THE SOCIOECONOMIC OUTCOMES OF THE PARTICIPATORY LEARNING AND ACTION RESEARCH (PLAR) APPROACH TO THE TRANSFER OF AGRICULTURAL TECHNOLOGY (IRM) IN RICE CULTIVATION

By:
Antwi Kwaku Dei

February, 2009

THE SOCIOECONOMIC OUTCOMES OF THE PARTICIPATORY LEARNING AND ACTION RESEARCH (PLAR) APPROACH TO THE TRANSFER OF AGRICULTURAL TECHNOLOGY (IRM) IN RICE CULTIVATION

By:
Antwi Kwaku Dei
BSc. (Hons.) Agriculture

A Dissertation Submitted to the Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of Science and Technology, in partial fulfillment of the requirement for the degree of

MASTER OF SCIENCE, AGRICULTURAL ECONOMICS

Faculty of Agriculture

College of Agriculture and Natural Resources

February, 2009

DECLARATION

I, ANTWI KWAKU DEI, author of this thesis titled 'The Socioeconomic Outcomes of the Participatory Learning And Action Research (PlAR) Approach to the transfer of Agricultural Technology (IRM) in Rice cultivation' do hereby declare that this work herein submitted as a dissertation is the results of my own investigation, and that except for other people's work, which has been duly acknowledged, this dissertation has never been accepted for any degree in this University or elsewhere.

Kwaku Dei Antwi ……………………… ………………

STUDENT (PG 8830505) Signature Date

Certified by:

Dr. N. K. Gyiele ……………………… ……………….

SUPERVISOR Signature Date

Dr. K Ohene-Yankyera ………………… …. …………

Head of Department Signature Date

DEDICATION

This work is dedicated to the Lord God Almighty, the Giver of life and the strength of my life.

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to the Lord God Almighty for how far He has brought me in life. He has been the source of my life, strength, and wisdom.

My profound gratitude goes to my Supervisors, Dr N. K. Gyiele, Dr. J. A. Bakang, Dr. F. C. Fialor and all the Lecturers of the Department of Agricultural Economics, Agribusiness and Extension for their time, patience, guidance, advice, and for reading through this work. Special thanks go to my lovely and caring wife for her support, advice and prayers throughout the study period.

I am grateful to Mr. Philip Idinoba of WARDA, Mr. Achaempong of Crop Research Institute and Mr. Ayeah of Secondi – Takoradi Metropolitan Agricultural Development Unit for their support and contributions to the work and also to Mr. Frimpong, Mr. Addo, Mr. Cephas (Extension agents for Biemso 1), Mr. J. H. Achaempong, and Zinabu, (Extension agents for Ohiamadewn and Kobinanokrom respectively) for their hospitality and cooperation during the data collection period. To all the rice farmers interviewed in all the three communities, I say thank you and may God bless you all.

My next appreciation goes to my parents and siblings for their support, love and encouragement throughout the period of my study.

My appreciation cannot be concluded without mentioning the names of Lesley Hope (Mrs.) my project colleague, Anthony Amoah and all my course mates for their encouragement, advice, prayers and support during the period of my study.

ABSTRACT

For many years now, the linear model of technology transfer has been used by Extension Agents in Ghana to transfer improved agricultural technologies to famers.

This model of transferring agricultural technologies has led to the low adoption of many improved agricultural technologies and where adoption has been attempted, these technologies are often abandoned by famers.

This work looks at the effectiveness of the participatory model (*Participatory Learning and Action Research – PLAR*) as an alternative to the transfer of agricultural technologies. This was necessitated by the fact that many authors have criticized the conventional approach as ineffective in transferring agricultural technologies to farmers. First the study was to examine the impact of the approach on farmers' knowledge concerning improved practices in rice cultivation. Secondly the study was to find out how the knowledge acquired could influence farmers' outputs and farmers' profits per an area of land. To examine these questions an investigative survey was conducted in three rice cultivating communities in Ghana where PLAR has been used to transfer Integrated Rice Management as a technology.

Results from the study, using KASA analysis, indicated that in all the three communities the PLAR farmers showed higher levels of improved knowledge and practices in rice cultivation than their non PLAR counterparts. Results from independent sample t-test at a significance level of 5% also showed that the PLAR farmers in all the three communities had significantly higher outputs per acre and also higher cost of production than their non PLAR counterparts, whiles the non PLAR farmers had higher gross profit margins than their PLAR counterparts in all three communities.

The study recommends that PLAR should be re-designed to make it less expensive for farmers to practice to ensure higher gross margins among farmers.

Provision of subsidies to farmers to reduce the cost of using recommended agricultural technologies is also recommended by this study.

TABLE OF CONTENT

CONTENT **PAGE**

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The communication gap between research, extension and farmers has been under serious scrutiny over the past decades as a result of the fact that the gap between researchers and farmers seems to be widening every now and then. Though many attempts have been made to close this gap, little has been achieved. As a result of this gap, most agricultural research especially in Ghana are not demand – driven to meet the needs of the resource poor farmer.

Agricultural research has been traditionally a linear process between scientists and the end users (generally the farmers) at the opposite ends. The scientists produced innovations that farmers were expected to use to their benefit. In between the two a link such as the extension service has the responsibility of transferring the innovations from the scientists to the farmers. The process has been traditionally and in the majority of cases unidirectional, or in other words, supply-driven.

The linear or the conventional approach, also known as the *transfer of technology* has been the dominant model used in the transfer of agricultural technologies to farmers especially in many developing countries like Ghana. This linear and mainly technology - driven model reflects the modernistic development perspective and it includes three main actors which are *formal researchers* who are responsible for providing scientifically valid research results, *extension agents* who 'transfer' the scientifically proven technologies and the *farmers* or other *clients*, who have the role of the adopters or rejecters of such technologies developed by the researchers. Researchers define the research agenda and design trials which farmers are allowed to implement under their (Researchers) supervision. The relationship between the researcher and farmer is hierarchical. Researchers are the main decision-makers, setting the research agenda designing and implementing trials with no farmer participation. This linear approach has a fundamental assumption that people are incapable of doing research and that it is only the elite who know scientific methodologies and hence develop technologies without the involvement of the targeted farmers. Based on this assumption, agricultural researchers, planners, implementers, and extension agents have developed and transmitted agricultural information on the idea that farmers' indigenous knowledge systems, strategies, and

capacities are limited and unsuitable for a fast changing technology-dependent means of agriculture. Researchers work in farmers' fields to develop technology for farmers or to test and validate research findings obtained in their research stations.
Despite some positive results from this linear or conventional approach to agricultural technology transfer, there are difficulties in terms of scaling- up of agricultural technologies transferred to farmers through the linear approach. These difficulties have over the years accounted for the low adoption and rejection of most agricultural technologies by local farmers especially in Africa.

Currently, various mainstream agricultural research and development projects use new methods for interacting with smallholder farmers to develop and spread appropriate technology, such as the farmer field schools, local agricultural research committees and the Participatory Learning and Action Research – PLAR (Bentley, 1994). These methods rely on engaging people in experimentation, observation, measurement and other activities which allow them to draw their own conclusions.

The PLAR approach, which is a bottom-up approach and allows for easy scaling-up is a farmer education approach, which is based on adult farmers learning in groups and making use of the experiences of the group members. The approach allows farmers analyze their own practices, discover problems, and seek solutions to solve them. Instead of diffusing or transferring the technologies coming from research or extension services, this approach encourages farmers to diagnose problems and find solutions by themselves. The objective of the PLAR approach is to develop farmers' capacities or abilities to observe and analyze their working environment (practices) in order to identify the major constraints and come up with possible improved practices to achieve more productive and sustainable results. One of the major outcomes of Participatory Learning and Action Research-Integrated Rice Management (PLAR-IRM) is to improve the knowledge level of farmers in integrated rice management and eventual translation into increased productivity. According to Defoer (2001), PLAR-IRM mainly aims at improving farmers' knowledge and encourages them to put this knowledge of improved and integrated rice management into practice.

The West Africa Rice Centre (WARDA) achieved a measure of success in soil management for diverse environments with this PLAR approach (WARDA Annual

Report, 2001). With the success on soil fertility management, WARDA embarked on a programme to introduce Integrated Rice Management (IRM) in some communities in Ghana with inland valleys with rice-based cropping systems in 2001. These communities include Biemso 1 in the Ahafo Ano- South District, Kobinanokrom and Ohiamadwen, both in the Shama-Ahanta East District, and Golinga in the Builsa District.

This was to test the effectiveness of the PLAR approach as a means of transferring agricultural technologies to rice farmers in these areas. Farmers were organized into groups and were taken through effective learning about the appropriate cultivation practices which include improved rice seed selection procedures, proper pre-nursery seed handling practices, improved soil/land preparation procedures, proper water management practices, integrated weed and pest management practices as well as improved harvesting and post harvest handling practices.

Demonstrations were carried out on farmers' own fields for their own observation after which participating farmers transferred lessons learnt from the demonstration fields to their own fields. In this regard, farmers were expected to progressively incorporate new ideas or integrate several improved crop production practices that could improve farm yields.

The purpose of this research is therefore to assess the effectiveness of the PLAR approach as an alternative to the linear approach of agricultural technology transfer by assessing its effect on farmers' yields and profits in the selected communities.

1.2. Problem Statement

The development of new rice cultivation techniques such as the integrated rice management (IRM) techniques alone does not necessarily result in higher rice yield, profitability, or improved farmers' capacities. The mode or the approach through which these technologies are disseminated or transferred to farmers also influences the level of use and hence the outcome/ impact of such technologies.

The linear or the conventional approach to agricultural technology transfer has been the major approach to the dissemination of agricultural technologies to farmers in Ghana. Extension agents who are the main agricultural technology transfer agents in

Ghana carry research findings to farmers for farmers to practice under the supervision of these extension agents. The involvement of farmers who are the main stakeholders is completely absent during the developmental stages of the technologies under the linear approach. This nature of the linear approach has led to the low adoption of agricultural technologies by farmers and even where adoption is attempted by farmers, the technologies are often abandoned by farmers. Meertens and Rolling (1995) identified non-adoption of rice technology in Sukumaland, Tanzania as due to low farmer participation during priority setting of on-farm activities, poor involvement of extension service. The linear approach is likely to be successful and scaled - up only in relatively homogenous, low-risk, natural and social environments, where farmers live under similar conditions, perceive the same kinds of challenges and share a common set of beliefs and values Rogers (1995). However, farmers in Ghana are widespread in terms of their geographical locations and hence cultivate under different environmental, social and economic conditions which make the use of the linear approach not the best approach to the transfer of agricultural technology in the country.

It is against this background that participatory research approaches such as PLAR have emerged in recent years as a significant methodology for intervention, development and change among farmers. The focus of the participatory approach centres on the identification, development and use of technologies specifically tailored to meet the needs of small, resource-poor farmers.
The central question therefore, is 'what has changed as far as farmers' yields, profits and knowledge in rice cultivation are concerned as a result of using the PLAR approach in the dissemination of agricultural techniques to rice farmers in the study areas?

1.3 Objectives of study

The broad objective is to evaluate the effectiveness of PLAR as an approach to the transfer of agricultural technologies to rice farmers in some communities in Ghana.

Specific objectives include

i) To quantify the contribution of the PLAR approach on farmers' rice yield.

ii) T o determine the profitability of using the PLAR approach.

iii) To determine how the PLAR approach has influenced farmers' knowledge.

1.4 Justification

Total rice consumption in Ghana is about 500,000 metric tons of which 350,000 metric tons costing US$ 600.00 million are imported. Local rice production has satisfied less than 50% of the total demand (Rice Web, 2007). For a long time, domestic production of rice in Ghana has been lower than consumption needs. Demand for rice began to outstrip supply due to population increase, urbanization, improved standard of living and farmers' inability to produce enough to meet the growing demands of consumers. There is therefore the need to reduce this yield gap and food dependency and also to accelerate the growth of local rice production. However, this cannot be achieved without the development of the appropriate agricultural technologies and the use of the right approach in getting these technologies to farmers for implementation.

Again, the relevance of this study stems from the fact that it conforms to government's current position on extension development efforts which emphasises demand – driven technology dissemination approaches.

Results from this study would provide information that would be useful in a number of ways. The outcome of the study would serve as a useful guide to government, NGOs, policy makers and other stakeholders to identify the appropriate approach to disseminate improved agricultural technologies to farmers especially rice farmers in the country. Again the study hopes to help to identify the appropriate technology transfer approach which is farmer friendly and which better builds up farmers' capacities in terms of their knowledge level in rice production. The building of farmers' capacities hopes to help in reducing the yield gap that exists in the rice sector. The study is also expected to identify the bottlenecks that may be encountered in using any participatory approach such as PLAR for recommendation. The recommendations made would go a long way to improve upon the approach during scaling – up with other crops in other parts of the country.

1.5 The Conceptual Framework:

The PLAR approach ensures farmer participation in deciding on the appropriate Integrated Crop Management options for rice production that suit their social, economic and institutional environment, and also rely on the combination of farmers' indigenous/local knowledge and research/scientific information in the achievement of the desired outcome or results.

The process of technology transfer is influenced by the availability, accessibility and control of resources such as land (own or hired), labour (hired or household), and inputs (pesticides, irrigation facilities etc.), since technology transfer process and adoption do not occur in a vacuum. The availability and accessibility of these resources may promote the transfer and adoption process, whiles their absence may hinder the transfer process. The transfer process is also influenced by the existence and accessibility of institutions and support agents to the farmer. Such institutions include the extension services, markets (input and outputs), financial institutions to provide credit facilities, and farmers' organisation. The existence of these institutions also influences the availability of and accessibility of resources available for the transfer process. Also the existence of a favourable local institution such as a good land tenure system would also enhance the adoption of the technology.

The farming household which is the potential adopter/beneficiary of the expected outcome of the technology is affected by such factors as socio-economic factors in its quest to adopt the improved practices. Such factors include household's access to credit facilities, household size, and local laws/customs. The household may participate in the technology transfer process if such factors favour the household. These socioeconomic factors also influence the kind/type of technology that is to be transferred. According to Rogers (1995), technologies are easily transferred and adopted if they are compatible with the socioeconomic environment of the potential adopters.

The PLAR approach combines local knowledge with scientific knowledge options in its implementation. It is expected that farmers' knowledge concerning the production of rice would be improved as the appropriate options are adopted and practiced. This is expected to result in increased yield, as the appropriate practices are performed at the required times as recommended by the ICM technology. The increase in farmers' knowledge, skills and capacities in rice production is expected to result in increased rice yield at a reduced cost of production through optimum use of resources on farmers' fields. The increase in yield at a reduced cost of production is further expected to result in increase in income level from rice production, which could result in improved standard of living of farmers in the long run.

The PLAR approach also takes farmers through the appropriate post-harvest practices to improve the quality of rice produced. This ensures that quality rice is produced for higher prices on the market. With increase in yield and higher market prices, the farmers' revenue is expected to increase.

Figure 1 below shows the diagrammatic representation of the relationship between the PLAR approach of introducing ICM and the various factors influencing the approach as well as the expected outcome/impact of the approach as explained above.

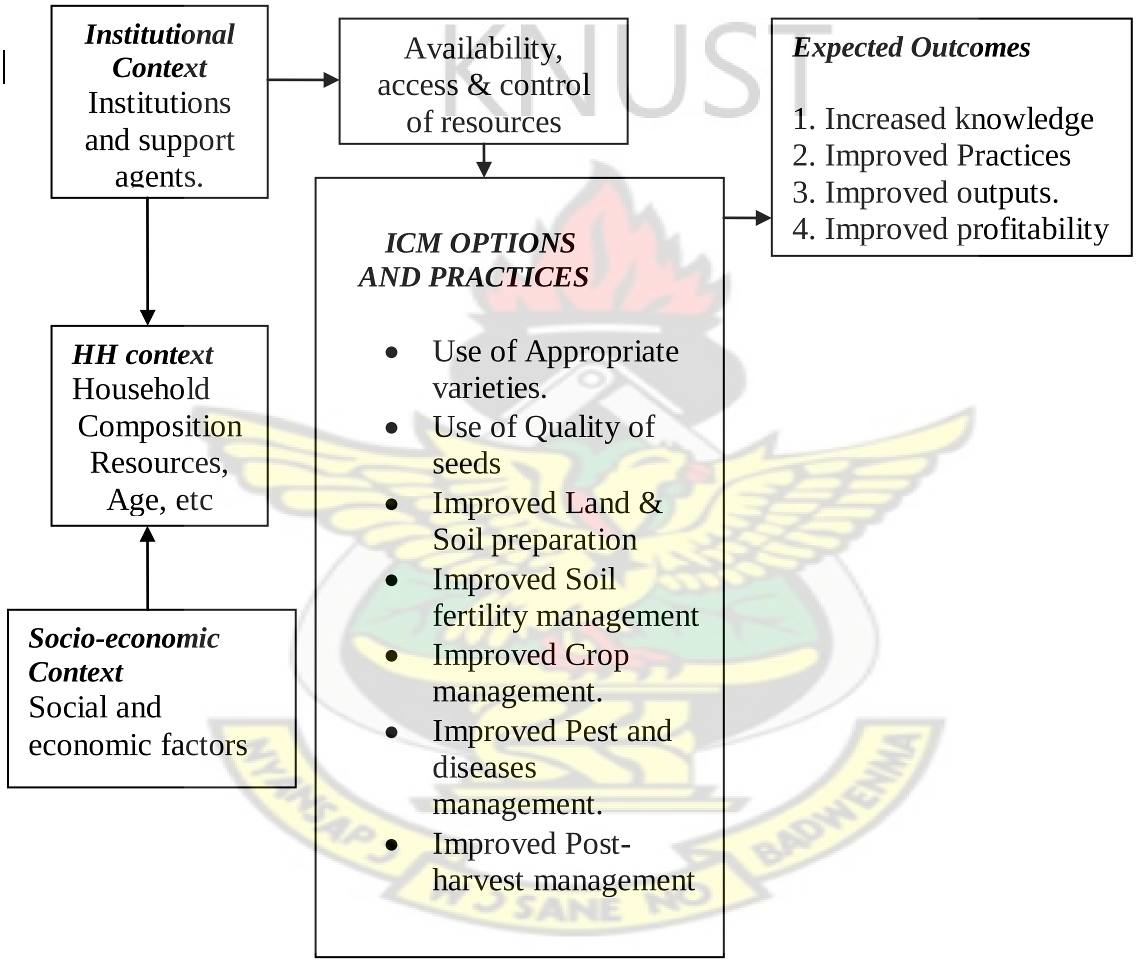


Figure 1: Conceptual model relating ICM practices and outcomes as governed by different contexts.

