........... acres

ii. Agricultural loan ............Yes/No.
    If yes, indicate amount: #.............

iii. Irrigated Field ............ Yes/No. If yes how many acres? ............ acres.

iv. Water control along the Fadama.............Yes/No.
    If yes tick mode of water control:
    a. Water control channels: ............
    b. Water bunds: ................
    others please indicate:...................

V. Water supply through borehole or pipe-borne ........Yes/No

vi. Plough/ridger for field preparation:........Yes/No.
    If yes, how many acres did you plough? ............acres
APPENDIX C

QUESTIONNAIRE FOR PHASE III DATA COLLECTION AMONG FSR/E PARTICIPANTS WITHIN THE RICE-BASED INLAND VALLEYS OF THE BIDA ADP
QUESTIONNAIRE FOR PHASE III DATA COLLECTION AMONG FSR/E PARTICIPANTS WITHIN THE RICE-BASED INLAND VALLEYS OF THE BIDA ADP

General Introduction:
We are interested in finding out some information about the technologies you are using in the cultivation of fadama rice. Whatever information you supply will not be revealed to anybody else, neither will it have any negative effect on your farming activities. Therefore, provide us with truthful information so we can correctly identify the problems confronting you in the production of fadama rice.

1.0: IDENTIFIERS

Name of enumerator: ..........................................................
Local Government area: ....................................................
District: ...........................................................................
Name of village: ..................................................................
Ward: ..............................................................................

2.0 RICE PRODUCTION HISTORY:

1. How many years ago did you first plant your own field of fadama rice? ..........YEARS.
2. Did you cultivate fadama rice last year? (Circle the right number)
   Yes: 1; No: 0;
3. How big is the area of your fadama field? acres: .................
4. How many mudus of rice seed did you cultivate last year? .................
5. Provide the following information about the varieties of rice you planted last year:

Code for sources of seed: ADP/GOVT=1; OTHER FARMERS=2; MARKET=3
BADEGGI RESEARCH=4; IITA=5; (Write the appropriate code under source of seeds)

<table>
<thead>
<tr>
<th>LOCAL NAMES</th>
<th>SOURCE</th>
<th>YEAR OF USING</th>
<th>LOCAL=0 IMPROVED=1</th>
<th>*NO OF MUDUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Total should agree with the number of mudus of rice planted last year.
6 What months did you sow fadama rice last year? Check ( ) Ja=1 ( ); Fe=2 ( ); Mar=3 ( ); Apr=4 ( ); May=5 ( ); Jun=6 ( ); Jul=7 ( ); Aug=8 ( ); Sep=9 ( ); Oct=10 ( ); Nov=11 ( ); Dec=12 ( ).

7 How many bags of milled rice did you harvest last year? (Use only one)
   a. 50 kg. fertilizer bags=...................
   b. Big jute bags=..............................
   c. No of tins=.................................
   d. Mudus=......................................

8. Indicate what proportion of the your total harvest of rice was used for the following purposes. (Total should equal total harvest in 7 above).

<table>
<thead>
<tr>
<th>Total Harvest</th>
<th>Consumed</th>
<th>Sold</th>
<th>Gift</th>
<th>Stored</th>
<th>Other uses</th>
</tr>
</thead>
</table>

USE OF INPUTS IN RICE PRODUCTION

9. Check ( ) yes for each of the following inputs you used on your rice field last year.

   a. Fertilizer Yes=1 ( ) No=0 ( );
   b. Herbicide Yes=1 ( ) No=0 ( );
   c. Insecticide Yes=1 ( ) No=0 ( );
   d. Tractor Yes=1 ( ) No=0 ( );
   e. Seed dressing Yes=1 ( ) No=0 ( );

10 If the farmer answered yes for the items in question 9, proceed to the items in question 10.

   a. Indicate the type and number of bags of fertilizer you applied last year on your fadama rice field? (Check ( ) the ones indicated by the farmer and write the number of bags).

<table>
<thead>
<tr>
<th>Type</th>
<th>No of bags</th>
<th>Type</th>
<th>No of bags</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPK/Compd=1 ( )</td>
<td></td>
<td>Super Sulphate=2 ( )</td>
<td></td>
</tr>
<tr>
<td>Urea=3</td>
<td></td>
<td>CAN=4</td>
<td></td>
</tr>
<tr>
<td>Manure=5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   b. What type of seed dressing did you use last year? (Check ( ) the ones indicated by the farmer)
      i. Fernasan D=1 ( );
      ii. Aldex T=2 ( );
      iii. Kerosene/Battery=3 ( )
c. How much did you spend on the following inputs last year for your fadama rice field?
   i. Fertilizer: \( N \) \ldots; Seed Dressing: \( N \) \ldots;
   ii. Tractor Hire \( N \) \ldots; Insecticides: \( N \) \ldots;

3.0 ADOPTION OF TECHNOLOGIES:

For each of the following technologies in fadama rice production, supply the following information: (a) How many years ago you first heard about and first tried it on your farm; (b) What was the source from which you first heard about the technology?

Code for sources of information: ADP/GOVT=1; OTHER FARMERS=2; MARKET=3; BADEGGI RESEARCH=4; IITA=5; Market=6
(Write the appropriate code under source of information)

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Year 1st aware</th>
<th>Source</th>
<th>Year tried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved seed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed Dressing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbicide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tractor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insecticides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sprayer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation pump</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water channel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage Channel</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.0 Research Collaboration

We are interested in finding out whether you had ever assisted any of these research institutions in the last ten years in the development or testing of any technology in rice production. Check ( ) yes for any institution you had worked with before.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. IITA, Ibadan</td>
<td></td>
</tr>
<tr>
<td>b. ADP (Project)</td>
<td></td>
</tr>
<tr>
<td>c. Baddegi Research (NCRI)</td>
<td></td>
</tr>
<tr>
<td>d. River Basin</td>
<td></td>
</tr>
</tbody>
</table>

If you answered yes for any of the institutions above, please tick ( ) against the technologies with which you worked.

Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fertilizer application</td>
<td></td>
</tr>
<tr>
<td>2. Improved seeds</td>
<td></td>
</tr>
<tr>
<td>3. Seed dressing</td>
<td></td>
</tr>
<tr>
<td>4. Herbicide</td>
<td></td>
</tr>
<tr>
<td>5. Insecticide</td>
<td></td>
</tr>
<tr>
<td>6. Water Control</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Do you assist the ADP as the farmer who helps in contacting other farmers in the village in order to pass information from the village extension worker to the farmers (Contact Farmer).

Yes=1 ( ); No=0 ( );

If yes how long ago did you start being the extension contact farmer?

...........Years
5:0 CHARACTERISTICS OF TECHNOLOGIES

On the five-step scale described below, how would you rate the qualities of the fadama rice varieties introduced by the government when compared with the local varieties. (Circle one)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Much lower</td>
<td>Lower</td>
<td>Equal</td>
<td>Higher</td>
<td>Much Higher</td>
</tr>
</tbody>
</table>

1). Yield  
2). Pest resistant  
3). Weed tolerance  
4). Labor required  
5). Early maturity  
6). Cooking quality  
7). Profitability  
8). Storage quality  
9). Marketability  
10). Availability of seeds

5:2. COMPATIBILITY

We would like to identify the problems you have faced in your attempt to use the following technologies in your rice field. For each of the following problems below, ask whether it constitutes:

1. No problem at all; 2. Only minor problem; 3. Serious problem; 4. Very serious problem. (Circle the corresponding code)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No problem at all</td>
<td>Minor problem</td>
<td>Serious problem</td>
<td>Very serious problem</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seed Dressing</th>
<th>Fertilizers</th>
<th>Insecticides</th>
<th>Herbicides</th>
<th>Tractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The cost of inputs Vs. Benefit</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>b) Appropriateness of technology</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>c) Labor requirement</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>d) Difficulty of technology</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>e) Availability of technology</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>f) Access to information</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>
6.0 PSYCHO-SOCIAL VARIABLES: Check ( )

a. Age ....; Religion: Islam=1 ( ); Christianity=2 ( );
   Ethnic group (Check) Nupe=1 ( ); Hausa=2 ( ); Yoruba=3 ( );
   Others please indicate ..............;

   Gender: Male=1 ( ); Female=2 ( ); (check )

b. Main Occupation: (Check) Farming=1 ( ); Trading=2 ( ); Govt. =3 ( );
   Artisan=4 ( ) Fishing=5 ( );

c. If you divide your income last year into ten parts, how much of it came from your primary occupation?: ..................(0-100%) 

d. Apart from your primary occupation what other occupation do you obtain your income from? (Check )
   Farming=1 ( ); Trading=2 ( ); Govt. Worker=3 ( ); Artisan=4 ( );
   Fishing=5 ( ); Hunting=6 ( );

e. How much money did you make from crop sales last year?: N ........

f. Number of years of formal education completed .............years 

g. Number of years of formal Islamic/Arabic studies completed: ...........years 

h. Social Integration: Please put circle against any of the following associations in which you are a member and/or an officer .

<table>
<thead>
<tr>
<th>Organization</th>
<th>Membership</th>
<th>Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative Group Farm</td>
<td>.....1....</td>
<td>.....2....</td>
</tr>
<tr>
<td>Cooperative Saving/credit</td>
<td>.....1....</td>
<td>.....2....</td>
</tr>
<tr>
<td>Cooperative Exchange Labor Pool</td>
<td>.....1....</td>
<td>.....2....</td>
</tr>
<tr>
<td>Village Council</td>
<td>.....1....</td>
<td>.....2....</td>
</tr>
<tr>
<td>Ward Council</td>
<td>.....1....</td>
<td>.....2....</td>
</tr>
<tr>
<td>Emirate Council</td>
<td>.....1....</td>
<td>.....2....</td>
</tr>
</tbody>
</table>
7.0: SOECIOECONOMIC VARIABLES

7:1 HOUSEHOLD STRUCTURE

a). What is your status within the village? Check ( ) Native=1 --- Migrant=2 ---

b). Is your farm operation: Check ( ) Efako=1------; or Gucha =2------?

c). What is your status within the house hold? Check.

Household head=1 ----- ; Eldest son=2 ------ ;

Married son=3 --------; Wife to the household head=4 ----;

Unmarried son=5 ------

8.1 ANALYSIS OF HOUSEHOLD CONSUMPTION & PRODUCTION UNIT.

We would like to know how many members of your household eat from the same pot? Of these members we would like to know how many of them work: a. full time; b. half time, c. quarter time d. completely unavailable for work on the household's farm.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Total Number</th>
<th>Full-time</th>
<th>Half-time</th>
<th>Quarter time</th>
<th>Unavailable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head's wives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married sons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sons' wives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried sons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried daughters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9.0 ESTIMATED DISTRIBUTION OF HOUSEHOLD LABOR ACCORDING TO TASK & GENDER

For each of the following activities on your rice field, please indicate what proportion is done by men and women.

<table>
<thead>
<tr>
<th>Task</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Preparation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvesting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer &amp; agro-chemical application</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How much did you spend on hired labor on your rice field last cropping season? N..........................

10.0 RESOURCE BASE

Indicate how many of the following items you had (or owned) before the Bida ADP (earlier than 10 years ago); during BADP (5 years ago) and now.

