Consultative Group on International Agricultural Research - CGIAR

Document *NO: ICW/98/12*
Distribution: General
Date: October 29, 1998

International Centers Week 1998
October 26 - 30
Washington D.C.

Shaping the CGIAR's Future

IAEG - Factors Affecting the Adoption and Impact of CGIAR Innovations. Executive Summaries of Individual Case Studies

Attached are executive summaries of individual case studies. These are circulated as background to agenda item 7, iv. This item is scheduled for discussion in parallel session.

The IAEG Chair will report on the results of research conducted in cooperation with the centers. At the conclusion of the discussion, the session chair will summarize the decisions reached.

CGIAR

Factors Affecting the Adoption and Impact of CGIAR Innovations

EXECUTIVE SUMMARIES OF INDIVIDUAL CASE STUDIES

1AEG
October 1998

FOREWORD

The IAEG-sponsored project "Factors Affecting the Adoption and Impact of CGIAR Innovations" had its genesis at the CGIAR impact assessment and evaluation workshop held at ISNAR in April 1996. Centers and NARS participants identified case study methodology as potentially one of the more useful evaluation methods for assessing impact which could be used by CGIAR evaluators. The evaluators requested further training in the methodology.

The IAEG commissioned Prof Lee Sechrest from the University of Arizona to conduct a workshop (held in February 1997) in the use of case study for impact assessment and for designing potential studies. The workshop was attended by evaluators from seven Centers and a number of NARS. Prof. Sechrest was then engaged to provide on-going advice to participating Centers to ensure that appropriate design and rigour was applied to their studies. A project overview was reported to the CGIAR at ICW 1997.

Nine studies in the project have been completed, or nearly completed, and the results were discussed at a synthesis workshop held in Hawaii at the end of June 1998. The workshop was attended by the senior Center investigator from each participating Center and a collaborator from a NARS partner. The workshop initiated a cross-system analysis of the findings of the individual case studies. The workshop also discussed a draft paper on technology adoption commissioned as part of the project.

This document presents the Executive Summaries of the nine individual case studies. The summaries are in pre-publication draft form and are presented for the information of the CGIAR. The synthesis report prepared for the IAEG by the Arizona group is available in a companion volume at CGIAR at ICW this year.

We propose that full accounts of each study will be available on the CGIAR Website and that each study will be independently published. We have also been negotiating for shorter versions of these impact studies and the synthesis to be published in a special edition of a leading Evaluation Journal.

IAEG
October 1998

CASE STUDIES

CIAT's Integrated Cassava Research And Development (ICRD) Strategy: A Case Study On Adoption And Impact In Northeast Brazil

By

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Technical change is a key to economic growth and meeting human needs particularly in agriculture in less industrialized countries where agriculture is a major source of employment for the poor as well as being a major factor in food security. Understanding how innovations are diffused among small farmers in low income countries is a crucial issue in insuring that the benefits of innovations are widely disseminated, especially to the poor.

This paper studies the adoption process of new cassava post harvest production technology in the northeast of Brazil in the state of Ceara. This has been chosen for a topic of study because cassava farmers in Ceara are typical of poor farmers in low-income countries in terms of their small scale and scarcity of capital and the difficult growing environment. The technology of chipping and sun drying cassava has the advantage of linking small farmers to dynamic growth markets that offer them the opportunity to increase their incomes, and the technology is quite suitable to village conditions in developing countries as evidenced by its widespread use in northern Thailand over the last three decades. Nevertheless, this innovation is relatively complex in that its use requires collective action by farmers as well as the entry into a new market.

This paper will utilize a case study approach to address some key issues in adoption among rural people in low income countries. This case study will aim to provide a thick description of the process from the points of view of various actors utilizing a range of data and information sources (Secherest et al 1997).

1. BACKGROUND

Cassava is the fourth most important food staple produced in the tropics, with a global production of 118 million tons, of which 32 million is produced in South America. (FAO 1997). However, since cassava deteriorates rapidly after being harvested, its importance has declined as populations have urbanized so that per capita cassava consumption has been declining in South America. This has led to stagnating opportunities for cassava producers, most of whom are small low income farmers. Consequently, studies of alternative uses and markets for cassava are of considerable importance in particular in an effort to identify markets for cassava that have considerable growth potential and thus provide opportunities for small cassava farmers to increase their incomes.

Initially the most promising alternative market for cassava identified in South America was to produce dry cassava chips for incorporation in animal feed concentrates (Pachico et al 1983). The industry of dry cassava chips for animal feeds was originally developed in Asia, where millions of tons of cassava chips have been produced for some decades now. Based on these economic studies, an integrated program of cassava research and development was initiated in order to introduce the opportunity of the market for dry cassava chips for small farmers in South America (Cock 1988; Lynam 1987). The strategy was then defined as an attempt to develop new markets and to fink cassava farmers to these new and expanding markets (Best, 1991).

This approach was implemented through an integrated set of institutional, organizational, social and technological interventions designed to link small-scale cassava farmers to new or improved growth markets. In Colombia, project activities rapidly led to penetrating the Colombian animal feed market with dry cassava chips as an alternative carbohydrate source. Estimates calculated that during the period 1984-91 the cassava sector in Northern Colombia benefited by almost US$ 22 million when research to improve cassava crop management was integrated with research on its processing, marketing and consumer preferences (Gottret and Henry, 1992).

In 1989, based principally on the experiences accumulated in Colombia, CIAT and collaborating agricultural research and technical assistance institutions formulated a proposal with the objective of testing the same strategy in the State of Ceari in northeast Brazil.

Northeast Brazil suffers the highest levels of poverty and underdevelopment in Brazil. An estimated 50% of the population earning less than (US$130 annually). Low and variable rainfall makes cassava practically the only staple food crop alternative for farmers, and cassava consequently constitutes the main food source. The principal market for cassava in Ceari has been to local small-scale units that process the roots into a flour ***called farinha de mandioca, a*** basic staple product.

The introduction of new post production technology into Ceari was facilitated by prior involvement of state agricultural sector agencies in the promotion of cassava-based development activities, especially EMATER (the State Technical Assistance and Extension Service) that had been promoting the development of alternative markets during the period 1981-87.

The strategy followed in Ceari was to look for a large, alternative market into which cassava could enter in good rainfall years when excess cassava production usually means low prices. A pilot project was established which involved the setting up and testing of the production, processing and marketing technology and channels on a small-scale semi-commercial basis.

2. METHODOLOGY FOR THIS STUDY

This case study is part of a series of case studies being implemented by CGIAR Centers to assess the acceptance, adoption and impact of technologies and methodologies, developed, by the Centers in collaboration with national agricultural research systems. This study will analyze the level of adoption and impact in Ceari, of the Integrated Cassava Research and Development Project Methodology (ICRD) based on the development and adaptation of improved production, processing and commercialization technologies. This study will both provide feedback to improve the performance of integrated postharvest development programs as well as to document the impacts achieved through this work.

The conceptual framework for this study is that the promotion of small-scale, cassava based agro-industries created an alternative market for cassava roots. It is expected that this alternative market established a floor price for the product, reduced price fluctuations, and increased the farmers bargaining power. These changes in demand and prices reduced the market risk faced by cassava producers, which in turn served as an incentive to increase cassava production.

A variety of data sources are used in this case study including both primary and secondary quantitative and qualitative data. An important source of quantitative data is the project monitoring and evaluation system that was implemented as part of the original project. This database included an inventory of the plants constructed in the project including location, size, source of funding etc. In addition, this data base contains annual information on the processing costs, production and sale of cassava chips for each cassava chipping plant. The database also includes cassava fanner groups member information, such sex, age, land tenure, farm size, cassava area, etc.

For this study qualitative data was obtained from focus groups and interviews with key informants. Focus groups were conducted with cassava producers and processors from successful, partially successful and non-successful groups. The focus group discussion guide included the following themes: (1) Factors which influenced the community decision to establish a dry-cassava agro-industry. (2) Level of community participation on dry-cassava processing activities. (3) Identification and analysis of factors which effect the success or failure of dry-cassava agro-industries. . (4) Effect of the new alternative market for cassava (new processing technology) on the adoption of cassava production technology recommended

during the project. (5) Identification and analysis of the new processing technology on cassava commercialization channels (cassava uses). (6) Type and quality of institutional support received by cassava producers and processors during the project (technical assistance, credit, community organization, etc.). (7) Effect of the new agro-industry established in the community on its overall development.

Special interviews were also conducted with women who participated in the project. Guides for women interviews included the following themes: (1) Participation of women on the community decision to establish the new dry-cassava agro-industry. (2) Analysis of the participation of women and children in dry-cassava processing agro-industries. (3) Identification of the type and quality of institutional support received by women during the project. (4) Effect of the project on the sociopolitical position of women in the community. (5) Effect of the establishment of the new cassava agro-industry on overall community development and household quality of life.

Communities were sampled for the focus group interviews based on the information in the project monitoring system. Two parameters were calculated for each drying plant: technical efficiency and financial efficiency. Also, plants were classified according to their source of funding and the support received by the integrated cassava project. The latter was important since some of the plants built, during and after the project, were funded by the Secretaria de Industria y Comercio (SIC), which was a political initiative, but those plants did not receive any support from the project (technical assistance, credit, etc.). Afterwards, drying plants were stratified by their level of technical efficiency and the source of funding. The number of communities sampled were determined based on the mean and standard deviation of the technical and economic efficiency of the drying plants as the key variables of the study, with a confidence level of 90% and a probability of error of 7%.

3. PROCESS OF ADOPTION

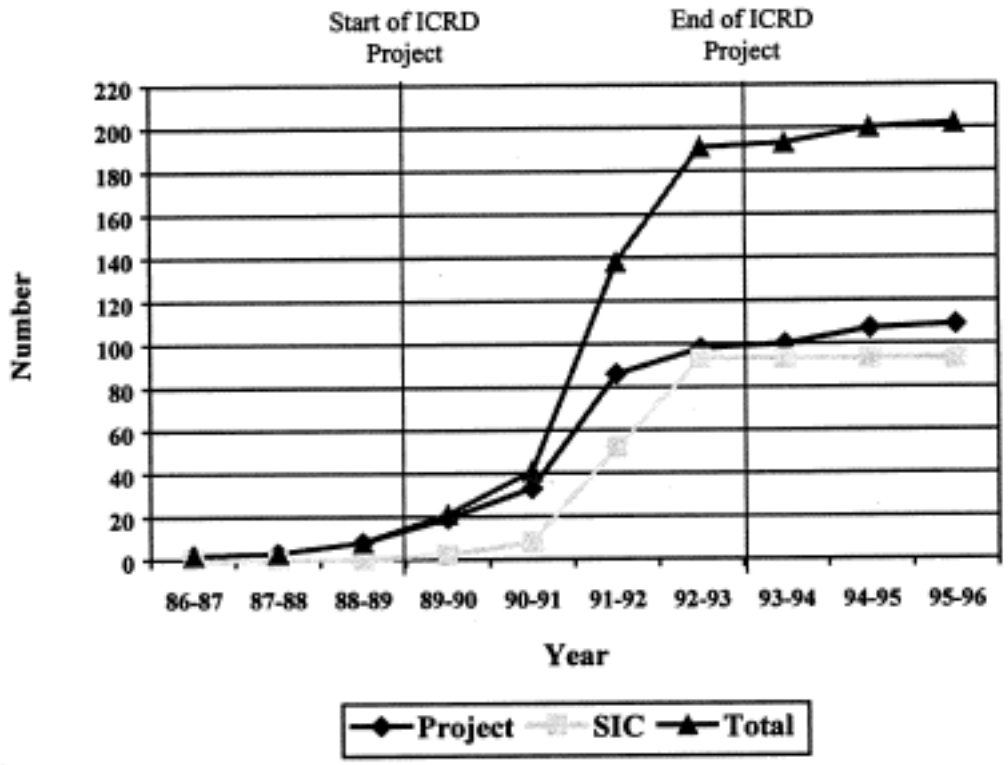
The ICRD project in Ceara, northeast Brazil, was initiated with the aim of establishing the production of dry cassava chips for animal feeding as a viable agroindustrial activity among small-scale farmers. In 1988, the coordination of work among technicians and policy makers led to the formation of the Ceara Cassava Committee (CCC), with the aim of coordinating cassava crop development activities statewide. The incipient CCC played a fundamental role in identifying additional financial resources, which made it possible to install dry cassava agroindustries during the period 1988-89.

As part of the project activities, the I I groups existing at the onset of the project were reorganized and/or reactivated, and another 147 farmer groups were established for a total of 158 producer groups organized around dry cassava agroindustries by June 30, 1992 when the project was terminated. Most of these groups (75%) were organized during the last year of the project. Some groups were not completely established before the end of the project, because they faced serious problems for lack of availability of funds and consolidation of the groups themselves.

Figure I shows the number of plants installed per year during the 1986-1996 period by source of funding. As shown in this Figure, 90 plants where installed during the 1989-92 period, with funds obtained through the ICRD project activities. These groups of farmers received services from the project including technical assistance, credit and training. However, the rapid expansion of the project in terms of number of farmer groups organized was specially significant during the third and fourth year of activities. This fast growth was in part due to the strong intervention of the Ceara State Secretariat of Industry and Commerce (SIC), which launched a program of grant-type financial aid that permitted 93 rural communities to build dry cassava agroindustries. These groups received the grant but not the support system given by the ICRD project.