Source: (Idinoba, 2006)

1.6 Limitations to the Study

During data collection almost all the farmers interviewed in all the three communities complained that they had been involved in a number of similar exercises of responding to questionnaires from researchers without any improvement in their economic status, though the researchers promised them of improved standard of living. This resulted in low level of cooperation from some of the farmers.

1.7 Organisation of the Study

The study is organised into five chapters. Chapter one comprises the background to the study, the problem statement, objectives, significance (justification) of the study, the conceptual framework, limitations and the organisation of the study.

Chapter two comprises the review of relevant literature related to the study. It includes the importance of technology to agriculture, approaches to the transfer of agricultural technologies (extension), factors that influence the transfer and the adoption of agricultural technologies at the farm level.

Chapter three outlines the methodology and the procedures which were used in conducting the study. It comprises the description of the study areas, questionnaire design, the sampling techniques, data collection procedures and the data analysis procedures used in the study.

Chapter four touches on the results obtained from the study as well as the interpretation and discussions made from the results of the study. Chapter five looks at the conclusions drawn from the study as well as the various recommendations made by the researcher.

CHAPTER TWO

LITERATURE REVIEW

2.1 THE ROLE OF TECHNOLOGY IN AGRICULTURAL DEVELOPMENT

According to the U.S. General Accounting Office publication (2004), technology may be broadly defined as the knowledge, skills, methods, and techniques used to accomplish specific practical tasks. Thus, technology is more than just methods and materials; in the broader context it also includes the people, policies, and procedures which ensure the application of a particular technology.

Rogers (1995) also defines technology as a design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome. According to Ayichi (1995), agricultural technology involves the application of mechanical, chemical and biological inputs such as tractors, fertilizers, agro- chemicals, livestock breeds, high yielding crops, storage and processing facilities, to improve food production. Technology, in the classical sense, according to Hutchins (1990), includes the development and use of nutrients, pest control products, crop cultivars, and farm equipment; but it also includes the vision of genetically modified crops providing greater nutritional efficiency (more calories per yield, or more yield), manipulation of natural pest control agents, and use of farm management techniques that focus on whole-farm productivity over time, not just annual production per hectare.

Agricultural technology looks at the application of science and technology in the production of food and raw materials for human consumption and industries respectively.

Technology has played an important role in agriculture in the area of plant varietal improvement, integrated nutrient management, integrated pest management and agricultural engineering.

The rapid modernization of agriculture and the introduction of new technologies such as those that characterized the Green Revolution have had a great impact. Studies on the impact of the Green Revolution have shown that technological change in agriculture can generate major social benefits (FAO, 2000).

The rapid adoption and diffusion of new technologies within the U.S. agricultural sector has resulted in sustained agricultural productivity growth and ensured an abundance of food (Evenson and Huffman, 1997). In his article '*The role of technology in sustainable agriculture'*, Hutchins (1990) reported that the early applications of technology have not only increased food production in real terms, but have dramatically reduced the number of individuals directly involved in food production/processing. Hutchins (1990) again asserted that to deny the role that biological and chemical technology have played, continue to play, and will play in the future development of agriculture is to deny natural history itself. According to Avery (1995), credible arguments have been advanced to suggest that production of food via high-yield agriculture techniques can meet the nutrition requirements of the global population. In his contribution to the importance of technology to agricultural development, Richards (1990) remarked that the global land in production today, which is roughly the size of South America, would have been the size of South America and North America if the high yield benefits of technology were not employed'.

2.2 APPROACHES TO AGRICULTURAL TECHNOLOGY TRANSFER (AGRICULTURAL EXTENSION)

The development of agricultural technologies is only one step in helping increase food production. Technology generation is widely recognized in agriculture sector as one of the major determinants of economic growth, but has to be transferred and adopted by farmer in order to realize growth and food security. The role of extension is to disseminate technologies generated by public sector research organizations.

The transformation of traditional agriculture into knowledge based agriculture requires expeditious transfer of research results from the laboratory to land. The technologies must be adapted and disseminated among farmers and this calls for successful technology transfer. According to Feder and Umali (1993), three basic models of agricultural extension are discussed in the literature: technology transfer, farmer first, and the participatory model.

2.2.1 The Technology Transfer or the Linear Model

This approach to technology transfer as shown in figure 2 involves a top-down approach where scientists determine research priorities, generate innovations they believe are good for farmers and provide the results to extension agents and subsequently to farmers. Information about the innovation, including its likely benefits, is then passed to individual farmers on the assumption that this will encourage them to adopt the innovation. This conventional extension theory which is based on the central source model of technology development and diffusion, examines the role of various organizational arrangements and communication techniques in persuading farmers to adopt a recommended technology. The Training and Visit System, promoted extensively by the World Bank in the 1970s and 1980s, exemplifies this approach.

In practice, farmers often do not adopt the new technologies and practices extended, for quite sound reasons. The research-driven nature of the top-down process can result in products that do not fulfil genuine needs of the farmer (Chamala *et al*, 2004).

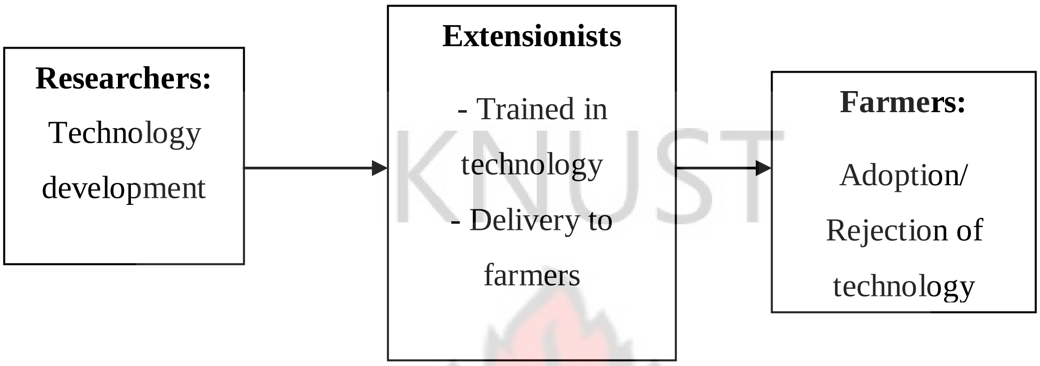
Assumptions in the conventional paradigm or the technology transfer model include the following;

1. knowledge is with the researcher
2. farmers receive knowledge from elsewhere
3. technology is 'something' that can be transferred

4. technology is either adopted or rejected

The problems of non-adoption associated with this approach are due to poor communication of the technology between extension providers and farmer, or with the farmers themselves (Chamala *et al*, 2004).

Figure 2: The Linear Model of Technology Transfer



Source: Nyborg *et al* (2008)

2.2.2. The farmer first

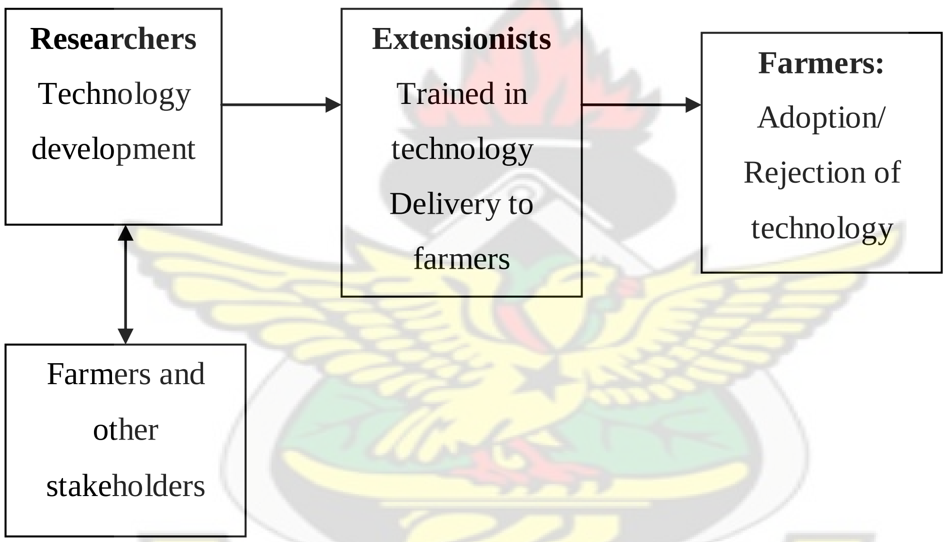
The farmer first model differs strongly from the technology transfer model or approach. It acknowledges that farmers often have sound local knowledge and good reasons for their behaviour, which may not be understood by scientists. Farmers experience with experimentation and evaluation provides a basis on which scientists can learn from and with farmers to set research priorities. The main objective of the farmer first approach is to empower farmers to learn and create better situations for themselves rather than being passive recipients of new technology (Gough, 2003). Researchers do not drive the research, development and extension process; they interact with and assist farmers. The process is bottom-up with emphasis on bringing about changes that farmers want.

An important limitation of the farmer first approach is that significant off-farm structural forces (social, political and cultural), which inevitably shape farmer priorities and decision-making, can be overlooked. For instance, private sector infrastructure for the marketing of a new technology can have a significant influence on on-farm Integrated Pest Management (IPM).

2.2.3. The Participatory Approach (model)

The third extension model or approach is the participatory model as depicted in fig. 3 and which is based on cooperation and participation. It arises from the recognition by many agricultural researchers, extension personnel, and farmers of the need to view agricultural problems as a complex human activity system. Research, development, and extension processes are seen as both iterative and interactive. The emphasis of this approach, as depicted in figure 3 below is on involving key stakeholders in a cooperative and flexible process that facilitates the implementation of activities to achieve practical improvements.

Figure 3: The Participatory Model of Technology Transfer



Source: Nyborg *et al* (2005)

The common themes of these approaches are qualitative data gathering, active participation of those having an interest in the outcomes, and responsiveness to both on-farm and off-farm decision making (Feder and Umali, 1993).

The participatory approach is especially appropriate when dealing with bundles of technologies rather than single innovations. Integrated Crop Management for rice also known as Integrated Rice Management (IRM) as an agricultural technology clearly falls into this category. A participatory approach to ICM, which involves the cooperation of key players throughout the ICM research, development and implementation process, is likely to be far more effective than technology transfer or farmer first approaches. What is required for long-term ICM success is a high quality interaction between key players. This is most likely to be achieved where key players have common goals, work together as a team, and enhance each others activities.

The focus of farmer participatory research is the development of agricultural technology to increase productivity. This centres on the identification, development or adaptation, and use of technologies specifically tailored to meet the needs of small, resource-poor farmers. Technology must emerge from the farmers' needs (demand – driven) as they identify them. Farmers conduct experiments and evaluate the appropriateness of a technology based on their own criteria. With the participatory agricultural extension approach agricultural extension program planning could be controlled locally, the content fixes the needs and interest of farmers, enhances the learning process of the beneficiaries, reduce the total cost of the extension system, and stimulates increased confidence, awareness, and activity among farmers and other beneficiaries (Nyborg *et al*, 2005).

Some Participatory Model Methods

Rapid Rural Appraisal (RRA)

Rapid Rural Appraisal (RRA) can be defined as 'a qualitative survey methodology using a multi-disciplinary team to formulate problems for agricultural research and development (Dong and Saha, 1995). RRA is described by Grandstaff and Grandstaff (2000) as a process of learning about rural conditions in an intensive, iterative, and expeditious manner or any systematic activity designed to draw inferences, conclusions, hypotheses, or assessments, including the acquisition of new information, during a limited period of time. It characteristically relies on small multidisciplinary teams that employ a range of methodological tools and techniques specifically selected to enhance understanding of rural conditions (Dong and Saha, 1995).

RRA embraces a holistic approach to the processes of defining a research context and selecting a team. Commonly RRA teams are multi-disciplinary; gender balanced and tries to explore problems within their context. RRA is more 'naturalistic' in its scientific approach. It does not attempt to control the research setting and is therefore not experimental or reductionist. According to (Dong and Saha, 1995), RRA is important in extension because of four basic reasons,

1. Farmers and rural communities face complex problems like land and resource degradation, disease and pest control, conservation farming techniques and farmer driven marketing activity. The traditional extension approach of 'diffusion of innovations' may not apply to many of these complex long term problems.
2. Farmers often find it difficult to understand research recommendations because they cannot see the relevance in the context of their own farms.
3. It is increasingly important for researchers and extension workers to understand the ways in which farmers perceive problems.
4. Farmers often adapt and improve research findings to suit their particular conditions, but often researchers are not aware of, and so do not benefit from, such feedback.

It is also important to recognise that RRA has some drawbacks, not the least of which is that teams can be difficult to organise. Team training is essential and requires time and expertise. Again the analysis of qualitative data is often new and difficult to most agriculturally trained people who have come from natural science traditions. The findings are most often not statistically "sound", even if RRA teams can use "quick and dirty" sampling methods to make sure that they cover a reasonable number of people or households in a particular area. There is the risk that the information gathered by an RRA is not very representative but is a collection of particular cases which do not tell researchers very much about general conditions.

It must be noted that Participatory Rural Appraisal (PRA) methodology is a development of RRA which gives local people more of an involvement with the research process and also expects more action from them. While 'exploratory' RRAs aim to elicit local people's definitions of their problems, there is a temptation for a research team to 'extract' the data from the community, analyse it and write it up for their peer group. For the community, the data and the experience has been lost and so has the opportunity to take action or make changes. To avoid this preoccupation with the data Chambers *et al* (2004) uses the term 'Participatory Rural Appraisal' to stress the process of continued community involvement and ownership of the data and the process. In these cases the data and feedback process are an integral part of the research and change (local action) occurs and is promoted by the research team.

Participatory Rural Appraisal (PRA)

Participatory rural appraisal (PRA**)** is an approach which aims to incorporate the knowledge and opinions of rural people in the planning and management of development projects and programmes (Chambers *et al*, 2004). It comprises a set of techniques aimed at shared learning between local people and outsiders. It enables people to express and analyse the realities of their lives and conditions, to plan themselves what action to take, and to monitor and evaluate the results.

It makes use of a wide range of visualization methods for group-based analysis to deal with spatial and temporal aspects of social and environmental problems. PRA provides a structure and many practical ideas to help stimulate local participation in the creation and sharing of new insights. The emphasis on ensuring community feedback broadens the scope of people involved.

There is no single way to undertake PRA, although there are core principles and over 30 methods available to guide teamwork, do sampling, structure discussions and visualize analysis (Blackburn and Holland, 1998). The combination and sequence of methods will emerge from the context. PRA employs a wide range of methods to enable people to express and share information, and to stimulate discussion and analysis. Many are visually based, involving local people in creating. PRA activities usually take place in groups, working on the ground or on paper. The ground is more participatory, and helps empower those who are not literate. Visual techniques provide scope for creativity and encourage a frank exchange of views. They also allow crosschecking. Using a combination of PRA methods a very detailed picture can be built up, one that expresses the complexity and diversity of local people's realities far better than conventional survey techniques such as questionnaires.

There are five key principles that form the basis of any PRA activity no matter what the objectives or setting: (Blackburn and Holland, 1998). These are participation, flexibility, teamwork, optimal ignorance and systemic analysis.

*Participation***.** PRA relies heavily on participation by the communities, as the method is designed to enable local people to be involved, not only as sources of information, but as partners with the PRA team in gathering and analyzing the information.

*Flexibility***.** The combination of techniques that is appropriate in a particular development context will be determined by such variables as the size and skill mix of the PRA team, the time and resources available, and the topic and location of the work.

*Teamwork***.** Generally, a PRA is best conducted by a local team (speaking the local languages) with a few outsiders present, a significant representation of women, and a mix of sector specialists and social scientists, according to the topic.

*Optimal ignorance***.** To be efficient in terms of both time and money, PRA work intends to gather just enough information to make the necessary recommendations and decisions.

*Systematic analysis***.** As PRA-generated data in their original form are seldom conducive to statistical analysis (given its largely qualitative nature and relatively small sample size), alternative ways have been developed to ensure the validity and reliability of the findings. These include sampling based on approximate stratification of the community by geographic location or relative wealth, and cross-checking.