<table>
<thead>
<tr>
<th>Items</th>
<th>(Before ADP)</th>
<th>(End of ADP)</th>
<th>At time of Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milling Machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grinder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Sprayers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granaries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck/Lorry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorcycle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycle</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11.0 Land Tenure:

How did you gain access to your fadama field?: (Check( )

- Inheritance =1 ( )
- Rent=2 ( )
- Share-cropping=3 ( )
- Family usufruct right=4 ( )
- Communal usufruct right=5 ( )

11.1 Cropping Intensity:

Did you cultivate all your fadama field last year? Yes=1 ( ) No=0 ( )

If you checked (No), how many acres did you leave uncultivated? .......Acres

How many years ago did you last cultivate the area that now stands uncultivated? ....Years.

Which of the following reasons is/are responsible for leaving your fadama (uncultivated)

- a) Soil is poor, need to rest it. (Check) Yes=1 ( ) No=0 ( ).
- b) Not enough labor to bring the area under cultivation (check)
  Yes=1 ( ) No=0 ( ).

12.0 POLITICO-BUREAUCRATIC VARIABLES: Indicate how many kilometers you have to travel to gain access to the following services and facilities.

<table>
<thead>
<tr>
<th>Service/ Facilities</th>
<th>Distance</th>
<th>Service/ Facilities</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Extension agent</td>
<td></td>
<td>4. Banking facilities</td>
<td></td>
</tr>
<tr>
<td>2. Input Depot</td>
<td></td>
<td>5. Local Govt. Headquarter</td>
<td></td>
</tr>
</tbody>
</table>
12.2 ACCESS TO FACILITIES AND SERVICES

We want to find out how regularly you obtain information about your farming business from the following government agencies and media during the past twelve months. Please tell us how many times you have actually been able to discuss your farm problems with these agencies.

<table>
<thead>
<tr>
<th></th>
<th>No of Times</th>
<th></th>
<th>No of Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Village extension worker</td>
<td></td>
<td>2. Attend agriculture show</td>
<td></td>
</tr>
<tr>
<td>3. Agricultural chemical dealer</td>
<td></td>
<td>4. Listen Agric talk on radio</td>
<td></td>
</tr>
<tr>
<td>5. Watch agric. television</td>
<td></td>
<td>6. Read extension pamphlets</td>
<td></td>
</tr>
<tr>
<td>7. Attend extension program</td>
<td></td>
<td>8. Visit demonstration plots</td>
<td></td>
</tr>
<tr>
<td>9. Visit farm service center</td>
<td></td>
<td>10. Visit research station</td>
<td></td>
</tr>
</tbody>
</table>

12.3 (b) For each of the following services and facilities, check ( ) yes=1 for the ones you had access to, and No=2 for the ones you did not have access to during the last cropping season. If you checked ( ) yes, indicate level of access.

1. Agricultural loan: Yes=1 ( ); No=0 ( )

If yes, indicate amount. $\ldots\ldots\ldots$

2. Irrigated Field: Yes=1 ( ); No=0 ( )

If yes how many acres? $\ldots\ldots\ldots$ acres.

3. Water control along the Fadama Yes=1 ( ); No=0 ( )

If you checked yes, please state the mode of water control you used:

a. Water supply channel only=1 ( ); b. Drainage Channel only=2 ( );

c. Bunds only=3 ( ); d. Both Supply & Drainage=4 ( );

e. Supply and Bund=5 ( ); f. Drainage & Bund=6 ( );

g. Supply, Drainage and Bund=7 ( ); h. Paddy levelling=8 ( );
APPENDIX C

REPORT OF THE EXPLORATORY SURVEY OF THE BIDA AGRICULTURAL DEVELOPMENT PROJECT AREA
REPORT OF THE EXPLORATORY SURVEY OF THE BIDA AGRICULTURAL DEVELOPMENT PROJECT AREA

1.1 Introduction

This report presents the findings of an exploratory survey conducted within the original Bida Agricultural Development Project (BIDA ADP) area between 18th and 28th September, 1990. The main purpose of the survey was to provide the researcher with a firsthand insight into the general agro-economic and social parameters existing in the project area, as a springboard for a more detailed study of the adoption of agricultural technologies by farmers within the enclave. Given the very broad nature of the survey's objective and the narrow disciplinary bias of the survey team, the report does not lay any claim to completeness. It is, however, envisaged that the inherent data gap, especially in the agro-ecological domain, will be supplemented from the extensive secondary data available on the enclave.

1.2 Background information about the project enclave

The Bida ADP belonged to the second generation of the World-Bank supported agricultural development projects embarked upon by the Federal Military Government of Nigeria in the 1970s. The ADPs were set up to reverse the downward trend in the fortune of the agricultural sector, in the wake of the ascendancy of the petrodollar as the prime-mover of the Nigerian economy. The project, which enjoyed a tripartite funding arrangement involving the Federal and State Governments and the World Bank, was set up with the objective of increasing agricultural productivity through the provision to farmers, of improved agricultural technologies and the necessary infrastructure and input back-ups. The project had a strong extension component which adopted the Training & Visit (T & V) Extension model developed by the World Bank. The commencement of the project
was preceded by an exploratory survey of the area, resulting in the characterization of the existing farming systems into agroecological zones. The Bida ADP was made effective from June 1980 with a lifespan of five years. The project, has since the completion of its five-year term, been expanded to cover the whole of Niger State in what is now known as the Niger State Agricultural Development Project (NSADP). This survey was, however, limited to the original Bida ADP enclave.