As a consequence, the rapid expansion of the project in terms of the number of dry agro-industries resulted in the following limitations: (1) poor selection of farmer groups, (2) lack of institutional presence, making it difficult to offer technical assistance support to farmers, and (3) delay in delivering economic resources to farmers, which caused delay in the installation of dry cassava plants. Moreover, these processes had, all too often, been characterized by its political motivation and the need for rapid action, with minimum time for careful deliberation with farmer groups.

Figure 2 shows the quantity of cassava roots processed by the dry cassava agro-industries during the 1990-96 period. The plants increased production until 1992. Afterwards., production decreased significantly during the 1993-95 period and in 1996 it began to raise again Figure 2 also shows a marked difference on the quantity of cassava roots processed by the cassava drying agro-industries established with the whole support from the project, and the quantity processed by those established by the SIC. agro-industries established by the SIC only processed 247.4 MT of cassava roots until 1996, while those established by the ICRD Project processed 7002.8 MT of cassava roots in the 1990-96 period.



Data source: ICRD project monitoring and evaluation system

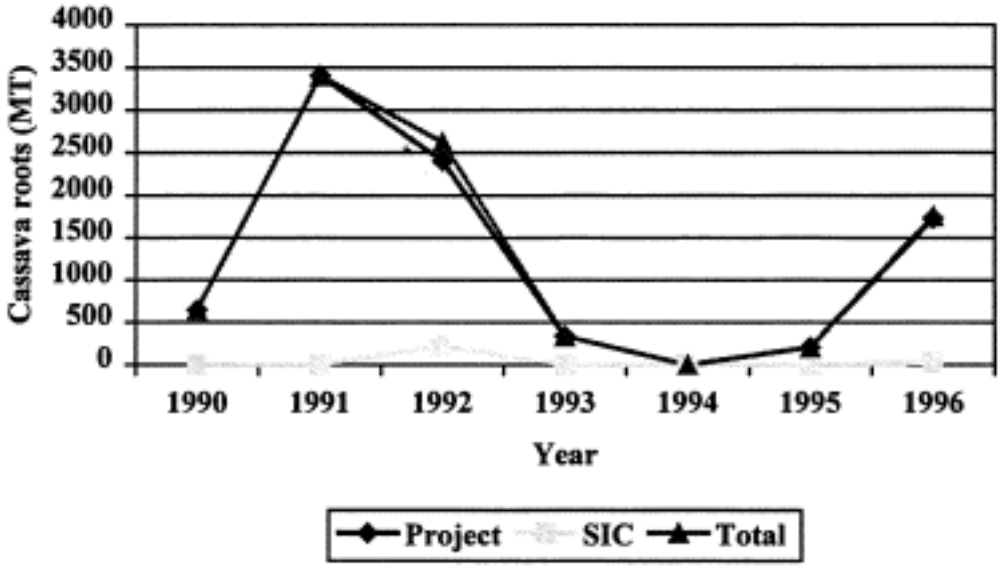
Figure 1. Numbers of cassava drying plants installed during the 1986-96 period in the Ceara State of Brazil, by source of funding.

In 1992, the region had one of the worst droughts they ever had in 1993 and yields decreased dramatically (down to approximately 3.5 ton/hr). This not only affected 1993 cassava yields, but also decreased the area planted to cassava in the next year (1994) since people did not have enough seed to plant. Thus, the startling collapse in dry cassava production in 1993-5 was due principally to the drought. Once the drought was over, the production of dry cassava chips recovered in 1996.

4. REASONS FOR ADOPTION AND SUCCESS

4.1 Community decision to establish a cassava drying agroindustry

Table I shows a summary of the results obtained on the fanner group discussions, when farmers were asked about the factors which influenced the community decision to establish a dry-cassava agroindustry. The reasons given by the farmer groups were classified according to community strata, which was defined by the level of technical performance of the processing plant. Adopters include those communities which adopted the processing technology, their agroindustry operated more than one year, and had a technical efficiency higher than 10%. Experimenters includes those communities which adopted the processing technology, their agroindustry operated only one year (at the beginning), and had a technical efficiency lower than 10%. The last group of communities includes those which installed a dry cassava processing plant, but which never operated. This community classification is also applied to the rest of the qualitative data analysis.



Data source: ICRD project monitoring and evaluation system

Figure 2. Cassava roots processed by the cassava drying agroindustries during the 1990-96 period.

Table 1. Factors which motivated the community decision to establish a cassava drying agroindustry.

TYPE	Factors	Strata		
		Adopters	Experimenters	Installed but never worked
NEW MARKET OPPORTUNITIES AND USES FOR CASSAVA	Alternative market for cassava roots which gives the community an increased bargaining power when *farinha* prices are low	*** *	***	**
	Lower labor and other production costs than those for *farinha* processing made cassava chips production more profitable	***	*	*
	Some cassava producers did not have a *farinha* processing plant, and those who had it, take advantage of the others by charging high rates for using it	*	*	
	Hope to increase the community cash income since *farinha* is mainly produced for own consumption, is less profitable, and the profits from cassava chips production could stay in the community.	**	**	**
	Way to guarantee good feed at a lower price for their animal production		*	*
	To generate employment opportunities in the community	*		
	Hope to improve their quality of life	*	*	
INSTITUTIONAL APPROACH	Influenced by the motivation and support given by EMATERCE, and the trust they had in the institution	***	*	
	Influenced by visits to other cassava drying groups who had experience with the new product	***	*	*
	Availability of grant-type financial resources for the construction of the plant	*		
	The new processing technology was tested with the community	*		
CIRCUMSTANCES	Surplus cassava production when the community took the decision	**	**	*
	Low prices of *farinha* when the community took the decision	***	***	*
	Had some previous experience with the cassava drying technology	*		
	Their land is suitable for cassava production	*		
	There was no interest of the community, the group took the decision without taking into account the community decision			*
	That was what the politicians where offering at that moment			*

* The number of asterisks refers to the frequency of response by the communities as follows : *** = high response frequency (70-100% of communities), ** = medium response frequency (30-70% of communities), and * = low response frequency (less than 30% of the communities).

The reasons given by all community strata can be classified in three type of responses. The first set of reasons are those related to the advantages related to the development of a new product. The new agroindustry was seen as an alternative market for cassava roots; as a way to reduce the labor and other

production costs involved *in farinha processing,* and therefore, as a possibility to generate additional cash income for farmer households.

The second set of reasons is related with the motivation given by institutions through the ICRD project. The ICRD project, through its strategic alliance with EMATERCE motivated fanner groups to establish dry-cassava agro-industries, using two approaches. First, EMATERCE gave a direct support to farmer groups, including technical assistance, grant type funds for the installation of the cassava drying plants, credit for operation capital, community organization, and training for the agroindustry management. Second, the ICRD project promoted the exchange of experiences among the different farmer groups, through visits to other neighborhood communities with more experience, and some community leaders traveled to Colombia to learn from farmers groups with more and longer experience with the agroindustry.

The third set of reasons include those that were circumstantial to the moment when the ICRD project was implemented and, as found in this case study, changed later on. In the 1989-91 period there was a surplus of cassava production in the region, and therefore, also a surplus of farinha. This production surplus put a downward pressure *on farinha and* cassava root prices, and farmers were loosing money with farinha production.

Table I also shows reasons given only by some community strata. Among the adopter communities, there are two reasons given by farmers which may have fostered the success of these agro-industries. First, some of these communities have had previous experience with the technology and that gave them some advantage over the other communities. Second, these communities were involved in testing and adapting the technology, therefore, they were empowered by the project through some type of participatory research.

On the other hand, communities which installed the processing plants with grants from the SIC, but never produced cassava chips, gave reasons for establishing the agro-industries which explain in' part their failure. First, they establish the agroindustry only because that was what politicians were offering for free and there was no commitment of the community. Second, the whole community was not involved in the decision process, but only a small group of farmers made the decision.

In general, the communities where the cassava plants were established without a full institutional support effort, lacked clarity of vision about the potential benefits of cassava plants. In the more successful adapting communities there was both greater clarity about the reasons for establishing the plants as well as a much closer articulation with official institutions which provided the communities with training and technical assistance that enabled them to be more successful in operating their plans.

4.2 Factors which Enhance the Success of the Dry-cassava agro-industries

Table 2 presents the farmer groups' views on the factors which enhance the success of the dry-cassava agro-industries. This information was only obtained in the communities where the drying plants operated (adopters and experimenters only), since those communities where plants were installed but never worked could not answer to this question because they failed.

The factors related to marketing of cassava are important. The new agroindustry offered cassava farmers an alternative market with the following advantages according to farmers: (1) Cassava chips can be sold easier than farinha and farmers receive cash income almost immediately, in contrast to the lack of a secure market *for farinha. (2*) Cassava chips can be easily stored for a long time, giving farmers the option to wait for good prices instead of having to sell them at the current price. (3) Cassava farmers that

were not members of the cassava drying farmer groups, could also sell their cassava roots to the agroindustry and receive cash income.

It is important to note that those communities that were successful, emphasized that there was integration, effort, and involvement of the dry cassava group members from the beginning of the project to build and operate the agroindustry. In some communities, farmers were already organized for agricultural production activities prior to the project, and with the institutional support provided by the ICRD project, they strengthened their organizations. Therefore an important factor which enhanced the success of the agro-industries was the level of community organization and commitment of their members.

The technology for producing dry-cassava chips was also an advantage of the agroindustry according to farmers. The processing technology is simple and low cost. Farmers were able to learn fast how to produce cassava chips and to manage the agroindustry, and the processing costs are lower than those of *farinha production*. These advantages resulted in a lower requirement of working capital and labor and, therefore, a higher probability of economic feasibility of the agroindustry, even at low cassava chip prices. Another important advantage of the technology was that it requires less labor than farinha processing, and therefore, liberates labor for other activities and/or increases their leisure time. The technology was also attractive to some communities which have animal production, since it offered the possibility to use their cassava production to feed their own animals and increase their number.

Another important factor, was the support and services provided by the ICRD project, through local institutions, to the fanner groups and their institutions. According to farmers, one of the key factors for their success was the training and technical assistance they received for the production of cassava, its processing into cassava chips, the commercialization of the product, and the management of the agroindustry. However, only a few communities said that the credit they received for cassava production was an enhancing factor.

Table 2. Factors which enhanced the success of dry-cassava agroindustries

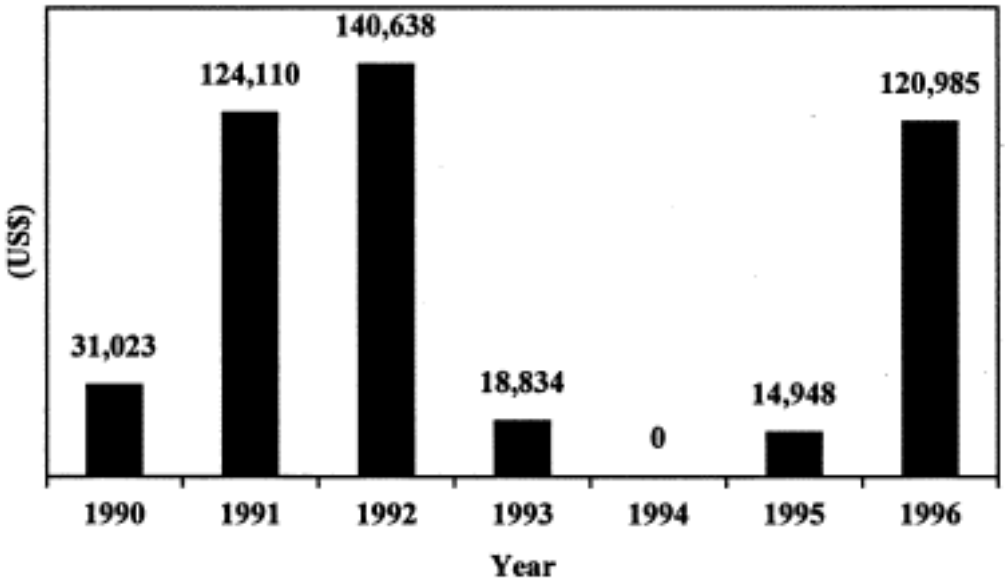
GROUP	Factors	Strata	
		Adopters	Experimenters
ALTERNATIVE MARKETS AND USES	The increased bargaining power that the new alternative market for cassava roots gave to farmers.	*** [a]	***
	The new agroindustry offered farmers an option to make a more efficient use of cassava production and an alternative market for cassava roots.	***	***
	It was easier to sell cassava chips than *farinha* and they can get cash income immediately.	***	*
	Cassava chips can be easily stored for a long time until prices improve.	**	**
	Cassava producers were motivated to sell their roots to the drying plant since they were paid in cash.	***	
	Cassava chips offered the community a possibility to use their cassava to feed their own animals and increase their number.		
	Lack of a secure market for *farinha*	*	
COMMUNITY ORGANIZATION	There was integration, effort, and involvement of the dry cassava group members since the beginning of the project to build and operate the plant.	***	*
	Since the cassava drying plant is of the community everybody could participate	*	
	Producers began to plant community cassava plots	*	
	Some people were already organized for agricultural production activities		**
TECHNOLOGY	Cassava chips processing cost is lower than *farinha* processing cost, therefore, less working capital is required and the agroindustry is still profitable at lower prices than *farinha*.	***	***
	Cassava chips processing requires less labor, and at the same time liberates labor from *farinha* and *goma* processing.	***	**
	The technology to produce cassava chips is simple and low cost	*	**
	Producers validated cassava production technologies	*	
INST. SUPPORT	Producers received training and technical assistance on cassava production, processing, commercialization of dry cassava, and management of the agroindustry by experienced personnel.	***	**
	The community received credit for cassava production		*
COMMUNITY MOTIVATION	There was interest of households on having a new source of income. Some producers use all their cassava to produce cassava chips and bought *farinha* for own family consumption.	**	**
	The good results were seen fast, therefore, the community began to believe in the success of the project.	*	
	Profits stayed in the community	*	
CIRCUM.	There was cassava surplus production when the agroindustry was established.	*	***
	The community has adequate transportation	*	

[a] The number of asterisks refers to the frequency of response by the communities as follows : *** = high response frequency (70-100% of communities), ** = medium response frequency (30-70% of communities), and * = low response frequency (less than 30% of the communities).