PRA involve some risks and limitations. Many of them are not unique to this method but are inherent in any research method that aims to investigate local conditions. One of the main problems is the risk of raising expectations (Chambers *et al*, 2004). This may be impossible to avoid, but can be minimized with careful and repeated clarification of the purpose of the PRA and the role of the team in relation to the project, or government, at the start of every interview and meeting. Trying to use PRA as a standard survey to gather primarily quantitative data, using large sample sizes, and a questionnaire approach could greatly compromise the quality of the work and the insights produced. And, if the PRA team is not adequately trained in the methodology before the work begins, there is often a tendency to use too many different techniques, some of which are not relevant to the topic at hand. In general, when a training element is involved, there will be a trade-off between the long-term objective of building the capacity of the PRA team and getting good quality results in their first experience of using the methodology (World Bank, 2003).

Furthermore, one common problem is that insufficient time is allowed for the team to relax with the local people, to listen to them, and to learn about the more sensitive issues under consideration. Rushing will also often mean missing the views of the poorest and least articulate members of the communities visited. The translation of PRA results into a standard evaluation report poses considerable challenges, and individuals unfamiliar with participatory research methods may raise questions about the credibility of the PRA findings (Theis and Grady, 1991).

Farmer Participatory Research

Farmer participatory research (FPR) is an approach, which involves encouraging farmers to engage in experiments in their own fields so that they can learn, adopt new technologies and spread them to other farmers. With the scientist acting as facilitator, farmers and scientists closely work together from initial design of the research project to data gathering, analysis, final conclusions, and follow-up actions. Farmer participatory research has also been defined as "the collaboration of farmers and scientists in agricultural research and development" (Bentley, 1994).

Scientists need to understand farmers' knowledge if they want to contribute to farmers' welfare by providing new information to them, by developing appropriate technologies with them, or communicating effectively with them. Farmers' knowledge should not be dismissed or, conversely, idealized. Understanding this knowledge is a fundamental step towards generating a dialogue between farmers and scientists. It is a key reference point that farmers use to make decisions and to communicate among themselves.

(Bentley, 1994) described four approaches to farmer participation;

Contractual: Scientists contract with farmers to provide land or services.

Consultative: Scientists consult farmers about their problems and then develop solutions.

Collaborative: Scientists and farmers collaborate as partners in the research process.

Collegiate: Scientists work to strengthen farmers' informal research and development systems in rural areas.

The main advantage of the Farmer participatory approach is that farmers "learn by doing" and decision rules are modified on the basis of direct experience. To shape learning, interpretations of experience must provide information about what happened, why it happened and whether what happened was satisfactory or unsatisfactory.

Participatory Action Research (PAR)

Participatory action research (PAR) is a method of research where creating a positive social change is the predominant driving force. PAR grew out of social and educational research and exists today as one of the few research methods which embrace principles of participation and reflection, and empowerment and emancipation of groups seeking to improve their social situation. Participatory Action Research (PAR) is a more activist approach, working to empower the local community, or its representatives, to manipulate the higher level power structures (Okali *et al*, 1994). PAR can empower a community, entrench local elite, right a wrong or totally mess things up.

Many of the problems in rural development where agriculture is a main driving force are complex involving contrasting and often competing objectives of different members of the community, local and regional authorities (Okali *et al*, 1994). Thus a traditional approach to research often misses out these important interactions that determine the outcome of any intervention. To accommodate this, it is increasingly recognized that users' participation is a more efficient and more effective way of conducting agricultural research. This is a highly dynamic process because the users are capable continuously to adjust the objectives and the methodologies to make them fit the newly emerging needs.

The benefits PRA brings to local communities can be intangible and even disappointing. PAR, by contrast, works directly with local political/development capacities to bring real, visible organizational structures, effective local advocacy, and a durable change in power relations with the centre.

2.2.4. Participatory Learning and Action Research (PLAR)

The Participatory Learning and Action Research (PLAR) were developed by the West Africa Rice Development Agency (WARDA) in 2001 to disseminate rice technologies to inland valley rice farmers across West Africa. The method supported farmers to help themselves, teaching them to observe, exchange ideas, analyze, and think things through in the preparation of taking action to support their farming techniques (Defoer, 2001).

According to Defoer (2001) the philosophy of PLAR is fundamentally different from that of traditional research, farming system research and from most of participatory research. PLAR is based on the philosophy of Constructivism whiles conventional research, farming system research and most of participatory research is based on the Positivism philosophy.

Under conventional research, researchers develop technologies at the research stations and transfer them to farmers. Success can only be seen under homogenous environment and where farmers have access to relevant information and inputs as it happened under the Green Revolution. Under the farming system research which was the main system of transferring agricultural technologies in the 1970's, technologies are developed primarily on research stations with targeted recommendation domains where they are then tested and adapted with farmers. The participatory research seeks to use farmers' knowledge to improve research output. It still involves completed technologies being given to farmers to see if they are adaptable.

The Constructivism philosophy under which PLAR falls assumes that reality is not absolute, but is rather actively constructed by people from their experiences and social interactions (Defoer, 2001). It is especially relevant in natural research management in diverse and complex farming environments where positivism does not work. It is also an action research (learning by doing); social learning; and the focus is not on the technology alone but also on the process of its transfer. The researcher also assumes a new role of translating scientific principles and technologies to something usable to farmers (develop training manual). The philosophy seeks to help farmers to help themselves rather than using farmers to help researchers.

Impact of PLAR-IRM on Farmers' Knowledge

One of the major outcomes of PLAR-IRM is to improve the knowledge level of farmers in integrated rice management and eventual translation into increased productivity. According to Defoer (2001), PLAR-IRM mainly aims at improving farmers' knowledge and encourages them to put this knowledge of improved and integrated rice management into practice.

One of the key elements of PLAR-IRM is the module. The module is the basic component of PLAR-IRM curriculum. The module takes as a starting point the farmers' existing knowledge and practices. The PLAR-IRM modules are intended to bring new and relevant information to farmers in a more digestible form so that new information can be captured by farmers and thereby become internalized knowledge (Defoer, 2001). Each module aims at improving farmers' knowledge, motivation, capacity and interest to innovate and thereby to change behaviour in a sustainable way. This is ultimately expected to lead to improved resource mobilization. This is represented in figure 4 below.

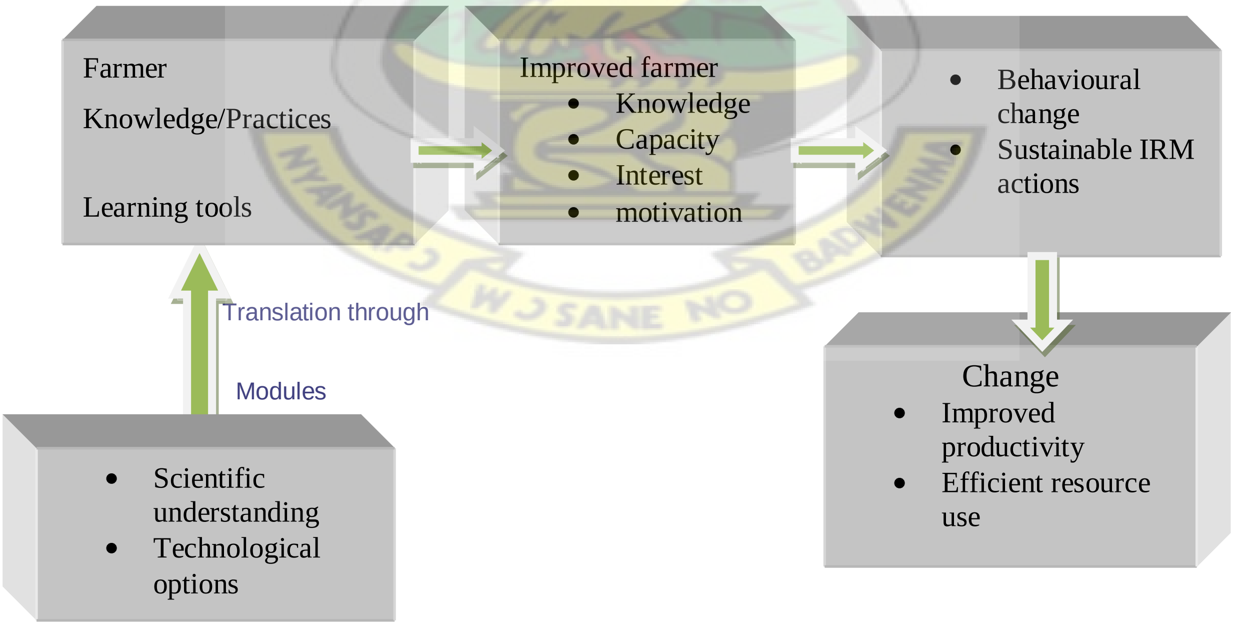


Fig. 4 Influence of PLAR-IRM on farmers' knowledge (Defoer, 2001)

Impact of PLAR-IRM on farmers' knowledge is assessed after PLAR sessions through observations by farmers. This assessment is usually done during field visits. Multiple choice questions are usually used for this assessment and farmers give reasons why certain choices are made and that reflects as functional knowledge. Functional knowledge according to Defoer, 2001 is the knowledge which allows learners not only capable of reproducing facts learnt but they are also able to argue out reasons for the facts known.

2.3. FACTORS THAT INFLUENCE THE TRANSFER AND ADOPTION OF TECHNOLOGY AT THE FARM LEVEL

An understanding of the processes leading to the adoption of new technologies by smallholders has been important to the planning and implementation of successful research and extension programs. At one level, a number of farm-household factors are typically associated with adoption, such as: age, education and personal characteristics of the household head; size, location and tenure status of the farm; availability of cash or credit for farm investment; access to markets for farm produce.

These factors that influence the transfer and the adoption of technology at the farm level are classified as those that affect the farmer (adopter), the technology being transferred, and the farmers' working environment.

According to Rogers (1995), farmers' socioeconomic factors that influence their innovativeness include the farmers' educational attainment, experience and age of the farmer. Also influencing the innovativeness of farmers includes farmers' farm size (Khanna, 2001). Surry (1997) found out that the socio-economic factors that influenced behaviour of farmers with respect to nitrogen fertilizer management in Nebraska, United States were education, experience, farm size, and the financial health of the farm firm. Similarly, Erbaugh *et al*. (2002) using discriminant analysis showed that education, farm size, perception of soil erosion, double cropping and increasing net farm income were successful predictors of Australian farmers who were carrying out soil conservation.

The characteristics features of agricultural technologies that influence their adoption include the perceived usefulness of the technology; its compatibility with the existing norms, values and practices; and the economic value of the technology being transferred. Support institutions existing in the farmers' environment and available to farmers also influence the innovativeness of farmers concerning agricultural technologies.

2.3.1. Farmers' Characteristics

Education, Experience and Age

Education level of farmers has been used as a proxy for many attributes including some of Roger and Stanfield's variables such as education, literacy, knowledgeability, and educational aspirations. Nelson and Phelps (1996) state that education enhances one's ability to receive, decode, and understand information. They went on to hypothesize that educated people make good innovators, so that education speeds the process of technological diffusion. Lin (1991) points out that though imperfect information causes new technologies to be risky, better-educated people are better prepared to manage the risk. Rahm and Huffman (1984) added that, human capital variables including schooling may enhance the efficiency of adoption decisions.

A number of studies, however, have found education not to be significantly related to adoption. For example, Dorfman (1996) do not find education to be significant in the decision to double-crop soybeans and wheat. However, other authors find education to be negatively related to adoption in a negative way. Harper *et al* (1990) find education to be negatively related to the adoption of an integrated pest management technology among Texas rice farmers.

Experience is informal education. Variables relating to experience are found in many economic models, with mixed results. Experience may positively relate to technology adoption by increasing a decision maker's ability to assess whether a new technology will be profitable (Khanna, 2001). Lin (1991) finds experience to relate positively to the adoption of hybrid rice in China. On the other hand, experience may be related to age, which has often been shown to negatively relate to adoption (Polson and Spencer, 1991). Caffey and Kazmierczak (1994), for example, find experience in the aquaculture industry in Louisiana not related to the adoption of flow-through and re-circulating technology in soft-shell crab production.

A number of studies have included age in their models, and though many, like those listed above, show age to be negatively related to adoption, some show a positive relation. For example, Adesina and Baidu-Forson (1995) study of the adoption of improved rice varieties in Guinea find age to relate positively to adoption. Other studies show no significant relation between adoption and age. Examples include Amponsah (1995) study of computers and information services in North Carolina.

Caviglia and Kahn (2001) study of sustainable agricultural practices in Brazil, speculated that age may also influence adoption via a correlation with physical health. The most extensive meta-review of socio-economic factors influencing adoption found both positive and negative relationships between age and adoption (Rogers 1995).

Farm size

Khanna (2001) finds farm size to positively relate to site-specific technologies in four Midwestern states. Kivlin and Fliegel (1967) find that larger-scale dairy farmers in Pennsylvania tend to adopt technologies faster than smaller-scale farmers. Lin (1991) finds farm size positively related to the speed at which Chinese farmers adopt hybrid rice. The adoption of improved cassava in Nigeria (Polson and Spencer, 1991) and the adoption of reduced tillage in Iowa (Rahm and Huffman, 1984) are found to be positively related to farm size. Further, the adoption of numerically controlled machines positively relates to firm size in ten different industries (Romeo, 1975). Some studies, however, find farm size not to be significant, for example (Baidu-Forson, 1995) while others such as (Bisanda *et al*, 1998) find the two variables to be negatively related.

Property size is often, but not always, related to innovation adoption (Abadi *et al.* 1998). Larger areas tend to increase the overall benefits of adoption of beneficial innovations and so increase the likelihood of adoption. Alternatively, social issues related to adoption may also lead to people having larger properties. D'Emden *et al.* (2006) also found a lack of relationship between farm size and adoption of conservation tillage in Western Australia.

2.3.2. Characteristic features of the Technology

The characteristics features of agricultural technologies that influence their adoption include the perceived usefulness of the technology; its compatibility; and the economic value of the technology that is transferred at the farm level.

Compatibility of the innovation/technology

Rogers (1995) defined compatibility as the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. An innovation or a technology that is incompatible with the values and norms of a social system will not be adopted as rapidly as an innovation that is compatible. According to Rogers (1995), the diffusion of water boiling as an innovation in Los Molinas in Peru failed because the villagers were not motivated enough to adopt it since it was not compatible with the cultural beliefs of the villagers. To such a farmer, a new type of tree crop is unlikely to be so compatible with existing practices, and so the cost of making the transition to a new farming system that includes the tree crop would tend to reduce its relative advantage and moderate its adoption.

Perceived usefulness of the technology

Perceived usefulness of a technology is seen in terms of its relative advantage. The relative advantage of a technology or an innovation, according to Rogers (2005) is the degree to which an innovation is perceived as being better than the idea [or practice] it supersedes or existing. The degree of relative advantage may be measured in economic terms, but social prestige, convenience, and satisfaction are also important factors. It does not matter so much if an innovation has a great deal of objective advantage. What does matter is whether an individual perceives the innovation as advantageous. The greater the perceived relative advantage of an innovation/technology, the more rapid its rate of adoption will be among farmers. The economic value of a technology is measured here in terms of its ability to increase farmers' yield per unit area, its ability to increase farmers' profit and farmers' income. Economists generally assume that firms maximize profit. Many of the studies deal with agriculture and, therefore, farmers. In many cases, expected utility maximization is the underlying assumption as opposed to profit maximization. Even so, there is no reason to assume adoption if there is no expected payoff. Varying degrees of expected profit will lead to varied adoption rates (Rubas, 2004). The first adopters assume the most risk because of imperfect information, but as more becomes known about the technology, the risk decreases. Also, the cost of new technologies often decreases as more firms adopt (Rubas, 2004).

The economic value of the technology

Related to the idea that adoption rate is a function of profitability is Griliches's (1995) idea that firms supplying new technologies will supply them first in areas they expect to be most profitable. Even the availability of new technology may be a function of its profitability. Mansfield (1961) found profitability to relate to adoption in industry. Capital constraints, however, prevented Mexican farmers from adopting the package all at once, so they adopt in a stepwise manner, beginning with the most profitable.

Essentially, empirical studies tend to include profitability and find increased profitability to positively relate to the rate of adoption or assume the technology is profitable and leave profitability out of the model. In no case, has anybody argued that adoption decisions are totally unrelated to perceived profitability. Erbough *et al.* (2002) using discriminate analysis showed that education, farm size, perception of soil erosion, double cropping (as a measure of management efficiency), and increasing net farm income are the main motivation for technology adoption by farmers. According to Okali *et al* (1994), the aim of agro-technology generation is to address better techniques of land development, crop and animal management and achieve higher yields.

According to Rubas (2004) varying degrees of expected profit will lead to varied adoption rates. Caswell and Zilberman (1985) find that cost savings lead to the adoption of irrigation technologies in California. An innovation's profitability compared with traditional alternatives, has been regarded as the primary motivation behind adoption (Fernandez-Cornejo and McBride, 1991). In their work on '*the adoption of bioengineered crops*, they reported that the widespread adoption of genetically engineered crops over traditional methods follows from their perceived profitability. The results obtained by the USDA Economic research briefing on '*the adoption of genetically engineered crops'* confirmed the other adoption studies showing that expected profitability to positively influence the adoption of agricultural innovations. It therefore reported that factors that are expected to increase profitability by increasing revenues per acre [product of the selling price of the crop and the output (number of 84kg bags harvested)] or reducing costs are expected to promote adoption. Cross *et al* (2000) identified financial reward as the strongest motivating factor for growers to adopt IPM programmes and that this reward needed to be sufficient to cover additional costs or difficulties associated with the change in management practice. At the same time such a reward could amount to less than 1% increase in fruit price, being sufficient motivation to encourage adoption. Meertens and Roling (1995) reported in their article '*non adoption of rice fertilizer technology'* that farmers in Sukumaland, Tanzania failed to adopt the technology due to decreasing profitability of the rice-urea technology.