1.3 Location of the Project Area

The Bida ADP area is situated in the southern part of Niger State and includes Lavun, Gbako, Agaie and Lapai local government areas (LGAs). Niger State, carved out of the former North Western State in 1976, is bordered to the North by Sokoto and Kaduna States, to the South and West by the Niger River, across which is Kwara State, and to the east by the Federal Capital Territory. The project area lies entirely within the Southern Guinea Savanna ecological zone (see appendix i). The project area is estimated to cover 17,000 sq. km., covering 26% of Niger State's land area and 40% of its population (Bida ADP baseline survey, 1980). Population estimates for the area are shrouded in the controversy and inconsistency that has characterized demographic data for the whole country. Using the 1963 census figure as a baseline, the official population projection for the area was put at 700,000 in 1979. However, the World Bank's estimate of 405,200 at the commencement of the Bida ADP in 1978/79 is considered more realistic.

1.4 Survey Methodology and Sample Design

The design employed was a three-stage cluster sampling procedure. The primary sampling frame consisted of the geo-political parameter of local
government areas. The use of agro-ecological zones as the sampling frame as originally planned at the preparatory stage of the survey had to be discarded when it was discovered that the characterization of agro-ecological zones was based on doubtful criteria (see also Ward, 1982:6). Each local government area (except Gbako, which has 4) is divided into 2 Blocks by the ADP management for the purpose of program implementation. Two blocks from each of the local government areas were selected, after which a purposive sample of one village was drawn from each block. Hence, a total of eight villages were surveyed. With the assistance of the respective Block Extension Officers, a purposive representative sample of 6-12 farmers was selected from each village for group interviews. A group interview involving women was also conducted to get the female perspective for an understanding of the existing farming systems.

The group interviews were conducted mostly in the late afternoons and evenings. The interview team consisted of the researcher, and two to three interpreters. The interviews were semi-structured, thus allowing for the flexibility required for extensive follow-up questions and unobtrusive exchange of information between the informants and the interview team.

2.0 Farming Systems

2.1 Major Crops

Major food crops in the area are sorghum, rice, and yam, with cassava, maize, millet, cowpea and sweet potato regarded as secondary crops. Cassava and maize appear to have made a major in-road into the cropping system a couple of years ago. Sorghum is the dominant food crop in all but one of the villages covered in the survey. The only exception is Gabi, in the Lapai LGA, where yam is more important. In deference to the evaluation report compiled by the ADP in 1986
(See Wedderburn, 1986), rice (fadama) is still ranked next to sorghum in importance by farmers in the area.

The most important cash crops are rice, groundnuts, and melons. Yam, maize, cassava, pepper and bambara nuts are considered as secondary cash crops. Economic tree crops such as sheanuts and Locust beans constitute another source of cash within the farming system.

2.2 Cropping Pattern

Three distinct cropping systems were encountered within the area. They include the Sorghum-, Yam- and Rice-based cropping systems. The first two systems are upland production, while the rice-based cropping system is essentially an inland valley (Fadama) production system. The upland-rice production system is perceived by farmers to have suffered serious decline due to erratic rainfall pattern and pest (especially birds) infestations. It is, however, pertinent to point out that the occurrence of the aforementioned systems in farmers' production systems is not mutually exclusive. In the upland sorghum-based cropping system, sorghum (sole and or inter-cropped with melons), and early millet are planted at the onset of the rains between mid-April and May. Groundnut, late millet inter-cropped with melons are planted in June. Between June and July, maize, bambara nut and cassava are planted. Planting of fadama rice begins in most villages three months after the onset of the rains which also coincides with the completion of upland plantings and first weeding. This usually occurs between late July and August. In the yam-based cropping system, land preparation is carried out between September and October while planting of yam setts extends from November through January during the dry season. Other plantings follow the sequence explained for the sorghum-based cropping system. The distribution of the different
cropping systems seems to be related to ethnic and food preference differences. For instance, the yam-based cropping system seems to be more predominant among the Gwaris who account for over 90 percent of the population of Gabi where yam is both the preferred and most widely cultivated crop. Crop rotation involving sorghum and groundnut is very common. In view of the fact that most farmers operate the three cropping systems, mixed cropping and multiple field ownership are very prevalent.

3.0 Human Environment and Physical Infrastructure

3.1 Household structure and Intra-household analysis

An analysis of the existing household structure in the area reveals a complex hierarchy of structures. The "Efako" household structure encompassing a father, (the household head) his wives, his married sons and their spouses and children, and his unmarried sons and daughters, is the fundamental household structure among the Nupe people who account for over 90\% of the people found in the survey area. This "Efako" household unit constitutes both a production, consumption and sometimes a marketing unit. It constitutes the decision making unit for the choice of agricultural enterprise, the consumption and marketing of farm produce and the distribution of farmland among its constituent members for individual cultivation. It also takes major responsibility for the distribution of labor and time between group's (efako) and individual cultivation. In most of the villages, specific days and times of the week are earmarked for work by members on the households' (efako) farms. This procedure takes precedence over individuals' activities on their farms. The only exception was in Gbamace where the "Efako" family structure has almost completely broken down. Within the large efako family structure is a network of individual households encompassing a nuclear family of a
man, his wife/wives and children. Each owns its individual farm under the Gucha system. Under the efako production system, individual production efforts are geared towards meeting supplementary cash needs. Males begin to engage in individual crop cultivation from the age of fifteen. The efako unit is, however, responsible for meeting their dowry obligations to their brides' families.

The "Gucha" household structure of individual agricultural production unit is said to be gaining increasing prominence. This trend is attributed to the out-migration of young men from the villages either for educational advancement and or for non-farm jobs, and the increasing commercialization of production from being mainly subsistence to increasing emphasis on market-oriented production. This development is perceived as a potential source of threat to the survival of the "Efako" system.

Attempts to investigate the presence of female-headed households from the informants was perceived as culturally offensive. The whole idea of woman-headed household was regarded as a taboo. The Nupe world is definitely a man's world. Other important ethnic groups in the area, apart from the dominant Nupes, are the Gwaris, the Fulanis and the Kambaris. The most predominant religious belief in the area is Islam. There are, however, pockets of locations in which there are sizeable numbers of Christians. A typical example is Loguma, where Christians account for 30 percent of the population.