5. BENEFITS AND IMPACT OF THE ICRD PROJECT

5.1 Benefits Produced by the Dry-cassava agro-industries, over Time

Figure 3 shows the flow of total direct benefits from the dry-cassava agro-industries during the 1990-96 period. During this period, a total of US$ 450,537 was generated by the new agroindustry established by the ICRD project in the Ceara State of Northeast Brazil. These benefits resulted from cassava chips sales and include cassava roots sales, processing wages, payments made for other goods and services bought by the agroindustry (fuel, sacks, replacement parts, and oil), and from the distribution of net benefits obtained in the commercialization of the cassava chips. As discussed previously, the drought of 1992 and 1993 constrained the supply of cassava roots in the region, severely affecting the production of cassava chips during a three year period, which in 1994 was zero. Therefore, it can be argued that the agroindustry was successfully established in the region. However, it is highly dependent on the availability of cassava roots.



Source: Estimations based on the ICRD project monitoring and evaluation system.

Figure 3. Flow of economic benefits generated by the dry-cassava agroindustry, Ceara, Northeast Brazil, 1990-96.

5.2 Aggregated economic benefits of the dry-cassava agroindustry in the region

Table 3 summarizes the estimated direct benefits of the dry-cassava agroindustry in the Ceara State of Northeast Brazil. These results show that the main beneficiaries of the project were cassava producers who sold their roots to the agroindustry and received 69.4% of the total benefits (US$312,707). Dry cassava fanner groups or processors also received an important share of benefits from the project (20. 1 %). Furthermore, the majority of these small-scale processors are also cassava producers and they therefore benefited in two ways. The agroindustry also generated some direct employment in the region and dry-cassava plant workers received 5.6% of the benefits. These results show that most of the benefits (95. 1 %) stayed in the rural communities, and therefore, the ICRD project objective to target benefits to cassava producers and their rural communities has been accomplished.

Table 3. Aggregated direct economic benefits of the dry-cassava agroindustries in the Ceara State, Northeast Brazil, 1990-96.

Distribution of total income generated by sales of cassava chips	Aggregated benefits, 1990-96 **(nominal US$)**	NPV of benefits flow (1990-96) at 5% discount rate **(US$)**	Distribution of benefits by group of society **(% of total benefits)**
Cassava producers	312,707	264,225	69.4
Hired labor	25,278	20,853	5.6
Other goods and services [a]	21,829	18,313	4.9
Net benefits to processors	90,723	72,845	20.1
Total income from sales	**450,537**	**376,236**	**100.0**

[a] includes fuel, sacks, spare parts for motors, and oil.

Source: Estimations based on the ICRD project monitoring and evaluation system.

With respect to the distribution of benefits from selling cassava roots to cassava-based agroindustries, according to farm size, most of these benefits were perceived by farmers with cassava plots smaller than 2 ha. as, 89.5% of cassava producer benefits from root sales to the agroindustry went to the smaller cassava farmers.

Another important contribution of the ICRD project to improving cassava farmers well- being in Ceari is the fact that the benefits generated were spread among all farmers involved regardless of its land tenure situation. Data from the monitoring and evaluation system of the project shows that those farmers who owned their land captured 58.9 % of the total benefits, renters 32.4 % and share-croppers **benefited with 8.7**

53 Women's view of impact

Table 4 summarizes women's perceptions and views of the impact of the ICRD project in the region. Intermediary effects of the ICRD project (the new alternative market, training, and employment generation) were only mentioned by a few women and work not given much importance. However, for women of the community the effects of the ICDR project on their workload, income, quality of life,

community empowerment, and women's position in the community were given equal or more importance than that given by the cassava farmer groups.

With respect to women's workload, it is important to analyze this point by understanding that women in this region have to do a lot of hard work. Most *of farinha* processing activities are done by women with the help of children. When part of the cassava roots produced are processed into cassava chips, women's workload is reduced. Therefore, some labor is released for other activities, and women can either have more leisure time or start some new activities to generate some extra income for the household.

With respect to the extra cash income generated by the new established agroindustry, women stressed that the extra income was used mainly for household expenses, and therefore, the quality of life of community households was improved. With respect to the cassava farmer groups, women gave a high importance to the community empowerment and capacity building effect of the ICRD project. They also mentioned that producers and the community are better organized, and as a consequence other projects and services were attracted to the community.

An additional effect from those cited by the fanner groups, perceived by women is the change in their position in the community. Some women said that the project helped women to get better organized. Therefore, the community began to have a better opinion of women and that increased women participation on activities and on decision making. Also, as expected, women from communities that have dry-cassava plants, but that never worked, have the opinion that the ICRD project had no effect on the community.

6. CONCLUSIONS

Some key conclusions that can be drawn form the results of the present paper are:

Integration of activities is a sound approach he integration of production, processing and commercialization activities around the cassava crop at community level, and stimulate development of the crop. Institutions in charge of technical assistance activities for cassava farmers can not and should not work exclusively in any of these three activities, in isolation from the others.

o **Farmers obtained important economic and social benefits** Analysis of the benefits generated by the ICRD project in Ceara and the distribution of these benefits among the different actors, clearly indicates that cassava farmers in the region were benefited with new employment opportunities and additional cash income. The establishment of a new market outlet allowed farmers to decide in which market to sell their production according to the prices. This empowerment process of farmers represented a radical rupture on the commercialization schemes that were prevailing in the region for the cassava crop.

Benefits generated by the project were important and significant for groups such as women and landless farmers who are usually left out from the benefits of rural development projects. Additionally, the communities in which the cassava-based agroindustries operated obtained other important benefits such as credit programs, training opportunities and several other projects and activities that were brought to the community as a consequence of the cassava agroindustries.

Table 4. Effect of the ICRD project on the community development, according to women.

IMPACT AREA	Effect of the Project	Strata		
		Adopters [a]	Experimenters [b]	Installed but never worked [c]
MARKET	The alternative market for cassava improve cassava roots and products commercialization and the market for *farinha* became more stable.		*	
TRAINING	The community learned the technology to produce cassava chips.		*	
EMPLOYMENT	Employment was generated in the community	*		
WOMEN WORKLOAD AND OTHER ACTIVITIES	The working load of women was reduced, since *farinha* processing requires a lot of labor, which is mainly provided by women.	**		
	Women began to plant small plots of cassava by themselves		*	
	The availability of feed for the animals increased and women began to raise animals with cassava chips.		*	
USE OF EXTRA CASH INOME	With *farinha* they never had cash money to buy things for the house and the children, however, the production of cassava chips provided some cash to buy food, clothes and shoes, specially for the children, and things for the house; and to send the children to school, and get health services when needed. Some of the people were even able to buy a house or improve it.	**		
	When the agroindustry gave cash income to the husbands, women receive the extra income to spend in things for the house.	*		
QUALITY OF LIFE	The quality of life of families and the community improved, since they got an alternative market for cassava and household income increased.	*	**	
COMMUN ITY EMPOWER-MENT	Producers became better organized		*	
	Other projects were attracted to the community as a consequence of the ICRD project and the organization of the community.	**	***	
WOMEN POSITION IN THE COMMUNITY	The project helped women to get better organized and participate more in the community activities and decisions.	*	*	
	Now women ask for more things, are asked to do more things, and work more.	*		
	The community began to have a better opinion of women and began to accept that they will participate in the project.	*		
SIDE EFFECTS	The infrastructure of the plant is used also for other purposes		*	
	Some women's husbands had to travel because of the project, and the women had to stay alone with the family.	*		
NO IMPACT	The project had no effect on the community			**

Source: Semi-structured interviews with key women from the communities

[a] The number of asterisks refers to the frequency of response by the communities as follows : *** = high response frequency (70-100% of communities), ** = medium response frequency (30-70% of communities), and * = low response frequency (less than 30% of the communities).

The Ghana Grains Development Project: A Case Study in Farm-level Technology Adoption By

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1. INTRODUCTION

The Ghana Grains Development Project (GGDP) was launched in 1979 with funding from the government of Ghana and the Canadian International Development Agency (CIDA). The purpose of the Project was to develop and difluse improved technology for maize and grain legumes. The Crops Research Institute (CRI) and the International Maize and Wheat Improvement Center (CIMMYT) served as the primary executing bodies, while three other organizations provided ancillary support. The Grains and Legumes Development Board (GLOB) and the Ministry of Food and Agriculture (MOFA) assumed main responsibility for technology transfer activities while the International Institute for Tropical Agriculture (IITA) supported technology development efforts for grain legumes.

The GGDP operated for 18 years before concluding in 1997 following the termination of external funding. The GGDP can take credit for several important accomplishments. It contributed significantly to the strengthening of local research and extension capacity by supporting numerous staff training activities. It also helped to establish methods and procedures for organizing adaptive research and linking research to extension programs. Finally, it helped to develop technology recommendations for maize and grain legumes.

This summary report describes the main findings of a recent study that examined the adoption of three improved maize production technologies developed through the GGDP: (a) improved germplasm, (b) fertilizer recommendations, and (c) plant configuration recommendations. Although these three technologies were by no means the only ones developed by the GGDP, they were among the most important.

2. DESCRIPTION OF THE GGDP-GENERATED MAIZE TECHNOLOGIES

(a) Improved germplasm Prior to the inception of the GGDP, plant breeders working at CRI had developed and released several modem varieties (MVs) of maize. These early MVs generated little interest among farmers, however, and they were not widely adopted. Under the GGDP, Ghana's national maize breeding program was completely reorganized, and the links between CRI and CIMMYT were greatly strengthened. For a relatively small country such as Ghana, this strategy made a good deal of sense. In accordance with its global mandate for maize improvement, CIMMYT administers a worldwide system for testing and evaluating promising germplasm. Each year, CIMMYT maize breeders distribute hundreds of experimental varieties, hybrids, and inbred lines to collaborators in dozens of countries. The collaborators grow the experimental materials under carefully controlled conditions and report performance data back to CIMMYT. By analyzing performance data collected across a wide range of locations, the CIMMYT breeders are able to identify superior materials for distribution to national breeding programs.

The GGDP maize breeding effort was successful in part because it was able to capture "spillover benefits" generated by CIMMYT's global germplasm improvement network. Each year during the life of the Project, CIMMYT breeders provided their CRI counterparts with a selection of experimental varieties. Trials were conducted at CRI to identify which of the CIMMYT varieties were best adapted to Ghanaian conditions, and seed of the most promising was distributed to farmers for on-farm testing. Working hand in hand with farmers, GGDP scientists identified truly outstanding varieties, which were taken back to CRI for several additional cycles of selection and improvement. This collaborative process involving CIMMYT breeders, CRI breeders, and Ghanaian farmers led eventually to the release, beginning in 1984, of a series of improved maize varieties, all of which contain germplasm whose origin traces back to CIMMYT.

(b) Fertilizer management In spite of numerous government- sponsored projects designed to promote the use of fertilizer on food crops, at the time the GGDP was launched in 1979 few farmers in Ghana were applying fertilizer to their maize fields. The low level of fertilizer use on maize was quickly identified as a priority problem for research, because experimental evidence showed clearly that soil fertility was severely constraining yields in many areas.

Although the relative unpopularity of fertilizer among Ghanaian maize farmers could be attributed to a number of causes, a big part of the problem was that there were no consolidated, widely accessible recommendations for applying fertilizer to maize. In an attempt to rectify this problem, GGDP researchers organized an on-farm testing program aimed at developing fertilizer recommendations for maize. The challenge was to formulate recommendations that would be sufficiently flexible to accommodate the wide range of soil fertility conditions found in farmers' fields, yet at the same time simple enough to be incorporated into existing extension programs.

In contrast to the GGDP plant breeding effort, GGDP research on crop management practices (fertilizer use and planting practices) did not involve direct introduction of CIMMYT-generated technologies. Unlike improved germplasm, which can be developed at CIMMYT headquarters in Mexico and distributed around the world, crop management recommendations are by nature location-specific. Thus, they have to be developed on a country-by-country basis, taking into account local agro-climatic conditions, planting materials, crop management practices, and prices.