Farmers can only use new technology in a sustainable manner if it increases profits (Binswanger 1974). The opportunity to earn profits is the primary motivation for adopting new technologies, whether they are valued through the market or in home consumption.

Yield increase on farmers' yield is also a prominent motivation for farmers to adopt a particular technology. The rapid adoption and diffusion of new technologies within the U.S. agricultural sector has resulted in sustained agricultural productivity growth and ensured an abundance of food (Evenson and Huffman, 1997).

According to (Avery, 1995) credible arguments have been advanced to suggest that production of food via high-yield agriculture techniques can meet the nutrition requirements of the global population.

2.3.3. Institutional Arrangements

Institutions (local and government) available at the farm level also go a long way to influence farmers' innovativeness at the farm level. The institutions discussed here include the system of farmers' land ownership, credit institutions, output and input markets and availability of extension services to farmers.

Land Tenure system

Several studies examine the role of land tenure among farmers and ownership structure of firms and how they relate to adoption. Mukhwana and Musyoka (2005) found out that social factors such as insecure land tenure systems and gender imbalances may limit farmers from adopting some innovations. Farmers lacking clear title to land refrain from investing in conservation measures or tree planting

In their review, Feder and Umali (1993) cited several studies that conclude that renters are less likely to adopt conservation practices than are landowners. Polson and Spencer (1991) find, however, that migrant farmers are more likely to adopt improved cassava in Nigeria than are landowners. They explained that migrant farmers, because of their non-privileged position in the farming community in terms of access to land and other farm resources are more aggressive in their adoption of improved varieties. Lee and Stewart (1983) find landowners to be less likely to adopt minimum tillage practices on cultivated cropland than other groups. They also find that non-family corporate structure does not significantly influence adoption decisions. In the same vein, Harper *et al* (1990) do not find a significant relationship between Texas rice farmers' adoption of integrated pest management techniques and whether the farm business is a partnership or a corporation. Caffey and Kazmierczak (1994), on the other hand, find the adoption of new technology used in soft-shelled crab operations to be significantly related to a producer's involvement in a full-time operation relying solely on family labour.

There are some controversies about the role of land tenure in semi-feudal situations (Rubas, 2004). On one hand, landowners are also creditors and, therefore, have an incentive to prevent the adoption of technologies that would increase yields and reduce the indebtedness of the tenants. On the other hand, under feudalism, these landlords are powerful enough they could extract the rents from adoption. For example, they could evict their tenants and use hired labour to cultivate using the new technology. Landowners cannot observe sharecroppers' behaviour; thus they do not want to risk losing the benefits.

Other studies have looked at ownership structure and adoption of technology in industry. Rose and Joskow (1988) find, for example, that in the electric utility industry, investor-owned firms tend to adopt new technologies earlier than publicly-owned firms. Baptista (2000) does not find ownership structure to relate to microprocessor or computer numerically controlled machine tool adoption.

Credit Institutions

Diagne and Zeller (2001) argues that lack of adequate access to credit for the poor may have negative consequences for various household level outcomes including technology adoption. Access to credit therefore affects welfare outcomes by alleviating the capital constraints on agricultural households, hence enabling poor households with little or no savings to acquire agricultural inputs (Diagne and Zeller, 2001). This reduces the opportunity costs of capital intensive assets relative to family labour, thus encouraging the adoption of labour-saving, higher-yielding technologies and therefore increasing land and labour productivity. Access to credit in addition increases the poor households' risk-bearing ability, improves their risk-copying strategies and enables consumption smoothing over time (Diagne and Zeller, 2001). Financial help received was positively and significantly associated with adoption level. It indicated that those who received financial help either from government or financial institution adopted new technologies on their farms (Rahman, 2007). Galiba and Glehouenou (1998), reported on the SG 2000 programme in Benin, that farmers who had graduated from the SG 2000 programme, and had access to credit facilities were thus able to continue their application of the technology recommendations on 3,705 hectares of maize and 2,908 hectares of rice, obtaining yields of 2.9 t/ha for lowland rice. Faturoti *et al* (2006) assert that the adoption of a technology is strongly motivated by market access and access to credit. Access to credit as a motivation to technology adoption is explained by Faturoti *et al* (2006) in the fact that innovations mostly require additional expenditure on the part of the farmers where there is access to credit, the adoption is promoted. They also report of a highly significant relationship between technology adoption and access to markets and reinforce the assertion of other authors that market forces played an important role in cooking banana adoption.

Contact with change Agents (Extension)

According to Rogers and Stanfield, contact with change agencies (Extension) is positively related to innovativeness. Most findings by other researchers have also reported a strong positive relationship between adoption decisions and extension contacts with and visits/advice to farmers (Baidu-Forson, 1999).

Tziunza *et al*. (2001) however, recorded a negative relationship between staff of disseminating institutions and farmers in the dissemination of cooking banana in South Eastern Nigeria. Faturati *et al*, (2006) in their work on the *determinants of adoption of IITA banana and plantain,* also established that there is a negative significant relationship between extension visits and adoption index. Their results also supported the findings of other authors on farmers' perception and adoption of new technology in Burkina-Faso and Guinea which also supports the assertion that extension-farmer interactions and linkages in Africa have been chronically weak and ineffective in inducing innovation diffusion and adoption. Meertens and Roling (1995) reported in their article '*non adoption of rice fertilizer technology'* that farmers in Sukumaland, Tanzania failed to adopt the technology due to poor involvement of extension services. It is found to be positively and significantly associated with the adoption level of farmers. In a paper presented on '*Adoption of improved technologies by pig farmers in Aizawl, India*', Rahman (2007) found out that contact with extension personnel/veterinarians influenced the farmers to adopt improved pig production practices in their farms.

CHAPTER THREE

METHODOLOGY

3.1 Location of Study Areas

Biemso 1 is located in the Ahafo Ano South district which is located on Latitude 6° 42’’N, 7° 10’’ N and longitude 1° 45’N and 2° 20’’W. The district falls within the forest belt of Ghana. Kobinanokrom and Ohiamadwen are neighbouring communities found in the Shama – Ahanta East district of the Western region of Ghana. The district is located about 280km west of Accra and 130km East of Cote D’Iviore.

3.2 Methodological Approach

3.2.1 Types and Sources of Data

Both quantitative and qualitative primary data were collected and analysed for the research. Secondary data was also collected from the Agricultural Extension agents. Quantitative primary data were collected on variables such as the age of respondents, years into rice cultivation, years in formal education, area of land cultivated to rice, output per area of land, cost of production per area of land as well as the market prices of 84kg bag of paddy rice and milled rice in each of the communities.

Qualitative primary data was also collected basically on the practices that were transferred to the farmers by the PLAR approach. These options include improved seed selection procedure, improved seed storage practices, improved pre-nursery seed handling practices, proper water management practices on the field, improved weed management practices, and improved post harvest operations. These data was used to compare farmers’ knowledge on ICM options between the PLAR farmers and the non PLAR farmers.

The secondary data that was collected from the Agricultural Extension agents were the names of the rice farmers who took part in PLAR and the names of all the rice farmers in each of the three communities.

The data was collected using both open-ended and closed-ended questionnaire.

3.2.2 The Questionnaire Design

The questionnaire was divided into four main sections taking into consideration the data that was needed for the analysis of the results. Section one contained questions on respondent’s personal information such as name, age, gender, years in rice cultivation, literacy, number of years in formal education etc. One important question in this section was to find out if a respondent had taken part in PLAR or not.

Under section two, respondents answered questions on the practices used in rice cultivation. The purpose of this section was to test and score the respondents on their knowledge of ICM practices under rice cultivation. Questions were asked on practices such as the selection procedures of quality seeds by farmers, pre-nursery seed handling procedures, improved nursery bed preparation procedure, improved land preparation practices, proper water management practices, weed, pest and disease control practices, and improved harvesting and post harvesting practices.

Questions on farmers' total production were asked under section three to come up with farmers' production information. Questions were asked on farmers' variable costs of production, land area cultivated to rice, and the market price of a 84kg bag of paddy in the respective communities as at the time the data were being collected.

3.2.3 Period of Data collection

Data was collected throughout the cultivation season. This ensured that the relevant information on farmers practices needed for the research were gathered. The data collection started in September, 2006 and ended in March, 2007.

3.2.4. Sampling Procedure

Choice of study Area

The PLAR approach was used to introduce IRM practices to rice farmers in three districts of the country. The districts in which the approach was used were the Ahafo-Ano south district in the Ashanti region, the Shama-Ahanta East district in the Western region. The two districts were purposively selected due to the fact that, these were the districts within which PLAR was used to introduce IRM to farmers. The study could not have been carried in any other location except these districts.

The study was carried out in those communities within the two districts where the PLAR approach was used. The specific communities where the approach has been implemented are Biemso N^o 1 in the Ahafo-Ano south district, and Kobinanokrom and Ohiamadwen, both in the Shama-Ahanta east district. These communities would therefore be used for the study.

Choice of Respondents

An important objective of the sampling procedure for the choice of respondents was to have two comparison groups composed of PLAR participants and non- PLAR participants. All the respondents have been introduced to various agricultural technologies in rice production by Agricultural Extension agents. The linear approach was however, used.

Stratified procedure was used to put the rice farmers into the different strata (PLAR participants and non-PLAR participants). This method was used in other to have two groups for comparison to be made. Simple random sampling procedure was also used to select the working sample from each of the stratum. The names of the PLAR farmers were written on pieces of papers (one name on one piece of paper). The papers were folded and mixed up in a basin after which the papers were randomly picked out of the basin to represent the working sample. The same procedure was used to get the working sample for the non PLAR participants.

Participation was established by asking respondents if they had participated in PLAR or not and participation was then confirmed by the Extension agents who provided the researcher with the list of participants.

In all 100 PLAR farmers were randomly selected out of the 148 PLAR farmers from the three communities. Thirty (30) PLAR farmers out of the forty-five (45) PLAR farmers were from Biemso 1 in the Ahafo-Ano South district of the Ashanti region, thirty (30) out of forty-seven (47) PLAR farmers were from Ohiamadwen and forty (40) out of fifty-six (56) PLAR farmers were selected from Kobinanokrom in the Shama-Ahanta-East district of the Western region.

A list of rice farmers in these communities who did not participate in PLAR was collected from the extension staff in these communities. The same number of 100 non PLAR farmers was randomly selected from 176 non-PLAR farmers in the three communities and were used as the 'control group' for the study. Thirty (30) PLAR farmers out of fifty-six (56) non-PLAR farmers were from Biemso 1 in the Ahafo-Ano South district of the Ashanti region, thirty (30) out of fifty-eight (58) non-PLAR farmers were from Ohiamadwen and forty (40) out of sixty-two (62) non- PLAR farmers were selected from Kobinanokrom in the Shama-Ahanta-East district of the Western region. The total sample size was thus, two hundred (200).

3.2.5 Data Collection Procedure

Personal Interviews

The questionnaires were administered to the farmers by means of face to face personal interview by the researcher and each farmer was interviewed by the researcher in the farmers' individual homes and sometimes on individual farmers' fields when it became necessary.

Focus Group Discussion

Also undertaken were focus group discussions with the selected groups of farmers to receive collective information which would help the researcher to achieve the objectives of the research. The group-discussions were conducted for both groups of farmers but on separate days. The group-discussions were undertaken on days on which farmers did not work on their farms.

The focus group discussion was used in each of the communities to gather information on general practices involved in rice cultivation in the various communities.

Direct Observation

Personal field visits were conducted by the researcher to selected farmers' fields to observe at first hand the various IRM practices undertaken by farmers on their individual fields.

Pre-test

Before the collection of the actual data, a pre-test with the questionnaire was undertaken to test for the effectiveness of the questionnaire with regards to the objectives of the study. Based on the results of the pre-test, further modifications were made to the wording and flow of the questions.

3.2.6 Data Analysis Procedure

Both qualitative and quantitative analytical procedures were used. The main quantitative analytical procedure that was used is the independent sample t – test. It was used to compare the sample arithmetic mean of the PLAR farmers and the sample arithmetic mean of the non – PLAR farmers as far as their outputs and gross margins are concerned.

Output per Acre

The output was measured in terms of the number 84kg bags of paddy harvested from a farmers' field. The Independent sample t-test was used to compare the mean (average) yields of the PLAR farmers and the non PLAR farmers as far as ouput per acre are concerned. This analytical procedure was used due to the following assumptions made;

1. The dependent variable (yield) is normally distributed.
2. The variance of the two groups (PLAR farmers and the non-PLAR farmers) is the same as the dependent variable.
3. The two samples are independent of each other.
4. Samples were drawn from the population at random.
5. The dependent variable (Yield) is measured on an interval or ratio scale
6. The independent variable 'PLAR participation' has two discrete levels, which are participation and non-participation.

The simple equation used for the analysis is stated as equation 1 below;

$$t=\frac{\bar{X}_1-\bar{X}_2}{\sqrt{\left(\frac{(N_1-1)S_1^2+(N_2-1)S_2^2}{N_1+N_2-2}\right)\left(\frac{1}{N_1}+\frac{1}{N_2}\right)}}$$

Since two variances are used in estimating the standard error of the difference between means, the degrees of freedom will equal the sum of the degrees of freedom for each of the variance estimates, that is:

$$df=(N_1-1)+(N_2-1)=N_1+N_2-2$$

Where;

N = Sample size

S^2 = Variance

$\bar{X}$ = Sample mean

$Subscript_1$ = Sample 1

$Subscript_2$ = Sample 2

The null hypothesis for the test was that PLAR participation has no influence on farmers' output, which is, the mean or average of the output of the two groups of farmers (PLAR participants and non-participants) are significantly the same or equivalent. Conclusions were made based on the results of the independent t-test with respect to the difference in the means of the two groups at 5% level of significance to determine if there were difference in the means of the two groups and whether or not the difference in the means were statistically significant.

Farmers' Profit

Also according to Josef Hvorecky (2005), the profit function can also be written as

Profit = R(x) – C(x), where x represents the price factor.

It then becomes easy to see that gross profit margin depends on total revenue and the cost (variable cost) of production.

In this study, the Hvorecky and Moran method of calculating gross profit margin were employed as it best suits the objective of the study. Profit here is therefore defined as the increased difference in total revenue (farm income) received from rice cultivation over the variable cost of producing rice as a result of PLAR participation.

Mathematical Equations

Gross Profit = Gross Revenue – Variable Cost of producing a commodity

ie. GP = GR – VC

GR = (market price/bag) * quantity of bags sold

VC = Cost of producing a commodity less fixed costs.

GM = GP/GR

GM – Gross Margin

GP – Gross Profit

GR – Gross Revenue

Profit was calculated as the difference between total revenue and total variable cost (cost of variable inputs, bird scaring, transportation, etc and the opportunity cost of labour i case of the PLAR farmers).

The independent sample t-test was employed to test the arithmetic mean profit as far as the two groups of farmers are concerned. The variables tested were farm income as the dependent variable and PLAR participation as the independent variable.
The simple equation used for the analysis is stated as equation 2 below;

$$t=\frac{\bar{X}_1-\bar{X}_2}{\sqrt{\left(\frac{(N_1-1)S_1^2+(N_2-1)S_2^2}{N_1+N_2-2}\right)\left(\frac{1}{N_1}+\frac{1}{N_2}\right)}}$$

$$df=(N_1-1)+(N_2-1)=N_1+N_2-2$$

Where;

N = Sample size

S^2 = Variance

$\bar{X}$ = Sample mean

$Subscript_1$ = Sample 1

$Subscript_2$ = Sample 2

The simple/null hypothesis tested was that there in no significant difference in the arithmetic mean gross profits margin of the two groups of farmers (PLAR participants and non-PLAR participants.), that is, their mean or average profits are equivalent.

Change in farmers' knowledge

The evaluation of the PLAR approach on its impact on farmers' knowledge was conducted at the third stage of the Targeting Outcomes of Programs (TOP) model which is KASA (knowledge, attitudes, skills, and aspirations) outlined by Bennett and Rockwell (1995). The TOP model assumes that change in knowledge leads to changes in practices, which in turn, create the desired change. This implies that an enhancement in the knowledge level of farmers would lead to the practice of improved agricultural practices by farmers.

PLAR farmers and non PLAR farmers' knowledge and knowledge gaps were compared to the improved practices suggested in the modules in the PLAR-IRM manual on the production of quality seeds; improved land preparation practices; improved weed and pest management practices; as well as improved harvest and post harvest operations.

This analytical procedure was adapted from the work of Drechsel *et al,* (1998) *on Major knowledge changes with respect to the introduction of poultry manure as new nutrient source for maize/cassava farming in Ghana.*

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results and discussions of this study. The results are discussed under three main sections. Section one describes the socioeconomic characteristics of the respondents which include age, gender, educational attainment, the system of land holdings and the average land area under rice cultivation. Section two discusses the impact of PLAR participation on respondents' knowledge, and compares the knowledge levels of PLAR and non PLAR farmers on improved practices. Section three looks at the impact of PLAR participation on respondents' outputs and gross margins by comparing the average outputs and average gross margins of the two groups of respondents using the independent sample t-test.

4.1 SOCIOECONOMIC CHARACTERISTICS OF RESPONDENTS

Personal Characteristics

The age distribution of the respondents ranges between 20 years and 70 years. The modal age group in Biemso 1 was 20 – 30 years which represents 55 % of the total respondents in Biemso 1, whiles that of Kobinanokrom and Ohiamadwen were 31 – 40 representing 50 % and 41.7 % in their respective communities.