3.2 Leadership structure

The pyramidal power structure is the prevalent leadership model encountered in the area. At the top of the hierarchy is the village head who derives his power by birth-right. Decisions are made, communicated and implemented through an organizational structure in which power flows from the village head
through a network of wards heads to the household heads. The allocation and management of communal resources are vested in the village head, who either exercises direct control or delegates such authority to the ward heads or other influentials within the village.

At the efako household level, decision-making powers in the areas of agricultural production and investment and allocation of resources, are vested in the family head. These powers are either directly exercised by the family heads or sometimes delegated to the most senior sons. Women's roles in the intra-household agricultural decision making process are mainly secondary and consultative at best. Individuals, are however, responsible for the day-to-day management of their individual farms.

3.3 Physical Infrastructure and Facilities

The operations of the defunct Bida ADP and its metamorphosis into the Niger State Agricultural Development Project (NSADP) has helped to create a fair level of extension network within the area. Each local government area is constituted into an area extension structure, which is further divided into blocks, villages, cells and sub-cell levels. This elaborate extension structure should, theoretically, bring extension services closer to the rural farming households. In practice, however, this does not seem to be the case as extension activities seem to have been seriously hampered by logistic problems of poor mobility and inadequate incentive mechanisms, both of which have combined to dampen the morale of the extension staff. This opinion were conveyed during informal discussions with extension staff working in the project area. This finding was further confirmed by the farmers who complained about the inability of the NSADP to sustain the high level of extension visibility that characterized the early 1980s.
during the operation of the original Bida ADP. Similar complaints were lodged in the area of input distribution, farm machinery hire services and the development of the irrigation schemes. Only two of the villages, Loguma in Agaie North and Kpada have agro-service centers located in them. Others have to travel long distances to have access to such facilities. Most of the agro-service centers are no longer operational.

Banking and credit facilities are not easily accessible to the rural farming households living at the peripheries. These facilities, where available at all, are concentrated in the major semi-urban settlements such as Baddegi, Gulu, Lapai, Kutugi and Agaie. Most households rely on the informal traditional saving and credit cooperative societies and inter- and intra-household borrowing for credit.

Most of the villages are linked to the major markets by rough but motorable feeder roads. The major markets for farm produce are located in Bida, Agaie, Lapai, Kutugi, Batati, Gulu and Baddegi. All the villages have primary and secondary schools within a distance of five to ten miles.

The villages have neither piped water nor electricity. Three of the eight villages, Nwogi, Salawu and Loguma have rural health centers. Others have to travel between five and ten miles to have access to health services.

4.0 Resource Endowments and Constraints

Factors of Production

4.1 Land: The area can be aptly described as land-abundant. The population density was estimated by the World Bank in 1979 to range from the highest of 28.9 persons per square kilometer in Agaie L.G.A. to between 14 - 17 per square kilometer elsewhere in the project area (APMEPU, 1980). The huge endowment of the area with suitable arable land was attested to by the informants and also by the
ease with which strangers can gain access to farmland. There is, however, a wide
range of perceived levels of fertility, from the rich upland farm land of Kpada to the
fadamas in Loguma whose fertility is reported to be low due to years of cultivation
and the problem of hardpan. While no attempt was made to measure the sizes of
farm holdings, investigation with the informants revealed a preponderance of small
and scattered holdings. In a bid to meet both subsistence and cash needs, many of
the households are involved in multiple cropping. For instance, the average
number of fields cultivated per household ranged from a high of 8 - 10 in Nwogi to
a low of 2 in Loguma in Agaie North. In conclusion, it is pertinent to note that there
are no landless labor class and neither are there any exploitative tenant farming
structures.

4.2 Labor:

This factor is regarded as the most limiting to agricultural production in the
area. The sources of labor for agricultural production ranked in their order of
importance include, group/pooled/communal labor, followed by family labor,
individual and hired labor. There are different forms of group/pooled labor. The
most important form is pooled exchange labor in which farmers in the same age
group work on a rotational basis on each other's farms. Other forms of group labor
include group of farmers helping old or indisposed farmers to catch-up on their
farming operations. It is also customary for sons-in-law to organize work gangs to
help in their fathers-in-laws' farms. Cooperative group farming is very prevalent in
the area and group/pooled labor is the major source of labor on such farms. On the
efako farm, family labor is the most important source of labor. It enjoys a first call on
individuals' labor. For instance, in Salawu, individuals can only a work full-day on
their farms on Thursdays and Fridays and from 2:00 p.m. on all the other days. The
relative importance of the different sources of labor will appear to vary from village to village depending on the relative integrity of the efako family structure. For instance in Gbamace, where the efako structure has broken down, individual labor was ranked as the most important source. There also appears to be a gender difference in labor utilization. In the interview with the female farming group at Lanle, hired labor was ranked as the most important source of labor. Social and cultural norms restrict a woman's access to family labor. Women often have to pay for their sons' labor if and when they help with their farming operations. Women, however, have unrestricted access to their daughters' labor. Women have thus been the hardest hit by the recent upsurge in the cost of hired labor. In Loguma, for instance, many women have had to abandon their individual farms due to the prohibitive cost of hired labor.