CIMMYT's contribution to the GGDP crop management research effort took two main forms: training of researchers and provision of technical assistance. During the life of the Project, over one thousand CRI researchers and local collaborators received training in the design and management of crop management trials. In addition, CIMMYT scientists were based in Ghana throughout the duration of the Project and actively participated in planning and implementing the GGDP crop management research program.

Following several years of trials, GGDP researchers came up with a set of fertilizer recommendations that distinguished among agro-ecological zones and took into account field cropping histories. Recommended application rates varied, ranging from no fertilizer application (in the case of forest-zone fields that had been fallow for five years or more) to application of compound fertilizer at a rate of 90-40-40 (in the case of transition- and savannah-zone fields that had been continuously cropped for two years or more).

(c) Plant configuration

In most parts of Ghana, maize has traditionally been planted in a random pattern, with a relatively large number of seeds placed in holes at least one meter apart. Although this strategy is appropriate for tall-statured local varieties being grown under low levels of soil fertility, GGDP researchers determined that the plant configurations produced using traditional random planting practices are less than optimal for short-statured MVs, especially when these are grown with chemical fertilizer. Experiments conducted at CRI very early on established that the Ghanaian MVs can tolerate a significantly higher planting density than the tall-statured local varieties that farmers were used to growing.

Like the fertilizer recommendations, the GGDP plant configuration recommendations were developed in Ghana based on extensive on-station and on-farm experiments; also like the fertilizer recommendations, they were easily communicable to farmers. Planting in rows was emphasized as an aid in calibrating plant population densities and as a means of achieving plant spatial arrangements that would facilitate subsequent crop management operations, such as weeding and fertilizer application. In addition to stressing the importance of planting in rows, the recommendations focused on reducing the distance between holes and on reducing the number of seeds planted per hole.

3. ADOPTION AND IMPACTS OF IMPROVED MAIZE TECHNOLOGIES

Data on the adoption of the GGDP-generated maize technologies were collected through a national survey of maize growers carried out between November 1997 and March 1998. A three-stage, clustered, randomized procedure was used to select a representative sample of 420 maize farmers. These farmers were questioned at length about their maize production, consumption, and marketing practices; their preferences for different maize varietal characteristics; and their knowledge of and access to improved inputs, such as seed and fertilizer (for additional details about the survey, see Morris *et aL,* 1998).

The survey revealed that adoption of GGDP-generated maize technologies has been extensive. During 1997, over one-half of the sample farmers (54%) planted on at least one of their maize fields, and a similar proportion (53%) implemented the plant configuration recommendations (Table 1). The rate of fertilizer use on maize was lower, however, as less than one-quarter of the sample farmers (21 %) reported having applied fertilizer to their maize fields. These findings provide clear evidence that the GGDP-generated maize technologies have diffused widely. In 1997, two-thirds of all Ghanaian maize farmers used at least one of the three improved technologies by any measure an impressive number, especially considering that maize in Ghana is grown mostly by small-scale farmers living in isolated communities. Clearly the GGDP has made good progress in achieving its objectives of developing and disseminating improved maize technologies.

Table 1. Adoption of GGDP-generated maize technologies, Ghana, 1997

	Percent of farmers that on at least part of their farm used:		
Modern variety	**Fertilizer**	**Row plantinga**	
Guinea savannah	66%	36%	73%
Transition	68%	29%	59%
Forest	38%	9%	39%
Coastal savannah	69%	29%	65%
All zones	54%	21%	53%

a n = 392 (excludes ridge planting). Source: 1998 CRI/CIMMYT survey.

What have been the impacts of the GGDP-generated maize technologies? In the absence of reliable baseline data, it was not possible to calculate quantitative measures of project impact. Based on farmers' assessments, however, it is clear that adoption of the GGDP-generated technologies has been associated with significant productivity gains, as well as noticeable increases in income earned from sales of maize. Impacts on the nutritional status of rural households appear to have been less pronounced. Even though the latest MVs have been extensively promoted for their improved nutritional status, relatively few of the survey respondents were aware of this, and those who were said they rarely seek out nutritionally enhanced MVs to prepare weaning foods for infants and young children.

4. FACTORS AFFECTING ADOPTION

In addition to documenting the uptake and diffusion of the GGDP-generated maize technologies, the Ghana case study provided important insights into the factors that affect the adoption of agricultural innovations. The survey showed that the adoption has been influenced by three sets of factors: (1) characteristics of the technology, (2) characteristics of the farming environment, and (3) characteristics of the farmer.

(1) Characteristics of the technology

It has long been recognized that the rate and extent of adoption of any new technology are conditioned by the nature of the technology itself. Important characteristics that can encourage or discourage adoption include the complexity of the technology, its profitability, riskiness, compatibility with other technologies or practices, and divisibility. By themselves, these characteristics do not determine adoption; technologies that are simple, inexpensive, and risk-free may never be taken up, just as technologies that are complex, costly, or risky may find wide acceptance. But as the GGDP demonstrated, the characteristics of new technologies tend to matter, and they deserve careful attention.

The three GGDP-generated maize technologies represented different levels of complexity. MVs were the least complex, because adopting MVs required relatively few changes to the farmer's current practices. Plant configuration ranked next in terms of complexity, because in order to adopt the row planting recommendation, farmers had to learn how to use planting ropes or sighting poles, and they had to know how to measure row and plant distances. Fertilizer was the most complex; managing fertilizer efficiently involved learning the names of different products, their nutrient composition, correct application rates, optimal application schedules, and efficient application methods.

The complexity of the technology is only one factor influencing adoption, however, and what actually happens in farmers' fields depends as well on many other things. Another important determinant of adoption is the expected profitability of the technology. Farmers naturally are interested in technologies that promise to give higher returns to scarce factors of production (e.g., land, labor, or cash). Of the three GGDP-generated maize technologies, adopting fertilizer potentially can bring about considerably higher yield increases than adopting MVs or row planting alone. But the higher yields that can potentially be achieved with fertilizer have to be balanced against the higher cash costs associated with fertilizer use. MV use and row planting generate lower net benefits, but adopting MVs and planting in rows requires very little cash investment, so the marginal rate of return to the additional investment required is extremely attractive.

Farmers also look at the risks involved in adopting a new technology. Several types of risk can be distinguished. Farmers may be convinced that the new technology works, but they may still be uncertain how it will perform on their own farm; this uncertainty can usually be allayed by observing the technology in a neighbor's field or in a nearby demonstration plot. Another type of risk relates to the technology's performance during periods of unusual climatic stress (e.g., drought), which may be more difficult to assess because such periods do not occur very often. Research has shown that farmers often place a premium on stability, choosing technologies that perform satisfactorily under a wide range of conditions, instead of technologies that perform exceptionally well, but only under favorable conditions. A third type of risk relates to the possibility of losing the investment made in an improved technology. This risk is particularly relevant in the case of fertilizer; purchasing fertilizer involves a significant cash outlay, and many farmers worry that in years of low rainfall, the fertilizer will have little effect.

New technologies stand a better chance of being adopted if they are compatible with current fanning practices. Generally speaking, the maize technologies produced by the GGDP were not only compatible

with other widely used crop production practices, they were also compatible and indeed highly complementary with each other. Other than switching their seed, farmers who decided to adopt MVs were required to make few changes to their crop management practices. Adopting row planting did involve learning a new planting technique, but the additional time needed for row planting was more than made up later on by labor savings in weeding and fertilizer application. Adopting chemical fertilizer did not significantly affect other practices, either. although it did create an increased need for labor during certain periods in the cropping cycle.

A final characteristic of the three GGDP-generated maize technologies was that they were divisible, meaning that they could be adopted on part of a farm or on all of it. This reduced the riskiness of the technologie's by allowing farmers to adopt each recommendation in step-wise fashion. Indeed, the survey results make clear that many farmers are partial adopters who even today use one or more of the technologies on part of their maize area. In addition to facilitating step-wise adoption, the divisibility of the three technologies made them accessible to both large- and small-scale farmers.

(2) Characteristics of the farming environment

Just because a technology is simple, profitable, relatively secure, compatible with farmers' current practices, and divisible does not necessarily mean it will be adopted. Adoption decisions depend partly on the characteristics of the technology, but they depend also on the environment in which farmers operate. Important characteristics of the farming environment that can affect technology adoption include agro-climatic conditions, the nature of prevailing cropping systems, the degree of commercialization of the cropping enterprise, factor availabilities, farmers' knowledge and access to technical information, and the availability of physical inputs.

Although maize is grown in most parts of Ghana, some areas are better suited for maize production than others. The most favorable areas for maize are concentrated in the transition zone and in parts of the Guinea savannah; these areas receive more solar radiation, feature lighter soils, and have fewer trees (which means land preparation is easier). Maize can be grown in forest areas, but agro-climatic factors are generally less favorable for maize production, and competition from tree crops is much greater. Also, arable land is still relatively abundant in the forest zone, which reduces the attractiveness of landconserving technologies, particularly fertilizer. The observed differences in adoption rates between the forest zone and other zones stem in part from the generally lower profitability of maize in forest are relative to alternative crops, especially cocoa.

Cropping systems in Ghana are complex and varied, and it is only to be expected that improved technologies will be accommodated in different ways, depending on local practices. Although MVs appear to be compatible with most current maize cropping systems, farmers who decide to adopt the recommendations for row planting and fertilizer management may be forced to make adjustments. In the northern part of the country, many maize fields are prepared by ridging up the soil, a practice that improves moisture conservation and facilitates fertility management. Farmers who ridge their fields already plant in rows, so for them the GGDP-generated row planting recommendation is of little relevance. In the southern part of the country, particularly in heavily forested regions, soil fertility is periodically replenished through a carefully managed bush fallow system. Farmers who have access to extensively fallowed land may not face soil nutrient deficiencies, so for them chemical fertilizer is of little relevance.

Farmers' technology choices tend to be influenced by the degree to which the crop is marketed. Varietal selection criteria often vary depending on whether the harvest will be consumed at home or sold for cash. If maize is being grown mostly for home consumption, food preparation qualities assume great importance (e.g., appearance, taste, smell, grain texture, ease of processing, storage quality). But if maize

is being grown for sale as a cash crop, grain yield and market price tend to be the most important factors. The Ghanaian experience with M`Vs has been quite revealing in this respect. In the north of Ghana, where a lot of maize is retained for home consumption, MVs have generally been judged acceptable for food preparation. In the south, initially there were some concerns about the suitability of MVs for preparing local foods, and these concerns were sometimes reflected in lower market prices for MVs. The higher yield of the MVs offset this disadvantage, however, and despite the occasional price differential, M`Vs have by now gained acceptance even among commercial farmers.

Regardless of how attractive a new technology may be, it will probably not be adopted if adoption requires farmers to contribute additional factors of production that they do not have and cannot easily obtain. Of the three GGDP-generated maize technologies, the two that might have been affected by factor scarcities were row planting and fertilizer use, both of which require additional labor to adopt, and one of which (fertilizer use) requires a significant cash investment. Judging from the survey results, the labor constraint does not appear to have been binding; few farmers reported that they had not adopted the GGDP technologies because labor was unavailable. The capital constraint may have been more serious, however. Many of the survey farmers reported that the reason they do not use fertilizer is that they lack the cash needed to purchase fertilizer, so shortages of capital may have been important in discouraging fertilizer use.

Since farmers cannot adopt improved technologies unless they have first heard about them, successful adoption is predicated on farmers having access to detailed and accurate technical information. Technical information can reach farmers from various sources, but it is likely to reach them most rapidly (and with fewer errors) if there is a well-functioning extension service in place. Regular contact with extension officers has been an important factor in explaining the adoption of all three GGDP-generated maize technologies. Extension resources are scarce in Ghana, however, and not all farmers have been reached equally. In the past, extension organizations have placed relatively little emphasis on promoting maize in forest areas, which may help explain lower adoption rates in those areas. And although good progress has been achieved in making extension activities gender-neutral, the survey results suggest that women farmers on average still have fewer contacts with the extension service than men farmers.

Finally, even if farmers know about a new technology, they will not be able to adopt the technology if adoption requires the use of an input that is unavailable. Two of three GGDP-generated maize technologies are based on physical inputs (MV seed and chemical fertilizer). Although improved seed theoretically should be available from local inputs supply shops, in practice the seed industry is still very underdeveloped, particularly in more isolated areas. Many farmers manage to procure improved seed from extension officers, who frequently are able to provide seed samples as part of an extension program or sometimes sell seed on a commercial basis as a business sideline. Of course, once a particular MV has appeared in an area, local farmers can usually acquire farm-saved seed from early adopters. Obtaining fertilizer is generally more problematic, since fertilizer is bulky and furthermore must be purchased each season. Fertilizer distribution was recently privatized in Ghana, but the number of agents continues to be restricted by low demand.

(3) Characteristics of the farmer

Two farmers considering exactly the same technology and operating in the exactly same fanning environment can end up making very different adoption decisions. A third set of factors that can affect technology adoption relates to farmers' personal circumstances, including ethnicity and culture, wealth, education, gender, and security of access to land.