The dominant gender among the respondents in all the three communities was males, representing 100 %, 92.5 %, and 86.7 % in Biemso 1, Kobinanokrom, and Ohiamadwen respectively. A focus group discussion revealed that, it is generally accepted in these communities that rice cultivation is reserved for the men due to the physical strength involved in the practices, especially land preparation. It was also revealed that women sometimes visit rice fields to support their husbands especially during such operations as transplanting, harvesting, and bird scaring. The discussion also revealed that women sometimes work as paid labourers in the field during operations such as transplanting and threshing but they do not own rice fields.

In all the three communities, there is high proportion of primary, junior secondary school and middle school graduates with no senior secondary or tertiary qualification among the respondents. This shows a general low level of education in these communities among the rice farmers. Inferences from the tables show a high rate of illiteracy in Biemso 1 than in the other two communities.

There is therefore the need for some form of informal adult education such as PLAR in these areas if improved innovations or technologies are to be well diffused and adopted among these rice farmers.

Table 1: SOCIOECONOMIC CHARACTERISTICS OF RESPONDENTS

SOCIOECONOMIC CHARACTERISTICS	BIEMSI 1		KOBINANOKROM		OHIAMADWEN	
	Number of Farmers		Number of Farmers		Number of Farmers	
AGE	**P Farmers**	**NP Farmers**	**P Farmers**	**NP Farmers**	**P Farmers**	**NP Farmers**
20 - 30	18 **(60%)**	15 **(50%)**	2 **(5%)**	6 **(15%)**	4 **(13.3%)**	11 **(36.7%)**
31 - 40	12 **(40%)**	8 **(26.7%)**	17 **(42.5%)**	23 **(57.5%)**	9 **(30%)**	16 **(53.3%)**
41 - 50	0	6 **(20%)**	15 **(37.5%)**	7 **(17.5%)**	16 **(53.3%)**	3 **(10%)**
51 - 60	0	1 **(3.3%)**	6 **(15%)**	4 **(10%)**	1 **(3.3%)**	0
61 - 70	0	0	0	0	0	0
GENDER						
Males	30 **(100%)**	30 **(100%)**	34 **(85%)**	40 **(100%)**	22 **(73.3%)**	30 **(100%)**
Females	0	0	6 **(15%)**	0	8 **(26.7%)**	0
EDUCATIONAL ATTAINMENT						
No Formal Education	11 **(36.7%)**	2 **(6.7%)**	0	13 **(32.5%)**	0	7 **(23.3%)**
Primary	16 **(53.3%)**	6 **(20%)**	8 **(20%)**	21 **(52.5%)**	5 **(16.7%)**	12 **(40%)**
Middle School/JHS	3 **(10%)**	21 **(70%)**	32 **(80%)**	6 **(15%)**	25 **(83.3%)**	11 **(36.7%)**
SHS	0	0	0	0	0	0
Tertiary	0	0	0	0	0	0
LAND HOLDINGS						
Own	8 **(26.7%)**	5 **(16.7%)**	4 **(10%)**	2 **(5%)**	0	4 **(13.3%)**
Hired	19 **(63.3%)**	14 **(46.7%)**	28 **(70%)**	28 **(70%)**	25 **(83.3%)**	26 **(86.7%)**
Family	3 **(10%)**	11 **(36.7%)**	8 **(20%)**	10 **(25%)**	5 **(16.7%)**	0

Land Related Issues

a. Land Ownership.

Table 4 shows the status of land under rice cultivation in the various communities. It can be seen that in all the communities, greater percentage of the land under rice cultivation is hired 55 %, 70 % and 85 % in Biemso 1, Kobinanokrom and

Ohiamadwen respectively. This could be attributed to the fact that most of the people who cultivate rice in these communities are migrants and that they do not own any land in their respective communities. Those who own the land are the indigenes that are into rice cultivation and they form the lowest percentage in all the three communities.

The land area under rice cultivation in all the communities by the PLAR farmers ranges between 1.0 and 3.0 acres whiles that for the non PLAR farmers in the three communities' ranges between 2.0 and 5.0 acres. The average land area for the PLAR farmers was calculated to be 2.93 acres, 1.09 acres, and 2.97 acres in Biemso 1, Kobinanokrom and Ohiamadwen respectively as seen from the table 5 below. This small size of land in these communities is due to the difficulty in hiring lager acres of land in these communities.

Table 2. Average land area under rice cultivation in acres by respondents in the three communities

Community	Average land area under rice cultivation (Acre)	
	Plar Farmers	Non Plar Framers
Biemso 1	2.93 (1.17ha)	4.5 (1.80 ha)
Kobinanokrom	1.09 (0.44 ha)	2.1 (0.48 ha)
Ohiamadwen	2.97 (1.19 ha)	2.98 (1.19 ha)

A focus group discussion in Kobinanokrom and Ohiamadwen revealed that land is not for sale; hence land owners are also not willing to release lager areas to the migrants who are mostly involved in rice cultivation since nothing or in some cases only a token would be received for releasing their lands. This is seen as a major social constraint to the adoption of improved agricultural technology in these communities. In Biemso, it was realized that, the price of an acre of land is paid in terms of bags of rice which was equivalent to GH ¢30 in monetary terms at the time the study was carried out.

4.2 IMPACT OF PLAR PARTICIPATION ON FARMERS' KNOWLEDGE

The practices of the PLAR farmers in all the three communities reflected the recommended in the modules in the PLAR-IRM manual. The analysis of the PLAR and the non PLAR farmers' practices is shown in table 4. The conformations of the PLAR farmers practices to the modules from land preparation to harvesting and post harvesting handling shows improved knowledge in IRM by the PLAR farmers and hence the application of improved practices on their fields.

The use of Quality Seeds.

Seed quality is a key factor in rice production, and hence the use of certified seeds is highly recommended by ICM. Accessibility to certified seeds to rice producers in Ghana is however, difficult hence the PLAR approach encourages farmers to produce quality seeds on their own to use. Both the PLAR and non PLAR farmers therefore used seeds raised on their own fields. The method used in raising the seeds however, differs among the two groups of farmers.

Through the field visits it was observed that the PLAR farmers select their seeds from plots with a healthy and homogenous plant stand. Seed selection from such plots took place after off-type varieties and weeds had been removed from the selected plot. Also, during harvesting, farmers harvested the seeds before the entire fields were harvested. Threshing and drying of the harvested seeds were also done before the other harvested grains were threshed and dried. It was also realized that the PLAR farmers performed germination test before seeds were sent to be nursed at the nursery. The story was different for the non PLAR farmers who undertook none of these practices. Their simple reason was that they had no knowledge as to why one has to waste time to perform all these activities before seeds are nursed at the nursery.

Improved Pre-Nursery Seed Handling.

Pre nursery seed handling (seed pre-germination) is a crucial ICM practice as far as seed germination in rice cultivation is concerned. The two processes involved here (soaking and incubation) help to trigger the germination process of rice seeds before the seeds are sent to the nursery.

In Biemso 1, the study revealed that these practices were introduced to the farmers during the PLAR sessions and hence only the PLAR farmers were observed practicing them. This was evident by the fact that these practices have been practiced by the

PLAR farmers for just some few years after ICM was introduced through PLAR. The non PLAR farmers seemed to be lost when they were asked about these practices. To them, they just take their seeds to the fields and sow them at stake and on some occasions nurse them at the nursery.

In Kobinanokrom and Ohiamadwen however, both the PLAR and the non PLAR farmers undertook these practices. According to them, they already knew about these practices and practiced them even before ICM was introduced to them through PLAR. Their source of knowledge according to them was the Afife rice irrigation project in the Volta region of Ghana from where they migrated. This was found to be true when the number of years they had been practicing these practices was compared to when PLAR was introduced into these two communities.

The difference in the average yield among the PLAR farmers and the non PLAR farmers in these two communities could therefore be attributed to other reasons other than improved pre-nursery seed handling.

Improved Land Preparation Practices.

Rice cropping require adequate land preparation as recommended by ICM. The different options under land development include land clearing, pre-irrigation, first ploughing, flooding, second ploughing, and levelling, all of which help to determine the quality of land for rice cultivation. These practices together with the depth of ploughing determine the quality of the land after its preparation.

Through personal interviews with farmers and field observation of farmers' practices, it was observed that the PLAR farmers in Biemso 1 undertook all the above land preparation procedures on their fields. In Kobinanokrom and Ohiamadwen however, not all the land preparation procedures were being used even by the PLAR farmers, though farmers had knowledge about the need for each of the procedures. Their knowledge about these improved land preparation practices was established by asking farmers to list the practices sequentially and demonstrate how they are performed. Prominent among the rejected procedures was flooding the field for about a week after the first ploughing has been done. The practice of flooding according to ICM is to help kill weed seeds thereby providing a means of controlling weeds in the rice field which could help the farmer to save the few monies that would have been used to purchase herbicides. It was however, observed that both first and second ploughing were done on the same day on a particular field, allowing no time for flood water to stay on the field for some time before the second ploughing is done. This contradicts land preparation practices which are recommended in ICM.

The major reason for not undertaking flooding as part of the land preparation procedure by the farmers was found to be purely economical. This is because the supply of the equipment (power tiller) is inadequate to complement the demand since few farmer and individuals own the equipment in these communities with the increase in rice farmers in these communities. Operators of these equipments spend just a day on farmer's field during which both first and second ploughing are done so they can move to other fields in order to make more monies. An interview with some of the operators revealed that they do so because they do not increase the fees charged for these activities. This therefore make them to visit as many farms they can visit in a day in order to make more money to cover their cost of operations. Also, a farmer who wants both the first and second ploughing to be done as recommended by ICM practices have to pay twice as much money as if the two operations are performed at a time. The inability of the farmers to raise such an amount of money cause them to allow both activities to be done on the same day, though they are aware of the importance of the need for allowing some time interval between the first and the second ploughing. Farmers are therefore not able to flood their fields after the first ploughing before the second ploughing is done. It was realized that farmers who are able to undertake flooding are few, and are those who own power tiller.

A PLAR farmer undertaking the second ploughing process in a field at Biemso 1

Improved Transplanting Operations:

Transplanting, rather than direct sowing is encouraged by PLAR since it gives seedlings a better start over weeds and also helps to avoid the negative effect of unexpected flooding of the field by rainfall. Above all the tillering advantage of early transplanted seedling is the overriding consideration.

It was observed that PLAR farmers in Biemso 1, before PLAR used to undertake direct sowing by means of broadcasting. The story was however, different after PLAR since field observation revealed that row transplanting was practiced by farmers in Biemso 1.

Both the PLAR and the non PLAR farmers in Kobinanokrom and Ohiamadwen use to undertake transplanting even before PLAR. However, they had no knowledge about the better approach to transplanting (transplanting in rows) and hence random transplanting was practiced. It was observed through field observation that transplanting in rows was not practiced by even the PLAR farmers in these two communities, though they are aware of the importance of row transplanting that is increased plant density per area and subsequent increase in yield.

A focus-group discussion with the farmers in these two communities revealed that, hired labour quote higher prices when transplanting is done in rows than when it is done at random. According to the labourers, they are not too conversant with row transplanting and hence spend more time on a particular field because they move at a slower rate and therefore charge higher price when transplanting is done in rows. The inability for farmers to pay the high prices has made them to reject row or line transplanting procedure in Kobinanokrom and Ohiamadwen.

The appropriate time of transplanting seedlings (2-3 weeks) after nursing was seen to be practiced by the PLAR farmers in all the three communities. Knowledge about the need to undertake transplanting at this was found to be familiar with the PLAR farmers than the non PLAR farmers when farmers were asked why transplanting was undertaken during the stated time. The major reason given was that transplanting at this time helps the seedlings to produce more tillers. The common practice among the non PLAR farmers in all the three communities was to transplant their seedlings when the seedlings were a month old or more due to their lack of knowledge about the best age at which seedlings should be transplanted for better tillering.

Improved water management practices

Each rice development phase has its specific water needs and deviating from these needs may lead to substantial yield losses. The rice plant according to ICM needs little water during the vegetative phase, a lot of water during the reproductive phase and no water during the last half of the maturity. Too much water during the vegetative phase may hinder tillering whiles too little water may favour weed infestation, both situations may lead to decrease in yield.

In all three communities, the study revealed poor water management practices by both groups of farmers. Through field observation, it was observed that whiles some of the fields were too dry during the vegetative phase others were completely filled with water. Though the PLAR farmers had better knowledge about ICM recommendations on proper water management on the field than the non PLAR farmers, the actual practice was not being carried out by the farmers. The improved knowledge about proper water management procedures by the PLAR farmers was observed when they were asked questions relating to the time of irrigating the field, reasons for irrigation, level of water in the bunds during each of the operations (land preparation, transplanting, fertilizer application, and harvesting) as well as the method of removing excess water from the field. Almost all the farmers responded that they irrigate their field during land preparation, transplanting and fertilizer application with the removal of water during the last half of the maturity stage of development of the rice. It was also observed that the only method of removing excess water from the field by the farmers was through the opening of the outlet of their bunds to allow excess water to drain away.

It was observed that the farmers could not practice what they know about proper water management on their fields due to the lack of a proper irrigation facility in the communities. In Biemso1, though some of the farmers have a pumping machine that pumps water to their fields, the source of the water was a river which sometimes dries up even when farmers needed water. The rest of the farmers who did not have a pumping machine depended on rain water as their main source of irrigation. In Kobinanokrom and Ohiamadwen, farmers had no access to any irrigation facility and therefore depended solely on nearby river as their source of irrigation water. It was observed that the farmers had constructed canals from their fields to the nearby river through which water flows to their field for use. It was revealed that these rivers sometimes dry up even when farmers need water on their fields for irrigation purposes.

The ICM recommendation on improved water management practices was observed not been practiced by the two groups of farmers in all the three communities due to lack of proper irrigation facilities to the farmers. The difference in average yield could not be attributed to improved water management since both groups use similar water management practices.

Improved soil fertility management

Soil fertility management in rice cultivation is an essential aspect if good yield is to be obtained by the farmer. The use of both organic and inorganic means of improving the fertility of the soil is recommended. The organic approach recommended by ICM involves leaving flood water in the bunds after the first ploughing so that dead plants and animals would enrich the soil as organic matter, and also the use of poultry manure and also the use of inorganic fertilizers to improve the fertility of the soil.

In Biemso 1, both methods were observed to be used by the PLAR farmers. Also the use of the inorganic fertilizer was observed to have become more popular among the PLAR farmers than the non PLAR farmers. NPK (15-15-15) and urea were observed to be the main types of inorganic fertilizers used by the PLAR farmers. The NPK is applied when the seedlings were two weeks old after transplanting as recommended by ICM in order to improve tillering. The adoption of the correct time of the urea application had not taken place as it was observed that farmers waited until the heading and flowering stage of development before they applied urea which contradicts the panicle initiation stage of the plant as recommended.

In Kobinanokrom and Ohiamadwen, the use of the inorganic fertilizers was the major means of improving the fertility of the soil since flooding was not been practices in these communities by both groups of farmers. The commonest fertilizers used were NPK and ammonia. The way these fertilizers were applied however, varied among the two groups. The PLAR farmers apply the NPK when the seedlings are two weeks old on the field after which the ammonia is applied during the panicle initiation stage of the plants as recommended by ICM. The non PLAR farmers on the other hand combine both the ammonia and the NPK and application is once, that is when the plants are about two months old on the field.

These differences in fertilizer application procedure could go a long way to influence yield and hence the observed differences in yield could be attributed to the proper use of both organic and inorganic fertilizers by the PLAR farmers.

A PLAR farmer applying fertilizer (NPK 15 – 15 - 15) to rice plants at Ohiamadwen

Improved Harvesting and Post-harvest Operations.

Timely harvesting, threshing and drying are essential operations to guarantee abundant and quality harvest.

It was revealed that 80.2 % of the PLAR farmers in Biemso 1, 76.5 % of PLAR farmers in Kobinanokrom, and 86.2 % of PLAR farmers in Ohiamadwen harvest their rice when 70 %- 80 % of the panicles turn yellow and grains are hard, light coloured and peels off easily in order to avoid grain loss during harvesting. The non PLAR farmers in the three communities could not however, tell what they look out for before they harvest their rice when they were asked to list some of the signs before harvesting is undertaken. They wait till the panicles are completely dried before harvesting is done. This is a major contributing factor to yield loss in rice cultivation.

ICM recommends that farmers leave their sheaves in the sun for 24-48 hours to dry before threshing takes place in order to make threshing easier. It was however, observed from field observation that both groups of farmers undertakes both harvesting and threshing simultaneously without leaving the sheaves to be well dried, especially in Kobinanokrom and Ohiamadwen.

A farmer at Ohiamadwen undertaking box threshing after harvesting.

Non adoption of this practice, according to farmers was due to the fact that they work in groups and hence spend little time on a particular farmer's field so that they can visit every member's field as quickly as possible to avoid harvest losses. They therefore thresh immediately after harvesting in order to save time. This was seen to cause grain loss during threshing since not all the grains are removed from the panicles because they are not thoroughly dried.

Another ICM practice that is seen to have been well adopted and practiced by farmers in all the three communities is the practices undertaken before storage. ICM encourages the drying of the paddy in the sun for about 48 hours before putting them in jute bags for storage, and all the PLAR farmers were seen to be doing this when visited. The paddy was dried on a tarpaulin with periodic turning of the paddy with shovels in their homes. Most of the non PLAR farmers dry their rice along the roadsides, reducing the quality of paddy.