Investigation within the area revealed gender differences in the allocation of labor for agricultural and non-agricultural tasks and functions. In interviews with farmers from 7 of the 8 villages, it was revealed that men were solely responsible for the production aspect of all cropping operations. Women were, however, very active in the harvesting, processing and marketing of farm produce from the efako farm. Intra-household marketing of agricultural produce was prevalent. This procedure involves the farmers selling their farm produce to their wives at a price lower than the current market price, thus leaving them a profit margin. This intra-household bargaining can be used as a source of control by the husband who might decide not to sell to his wife if she is not in his "good books". While women are solely responsible for the harvesting and processing of groundnuts, melons and bambara nuts, the men help with the cutting of sorghum, millet and rice, before the women proceed with the other aspects of harvesting and processing.
Cultivation of a fadama field is perceived as involving tedious labor, hence in most of the villages fadama cultivation is the exclusive preserve of men. For the same reason and possibly because fadama land is regarded as premium, women do not have easy access to them for their private cultivation in all of the villages visited.

A difference in role-perceptions between men and women was observed during the group interviews. Whereas in all the interviews with men in the other seven villages, they perceived the role of women to be limited only to harvesting, processing and marketing; the women farming group at Lanle claimed that they had the main responsibility for land clearing, and some responsibilities for planting and fertilizing. All the groups, both men and women agreed that women had the main responsibility for livestock management (mainly poultry, sheep and goats), for water and fuel collection, and for food preparation and processing.

The period of the first three months of the cropping season, between May and July is regarded as the busiest period during the cropping season. The main operations performed during this period include, land clearing, planting, weeding and staking. The month of July and sometimes extending into early August seems to present the greatest demand on available labor.

In conclusion, labor, as opposed to land, is regarded as the most limiting factor to increased agricultural production in the area. Farmers claimed that out-migration of residents has been too low in the last five years to constitute any major labor bottleneck in the area.

4.3 Capital, Capital goods and Capital formation

The major source of cash for the farmers comes from the sale of agricultural produce, mainly groundnut, rice, melon and maize. Other supplementary sources come from the sale of sheabutter and locust beans, from mat-weaving and other
handicrafts. Off-farm job opportunities are very minimal, except along the tributaries of the major rivers such as the Niger, Kaduna and Gbako where fishing can be an important source of income. The rural economy is, therefore, mainly agrarian.

Major capital inputs for agricultural production are minimal. Ownership and use of farm machinery such as tractors and other mechanical implements and of ox-driven mechanical devices is negligible. Purchased inputs are limited to fertilizers, seed-dressings and other agrochemical. Fertilizer, introduced to the area decades ago, is the most widely adopted input by the farmers. Farmers complained bitterly about the break-down of the tractor-hire services offered by the Bida ADP.

4.4 Decision Making and Production Choices

Agricultural production choices are based essentially on subsistence need, the need for an assured supply of the array of staple food for the households. This explains the premium attached to the production of sorghum and to some extent of rice, in most of the villages. In Gabi, where yam is the staple food, its cultivation is ranked higher than sorghum. In the same vein, maize and cassava are gaining in importance as dual crops - for subsistence and cash needs. Market-oriented production is also an important determinant of production choices. This fact underscores the importance of groundnut, melon and rice in the farming systems of the area.

The loci of control in decision making with regards to agricultural and non-agricultural production vary according to the hierarchy of operation. At the larger multi-family "Efako" household level, the locus of control resides with the family household head, who is the most senior male. He exercises this control in
consultation mainly with his eldest son and other adult males in the household. Women have little responsibility as far as production decision-making is concerned. At the individual household "Gucha" farming level, the individual farmers exercise control over their production choices. The "Efako" household head still exercises indirect control, by being vested with the power to make decisions about land allocation to individuals. This control over land allocation has greater implications for women who depend mainly on their husbands for land allocation.

In the group interview with women farmers in Lanle village, they were asked to indicate which member(s) of the household assume(s) entire responsibility (100%), main responsibility (75%), equally shared responsibility (50%), some responsibility (25%) and no responsibility (0%) for decision-making on the following issues:

i) Agriculture (family holdings): Interviews indicated that household heads had the entire responsibility for decision making on land allocation for food versus cash crops, for the purchase of inputs and equipment, and for the recruitment of hired labor. They also had main responsibility for deciding on the proportion of farm produce to be put up for sale while women share some responsibility in this domain.

ii) Income-generating activities: The household head has the main responsibility for the choice of activity and purchase of inputs and equipment. Other adult males share some responsibility in these domains. The household head holds the decision making responsibility for the sale of produce and the control of earnings.
iii) Wage employment: It was revealed that the household head holds the main responsibility for the decision to work for wages and the control of earnings. The wife however shares some responsibility for the latter.

iv) Decisions regarding household maintenance: Adult males have the main responsibility for expenditures on food, clothing, children's schooling, medical care and stimulants. The adult females have some responsibility in the aforementioned areas except for expenditure on household utensils where the women take main responsibility.

v) Decisions regarding household management and reproduction: The household head is entirely responsible for the allocation of tasks, while he takes main the responsibility for deciding on the family size, an issue in which the wife only has some responsibility. Women are entirely responsible for the division of food among household members.

It is obvious from the above analysis that the adult males, especially the household heads have an overwhelming responsibility for day-to-day agricultural production management decisions. A crude application of the decision-making model developed by Mitchell and Lowry (1973) will place household heads at the topmost echelon of influentials in the decision-making hierarchy, while other adult males may be classified as lieutenants and the women are essentially the doers.

5.0 Farming Systems Constraints and Possibilities

The agro-ecological, socioeconomic and institutional conditions in the area of study present both constraints and possibilities for increased agricultural production.
5.1 Agro-ecological constraints and possibilities:

The Bida ADP area has not been spared from the general drought conditions that have characterized sub-Saharan Africa in the last two decades and especially during the mid 1980s. Agriculture in the area is essentially rain-fed, hence uncertainties in the distribution and amount of rainfall have introduced a serious risk factor into the farming system. The critical factors in the farmers' production calculation are the timing of the on-set of the rains and its subsequent distribution throughout the cropping season. This risk factor has been accepted by the farmers as given, and farmers have devised appropriate adjustment mechanisms for reacting to this uncertainty. For instance, upland rice cultivation has been de-emphasized as a reaction to rainfall uncertainty.