Ghana's maize farmers belong to a large number of different ethnic groups, each with its own language, customs, and forms of social organization. With respect to technology adoption, cultural factors

frequently affect individuals' access to resources, their obligations to contribute to different types of agricultural production activities, their ownership claims to crops harvested from communally cultivated fields, their access to external sources of information, etc. Cultural factors are particularly evident in comparing the patrilineal societies of the north with the matrilineal societies that dominate much of the south. Women's access to land and capital, their decision-making responsibility in maize farming, and their ability to mobilize labor all differ significantly between these two traditions factors which directly affect the attractiveness of improved technologies. To further complicate matters, a considerable number of farmers are migrants to other areas; these migrants have to balance their own customs with those of the host culture, which can inject additional layers of complexity to technology adoption decisions.

The vast majority of Ghana's maize farmers cultivate only a few hectares of maize or less and thus can accurately be characterized as small-scale farmers. But despite the relatively restricted range of farm sizes, differences in wealth are evident between farmers, and these differences can affect the technology adoption process. Farmers with higher incomes generally enjoy advantages that facilitate adoption. For example, they may find it easier to make contacts with extension officers or to tap into other sources of technical information. Once they have heard about an improved technology, they may be better able to travel to distant towns in search of agricultural inputs. After they have located the inputs, they may experience fewer difficulties in raising the cash needed to purchase them. Considering these and other advantages associated with wealth, it is not surprising that the rate of technology adoption is slightly higher on larger farms (which presumably tend to be owned by wealthier farmers).

Another farmer-related characteristic that can be important in the adoption process is the farmer's level of education. The survey results show that farmers who have adopted one or more of the GGDP-generated maize technologies have significantly more formal schooling than those who have not adopted. Since the adoption of improved technologies requires the acquisition and assimilation of new information, this result is not surprising.

5. KEYS TO THE SUCCESS OF THE GGDP

Data collected in late 1997 and early 1998 through a national survey of maize farmers indicate that GGDP-generated maize technologies have disseminated widely throughout Ghana's maize-growing areas. Based on this evidence, it is clear that the Project has succeeded in meeting its objectives of raising productivity, increasing incomes, and improving nutrition for resource-poor households. In the process, an additional goal of the Project has also been realized, as the capacity of CRI to carry out effective commodity-focused research has been greatly strengthened.

In retrospect, the success of the GGDP can be attributed to four main factors:

First, the objectives of the GGDP were well chosen. Maize is produced and consumed throughout Ghana, so improved technologies that succeeded in increasing the productivity of resources devoted to maize production were bound to have significant and widely felt impacts.

Second, the GGDP adopted an extremely effective research strategy. By extensively testing experimental technologies at the farm level, researchers were able to foster the active participation of farmers in the technology development process, which helped to ensure that the recommendations were appropriate for farmers' circumstances.

Third, the GGDP was able to link its research component with an effective extension strategy. Considerable efforts were made to familiarize extension officers with the technologies by involving them in on-farm testing activities; once recommendations had been formulated, the same extension officers

played a key role in implementing a national program of demonstration trials which served to widely publicize the technologies.

Fourth, the Project served as a model for collaboration between three groups of key players: (1) national agricultural research and extension organizations, (2) international agricultural research centers, and (3) a committed donor agency. These organizations interacted very effectively throughout the duration of the 'Project, allowing the particular strengths of each to be exploited and ensuring that the product of the collaborative effort was far greater than the same organizations could have achieved by acting individually.

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Adoption of New Technologies for Groundnut in India and Vietnam: Assessment Using Focus Group and On-Farm Surveys

By

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Two country studies were undertaken in India and Vietnam to achieve an understanding of the adoption process and develop strategies to improve the adoption of improved seed, water, soil, and nutrient management practices for groundnut production. The studies were systematic appraisals of adoption and benefits derived from new technologies in crop and resource management using the case of a specific technology the Groundnut Production Technology (GPT) which was introduced to enhance the production of groundnut in these two countries.

1. GROUNDNUT PRODUCTION TECHNOLOGY.

GPT is a joint research product of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Indian National Agricultural Research System (NARS) on genetic enhancement, crop and resource management research and technology transfer program. It was later adapted and introduced in major groundnut growing areas of Vietnam through the Cereals and Legumes Asian Network coordinated by ICRISAT. Technology transfer and dissemination in South Vietnam was underway since 1991 under the primary responsibility of two research institutes (Oil Plants Institute and Institute of Agricultural Sciences) and a local extension unit (Center for Extension in Hochiminh City).

GPT is a technology package integrated at ICRISAT after reviewing all information available and carefully identifying constraints in groundnut production in major groundnut producing regions. Important components of the GPT are grouped as: (i) land management: making raised-bed and furrow for groundnut cultivation, (ii) macro- and micro-nutrient management, (iii) improved varieties, (iv) insect, disease and weed management; and (v) water management. The technology was initially tested in eight states of India in the late 1980's and later adapted in several provinces in Vietnam in the early 90's.

2. SCOPE OF STUDY.

The objectives of this study is first, to develop a framework to understand the adoption pattern of a package related to crop and resource management for groundnut; and second, to undertake an assessment of farmers' adoption of new technology options, along with identification of key constraints to adoption, some years after technology introduction. This study is vital in understanding the critical factors influencing the adoption process. The information learned will be essential in guiding the development of strategies that will effectively accelerate the use of new technology options on-farm. This report is part of a comprehensive adoption study entitled *"Critical factors influencing adoption of groundnut innovations"* undertaken as a collaborative project of ICRISAT and the national research programs of Vietnam and India, and funded by the CGIAR Impact Assessment Evaluation Group (IAEG).

The study addresses the complexities in adoption as resource management technology options are modified and/or partially adopted at farm level. The technology package is divisible and can easily be disaggregated into subsets of one or two or a mix of few components, providing flexibility to farmers who tend to opt for only those components which meet their objectives. The objectives in farm production may range from achievement of higher rate of return on capital investments to alleviation of major production constraints. The high degree of spatial and temporal variability observed in adoption of different technology options related to crop and resource management research also poses constraints in assessing the adoption and evaluating impact of various technology components.

The study was conducted in the state of Maharashtra in Central India and three major groundnut growing provinces of South Vietnam: Tay Ninh, Long An, and Hochiminh City. Data were gathered through focus group meetings and formal on-farm surveys. Each focus group were participated by approximately 9-15 farmers. Districts were chosen based on the extent of area grown to groundnuts. For the formal on-farm adoption survey, villages and respondents were randomly selected following a multi-stage stratified random

sampling technique. The samples were essentially drawn from the population of groundnut farmers in regions targeted in the groundnut production technology (GPT) development. The sample for the formal on-farm adoption survey consisted of 355 farmers from four districts of Maharashtra and 230 farmers from six districts of South Vietnam. Relevant information was collected from a random sample of farmers through a structured questionnaire designed to track the adoption of different GPT components and elicit data on three aspects: (i) adoption rates and the spread of different components of GPT, Cii) reasons for adoption or non-adoption, and (iii) benefits from use of the GPT technology options.

3. ADOPTION OF GPT IN INDIA: HIGHLIGHTS

The study found that farmers partially adopted the concept of crop and resource management research products, and modified the technology options according to their needs, convenience and resource endowments. Differential adoption of various components of the technology was observed and summarized in the following way:

* About 3 1 % of the summer season groundnut in the study area was assessed under raised-bed and furrow.
* The adoption rates for improved varieties was about 84% and for single super phosphate was about 70%.
* Farmers who cultivated groundnut on raised-bed and furrow also adopted ICRISAT groundnut varieties in about 65% of the groundnut area. The corresponding figure for those who did not adopt raised-bed and furrow method, sowed ICRISAT variety in less than 10% of the groundnut area.
* Gypsum and seed dressing are becoming popular and their adoption reached slightly above 40%.
* Use of ferrous sulphate and sprinkler irrigation were at the early stages of adoption.
* It was noted that the adoption of different components was largely associated with the raised-bed and furrow. Adoption of all components was significantly higher with those who adopted the raised-bed and furrow method. The probability of adopting the raised-bed and furrow was high when farmers had access to technology-generating and technology-transfer systems. Availability of appropriate implement, capital and irrigation also determined the adoption of the raised-bed and furrow technology, option.

At farm-level, benefits were realized in terms of yield gains (3 8%), higher income (7 1 %), and efficient utilization of inputs. Benefits related to gender and sustainability issues were also realized by the farmers who adopted the components of the GPT. The technology was generating employment and improving labor productivity.

At an aggregate level, the benefits of GPT were higher than investment on research, packaging and technology transfer. The internal rate of return of GPT was 25.26% if the total package of the GPT is adopted. It was 19.15% when only management practices, including raised-bed and furrow, nutrients, etc., were adopted. The internal rate of return was only 13.5% if only raised-bed and furrow is practiced. The distribution of economic surplus to producers and consumers showed that producers were the primary beneficiaries of the GPT sharing about 84% of the total benefits.

The following conclusions may be made on the basis of above discussion.

Partial and modified adoption: Different components of the GPT were partially adopted and modified by the farmers. A key component, ie. the raised-bed and furrow method of cultivation, was becoming popular amongst farmers. The level of adoption of improved varieties and use of macro- and micro-nutrients was impressive. Other components, especially the sprinkler method of irrigation and use of ferrous sulphate, need better market access for their adoption. The Government of India is already extending subsidy (ranging between 25-50%) on purchase of sprinkler sets. It is expected that in years to come the sprinkler method of irrigation will be more popular and widely adopted.

Positive on-farm benefits: Adoption of the technology had a positive impact in terms of higher grain yield and income, better grain prices, saving of important inputs, including irrigation and labor (particularly of the female labor force) for some tedious -operations. The technology generates employment and also improves labor productivity. The GPT has significant implications for issues related to gender and sustainability.

Modest economic surplus: Investment on research and extension on GPT, studied under different options, revealed that it was paying modest dividends. It generated welfare gains for consumers and producers, with the latter being the primary beneficiaries.

Research on developing appropriate implement: In view of the high cost of the available implement to make raised-bed and ***furrows,*** it is important to allocate resources for the design of cost-effective technology which suits farmers' requirements. There is a need for a well-designed suitable implement which will facilitate easier maintenance of raised-bed and ***furrows.***

Need for technology dissemination: Additional investment in technology transfer activities of GPT will be rewarding in the vertisol region. It is necessary to conduct large-scale demonstrations and give wide mass media coverage. It may be done after the target areas for technology transfer are carefully identified.

Follow-up action: It was observed that there was no follow-up activity on the GPT after the LEGOFTEN program concluded in all the regions except Maharashtra state. There is a need to follow-up its dissemination in areas where technology yields better results.

Identify constraints: It would be worth studying to. assess constraints to adoption of different components of the GPT, particularly of raised-bed and furrow, to propose appropriate strategy for wide scale adoption of the technology. Such a study may reveal whether adoption was limited by lack of necessary inputs and implements or the wrong choice of target regions.

4. ADOPTION OF GPT IN SOUTH VIETNAM: HIGHLIGHTS

Varietal adoption:
The first year of adoption reported by farmers correspond to the year of release of improved groundnut variety, that is 1995. The primary sources of improved seeds are the research institutes (OPI & IAS) and extension center (CFE), while the primary source of information is other farmers.

On-farm survey results show that the improved variety VD- I has started to replace the local variety since it's released in 1995. Two other improved varieties belonging to the VD series, i.e. VD-3 and VD-4, have also slowly been taken up by farmers after their release. Uptake of other improved varieties such as HL 25 and ICGV 87391 remained insignificant because of the following reasons. First, HL 25 produces good yield, but it is found to be suitable only in elevated areas because the excess moisture in lowland areas makes it susceptible to leaf diseases. This variety was released in Go Dau and Duc Hoa which are predominantly lowland areas so that the potential of this variety has been limited in these areas. Second, ICGV 87391 has the following undesirable traits: thick shell, pod reticulation and constriction, so that it fetches a lower market price compared to local variety. In addition, more intensive inputs are required by this variety compared to the requirements of the local variety. Lastly, Purified Ly is preferred with it's thin shell and high yield, but it's adoption has been constrained in Go Dau and Duc Hoa where this variety was first introduced due to unavailable elevated land for seed multiplication.

For all the three provinces covered in South Vietnam, VD- I reached highest adoption (4% in 1995, increasing to I 112% after 1-2 years). Among the districts, Trang Bang achieved the highest percentage of adoption of VD- 1 (3 1 % in 1997) as farmers like this variety and land is available for seed

multiplication. other improved varieties like VD3 and VD4 have larger seeds but farmers like to grow them only during the Winter-Spring season for fresh pods for export processing. VD-3 and VD-4 are not grown during other seasons because of unstable yield compared to VDI. They also have thick shells which result to lower shelling percentage.

There was zero adoption of improved varieties in Hoa Thanh district due primarily to unavailable seed supply and lack of institute and extension support.

Ranking of the important traits of improved variety by farmers indicated that good yield, homogenous pods, and thin shell are most desirable characteristics. Other important traits are high price, big seed, disease resistance, insect resistance, and short duration. Good fodder, drought resistance and pale skin color were noted but were given low ranking.

Constraints to adoption of improved varieties: The most limiting constraint in the adoption of improved varieties by farmers is that seed of improved varieties is not available. Although many farmers have experience growing improved varieties, they can't multiply them during the rainy season to meet seed requirement for the main groundnut growing season. They cite that not enough elevated land for seed multiplication is available. As a result, farmers are forced to discontinue to grow groundnut due to unavailability of seeds during the main season. In this regard, policy makers must pay attention on the development of new areas for production of improved seeds. Another important constraint is the lack of sources of information on improved seed.