As far as storage is concerned in these communities, much was not seen since farmers straightaway either sell off the dried and bagged paddy or send the paddy to the mill to be milled for sale. When asked about the proper storage procedures, farmers showed an improved knowledge about proper storage procedures as compared to their previous storage practices. Farmers were able to talk about the fact that the paddy should not be stored with chemical products and fertilizers, the fact that the bagged paddy must be placed on a raised wooden platform to allow for good ventilation, and the fact that the store room must be cleaned before storage. Farmers admitted that most of these were not known and practiced before PLAR. In Biemso 1, the non PLAR farmers put their sheaves in a crib as a means of storage. Threshing is only done when farmers are ready to sell their paddy. In Kobinanokrom and Ohiamadwen however, farmers used to put their grains in jute bags but then they used to store them together with other products like herbicides due to lack of space.

Table 4: Analysis of Respondents' Practices

IMPROVED PRACTICES	NON PLAR FARMERS	PLAR FARMERS
	Farmers do not select plots for seed production.	Farmers select plots for seed Production
	Farmers do not remove off type varieties from selected plots before harvesting is done.	Farmers take time to remove off type varieties from selected plots before harvesting is undertaken.
	Farmers harvest the whole farm at a time	Farmers harvest selected plots before the whole farm is harvested.
	All the harvested grain are threshed, dried and stored together.	Seed grains are harvested, threshed, dried and stored separately from the rest of the harvested grains.
NURSERY PREPARATION AND PRACTICES	Nursery beds are prepared (*planting at stake is done in Biemso 1*).	Nursery beds are prepared with the recommended measurement and layout.
	Layout for nursery is not made (*No measurement is taken during nursery bed preparation*).	
	The seeds are sprinkled on the surface of the nursery bed.	Drills are made on the nursery bed before the seeds are sown.
	Transplanting is carried a month or more after germination has taken place.	Transplanting is done 3 weeks after germination.
IMPROVED LAND PREPARATION PRACTICES	Farmers use herbicides to kill emerging weeds after land clearing.	Emerging weeds are ploughed into the soil during first ploughing.

IMPROVED PRACTICES	NON PLAR FARMERS	PLAR FARMERS
IMPROVED LAND PREPARATION PRACTICES	Bunds are constructed by farmers. (*They are not constructed at Biemso i*). Levelling is not done during land preparation	Bunds are constructed. Levelling is done during land preparation.
SOIL FERTILITY MANAGEMENT PRACTICES	Farmers in Kobinanokrom and Ohiamadwen apply some fertilizer to their rice crops. (*Those in Biemso 1, however, do not apply fertiliser to their crops).* NPK and Ammonia are mixed up and applied 2 months after transplant.	Farmers apply fertiliser to their rice crops. NPK is applied 3 weeks after transplanting Ammonia is applied during the panicle initiation stage of the rice growth.
<u>DISEASES AND PEST CONTROL</u>	No control measures are taken against stem borers.	Affected plants are removed from the fields. Rice straw is bunt in the plot where the pests was found for sometime before the next season begins.
HARVESTING / POST HARVEST HANDLING	Harvesting is done three and a half months after transplanting. Harvesting is done when the grains are fully dried. Stock harvesting is done in Kobinanokrom and Ohiamadwen but panicle harvesting is done in Biemso 1	Harvesting is done three months after transplanting. Harvesting is done at a moisture content of about 25% of the panicles / grains. This is determined by the colour of the grains.

IMPROVED PRACTICES	NON PLAR FARMERS	PLAR FARMERS
	In Biemso, threshing is not done after harvesting. The panicles are sent how and stored in a crib and are only threshed when customers are available	
	Empty barrels are used for the threshing.	Box threshing is carried out on the field.
	Threshed grains are dried on the ground in the house.	Threshed grains are sent to the house and dried on a tarpaulin.
	Dried grains are bagged and stored in a room.	Dried grains are sent to the mill to be milled. Buyers come to buy them after milling is completed.

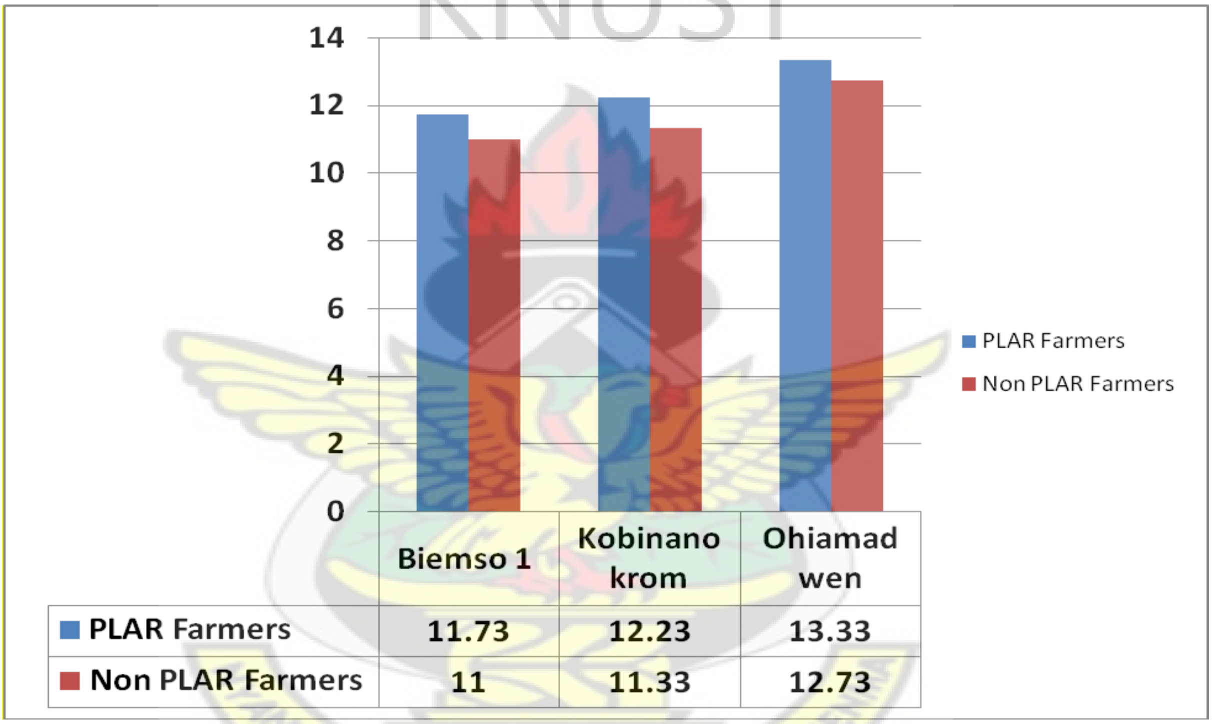
4.3 IMPACT OF PLAR PARTICIPATION ON FARMERS' OUTPUTS AND GROSS MARGINS

Farmers' Output per acre

The average output for both PLAR participants and non PLAR participants in all the three communities were measured in terms of the average number of 84kg bags per acre of land. This conversion was used due to the small sizes of land cultivated to rice by both the PLAR and the non PLAR farmers in the research areas.

The table below shows the average output per acre of land calculated for each of the three communities where the study was conducted.

Fig. 5: Average output per Acre by PLAR and non PLAR Farmers



The independent sample t-test was used to compare the mean (average) output of the two groups of farmers in each of the communities. This was done to test the null hypothesis stated as 'the PLAR approach to technology transfer does not lead to increase in the output of rice from farmers' fields'.

In Biemso 1, an independent sample t-test comparing the mean (average) output of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (58) = 2.143, p (.036) < 0.05]. This means that the mean output of the plar farmers was significantly higher (m=11.733, SD=1.66) than that of the non plar farmers (m= 11.00, SD=0.871).

Also in Kobinanokrom, an independent sample t-test comparing the mean (average) output of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (78) = 2.037, p (0.045) < 0.05]. This means that the mean output of the plar farmers was significantly higher (m=12.23, SD=1.99) than that of the non plar farmers (m=11.338, SD=1.903).

Again, in Ohiamadwen an independent sample t-test comparing the mean (average) output of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (58) = 2.085, p (0.041) < 0.05]. This means that the mean output of the plar farmers was significantly higher (m=13.33, SD=1.367) than that of the non plar farmers (m=12.733, SD=0.785).

The independent sample t-test results are shown in Table 5 below.

TABLE 5: INDEPENDENT SAMPLE T-TEST RESULTS TABLE FOR OUTPUT

COMMUNITY	MEAN OUTPUT (Number of bags of 84kg)	MEAN OUTPUT (kg/acre)	STANDARD DEVIATION	t	p sig. level (2 -tailed)
BIEMSO 1					
P Farmers	11.73	958.32	1.66	t (58) = 2.143	0.036**
NP Farmers	11.00	924.00	0.87		
KOBINANOKROM					
P Farmers	12.23	1,027.3	1.99	t (78) = 2.037	0.042**
NP Farmers	11.34	952.6	1.90		
OHIAMADWEN					
P Farmers	13.33	1,119.70	1.36	t (58) = 2.085	0.041**
NP Farmers	12.73	1,069.30	0.79		

Table 9 shows the average cost of production per acre, the average revenue per acre and the average gross margin per acre as was calculated for the PLAR and the non PLAR farmers in each of the three communities where the study was conducted.

Table 6: Average revenue per acre, average cost per acre and average profit per acre

Economic Indicators	Study Areas					
	Biemso 1		Kobinanokrom		Ohiamadwen	
	PF	NPF	PF	NPF	PF	NPF
Average Gross Revenue per acre (GHC)	322	300	342.83	317.45	345.31	320.53
Mean Variable Cost per acre (GHC)	135.98	92.43	181.3	121.8	180.07	126.93
Mean Gross Profit per acre (GHC)	186.02	207.57	161.53	195.65	165.24	193.6
Mean Gross Margin per acre (GHC)	0.58	0.69	0.47	0.62	0.48	0.60

Fig. 6. Average variable cost per acre

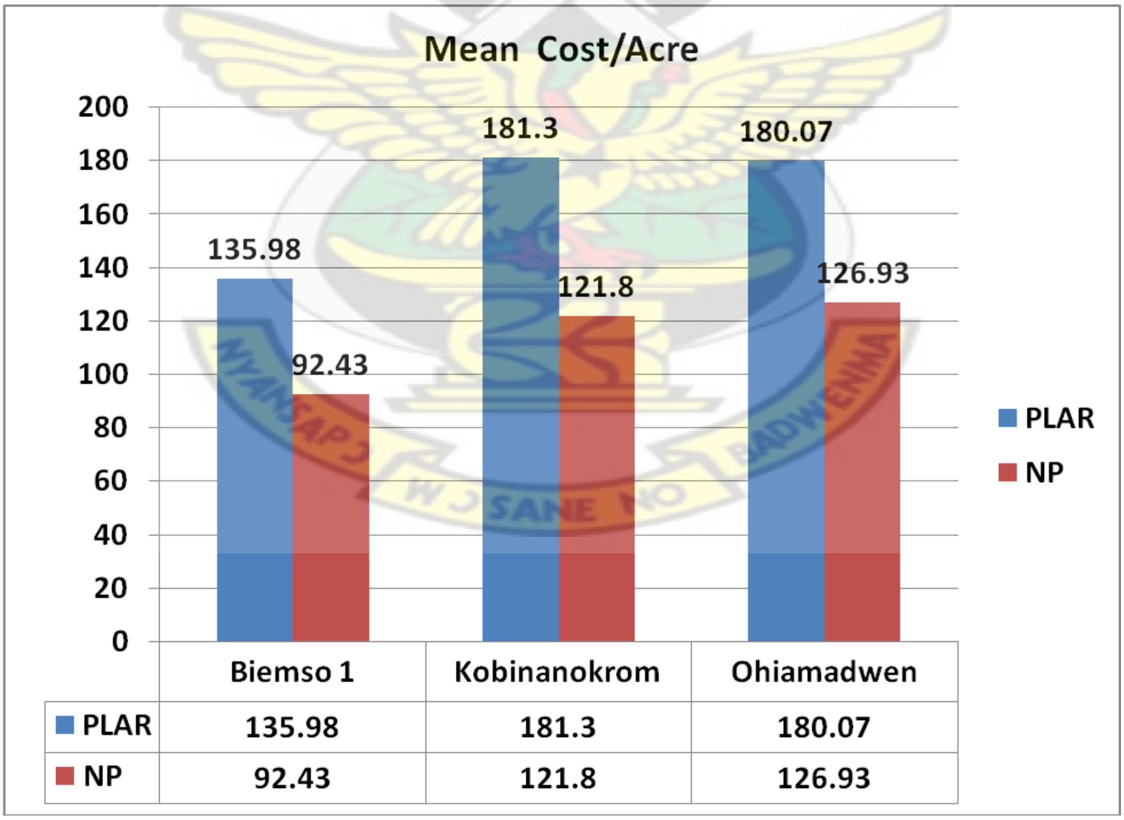


TABLE 7: INDEPENDENT SAMPLE T-TEST RESULTS TABLE FOR MEAN COST OF PRODUCTION PER ACRE

COMMUNITY	MEAN GROSS PROFIT (GHC)	STANDARD DEVIATION	t	p **sig. level (2 - tailed)**
BIEMSO 1				
P Farmers	135.98	65.29		
NP Farmers	92.43	39.06	t(58) =7.18	0.032**
KOBINANOKROM				
P Farmers	181.30	87.05		
NP Farmers	121.80	58.48	t(78) =7.37	0.042**
OHIAMADWEN				
P Farmers	180.07	86.41		
NP Farmers	126.93	60.91	t (58) =6.93	0.021**

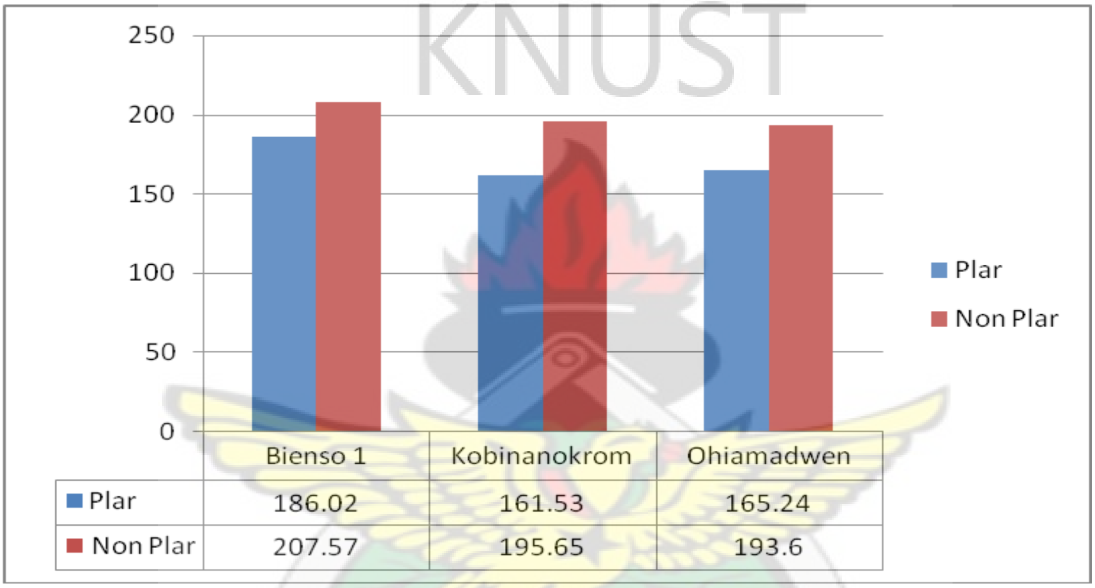
In Biemso 1, an independent sample t-test comparing the mean (average) cost of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (58) = 7.18, p (0.032) < 0.05]. This means that the mean variable cost of the plar farmers was significantly higher (m=135.98, SD=65.29) than that of the non plar farmers (m= 92.43, SD=39.06).

Also in Kobinanokrom, an independent sample t-test comparing the mean (average) variable cost of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (78) = 7.37, p (0.042) < 0.05]. This means that the mean variable cost of the plar farmers was significantly higher (m=181.20, SD=87.05) than that of the non plar farmers (m=121.80, SD=58.48).

In Ohiamadwen an independent sample t-test comparing the mean (average) variable cost of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (58) = 6.93, p (0.021) < 0.05]. This means that the mean variable cost of the plar farmers was significantly higher (m=180.07, SD=86.41) than that of the non plar farmers (m=126.93, SD=60.91).

The average gross profit for the two groups of farmers was also analyzed using the independent sample t-test. The average gross profit margin was analyzed since only the variable costs of production were estimated for the study. The figure below shows the average gross profit margins for the respondents in all the three communities.

Fig. 7. Average gross profit per acre



The independent sample t-test was used to compare the mean (average) gross profit margin of the two groups of farmers in each of the communities. This was done to test the null hypothesis stated as 'the PLAR approach to technology transfer does not lead to increase farmers' profit from rice cultivation.

In Biemso 1, an independent sample t-test comparing the mean (average) gross profit of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (58) = 4, p (0.025) < 0.05]. This means that the mean gross margin of the plar farmers was significantly lower (m=186.02, SD=36.12) than that of the non plar farmers (m= 207.57, SD=32.75).

Also in Kobinanokrom, an independent sample t-test comparing the mean (average) gross profit margin of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (78) = 2.080, p (0.042) < 0.05]. This means that the mean profit of the plar farmers was significantly lower (m=161.53, SD=47.72) than that of the non plar farmers (m=195.65, SD=44.72).