Weed infestation, especially striga in sorghum and maize and other weed problems with fadama rice is topmost on the farmers' prioritization of agro-ecological constraints. Other constraints mentioned by the farmers included the hardpan problem in fadama soil, declining soil fertility, and pest problems especially on cowpeas and rice.

The area, however, has its agro-ecological possibilities for increased agricultural production, among which are: the abundant supply of arable land, and the huge potential for small-scale irrigation schemes in the under-utilized in-valleys.

5.2 Socioeconomic Constraints and Possibilities

According to the farmers' perceptions, socioeconomic constraints offer both the greatest challenge and opportunities for increased agricultural production. The attitude of the farmers, which may be somewhat rational, is that little can be done to
avoid agro-ecological constraints. They, however, see a lot of possibilities for technological and policy interventions in resolving socioeconomic constraints.

Labor supply constraints were rated as the most serious problem confronting increased agricultural production in the area. These constraints include such factors as the astronomical upsurge in the cost of hired labor, the collapse of the tractor hiring services of the ADP and the consequent low level of mechanization. Farmers did not perceive the level of out-migration of people as high enough to constitute a major source of depletion of available labor. Women seem to be hardest hit by the labor bottleneck, as they have little or no access to family labor to help in their individual farms.

Other socioeconomic constraints mentioned by the farmers include low cash input into production. Rural banking and other sources of credit are inaccessible to the majority of the farmers. Inaccessibility to markets for farm produce was mentioned in only one village as constituting a major agricultural production bottleneck.

It is, however, pertinent to note that the farmers have devised appropriate coping strategies for overcoming the constraints. Group farming, exchange pooled labor and the organization of the cropping patterns are all geared towards resolving the labor bottlenecks.

5.3 Institutional Factors

An attempt to investigate farmer perceptions regarding agricultural production constraints emanating from the institutional set-up of the area revealed the tendency of farmers to rationalize their traditional institutional structures. For instance, farmers failed to perceive any constraint emanating from the institutional framework for labor utilization. Issues such as the gender-bias in the distribution of
family labor and the possibility of the efako family structure acting as a source of resistance to change were not perceived as constraints by the farmers.

Farmers, however, pointed out some constraints emanating from government institutions and policies. Principal among the constraints was the inability of the NSADP to sustain the high level of presence and activities that characterized the early 1980s. The near collapse of the tractor hiring and input supply structures, especially for fertilizer and other agrochemical, were rated among the greatest constraints. Others include the failure of the ADP to complete and/or install head dykes and other water control mechanisms in the fadamas. Farmer-Extention-Research contacts at the institutional level were regarded as inadequate. For instance, many farmers have only heard of the location of the National Cereal Research Institute (NCRI) at Badeggi, but have had no contact with the institute.

6.0 Technological Intervention and Uptake

Various agricultural technologies have been introduced in the area by different development agencies in the last three decades. However, the period 1980 - 85, spanning the life of the Bida ADP is regarded by the farmers as the major period during which a systematic and integrated attempt at agricultural development was undertaken. For instance, apart from some sporadic attempts made from the late 1950s through the 1970s, at introducing fertilizers and some improved crop varieties and the development of some irrigation schemes (for instance at Loguma in 1957); most of the other technologies were introduced by the BADP.

Most of the technologies introduced in the area have had to do with improved varieties of crops such as rice, cowpeas, maize, groundnuts and cassava
and their complementary farming practices and inputs. Cropping practices such as increased planting density, spacing, thinning, use of fertilizers, herbicides and other pesticides have been introduced.

Adoption rates for the different technologies have varied from crop to crop and from location to location. The adoption of fertilizer has probably reached the routinization stage. Its use has virtually become a routine practice among the farmers, contingent on supply. The demonstrated improved yield accruing from fertilizer application was cited by farmers as a crucial factor in its adoption. Sorghum, rice, cowpea, groundnut and maize are the most fertilized crops. Fertilizer use on yam is, however, not as common as with other crops, because some farmers claimed that it reduces cooking and storing qualities. Higher plant densities in rice, sorghum and millet have attracted a low level of adoption. The most quoted reasons for low-adoption rate of these technologies included poor heading, high labor requirements and their inappropriateness to the prevailing mixed cropping system. The rationality of the farmers' decision had been attested to by an Bida ADP's report which observed that the project's recommendations were all for sole crops, while mixed cropping was the most predominant cropping system (Wedderburn, 1986). Other practices such as use of pesticides for cowpeas, of herbicides and other agrochemical have attracted a low adoption rate due to price and supply constraints. The introduction of cowpeas as an off-season crop in the fadama has not achieved much success due to insect problems, low levels of residual moisture and competition for labor requirement for other crops, notably yam.

Efforts made by the Bida ADP in the early 1980s at fadama improvement through the construction of concrete head dykes, main drains down the center of
fadamas and peripheral channels at the sides, were not completed in many villages. However, in villages where these water control mechanisms were completed either by the ADP or the community, farmers seem to be making appreciable effort to maintain them. Farmers confirmed that participatory approaches such as field demonstrations, on-farm trials and personal contacts were largely adopted in introducing the technologies. It was also revealed that the Extension staff had been the most commonly used channel of introduction.

7.0 Summary, Conclusions and Implications for Further Research

The exploratory survey was conducted within the original Bida ADP area with the main objective of gaining a first-hand insight into the important agro-economic and social parameters existing within the farming systems. The ultimate goal was to develop an appropriate framework for conducting a more detailed research study into the adoption of technologies within the area. Eight group interviews involving both men and women farmers were conducted in a representative sample of eight villages within the area.