Adoption of different technical components:.

Land preparation: Nearly 75% of the sample prepare their land preparation for growing groundnut by making large rows. This method is preferred by farmers because it saves labor for irrigation.

Fertilizers: Farmers clearly prefer to replace coco ash by alternative coco ash (ACA). Since WinterSpring 1995-96 ACA was introduced to farmers for replacing coco ash; the trend On its uptake is observed to rise from 6% in 1996 to 23% in 1997. The use of the traditional coco ash has declined from 88% of total area in 1995 down to 77% area in 1997. Duong Minh Chau district achieved the highest adoption of ACA (from 10% in 1996 to nearly 45% in 1997) as district authorities implemented a project which provided loans to farmers who grow groundnut. Trang Bang and Cu Chi farmers benefited because ACA application was introduced for groundnut as part of on-farm. trials. In Trang Bang the percentage of ACA area adoption increased from 8 in 1996 to nearly 31 in 1997.

The use of lime in general increased significantly from 1995-1997, because farmers found that lime is good for pod filling. The area adoption of single phosphate and compound fertilizer such as 16-16-8 declined from 1996-1997 due to increase in farmers' use of different special fertilizers for groundnut.

From 1995 to 1997 the groundnut area under foliar fertilizers increased from 17 to nearly 33%. These fertilizers supply essentially micronutrients and are sold abundantly in the market. Use of rhizobium inoculant is very limited because this product is not available in the market.

Fungicides: Using fungicides for seed treatment did not increase much from 1995 to 1997; this technical component has been used by farmers even before 1995 for controlling early and late leaf spot diseases. Most of the farmers used Anvil to control this disease; Anvil helps increasing the quality of pod by keeping the groundnut leaves in good shape. In all districts surveyed about 45% of sample applied seed treatment in 1997 for preventing damping off disease.

Herbicides: Due to the high input of hand weeding, farmers prefer using herbicides, as it saves money by reducing at least one time hand weeding, so the adoption of using herbicides increased from 91 % of area in 1995 to nearly 97% in 1997.

Insecticides: Since 1995 nearly 98% of the area in all surveyed districts applied insecticides. It was observed that overdose and high frequency of application of insecticides for controlling leaf feeders such as Spodoptera litura, Spodoptera exigua and Helicoverpa armigera has constrained groundnut production. A positive development in Cu Chi district is noted, that is, the rate of adoption of insecticides declined from 96% in 1995 to 90% in 1997 because IPM techniques has been accepted successfully in this. area.

IPM: Adoption of IPM for groundnut is generally still limited, due to lack of information and limited field demonstration to illustrate and persuade farmers on IPM practices.

Analysis of the constraints and advantages of adoption of technical components: Constraints are faced by farmers in the adoption of the new technology options for groundnut production. The contact of farmers with institutions as well as mass media is still low; as much as 54% of the sample do not know about the improved package; only 24% of the sample had contacts with extension at least two times a year; 75% of the sample have not attended any fanner field's day; and only 32% of sample watch an agriculture program on television every week.

Resource availability among farmers is also limited. 86% of sample lack capital funds, and 71% are constrained by the high labor wages.

The advantages of the use of GPT highlighted by farmers are that the required inputs of the improved package is not high; and that they achieve significantly higher yields from use of groundnut improved package.

In conclusion, the groundnut production technology introduced in South Vietnam during the recent 4-5 years have benefited farmers in many ways. High adoption was observed in locations where the technology was disseminated by research institutes and the support of extension office through on-farms trials, demonstration fields and farmers' field's days. Low adoption was observed in areas not targeted by the research and extension agencies, and adoption was especially constrained where local conditions were limited and elevated land for seed multiplication during the rainy season was unavailable. A more aggressive government policy with more active farmer participation in the research, development and dissemination process is called for.

Integrating the results from the focus group meetings and formal on-farm surveys, a strategy development for further enhancement of groundnut technology adoption requires the following essential ingredients:

The improved GPT package must be simple for easy up-take by farmers. At the same time, the inputs recommended must be made available in the market and local resources.

Improved varieties must have the traits demanded by the ultimate clientele, i.e. the farmers: high yield, homogeneous pods, thin shell, big seed, early maturity and high oil content. While new varieties are to be adapted to local conditions, the desirable traits must be kept stable across different growing seasons.

0 A seed multiplication scheme must be organized to meet seed requirement to supply good variety seed especially in areas where farmers do not have high level lands for multiplication in the rainy season. Having enough supply of good seeds of improved varieties is urgently needed. A viable programme and

network for seed multiplication may be created with a key governmental unit coordinating private and state companies.

• Supply and distribution of ACA fertilizers may be enhanced through the private sector;

• Reasonable groundnut price set by government to prevent price manipulation among middlemen;

• Labor crisis at harvest time may be reduced by making available groundnut threshing machines;

• IPM application may be expanded by group action; community action is required in achieving effective use of IPM techniques. Plant protection networks may be established at hamlet and village level to maintain price and quality of pesticides.

* Extension network must be strengthened to create an enabling environment for adoption of new technologies like GPT. This must make use of mass media for technology transfer of new groundnut, innovations.

Factors Influencing Awareness and Adoption of CSV 111 and ICSV 400 Sorghum Varieties in Nigeria

By

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1. BACKGROUND.

The mandate of the ICRISAT Western and Central Africa Program in Kano, Nigeria was to develop and disseminate improved sorghum varieties and hybrids that have the following properties: adaptability to the Sudano-Sahelian agro-ecological zone, Wgh and stable yields, resistance to major biotic stresses, and suitability as local food of the farmers. In order to achieve this, ICRISAT sorghum breeding research in Nigeria, in collaboration with the National Research and Extension System (NARES) started in 1988 with primary emphasis on the development of early-maturing varieties and hybrids adapted to the SudanoSahelian agro-ecological zones. A number of improved varieties such as ICSV I 11, ICSV 400, ICSV 247, and hybrids such as ICSH 89002NG and ICSH 89009NG, were developed and tested on-farm. Two of these varieties, ICSV I I I and ICSV 400, demonstrated good performance in on-farm trials across several locations in Nigeria and were released in Nigeria in 1996.

ICSV I I I and ICSV 400 varieties are adaptable to the Sudanian agro-ecological zone of West Africa. They are of medium height (1.8 m), usually shorter than most popular local varieties. They are drought tolerant and resistant to leaf diseases. The heads are semi-compact and thresh freely without any awns. ICSV I I I matures in 100 to I 10 days while ICSV 400 matures a few days later. The colour of the grains is cream and the quality of food, particularly from ICSV I 11, is as good or better than food prepared from local sorghum. In addition, ICSV 400 possesses excellent malting quality which is in high demand by the brewing industry.

While these two varieties have been tested in on-farm adaptive trials across locations in the country, very little is known about the level of fanner awareness and factors that may influence farmers' decisions in adopting them. The aim of this study was therefore to assess the extent to which farmers adopt and make use of these two varieties, as well as to monitor farmers' experiences and perceptions, in order to provide feedback to research for refining the technology. There are three specific objectives. First, to determine the level of adoption of the two improved cultivars, in the regions of Nigeria targeted by research and technology dissemination. Second, to identify factors that influence acceptance and adoption of the improved cultivars. And third, to obtain feedback from farmers in order to improve the efficiency of research and the effectiveness of the extension programme.

2. EFFORT IN DISSEMINATING THE TECHNOLOGY.

The process of transfer and diffusion of the improved technology started prior to the release of the varieties in 1996. As of 1994, ICRISAT and the NARES had started conducting on-farm adaptive research trials on farmers' fields in Katsina and Kano states. Guiness Nigeria PLC, a brewing firm, on realizing the potential of the cultivars as a good malting material, started to contract and encourage farmers in Kaduna and Kano states to produce ICSV 460 for supply to their factories at a premium price. In 1996, a deliberate effort was made by ICRISAT and the NARES to promote the cultivation of these cultivars by conducting on-farm trials at several sites in Kano, Katsina and Jigawa states. This effort increased the awareness of farmers and motivated many of them to grow the varieties. Also in 1997, the West and Central Africa Sorghum Research Network (WCASRN) in collaboration with the NARES and (Agricultural Development Projects (APDs) initiated a strong promotion exercise in respect of ICSV I I I in Katsina state by establishing on-farm adaptive research (OFAR) trials at one site in each of 25 local government areas (LGAs) of the state. Successful stories were covered by mass media such as radio and television.

3. STUDY AREA.

This study focused on three states, Kano, Jigawa, and Katsina, in the Sudan savanna zone (SSZ) and one state (Kaduna) in the Northern Guinea savanna zone (NGSZ). The NGSZ is characterized by a growing period of 150-180 days, while the Sudan ecology has a growing period of about 100- 150 days. Because of the limited and erratic rainfall that is restricted to a few (about 4 months) months especially in the Sudanian zone, ICSV I I I and ICSV 400 were targeted to that zone as they mature early. These varieties are also relevant in the NGSZ because they provide opportunities for double and relay cropping . Kano, Jigawa, and Katsina states were selected as being representative of the Sudan savanna zone, while Kaduna state represents NGSZ in terms of rainfall and vegetation. These states are also among the leading sorghum producing areas in the country. Furthermore, previous on-farm adaptive research (OFAR) trials on these cultivars, were conducted in these states.

For analytical purposes, the villages selected were stratified into zones:

(i) Northern Guinea Savanna (NGS): Villages within latitudes 9° 00' to 11° 00’ N with annual rainfall between 1000 mm, and 13 00 mm.

(ii) Wet Sudan (WS): Villages between latitudes11° 00' and 11° 55' N with annual rainfall ranging from 800 to 1000 mm.

(iii) Dry Sudan (DS): Villages between latitudes 12° 00' and 13° 00’ N, and annual rainfall between 500 and 800 mm.

4. TECHNOLOGY ADOPTION SURVEYS.

The technology adoption surveys were conducted in two phases. At the beginning of this study, **focus** group meetings were carried out between December 1997 and February 1998 primarily to map out villages and identify farmers growing ICSV I I I and ICSV 400. The results of the **focus** group study facilitated the selection of the villages and farmers used in the adoption study survey. The selection of the villages was based on the existing line of demarcation of ADP zones representing different ecologies and production systems. Between March and April 1998,, a detailed on-farm adoption survey was conducted in 27 villages where ICSV I I I and ICSV 400 sorghum varieties were officially introduced through participation in on-farm trials on the new cultivars, or as out-growers of the Guiness Nigeria PLC. Three ADP zones were chosen in each of Kano,. Katsina and Jigawa states and two zones from Kaduna state. In each zone of Kano, Katsina and Kaduna states, three villages were randomly selected from those where the new cultivars, had been introduced since 1995. Only one village per zone was possible in Jigawa state where the cultivars, were least known. The sample consisted of 219 farmers. Data were collected through personal interviews, using structured questionnaire, to obtain information concerning demographic and socio-economic characteristics of the respondents, resource endowment and farmers' perceptions of the attributes of the new cultivars.

Awareness on improved varieties: The results indicate a high rate of awareness in the villages where the cultivars, were introduced. The main sources of information are the research staff, farmers' mutual interaction, and agents of the brewing companies. The extension agents have so far played very little role in disseminating the technology.

Although there is a great deal of enthusiasm on the part of the farmers, the rate of adoption is low especially among farmers in the dry Sudan savanna to whom the cultivars were initially targeted. Adoption rate was higher in the Northern Guinea and wet Sudan zones where the proximity and market facilities provided by the brewing industry made it viable for the farmers to market the grains of the new cultivars as a cash crop. Production in the dry Sudan zones of Katsina and Jigawa States are at the subsistence level.

According-to the farmers, earliness is the single most desirable property of the new varieties which could not be found in their local sorghum cultivars. Ease of threshing was also said to have led to a reduction in the total labour requirements in the production of the varieties. The short stalk of the varieties was not particularly liked, but its good palatable fodder was acceptable.

The probability of a wide adoption of the varieties will depend first and foremost on the availability of seeds which constitutes, at present, the most limiting factor to adoption. Promotion of the cultivars by extension services and availability of marketing facilities are expected to enhance adoption.

5. STATUS OF ADOPTION OF ICSV 111 AND ICSV 400 VARIETIES

Although there is an appreciable level of awareness about the improved varieties in villages where they have been introduced, the level of adoption is low or non-existent in some parts of the Sudan savanna ecological zone where the varieties were bred and for which they were developed. The technology can not be considered to be in the adoption stage yet; rather it is in the awareness stage.

Pattern of adoption: The pattern of adoption revealed that there is a relatively higher rate of adoption among the large scale farmers in the Northern Guinea savanna and the wet Sudan savanna zones in Kaduna and Kano states, who have more capital to produce the grains of these cultivars to supply to industries. Adoption rate remains very low in the drier parts of the Sudan savanna to which the varieties were targeted. If an appreciable adoption rate can be accomplished in wetter areas which have better options for other sorghum varieties and other crops, a greater and more sustained adoption rate can be obtained in the drier areas where these varieties are most suitable. Extension activities needs to be intensified in the dry Sudan sub-zone where the adoption of these varieties is more likely to be widespread and sustained.