Again, in Ohiamadwen an independent sample t-test comparing the mean (average) gross profit of the experimental group (PLAR farmers) and the control group (non PLAR farmers) found a significant difference between the means of the two group [t (58) = 2.064, p (0.043) < 0.05]. This means that the mean profit of the plar farmers was significantly lower (m=165.21, SD=27.94) than that of the non plar farmers (m=201.60, SD=30.254).

TABLE 8: Independent Sample T-Test Results Table For Mean Gross Profit

COMMUNITY	MEAN GROSS PROFIT (GHC)	STANDARD DEVIATION	t	p sig. level (2 - tailed)
BIEMSO 1				
P Farmers	186.02	36.12	t (58) = 4.0	0.025**
NP Farmers	207.56	32.75		
KOBINANOKROM				
P Farmers	161.53	47.72	t (78) = 2.1	0.042**
NP Farmers	195.65	44.17		
OHIAMADWEN				
P Farmers	165.21	27.94	t (58) = 2.0	0.043**
NP Farmers	201.6	30.25		

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the findings of the study, a number of conclusions are made.

The findings have revealed the effectiveness of the Participatory Learning and Action Research (PLAR) as an approach to the transfer of agricultural technologies especially in rice production. The farmer-friendly nature of the approach, according to the study led to an appreciable level of adoption of ICM options which were introduced through the PLAR approach. The adoption, according to the study has led to increased output per area of land. The study revealed that the cost of adopting PLAR-IRM is significantly higher in all the communities. This led to the PLAR farmers getting lower gross profit margins as compared to their non PLAR farmers. PLAR – IRM. The PLAR-IRM did not contribute to higher gross profit/margins among rice farmers due to the high cost associated with the technology.

The study has been able to empirically provide insight into the effectiveness of the PLAR approach in improving farmers' knowledge concerning improved practices in rice production. This is revealed by the fact that the farmers who participated in PLAR showed improvement in their knowledge levels concerning the various improved cultivation practices than their non-PLAR counterparts.

The study therefore adds to the various literatures that argue towards the need and relevance of the use of participatory approaches to the transfer of agricultural technologies to farmers at the farm level.

Recommendations

The effectiveness of the PLAR approach has thus been proven by this research. Based on this, the following recommendations are made;

1. Provision of subsidies to farmers to reduce the cost of using recommended agricultural technologies is highly recommended.
2. It is recommended that PLAR should be re-designed to make it less expensive and attractive for farmers to practice and also to ensure higher gross margins among farmers.

3. A further study is recommended in the next few years to assess the sustainability of ICM practices in the three communities, and the factors that ensure the sustainability.

REFERENCES CITED

Abadi Ghadim, A.K. and Pannell, D.J. (1998). "The importance of risk in adoption of a crop innovation: Empirical evidence from Western Australia", Paper presented at the 42nd Annual Conference of the Australian Agricultural and Resource Economics Society, University of New England.

Abbott Eric A. (2004). Knowledge, Attitudes and Practices of Kyrgyz Farmers and Rural Leaders about Land Rights Issues. Agricultural Communication Centre. Document ID: C20398, Pg. 22. University of Illinois at Urbana-Champaign.

Adesina, A. A. and Baidu-Forson J.(1995). "Farmers' Perceptions and Adoption of New Agricultural Technology: Evidence from Analysis in Burkina Faso and Guinea, West Africa." *Agricultural Economics* 13(1995):1-9.

Adhinkarya R. (1996). Strategic Extension Campaign: Increasing Cost-Effectiveness and Farmers' Participation in Applying Agricultural Technologies.

Alston, J.M., Norton G.W. and Pardey P.G. (1995). Science under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting (Cornell University Press, Ithaca, NY).

Amponsah, W.A. (1995) Computer Adoption and Use of Information Services by North Carolina Commercial Farmers." *Journal of Agriculture and Applied Economics* 27(1995):565-76.

Amudavi D. (2005). Exploring the Effects of Farmer Community Group Participation on Rural Livelihood. *A project of Cornell and Clark-Atlanta Universities for research and technical assistance, funded by a cooperative agreement with USAID.*

Arrow K. J. (1998). "What Has Economics to Say About Racial Discrimination?" *Journal of Economic Perspectives* 12 (2): 91-100.

Avery, D.T. (1995). Saving the Planet with Pesticides and Plastic. Hudson Institute: Practical advice for pesticides users to protect the water environment. Information leaflet; September, 1995 WI.

Ayichi D. (1995). “Agricultural Technology Transfer for Sustainable Rural Development”. In *Rural Development in Nigeria: Concepts, Processes and Prospects,*
Baidu-Forson, J. (1999). “Factors Influencing Adoption of Land-Enhancing Technology in the Sahel: Lessons from a Case Study in Niger.” *Agricultural Economics* (20):231-39.

Bandiera O. and Rasul I. (2005). Social Networks and Technology Adoption in Northern Mozambique. *Australian Journal of Agricultural Economics* **31**, 112-126.

Baptista, R. (2000). “Do Innovations Diffuse Faster Within Geographical Cluster?” *International Journal of Industrial Organization* 18(2000):515-35.

Bardsley P. H. M. (1987). An approach to the econometric estimation of attitudes to risk in agriculture. *Australian Journal of Agricultural Economics* **31**, 112-126.

Bentley Jeffery W. (1994) Facts, Fantasies and Failures of Farmer Participatory Research. Agriculture and Human values 11 (2&3) 140-150.

Binswanger, H.P. (1974). A microeconomic approach to induced innovation, Economic Journal 84(336), 940-958.

Bisanda, S., Mwangi W., Verkuijl H., Moshi A.J., and Anadajayasekeram P. (1998). *Adoption of Maize Production Technologies in Southern Highlands of Tanzania*. Mexico. Republic of Tanzania and Southern African Centre for Cooperation in Agricultural Research.

Blackburn J. and Holland J (1998). Who Changes? Institutionalizing Participation in Development. Intermediate Technology Publications.

Caffey, R.H. and Kazmierczak R.F., Jnr (1994). “Factors Influencing Technology Adoption in a Louisiana Aquaculture System.” *Journal of Agriculture and Applied Economics* 26(1994):264-74.

Caswell, M. and Zilberman D. (1985). “The Choices of Irrigation Technologies in California.” *American Journal of Agricultural Economics* 67(1985).

Caviglia, J. L. and Kahn J. R. (2001). “Diffusion of Sustainable Agriculture in the Brazilian Tropical Rain Forest: A Discrete Choice Analysis.” *Economic Development and Cultural Change* 49(2001):311-33.

Chamala R., Teixeira, S. S. A., Cowan, R. T. and Western, M. (2004) Participatory approach for the identification of dairy industry needs in the design of research, development and extension actions: Australian and Brazilian case studies. Australian Journal of Experimental Agriculture, 44 6: 521-530.

Cross, R.L., Parker, A. and Borgatti, S.P. (2000). A birds-eye view: Using social network analysis to improve knowledge creation and sharing. Knowledge Directions. 2(1): 48-61.

Defoer T. (2001) Curriculum for Participatory Learning and Action Research (PLAR) for Integrated Rice Management (IRM) in Sub-Saharan Africa: Facilitators Manual.

D’Emden F. H., Llewellyn R. S., Burton M. P (2006) Adoption of conservation tillage in Australian cropping regions: an application of duration analysis. *Technological Forecasting and Social Change*.

Diagne J. and Zeller F. (2001) Factors influencing adoption of agricultural technology: A case study of potato farmers in Northern Tanzania.

Dong, D. and Saha A. (1998). “He Came, He Saw, (and) He Waited: An Empirical Analysis of Inertia in Technology Adoption.” *Applied Economics* 30(1998):893-905.

Dorfman, J. H. (1996). “Modeling Multiple Adoption Decisions in a Joint Framework.” *American Journal of Agricultural Economics* 78(1996):547-57.
Economics, 75(3), August: 666-73.

Erbaugh J. M., Donnermeyer J., Kibwika P. and Kyamanywa S. (2002). An Assessment of the Integrated Pest Management Collaborative Research Support Project (IPM CRSP) Activities in Uganda: Impact on Farmers' Awareness and Knowledge of IPM Skills.

Evenson, R.E., and Huffman W.B. (1997). Science for Agriculture: Long Term Perspective - Long-Run Structural and Productivity. 2ND Edition, Blackwell Publication. 212, State Avenue, Ames, Iowa-50014, USA.

Faturoti B. O., Emah G. N., Isife B. I., A. and Lemchi J (2006). African Journal of Biotechnology Academic Journals ISSN: 1684-5315 Vol. 5, Num. 14, 2006, pp. 1319-1323.

Feder, G. and Umali D.L. (1993). "The Adoption of Agricultural Innovations: A Review." *Technological Forecasting and Social Change* 43(1993):215-39.

Fernandez-Cornejo J. and McBride D. W. (1991) Adoption of bioengineered crops. Agricultural Economic Report No (AER810) 67pp, May, 2002.

Food and Agricultural Organization Annual Report (2000). "The State of Food and Agriculture (SOFA-2000)," released today at a news conference at the Institut National Agronomique, Paris-Grignon.

Galiba M. and Gléhouénou B. (1998). "Les caisses rurales d'épargne et de prêt au Bénin." Paper presented at the Workshop "Partnerships and Rural Development in Sub-saharan Africa", Villars-Sur-Ollon, Switzerland.

Grandstaff T. and Grandstaff T (2000) Methodological experience in using Rapid appraisal in rural resource studies in Northeast Thailand. *American Journal of Agricultural Economics* 72(1990):132-197.

Griliches, Z (1995). "Hybrid Corn: An Exploration in the Economics of Technological Change." *Econometrica* 25(1995):501-22.

Harper, J. K., Rister M. E., Mjelde J. W., Drees B. M., and Way M. O. (1990) “Factors Influencing the Adoption of Insect Management Technology.” *American Journal of Agricultural Economics* 72(1990):997-1005.

Huffman, W.E., and Mercier S. (1991). “Joint Adoption of Microcomputer Technologies: An Analysis of Farmers’ Decisions.” *The Review of Economics and Statistics* 73(1991):541 46.

Hunter A. J., M. P. Hayes, and P. T. Gough (2003). A comparison of fast factorised back-projection and wavenumber algorithms for SAS reconstruction. In Proceedings of the World Congress on Ultrasonics, Paris, France.

Hutchins Scott H. (1990). The role of technology in sustainable Agriculture. Impact of insect feeding on alfalfa re-growth. A review of physiological responses and economic consequences. Agronomy journal 82:1035-1044

Hutchins, S. H. and Gehring P. J. (1993). Perspective on the Value, Regulation, and Objective Utilization of Pest Control Technology. Amer. Entomol. 39: 12-15.

Kerr J. (2000). Promoting Sustainable Development in Less-Favored Areas: Development Strategies for Semiarid South Asia.

Khanna, M. (2001) “Sequential Adoption of Site-Specific Technologies and its Implications for Nitrogen Productivity: A Double Selectivity Model.” *American Journal of Agricultural Economics* 83(2001):35-51.

Kivlin, J. E. And Fliegel F. C. (1967). “Differential Perceptions of Innovations and Rate of Adoption.” *Rural Sociology* 32(1967):78-91.

Lee, C., and Schluter G. (1993). “Growth and Structural Change in U.S. Food and Fibre Industries: An Input-Output Perspective,” *American Journal of Agricultural Economics 67(1993):137-185*

Lee, L. K. and Stewart W. H. (1983). "Land ownership and the Adoption of Minimum Tillage." *American Journal of Agricultural Economics* 65(1983):256-64.

Lin, J.Y. "Education and Innovation Adoption in Agriculture (1991): Evidence from Hybrid Rice in China." *American Journal of Agricultural Economics* 73(1991):713-23.

Mansfield, E. (1961) Technical Change and the Rate of Imitation. *Econometrica* 29(1961):741-66.

Meertens H. C. and Roling N. G. (1995). Non-Adoption of Rice Fertilizer Technology Based on a Farming Systems Research-Extension Methodology in Sukumaland, Tanzania.

Mukhwana E. J. and Musyoka M. W. (2005). Extension of organic resource management practices. Organic Resource Management in Kenya. Chapter 20.

Nayda, and R. Weiher. "The Value of Improved ENSO Prediction to U.S. Agriculture." *Climate Change* 39(1998):47-60.

Nelson, R. R. and Phelps E. S. (1996). Investment in Humans, Technological Diffusion, and Economic Growth." *The American Economic Review* 56(1996):69-75.

Nyborg N., Berg T. and Aune J. (2005). New paradigms in Technology transfer: Developing innovative approach to linking Agricultural research and practice.

Okali, C., Sumberg J. and Farrington J. (1994). Farmer Participatory Research: Rhetoric or Reality. London: Intermediate Technology Publications. Paper presented at the Annual Conference of the Association for Educational Communications and Technology (AECT), Albuquerque, New Mexico.

Pfaffenberger, B. (1988). Fetished objects and humanised nature: Towards anthropology of technology. The Journal of the Royal Anthropological Institute, 23(2), 236 252.

Polson, R. A. and Spencer D. S. (1991). "The Technology Adoption Process in Subsistence Agriculture: The Case of Cassava in South-western Nigeria. *Agricultural Systems* 36(1991):65-78.

Rahm, M. R. and Huffman W. E. (1984). The Adoption of Reduced Tillage: The Role of Human Capital and Other Variables. *American Journal of Agricultural Economics* 66(1984):405-13.

Rahman S. (2007)**:** Adoption of improved technologies by the pig farmers of Aizawl district of Mizoram, India. *Livestock Research for Rural Development. Volume 19, Article #5.*

Richards, J. F. (1990). The Earth as Transformed by Human Action. Cambridge University Press.

Rice Web (2007). http://www.ghanaweb.com/GhanaHomePage/food/rice.html

Rogers, E. M. (1995). Diffusion of innovations (4th Ed.). New York: The Free Press.

Romeo, A. A. (1975). Inter-industry and Inter-firm Differences in the Rate of Diffusion of an Innovation." *The Review of Economics and Statistics* 57(1975):311-19.

Romer, D. (1996) *Advanced Macroeconomics*. New York: McGraw-Hill Companies, Inc.

Rose, N. L. and Joskow P. L. (1988). "The Diffusion of New Technologies: Evidence from the Electric Utility Industry." NBER Working paper No. 2676, Cambridge, Massachusetts.

Rubas D. (2004) Technology Adoption: Who is Likely to Adopt and how does the Timing Affects The Benefits? A dissertation in partial fulfilment of the requirements for the degree of PhD.

Solow, A.R., R.F. Adams, K.J. Bryant, D.M. Legler, J.J. O'Brien, B.A. McCarl, W. Nayda, and R. Weiher. (1998) "The Value of Improved ENSO Prediction to U.S. Agriculture." *Climate Change* 39(1998):47-60.

Surry Dan (1997). Diffusion Theory and Industrial Technology. Paper presented at the Annual Conference of the Association for Educational Communications and Technology (AECT), Albuquerque, New Mexico.

Taylor, D. L. and Miller W. L. (1978). "The Adoption Process and Environmental Innovations: A Case Study of a Government Project." *Rural Sociology* 43(1978):634-48.

Theis, J. and Grady H. M. (1991) *Participatory Rapid Appraisal for Community Development: A training manual based on experiences in the Middle-East and North Africa.* International Institute of Environment and Development (IIED), London, UK.

Tietenberg, T. H. (2000) *Environmental and Natural Resource Economics*, 5th. ed. Reading, Pennsylvania.

Tshiunza M, Lemchi J., Tenkouano A. (2001) Determinants of market production of cooking banana in Nigeria. African crop science Journal. 9(3): 537-547.

United States General Accounting Office (2004). Using knowledge based approach to improve weapon acquisition. Government Accountability Office 441 G St., NW Washington, DC 20548

West Africa Rice Development Association (WARDA) (1997). WARDA Annual Report 1996. Mbé, Côte d'Ivoire.

World Bank Participation Resource Book (2003). The experience of Participatory Rural Appraisal in Northern Mexico. http://go.worldbank.org/R3WF0ID3N0

Zegeye, T., G. Taye, D. Tanner, H. Verkijl, Agidie A. and Mwangi W. (2001) Adoption of improved bread Wheat varieties and Inorganic Fertilizer by Small-scale

Farmers in Yelmana Densa and Farta Districts of Northwestern Ethiopia. Mexico. Ethiopia Agricultural Research Organization, 2001.

Zepeda, L. (1990) Adoption of Capital versus Management Intensive Technologies." *Canadian Journal of Agricultural Economics* 38(1990):457-69.

Zinnah M. M., Crompton J. L., Adesina A. A. (1993). Research-extension-farmer linkages within the context of the generation, transfer and adoption of improved mangrove swamp rice technology in West Africa.