The very complex and interactive farming systems characteristic of sub-Saharan Africa was clearly exhibited within the area. Three distinct but highly complimentary cropping systems are encountered within the area. These include the sorghum-based, yam, and rice-based cropping systems. Each of these systems involves a complex mix of crops within a mixed cropping structure. Sorghum, the staple food of the area, is the most important and widely cultivated crop. Other important crops within the farming systems include rice, groundnut, melon, maize, millet, cassava, bambara nuts, sweet potato and peppers. The rice-based cropping system involves both upland and fadama production, with the latter being the more important of the two.
The pyramidal leadership structure with the village head at the top of the hierarchy, supported by ward heads and finally by household heads predominates in the area. The organization of agricultural production, consumption and marketing units involve a complex hierarchy of household structures encompassed in the "Efako" and "Gucha" systems. The "Efako" structure is a multi-family unit headed by the most senior male in the family, and grouping his wife or wives, his married sons and their families, his unmarried sons and daughters into an agricultural production and consumption unit. The "Efako" production unit is the most predominant structure in the area, accounting for a large proportion of all cultivated area. The "Gucha" production unit is a single-family structure in which individuals own and take responsibility for the day-to-day management of their individual plots. In villages where the efako structure has disintegrated for various reasons, the "Gucha" structure predominates. It is, however, pertinent to note that the individual "Gucha" production units exist within the efako structure, in which individuals engage in private production outside the group's farms for extra cash to meet other exigencies.

In general, there is no landless labor class nor any exploitative tenant farming structure. Access to land is mainly through inheritance, in which the family head allocates land to individual members on the basis of need. There are gender differences in the allocation of land, labor and agricultural tasks. While men gain access to farmland through inheritance, women depend on their husbands for farmland. In the same vein, while men are mainly responsible for land preparation, planting, weeding and other crop management activities, the women are most active in harvesting, processing and marketing of farm produce. Women do have their own plots in some of the villages.
The infrastructure base of the villages is typical of most villages in Nigeria. Rural banking and credit facilities, health services, piped water and electricity supplies are few and usually concentrated in the semi-urban centers. The operation of the Bida ADP has, however, had some impact on rural road networks and access to extension services. Primary and secondary schools are generally within 5-10 miles from most villages.

Various agricultural technologies such as improved crop varieties, crop management practices and agricultural inputs (fertilizers, seed dressings and other agrochemical) have been introduced under the auspices of the Bida ADP. There have been wide variations in the adoption rates for the various technologies, with fertilizer application being the most widely adopted. Sporadic efforts were made by the Bida ADP to develop the in-land valley through both the formal and informal irrigation schemes with mixed results. A lot still remains to be done to fully tap the production potentials of the valleys.

The farming system constraints confronting the area are manifold. Prominent among these are labor and input supply constraints, and agro-ecological constraints such as poor rainfall distribution and quantity, reduced soil fertility, hardpan problems in the fadama fields, and high weed and pests infestations. Inspite of these numerous constraints, the management of the farming systems' resources endowment by the farmers provides ample evidence for the Schultzian paradigm of "poor but efficient" farmers (Schultz, 1964).

7.2 Conclusions:

On the basis of the findings of the exploratory survey, the following conclusions can be made regarding the existing farming systems in the Bida ADP enclave:
An understanding of the dynamics of the complex household structures existing in the Bida ADP area as encompassed in the efako and "Gucha" systems is fundamental to a thorough analysis and understanding of the existing farming systems.

The organization of the farming systems is very interactive and integrated. The allocation of labor and other resources, and other management decisions for the different cropping systems are very complimentary and integrated. For instance, the adoption of a labor-intensive technology in the in-land valley cropping system is likely to conflict with the labor requirement for the upland sorghum-based cropping system. Hence, a systems approach which takes cognizance of such an interactionist effect is germane to any attempt to understand and improve the existing farming systems.

The intra-house distribution of decision-making powers and the allocation of labor and resources would appear from an outsider's perspective to encourage a gender-bias and an under-utilization of women's labor.

The period spanning the operation of the Bida ADP and the post-ADP era form two different epoches for the explanation of the technical change that has occurred within the area.

The organization of the farming systems and the management of the existing resource endowment lay credence to the Schultzian paradigm of "poor but efficient" farmers. Given the multiplicity of the ecological and resources constraints confronting the farming systems, the farmers' choice of technological options would appear to be fairly sophisticated and rational.
Implications for Research

The following implications can be drawn for further research:

i) Any appropriate model for the study of technology adoption within the area must pay special attention to the need for temporal, gender and intra-household disaggregation. Given the complex nature of the household structure, it is obvious that each household must have appropriate strategies for rationalizing the multiple and sometimes conflicting objectives specific to individuals according to their structural position within the household hierarchy. As Schultz (1974, p.11) rightly pointed out "that the assumption that family integrates the welfare of its members into an internally consistent family-utility function, is not only over-simplistic, but it attributes a role to the family that undoubtedly exceeds its capacity as a social institution". Hence an analysis of technology adoption within the household unit must take cognizance of the dynamics of the multiple adoption decisions taking place therein. For instance, issues such as differential adoption on group and individual farms; the possibility of the household acting both as a source of resistance to change and at the same time as a buffer against the risk of innovativeness, merit further research attention.

ii) The explanation of farmers' adoption choices from the portfolio of available technologies must take cognizance of the interactive and complimentary nature of the cropping systems. This idea calls for a systems-approach, which pays special attention to the ripple effect of a technological choice in one commodity on the whole farming system.
iii) The structure-function theory which explains the diffusion and adoption of innovation within the framework of societal institutions (economic, political, family, education and religion) might be more applicable to this area.

References


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