Timely release of improved technology: The research work that led to the development of ICSV I I I and ICSV 400 started a decade ago in Nigeria. It took quite a long time to get the technology released and disseminated to the farmers. The delay in the release and the dissemination of varieties during a time when subsidy on fertilizer was removed has made the task of dissemination and adoption more difficult. The widespread adoption of maize in the Northern Guinea savanna was facilitated by the fertilizer subsidy. Although maize production suffered some setback -shortly after fertilizer subsidy was removed, it has already started picking up because the loyal adopters of improved maize could not give it up. The National Varietal Release Committee should be urged to facilitate early release of crop varieties forwarded to them for consideration.

Improvement in the yield performance of the new cultivars: Farmers complained of low yield performance of the improved varieties, especially when fertilizer is not applied. It is quite true that no cereal crop can perform reasonably well without fertilizer in the Sudan zone. Now that the distribution of fertilizer is privatized, effort should be made to link farmers with sources of fertilizer and credit. The complaint of low yield with respect of the new cultivars, should be looked into and if found to be true, research should work on their nutrient use efficiency.

Intensification of extension effort: Both awareness and adoption were limited to areas reached by either research staff or brewery agents. Adoption has been constrained by non-existence of a viable extension network. The extension services of the ADPs had so far played an insignificant role in extending the technology to farmers. Vigorous extension programmes should be mounted to promote the dissemination and adoption of the new technology. Various extension methods such as field days, demonstration plots, farm visit, radio, television and bulletins should be useful in promoting the new technologies. The result

of the focus group study revealed that many villages do not have extension agents and many farmers have not received any assistance from extension agents. Formulators of the extension programme policy should endeavour to redress these anomalies. Extension activities should include local government chairmen, and non-governmental organizations (NGOs) so that the majority of the farmers can benefit from the new technology. Sasakawa Global 2000 (SG 2000) Project, a non-governmental organization that has been responsible for the promotion the cultivation of hybrid maize in northern Nigeria, had expressed interest in promoting the cultivation of ICSV I I I and ICSV 400 in Kano, Jigawa and Katsina states at the beginning of 1998 cropping season Unfortunately, this organization will be moving out of Nigeria at the end of 1998 season. Other organizations such as the Catholic Resource Centre in Kaduna should be encouraged to take up the assignment. Private organizations such as the brewing industry that use the product of the technology should be further encouraged not only to join hands in the dissemination, but also in the development and funding of research to refine the technology.

Seed multiplication programme: Lack of seed has been the most important factor limiting the number of adopters and the land area a farmer can plant to these varieties. The seeds of the new varieties were not made available to all interested farmers. The provision of seeds requires particular attention. Currently, seed is frequently saved from year to year, exchanged among farmers or purchased from local markets. Seed companies are not likely to be interested in producing open pollinated sorghum varieties. Therefore, a seed multiplication system may be coordinated by IAR and ICRISAT, Kano for the first two years. This responsibility should thereafter be transferred to the village communities through farmers' groups. The nature of demand for early maturing varieties fluctuates from year to year depending on farmer's expectation of the rainfall pattern in any given year. When farmers anticipate either mid-season drought or terminal drought, there is usually a high demand for early maturing varieties. In a situation of unpredictable rainfall distribution and weather conditions, reasonable quantity of seeds of these early maturing varieties that can adapt to changing weather conditions and environment should be always available in the store. This will give farmers access to varieties that will enable them to make planting adjustments as the season unfolds. A cold room facility will also be needed for storage and preservation of the viability of the seeds.

Marketing: These varieties came to the limelight with the discovery of ICSV 400 as an excellent malting material after the ban on importation of cereal grains and malt in 1987. The ban has recently been lifted and this will allow brewers to obtain cheaper malt from abroad. The government should be made aware of the implication of this policy on domestic production of grains and on the income of the farmers.

Another threat to the adoption of the new varieties is in the form of religious and ethnic beliefs. Some people, on religious grounds, have expressed concern that the sorghum crop including these varieties should not be produced and sold by Muslim farmers to companies that produce alcoholic drinks. Muslims constitute the majority of sorghum producers in Nigeria.

A revisit of crop marketing structure for sorghum is very essential. The government should use extension agents to educate farmers that the sorghum varieties have a number of other uses, including the manufacture of biscuits, malt, non-alcoholic drinks and livestock feeds. Since most of the consumption has been limited to family food needs in some areas, the acceptability of the new varieties at the local markets should be investigated and promoted.

Adoption of these new varieties can be hindered or enhanced depending on whether it is favoured by the marketing system. Widespread adoption of the improved varieties will lead to significant increases in production, but if the extra production is not utilized effectively, then disadoption is likely to occur. If farmers know that they can market a considerable proportion of their harvest at higher prices, the

acceptability of the varieties can be enhanced. Other market avenues, including local markets and alternative uses, should therefore be explored.

Impact on women and children: Women can play a key role in the wide adoption of this technology. The survey showed that the labour use profile of these varieties reduces the amount of labour required for production, particularly the amount of labour required for harvesting and processing operations which are the main task of women and children. While the technology sustains the existing division of labour between men and women, it has made simpler the harvesting and threshing operations. Women are in a better position to assess the taste and quality of food prepared from these varieties. However, the degree to which this technology is reaching the women is unsatisfactory because of the purdah system which forbids adult females from being interviewed by male extension workers. Female extension workers are few. Therefore, more female extension workers should be employed and research enumerators should include women in order to reach and encourage more female farmers to take full advantage of the technology.

Credit Facility: Credit is an important factor determining adoption. Many farmers, both adopters and non-adopters, claimed that they could not use fertilizers and chemicals because of lack of cash or credit. Credit not only facilitates access to the technology, but can also be used to encourage farmers to use the technology. The brewing companies offered credit as a package that provided some other inputs apart from seed to encourage farmers to grow the improved varieties. There are many formal and informal sources of credit. Farmers should be informed of these sources and the procedures for obtaining such loans. The adoption process can be enhanced by giving farmers access to credit that may facilitate the purchase of necessary inputs. Because of difficulties involved in disbursing loans to small scale farmers, these loans can be made available to them through their farmers' cooperatives.

Inputs market: The use of these improved varieties requires other inputs such as fertilizers, seed dressing and storage chemicals. Results from the focus group survey revealed that only about I I% of the villages surveyed had depots selling required inputs. Agro-service centres located in the villages have not functioned for a long time. Inputs such as improved seeds, fertilizers, seed dressing chemicals, water pumps and spare parts were not available in local markets where farmers usually sell their farm produce. Rehabilitation of the existing agro-service centres and establishment of new ones in LGAs will facilitate the use of inputs and adoption of improved technologies.

Incorporation of other improved packages: Up until now, only seeds of the improved varieties have been introduced and emphasized. Other inputs and improved practices associated with the technology have not been emphasized. Now that some farmers have adopted the technology, they should be introduced to appropriate practices such as proper plant spacing, optimal planting date, and rate of fertilizer application.

Monitoring: In order to sustain the current level of awareness and adoption, an annual survey should be planned between September and October to monitor technology uptake. An inventory of farmers' feedback on desirable characteristics, welfare gains, as well as constraints will facilitate the commencement of a full-pledged impact analysis.

Smallholder Dairy Technology in Coastal Kenya:

An Adoption and Impact Study

by

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1. INTRODUCTION

In many parts of Africa, smallholder farmers are being compelled by policies and markets to diversify fro traditional export crops, whose outlook for growth remains uncertain. Alternative agricultural activities are needed which offer higher returns to land and labour, offer the expectation of future growth, and which are suitable for adoption by the resource-poor smallholder farmers who continue to dominate African production. Market-oriented dairy production may fill this need for some smallholder producers.

Adoption of dairy technologies can have a positive impact on the welfare of smallholder farmers and promote agricultural development. Dairy production is likely to increase in many developing countries because of increases in demand and higher real prices for dairy products in the foreseeable future. The potential benefits of dairying include higher and more regular incomes for smallholder producers; increased employment in rural areas both directly and indirectly through supply of inputs and locally produced household items; and increased rural capital accumulation. Direct consumption of dairy products and income from dairy sales may improve the nutritional status of adopting households. Dairying contributes to the sustainability of smallholder crop-livestock systems by recycling nutrients (crop residues and other fodders through their conversion into manure and its application to crops), which may otherwise be lost to the system by increasing availability of existing nutrients (improving soil structure with manure), and by enabling the storing of nutrients until needed (storing and composting manure). Adoption of dairy technologies may also imply changes in the use of household members' time (particularly for women and children) and in the intra-household distribution of income.

The objectives of this study are: 1) to examine the factors influencing adoption of three related dairy technologies in coastal Kenya, and 2) to assess the impacts of dairy adoption on household income, employment generation, and nutritional status of pre-school children. The adoption of dairy technologies in coastal Kenya was selected for this case study because of the history of KARI/ILRI collaborative dairy research in the region, and the potential for the research results to complement ongoing KARI and ILRI research into smallholder dairying in other parts of Kenya and ILRI research with national collaborators in Tanzania, Uganda, Ethiopia and west Africa. Results below are summarised from Nicholson *et al.* (1998).

2. COAST PROVINCE, KENYA AND THE ENVIRONMENT FOR SMALLHOLDER DAIRYING

Coast Province covers over 80,000 square kilometres in the southeastern part of Kenya, constituting about 15% of the country's land area. The economic development of rural Coast Province has lagged behind other areas of Kenya and as a result living conditions in large parts of the province have been described as 'harsh' (Leegwater *et al.*, 199 1). The coast is a milk deficit area; as much as 45% of the region's dairy consumption is supplied by other parts of Kenya. Strong demand for milk and higher farm-level prices have been taken as indicators of the potential for dairy development in the region (Staal and Mullins, 1996). Most of the milk production occurs on smallholder farms with local Zebu-type cattle; only about I% of households with cattle in the area own grade or crossbred dairy animals. Dairy cattle are more susceptible to diseases common at the coast, such as East Coast fever (Theileriosis), Anaplasmosis, and Babesiosis, diseases transmitted by ticks.

In response to a need identified by the then Ministry of Livestock Development (MoLD) in 1988, the Kenya Agricultural Research Institute (KARI) and the International Livestock Centre for Africa (ILCA) established a programme to identify and resolve biological, social and economic constraints to the development, adoption and productivity of smallholder dairy systems in the coastal lowlands. Fro ILCA's perspective the target group for the research products were the crop-livestock smallholders in the medium rainfall, lowland tropics of sub-Saharan Africa, while the target group from KARI's perspective

(and the test group for ILCA), were the the crop-livestock smallholders in coastal lowland Kenya. The programme was based at KARI's Regional Research Centre, Mtwapa in Kilifi district. The programme used a production-to-consumption systems approach (Rey *et al., 1993),* and was planned and carried out in close collaboration with MoLD's extension service through its National Dairy Development Project (NDDP; Maarse *et al., 1990),* with the participation of other research institutions. The integrated programme of on-farm and on-station research, which continued until *1994,* covered farming systems description and constraint identification and technology development and testing. The major research areas were studies of dairy consumption and marketing, smallholder resource management, disease risk to dairy cattle, feeding systems development and dairy cattle breeding.

3. ADOPTION AND IMPACT STUDY METHODS

For this study of the adoption and impact of the three dairy technologies (crossbred dairy cattle; the fodder grass Napier *(Pennisetum purpureum);* and the infection-and-treatment method of immunisation against East Coast fever or ECF), three separate surveys of farm households were conducted in three districts of Coast Province during 1997 and 1998. The project compiled an inventory of 750 households with dairy cows in the three districts comprising the study area.

Adoption Survey. For the 'Adoption Survey' in June and July 1997, 75 dairy adopters and 125 nonadopters were surveyed in the three districts. The adopters, defined as households owning at least one grade or crossbred (G/C) dairy animal, were randomly selected from the inventory of adopting households. The sample of adopters was stratified by division, the administrative unit below the district level. The total number of farmers interview from each division was proportional to the number of households in that location (Table 1). Non-adopting households were selected randomly from lists of 20 neighbours of adopting households.

Impact Survey. The 'Impact Survey' administered during February to April 1998 followed the same sampling procedure; 200 households not contacted during the adoption survey were interviewed. Indicators of nutritional status for pre-school children were collected for 112 children in these 200 households.

Detailed Survey. The 'Detailed Survey of Dairy Adoption History' consisted of semi-structured interviews with 29 farm households randomly selected from the households participating in the impact survey. Of the 29 households, 15 had previous experience with G/C dairy cattle and 14 had no experience with more intensive dairying.

Studies of the factors influencing adoption of agricultural technologies often focus on household resource endowments, characteristics of the household head, household locational characteristics, the nature and extent of information provided prior to adoption, and the characteristics of the technology (Feder et al., 1985). In coastal Kenya non-farm jobs and businesses are key alternatives to intensification of agriculture for farm households (Waaijenberg, 1994), but may also provide income needed for investment in more intensive dairying. Accordingly, the Adoption Survey collected information from 202 households on location, characteristics of the household head and sources of information used by the household head to make decisions about the choice of agricultural technologies. The survey included information about the characteristics of the household, perceptions about the availability of the G/C animals, availability of seeds and planting materials for Napier grass, and access to ECF immunisation. Households were asked their perceptions about the accessibility of the inputs and services associated with the three technologies. This information was used to develop econometric models of adoption and impact.