APPENDICES

A. Biemso 1 Economic Data

No	PLAR Farmers			Non Plar Farmers		
	output/acre (84kg/bag)	cost per acre (GHC)	Gross profit margin/acre (GHC)	output/acre (84kg/bag)	cost per acre (GHC)	Gross profit margin/acre (GHC)
1	12.0	82.00	278.00	9.0	84.50	115.50
2	10.0	120.00	255.00	11.0	95.00	295.00
3	13.0	71.00	289.00	10.0	95.00	145.00
4	13.0	82.00	158.00	11.0	125.00	265.00
5	10.0	350.00	10.00	12.0	99.00	111.00
6	10.0	91.00	269.00	10.0	70.00	140.00
7	11.0	84.50	305.50	11.0	170.00	55.00
8	10.0	120.00	270.00	12.0	115.00	125.00
9	12.0	87.50	297.50	12.0	60.00	320.00
10	10.0	300.00	60.00	10.0	100.00	110.00
11	12.0	120.00	120.00	11.0	82.00	278.00
12	12.0	125.00	265.00	12.0	120.00	255.00
13	12.0	99.00	111.00	11.0	71.00	289.00
14	10.0	175.00	35.00	11.0	82.00	308.00
15	16.0	170.00	55.00	10.0	71.00	289.00
16	13.0	186.00	144.00	12.0	91.00	159.00
17	11.0	220.00	20.00	10.0	84.50	305.50
18	11.0	120.00	120.00	11.0	65.00	325.00
19	10.0	120.00	150.00	10.0	85.00	305.00
20	10.0	150.00	150.00	12.0	82.00	278.00
21	10.0	200.00	40.00	10.0	81.00	159.00
22	10.0	120.00	120.00	12.0	74.00	316.00
23	14.0	270.00	80.00	12.0	99.00	111.00
24	15.0	120.00	255.00	12.0	80.00	130.00
25	12.0	95.00	265.00	12.0	96.00	129.00
26	12.0	82.00	308.00	10.0	186.00	144.00
27	13.0	71.00	289.00	11.0	90.00	150.00
28	11.0	82.00	308.00	11.0	65.00	175.00
29	13.0	71.00	289.00	11.0	56.00	334.00
30	14.0	93.00	269.00	11.0	99.00	111.00
Averages	**11.73**	**135.90**	**186.17**	**11.00**	**92.43**	**207.73**

B. Kobinanokrom Economic Data

No	PLAR Farmers			Non Plar Farmers		
	output/acre (84kg/bag)	cost per acre (GHC)	Gross profit margin/acre (GHC)	output/acre (84kg/bag)	cost per acre (GHC)	Gross profit margin/acre (GHC)
1	12.0	110.00	119.00	10.0	100.00	180.00
2	16.0	220.00	205.00	10.0	75.00	95.00
3	10.0	170.00	180.00	12.5	100.00	150.00
4	13.0	264.00	246.00	12.0	90.00	105.00
5	13.0	180.00	190.00	10.0	40.00	100.00
6	13.0	190.00	210.00	12.0	60.00	80.00
7	11.0	110.00	120.00	12.0	85.00	120.00
8	13.0	200.00	210.00	13.0	200.00	260.00
9	11.0	115.00	118.00	12.0	190.00	210.00
10	13.0	120.00	130.00	10.0	100.00	268.00
11	13.0	170.00	180.00	14.0	150.00	300.00
12	10.0	137.00	135.00	16.0	190.00	320.00
13	9.0	112.00	110.00	14.0	165.00	260.00
14	12.0	150.00	124.00	8.0	100.00	200.00
15	17.0	290.00	200.00	14.0	200.00	280.00
16	10.0	100.00	110.00	13.0	160.00	260.00
17	14.0	200.00	180.00	10.0	100.00	120.00
18	12.0	200.00	176.00	12.0	110.00	250.00
19	16.0	260.00	150.00	11.0	90.00	206.00
20	10.0	130.00	140.00	9.0	100.00	200.00
21	13.0	200.00	186.00	12.0	150.00	220.00
22	13.0	210.00	200.00	12.5	170.00	260.00
23	10.0	140.00	100.00	14.0	200.00	300.00
24	9.0	100.00	110.00	8.0	100.00	105.00
25	12.0	180.00	150.00	13.0	180.00	270.00
26	13.0	200.00	250.00	12.0	100.00	176.00
27	10.0	120.00	195.00	10.0	100.00	204.00
28	14.3	240.00	225.00	12.5	110.00	220.00
29	12.0	180.00	100.00	9.0	100.00	232.00
30	16.0	270.00	170.00	10.0	110.00	236.00
31	13.0	200.00	150.00	12.0	140.00	200.00
32	13.0	205.00	156.00	12.0	180.00	180.00

33	13.0	210.00	140.00	10.0	100.00	184.00
34	13.0	250.00	150.00	12.0	100.00	184.00
35	13.0	240.00	236.00	12.0	100.00	190.00
36	10.0	150.00	144.00	8.0	90.00	100.00
37	9.0	120.00	156.00	12.0	160.00	180.00
38	12.0	200.00	200.00	8.0	85.00	90.00
39	13.0	200.00	100.00	10.0	90.00	150.00
40	13.0	210.00	110.00	10.0	100.00	180.00
Averages	**12.23**	**181.33**	**161.53**	**11.33**	**121.75**	**195.63**

C. Ohiamadwen Economic Data

No	PLAR Farmers			Non Plar Farmers		
	output/acre (84kg/bag)	cost per acre (GHC)	Gross profit margin/acre (GHC)	output/acre (84kg/bag)	cost per acre (GHC)	Gross profit margin/acre (GHC)
1	13.0	174.00	162.00	13.0	100.00	236.00
2	14.0	190.00	200.00	13.0	150.00	186.00
3	13.0	180.00	210.00	12.0	100.00	208.00
4	15.0	210.00	100.00	13.0	150.00	186.00
5	13.0	170.00	186.00	12.0	100.00	200.00
6	14.0	210.00	212.00	12.0	120.00	188.00
7	12.5	120.00	90.00	14.0	110.00	254.00
8	15.0	210.00	200.00	13.0	100.00	236.00
9	12.0	250.00	70.50	12.0	100.00	208.00
10	11.0	100.00	150.00	14.0	100.00	264.00
11	13.0	200.00	198.00	13.0	131.00	205.00
12	13.0	245.00	150.00	12.0	120.00	188.00
13	13.0	195.00	200.00	13.0	124.00	200.00
14	14.0	210.00	150.00	14.0	176.00	188.00
15	14.0	200.00	210.00	12.0	131.00	177.00
16	14.0	210.00	100.00	12.0	110.00	198.00
17	12.0	100.00	130.00	12.0	131.00	177.00
18	12.0	100.00	120.00	13.0	120.00	216.00
19	12.5	120.00	160.00	12.0	100.00	150.00
20	15.0	227.00	240.00	13.0	100.00	165.00
21	12.0	150.00	180.00	12.0	80.00	100.00
22	11.0	100.00	120.00	12.0	100.00	150.00
23	13.0	145.00	150.00	12.0	100.00	130.00
24	13.0	120.00	91.00	12.0	150.00	158.00
25	13.0	186.00	200.00	13.0	100.00	270.00
26	13.0	190.00	220.00	15.0	260.00	280.00
27	14.0	200.00	160.00	13.0	230.00	160.00
28	14.0	210.00	200.00	13.0	120.00	180.00
29	14.0	200.00	120.00	13.0	140.00	150.00
30	18.0	280.00	300.00	13.0	150.00	186.00
Averages	**13.33**	**180.07**	**165.98**	**12.73**	**126.77**	**193.13**

D: Independent t-test results of the average output per acre by PLAR and non PLAR farmers in Biemso 1

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
total quantity of bags of paddy harvested per acre presently	Equal variances assumed	12.069	.001	2.143	58	.036	.7333	.3422	4.838E-02	1.4183
	Equal variances not assumed			2.143	43.850	.038	.7333	.3422	4.365E-02	1.4230

Group Statistics

	respondent's participation in PLAR	N	Mean	Std. Deviation	Std. Error Mean
total quantity of bags of paddy harvested per acre presently	yes	30	11.7333	1.6595	.3030
	no	30	11.0000	.8710	.1590

E: Independent t-test results of the average output per acre by PLAR and non PLAR farmers in Kobinanokrom

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
total quantity of bags of paddy harvested per acre presently	Equal variances assumed	.009	.927	2.037	78	.045	.8875	.4357	2.005E-02	1.7550
	Equal variances not assumed			2.037	77.831	.045	.8875	.4357	2.002E-02	1.7550

Group Statistics

	respondent's participation in PLAR	N	Mean	Std. Deviation	Std. Error Mean
total quantity of bags of paddy harvested per acre presently	yes	40	12.2250	1.9934	.3152
	no	40	11.3375	1.9027	.3008

F: Independent t-test results of the average output per acre by PLAR and non PLAR farmers in Ohiamadwen.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
total quantity of bags of paddy harvested per acre presently	Equal variances assumed	3.863	.054	2.085	58	.041	.6000	.2877	2.402E-02	1.1760
	Equal variances not assumed			2.085	46.254	.043	.6000	.2877	2.089E-02	1.1791

Group Statistics

	respondent's participation in PLAR	N	Mean	Std. Deviation	Std. Error Mean
total quantity of bags of paddy harvested per acre presently	yes	30	13.3333	1.3667	.2495
	no	30	12.7333	.7849	.1433

G. SAMPLE QUESTIONNAIRE FOR THE STUDY

Title: Investigating the socio-economic and institutional outcomes of PLAR-IRM in rural community

A]. BACKGROUND INFORMATION

I. Name of farmer ____

II. Gender Male [ ] Female [ ]

III. Age_________________ IV. Name of village:________________

V. Marital status Married [ ] Single [ ]

VI. Educational level Primary [ ] Senior Sec. [ ] Junior Sec [ ]. Tertiary [ ]

VII. Major occupation of spouse, if married

Trading [ ] Food crop production [ ] Wine distillation [ ] rice production [ ] no occupation [ ] not applicable [ ]

VIII. Native of village Yes [ ] No [ ]

IX. If not, Number of years resident in the village ______

XI. Ethnicity __________________________

XII. How long have you been cultivating rice? _________________

XIII Have you ever taken part in the PLAR group learning sessions?

Yes [ ] No [ ]

XIV If yes, for how long have you taken part in the training sessions? _____________

XV What was your main motivation for participating in PLAR?

Increased profit [ ] increased yield [ ] group membership [ ]

access to credit [ ]

XVI. What is the size of your rice farm? _________________

B]. FARMERS' KNOWLEDGE ABOUT IRM PRACTICES.

I] Choice of Variety, Seed Selection and Seed Conservation Practices

1. What rice varieties are cultivated now in the village?

a.

b.

c.

d.

e.

2. Which of the varieties did you use to cultivate in the past 5 years

a.

b.

c.

d. .

3. Which of these varieties of rice do you actually growing now?

a.

b.

c.

d.

4. Why do you now cultivate this variety instead of the others? ____

5. What do look out for in choosing the varieties you grow?(criteria for selection) ____

6. How do you get your seeds for planting (Sources)?

Buy [ ] produces Own seed [ ] Exchange within the community [ ]

Exchange across the next village [ ] from extension or Agric [ ] others (specify)

7. If own seeds, how do you select the rice seeds that you grow?

8. What problems or difficulties do you have with selecting your rice seeds?

9Where did you learn about the new method of seed selection?

10. How do you ensure that your seeds are good or pure for planting?

11. Do you perform germination test on selected seeds? Yes [ ] No [ ]

12. In No, why?

13. How do you conserve your seeds?

16. For how long have you been using this method for conserving your seeds? _______

17. What problems or difficulties do you have with seeds conservation, if any?

____

____

____

____

II] Pre- Nursery Seed Handling

1. What do you do to your seeds before they are nursed?

____

____

____

____

2. Foe how long have you been handling your seeds this way?

____

____

____

____

3. For how long have you been handling your seeds by this new method? __________

4. What benefits (advantages) have you derived from the pre-nursery seed handling?

____

____

____

____

5. What problems or difficulties do you face with pre-seeds handling?

____

____

____

__________ ____

III] Nursery Bed Preparation

1. Do you prepare nursery beds? Yes [ ] No [ ]

2. If No, why? ____
____
____
____
____

3. How do you prepare your nursery bed? ____
____
____
____

4. What is the dimension of your nursery bed?

Length ______________ Width _____________Height ____________

5. What difficulties do you have with nursery bed preparation, if any? ____
____
____
____

6. What planting pattern is the nursery bed seeded?

In rows [ ] Broadcasting [ ] others (specify) [ ]

7. For how long have you been using this pattern on the nursery bed? ___________

8. Do you locate your nursery bed under a tree in the farm? Yes [ ] No [ ]

9. If no, why? ____

10. Where did you learn about the preparation of nursery bed?
____
____

IV] Land/Soil Preparation

1. Which of these land preparation processes did/ do you undertake during land preparation? (Tick)

Land preparation process	In the last 5 years	Before the last 5 years
1. Clearing of weeds		
2. Burning of cleared weeds		
3. Construction of bunds		
4. Pre-irrigation		
5. First ploughing		
6. Flooding		
7. Second ploughing		
8. Leveling		

2. What is the reason/motivation for changes in the method of land preparation if any?

____

____

____

____

3. What is the source of your knowledge about the new method of land preparation? ________________

4. What is the source of knowledge about your current land preparation procedure? ________________

V] Water Management

1. How do you get water to irrigate your field? ________________________________

2. Do you leave water on your rice field during certain times? Yes [ ] No [ ]

3. If yes, when, how and why do you leave the water on your field?

Time of flooding	Reasons for flooding	Level(height) of water(cm)
Land/Soil Preparation		
Transplanting		
Fertilizer Application		
Harvesting		
Other times		

4. Do you periodically drain excess water from your field? Yes [ ] No [ ]

5. If yes, how and what reason(s) do you drain water during each of these activities?

Activity	How	Reason for drainage
Land/Soil preparation		
Transplanting		
Fertilizer application		
Harvesting		
Other times		

6. Where did the new information or idea come from? ______________________________

7. What major problems or difficulties do you still have with water management?

____
____
____

VI] Transplanting

1. Do you transplant your seedlings? Yes [ ] No [ ]

2 If yes, at what age of the seedlings are they transplanted? ___________days or weeks

2. Describe briefly how you undertake transplanting in your field? ____
____
____
____
____
____
____

7. How many seedlings do you transplant per hill? _______________

8. What is the estimated distance between transplanted seedlings? ___________cm

9. What is the pattern of transplanted seedlings?

Row planting [ ] randomly [ ] others specify [ ]

VII] Soil fertility Management

1. Do you use fertilizer on your farm? Yes [ ] No [ ]

2. If yes, for how long have you been using fertilizers on your farm? ____________

3. If no, why? ____
____
____
____

4. Fertilizer application practices with respect to timing, rates, etc,

Fertilizer type	NPK	Urea	Ammonium	Others
Reasons for application				
Rate of application (kg/acre)				
Total quantity (bags) used				
No. of times of application				
Time of application				

5. Where did you get information or idea on fertilizer application from? ____________

6. What major problems or difficulties do you have with fertilizer application?

____

____

____

____

VIII] Weed Management

1. How do you control weeds on your farm**?**

Manual weeding [ ] use of herbicide [ ] use of both herbicides and manual weeding [ ] other methods [ ] please specify _______________________

2. Provide information to the table below.

Method of control			
Reasons for using this method(change)			
Quantity/acre applied if herbicide			
Time of application			
Reasons for this time(change)			

4 Where did you get the information or idea on weed control from?
____

5. What major problems or difficulties do you have with weed control practices?
____
____
____
____
____

IX] Pests and Diseases Control

1. What are the pests that disturb you on your rice farm?

Rodents [ ]

Birds [ ]

Weevils [ ]

Stem borers [ ]

Others [ ]

2. How did you control these pests?

Pest	Control measures
Rodents	
Birds	
Weevils	
Stem borers	
African rice gall midge	
Others	

3. What diseases affect our rice, what are the symptoms and the control measures you have adapted to control them.

Name of disease	Symptoms of disease	Control measures

4. What are your reasons for using these control measures in controlling the pests and diseases?

____

____

____

____

5. What advantages have you gained in using the new methods of pest control?

i)

ii)

iii)

iv)

5. Where did you receive the information about the new methods of control?

X] Harvesting & Post-harvest Handling

1. At what age do you harvest your rice after transplanting? ____wks/months

2. What do you look out for before harvesting before PLAR? ____

____

____

3. What preparation do you undertake before harvesting?

a)

b)

c)

d)

e)

4. Could you please describe how you carry out the harvesting of your rice crop?

____

____

____

____

____

____

____

5. Where did you get information about this harvesting practice? ____________________

6. How do you thresh your rice after harvesting?

____

____

____

____

____

____

C] OUTPUT PER ACRE & COST OF PRODUCTION PER ACRE

1. What is the evolution in area, quantity produced and sold?

Area cultivated to rice	
Quantity of paddy harvested/acre (84 kg)	
Total quantity of paddy harvested (84 kg)	
Quantity of paddy sold (84 kg)	
Price per 84 kg bag of paddy rice (cedis)	
Quantity of milled sold (84 kg)	
Price per 84 kg bag of milled rice	

2. **Variable Cost of production**

Cost Items	**Amount of money (GHC)**
1. Seeds	
2. Ploughing	
3. Transplanting	
4. Herbicide	
5. Weeding	
6. Threshing	
7. Insecticide	
8. Harvesting	
9. Transportation from field	
10. Other inputs (hoe, cutlass, shovel, etc.)	
11. Cost of milling per 84 kg paddy	

D] Questionnaire for Focus Group Discussions

1. Name of village ______________________
2. What are some of the important assests in the village?
   a)
   b)
   c)
   d)
   e)

3. Which gender group in the village is actively involved in rice production? ____________________

4. Why is this gender the active gender involved in rice production? ____

5. What system of land ownership is practiced in the village? Arrange in ascending order ____

6. What are some of the institutions, either government/non governmental that have existed in the community by filling the table below.

Institutions in study areas and their activities before PLAR

Community	Name of Institution	Year of operation	Activities of Institution

Institutions in study areas and their activities after PLAR

Community	Name of Institution	Year of operation	Activities of Institution
			.