4. RESULTS OF THE ADOPTION. AND IMPACT SURVEYS

4.1. Overview of Sample Household Characteristics

The characteristics of the sample households illustrate differences among the districts and the importance of non-farm activities in the region (Table 2). Between 36 and 45% of household heads engaged in an of-farm activity. Income from wages, salaries, and other non-farm activities is important for sample households in all three districts, ranging from 42% of total cash income in Kwale to 58% of total cash income in Malindi. Cash income from crop sales accounted for 10 to 33% of total cash income, and was most important in Malindi district. The lower proportion of cash income from crop sales inKilifi may reflect the trade-offs between allocation of household resources to agricultural and non-agricultural activities. Dairying accounted for 18 to 25% of cash income for sample households, and was highest in Kilifi district.

The proportion of households in the sample with grade and crossbred cattle (also consistent with the proportion of income from dairying) was highest in Kilifi district. Kilifi district sample households also owned a larger number of grade and crossbred cattle on average than households sampled from the other districts. The amount of Napier planted per farm was highest in Kilifi, although the differences with other districts were less than 0.3 acres per farm. The mean area of total land farmed by sample households ranged from I I to 14 acres; 12-acre plots promoted under settlement schemes at the coast have meant that average farm sizes are often many times larger than farms in Kenya's highlands. In part, this reflects the lower productivity of land in the coastal lowlands. Many sample households hired permanent and casual labourers for farm and non-farm work. The average number of labourers, hired per household was highest in Kilifi, which again may reflect the importance of non-farm activities for household members in that district.

4.2 Results of the Detailed Survey

Fifteen of the 29 households interviewed for the Detailed Survey owned a G/C animal at some time. Of these 15, four no longer owned a G/C animal. For these households, the most important reason for getting out of dairying was that their previous animal died and they could not afford to replace it. The households also stated that they found the management of G/C animals difficult, and that they sometimes had difficulties selling milk produced. Since 1993, the number of these 15 households with G/C animals or planted Napier has declined somewhat (Figure 1), although the number of G/C animals owned has increased in recent years. The total number of acres of Napier planted on these 15 farms has also declined somewhat. Further research into the extent and causes of this de-adoption process would benefit dairy development efforts in the region.

The Detailed Survey indicated that the most often used, and most important sources of information about the benefits of G/C cattle ownership, were extension agents, courses or demonstrations, and other households owning G/C cattle. Information about the management of G/C animals came primarily from the same sources, although the importance of management information from others with G/C cattle surpassed that of information from courses or demonstrations. Not surprisingly, the most important reason indicated by households that acquired cows or heifers was their desire for more milk for sale and for family consumption. Households wanted to sell more milk to have a higher and more regular income,.

The Detailed Survey asked households to subjectively assess the risks associated with ownership of G/C, including the risk of death due to disease. Because perceptions of risk may change as more experience with G/C animals is gained, hougeholds were asked to assess risks before adoption and based on their experi ences after adoption. These before and after questions allow targeting information first to increase adoption and then to improve the contribution of G/C to household welfare. Loss of an animal due to

disease was the most important of the risks mentioned, both before and after adoption. Among other risks, 'much more work for the household' and 'changes to household routine' were similar to disease risk in importance. The perceived likelihood of these risks decreased somewhat after adoption, however. The perceived risk of providing the G/C animal with enough feed increased after adoption, but the perceived risk of not being able to sell milk decreased with experience.

Fourteen of the households interviewed for the Detailed Survey had never owned G/C animals. Eleven of those said they had wanted to acquire at G/C animal at some time, but had not done so. The principal reason for non-adoption was lack of money to purchase the animal, mentioned by eight households. These eight households indicated that lack of credit and inability to participate in a development project (such as NDDP) were 'somewhat important' in their decision not to adopt, given that they had insufficient cash to buy a G/C animal. Information on how to manage animals, insufficient land, and shortage of labour were mentioned as less important reasons for not purchasing G/C cattle.

4.3. Econometric Analyses of Factors Affecting Adoption

Econometric models are often used to relate the adoption decision to household and technological characteristics. When the outcome to be modelled is a binary choice, standard linear regression models have shortcomings that are typically overcome using probit or logit models. These models relate household and technological characteristics to the probability that a household will adopt a technology. Typically, factors included in the model are exogenous (i.e., cannot readily be changed by the household) rather than factors that the household can influence through its current choices. The models provide empirical estimates of how changes in these exogenous variables influence the probability of adoption, and have been widely used to assess the effectiveness of projects to promote technology adoption (Rahm and Huffman, 1984; Nkonya et al., 1997).

The factors with a statistically significant influence on the adoption of G/C cattle are location (district and agro-ecozone), ethnic group, age of the household head, number of household members, land area farmed, participation in NDDP, perceived availability of veterinary services in the household's area, and perceived availability of G/C cows for purchase (Table 3). Households residing in Malindi and Kilifi districts were more likely to adopt G/C animals than their counterparts in Kwale district. Households in the higher-rainfall climate zone (Coastal Lowland 3) are less likely to adopt G/C animals, perhaps' because of the higher agricultural potential of this zone for other agricultural activities. Migrants to the coastal region from other areas of Kenya had a higher probability of adopting G/C cattle, probably due to greater exposure to the technology in Kenya's highlands, where many of the migrants originated. As the age of the household head increased, the probability of adoption decreased. Although the effect is small for one year (about a I% decrease in probability), a difference of twenty years would imply a decrease in the probability of adoption by more than 28%. Previous studies of agricultural technology also have reported that older farmers may be more reluctant to adopt new technologies or practices (Feder et al., 1985). The number of household members is typically a proxy for the availability of labour, and is positively associated with G/C. adoption. This is consistent with the observation that G/C animals require more time for care and feeding. The probability of adoption increased as land farmed increased, although the effect of an additional acre of land was relatively small (1.2%). This seems to indicate that the amount of land available to these coastal households does not markedly constrain farmers wishing to adopt G/C animals.

Participation in NDDP considerably increased the probability of adoption. This is the case although only 5 1 % of' G/C adopters in the sample had participated in NDDP. The strong relationship between adoption and participation in NDDP indicates that the project was effective in involving at least a subset of coastal households in dairying. The availability of veterinary services and perceived availability of G/C animals for purchase should be expected to increase the probability of adoption. However, the signs of these

coefficients indicate that increasing availability is associated with a decrease in the probability of adoption. This counter-intuitive result is probably attributable to the fact that adopters were surveyed after the adoption decision, and thus may be more aware of the difficulties of obtaining veterinary services and G/C animals than non-adopters.

The probit model results also indicate factors that appear not to influence adoption of G/C cattle. Among these are the household head's years of education, sex of the household head, ownership of the farm, and whether the owner manages the farm. The relatively small and statistically insignificant effects of these variables support the hypothesis that diverse types of households (not just highly educated male-headed households, for example) can and do adopt G/C cattle. None of the variables representing frequency of use or sources of information have a statistically significant effect on the adoption-of G/C animals. This implies that the design of educational programmes to support adoption of G/C animals could benefit from further study of what types of information are most used and positively regarded by farmers. The lack of a statistically significant relationship between distance to roads and markets and adoption indicates the strong demand for milk in local communities in the coast region. As a result, access to more formal marketing channels may not constrain the ability of households to sell milk produced by G/C animals, at least at current levels of production per household.

The results of the probit model for adoption of Napier grass are similar to those for G/C cattle. District of residence, age of the household head, number of household members, participation in NDDP, and perceived availability of veterinary services significantly affect both G/C cattle and Napier adoption. The magnitudes of the marginal effects tend to be smaller for the adoption of Napier than for G/C, and for the number of household members the sign of the coefficient is different. The negative effect of household members on the planting of Napier may be related to the increased availability of labour for herding cattle. Households in the coastal area often use tethering and grazing as an alternative source of feed for cattle (Swallow, 1998). Because grazing and tethering tend to require labour, their use may be more appropriate (and therefore more common) for households with more labour available. Irungu *et al.* (1998) also reported a negative (but statistically insignificant) relationship between family labour and the decision to adopt Napier in Kiambu district of the Kenyan highlands.

In contrast to the G/C adoption decision, information from agricultural programmes on radio or TV and learning about new practices from other family members was positively associated with adoption of Napier. In addition, the agro-ecozone and land area fanned by the household had no statistically significant influence on planting of Napier grass. For 365 farm households in the Kenyan highlands, Irungu *et al.* (1998) also reported no significant relationship between the probability of Napier adoption and land area. The lack of a strong relationship between adoption and location or land area farmed provides evidence that Napier is appropriate for various locations or farm types in coastal Kenya.

The results of the probit models for the use of ECF immunisation indicate that none of the exogenous variables hypothesised to influence adoption behaviour is statistically significant. In contrast to the models of G/C adoption and Napier use, the explanatory power of the ECF immunisation model is limited. This low predictive power of the model in part reflects the nature of the data: there are relatively few adopters of ECF immunisation, and so there is less information available to the statistical procedure for determination of the factors influencing adoption (Greene, 1993). More importantly, the results support the observation that use of the 'infection and treatment' method is limited by institutional factors. The manufacture and distribution of the immunisation's components has been constrained by uncertainties over the responsibilities of the government institutions involved. The lower predictive ability of the model may also indicate that factors other than those typically associated with adoption appear to play a major role in determining which producers have access to the immunisation. Further research into current and potential distribution systems to provide smallholders with ECF immunisation is currently underway at ILRI.

4.4. Analysis of Impacts of Adoption

This study explores both the impacts perceived by adopting households and more measurable impacts based on comparison of adopting and non-adopting households. The Detailed Survey asked households to discuss the impacts of owning G/C cattle and to state which impacts they viewed as most important. The Adoption Survey provides indicators of the impact of G/C adoption on the income of smallholder households, on the number of hired labourers employed, and on the nutritional status of pre-school aged children. Although these impacts are a small subset of the potential impacts that could be examined, they are among those cited most frequently by households, and also are of interest for organisations involved in dairy development efforts.

Impacts Reported by Adopting Households: The Detailed Survey asked households who had owned a G/C animal at some time to describe the impacts they perceived as result of adoption. Thirteen of the 14 adopting households indicated that the increased milk consumption by some members of the household was an impact of G/C cattle ownership. Twelve of the households reported that they sold more milk, that they had higher incomes as a result, and that household income was more regular than before adoption. Thus, the most commonly reported impacts relate to the consumption and sale of milk, as might be expected. Other impacts reported by the households included hiring of more permanent labourers (11 households), substantial changes to routine household activities (10 households), and better health due to increased milk consumption by household members, especially children (10 households). Less than half of the households indicated that adoption of G/C animals resulted in changes in their cropping patterns, in the hiring of more casual labourers, or in increased workloads for household members. The households' rankings of impacts by their importance mirrors the number of households reporting the impacts: increased milk consumption is considered most important, followed by increased milk sales- and higher incomes.

Impact on Household Income: Examining means and distributions of income and number of hired labourers for adopters and non-adopters provides a starting point for assessing impacts. However, a limitation of this approach is controlling for other factors that may influence observed outcomes for adopting and non-adopting households. If factors other than G/C cattle ownership influence the outcomes, attributing differences in variables such as income to adoption alone may prove misleading (the multivariate econometric analysis discussed below controls for confounding factors and provides additional insights about adoption's impacts). With this caveat in mind, the percentage of households with income from various activities differed for adopters and non-adopters (Table 4). About threequarters of both adopting and non-adopting households received income from crop sales, despite the lack of food self-sufficiency previously reported for households in coastal Kenya (Leegwater et al., 1991). Two-thirds of both groups of households received cash income from non-farm activities (wages, salaries, or non-farm enterprises), consistent with the assertions of Waaijenberg (1994) that diversification into non-farm activities is a rational survival strategy for smallholder households in the region. Other sources of cash income, such as poultry production and remittances, were received by less than half of all households.

Average cash income per month received from dairying was a remarkable 54 times higher for adopting households than non-adopting households. This is due to adopting households owning cows that produce more milk (ie., G/C animals), owning more cows than non-adopting households, and perhaps receiving higher prices for milk sold. When adopting households are compared with non-adopters who own cattle, cash income from dairying is still more than 20 times larger for adopters. Only five percent of nonadopting households had cash income from dairying, and few non-adopters had dairy income larger than 1,000 KSh per month. The largest number of adopting households earned between 1,000 and 5,000 Ksh per month from dairying, and nearly one-quarter of adopters had cash income from dairying greater than

10,000 KSh per month. Thus, the adopting households' perceptions of increases in income due to adoption of G/C are supported by the large differences in cash incomes from dairying reported by adopters and non-adopters. For adopting households, dairy income constitutes more than one-third of total cash income, whereas for non-adopting households dairy income is less than 3% of total cash income. Adopting households also reported higher cash incomes from all other sources except remittances. Non-farm income was important for both groups: wages, salaries and non-farm businesses accounted for 44% of total cash income for adopting households, and 56% of total cash income for nonadopting households.

Adopting households had total cash incomes about four times higher than non-adopting households (Table 4). About 42% of the difference in total income for adopting and non-adopting households was due to the difference in income from dairying; higher income from wages, salaries and non-farm employment for adopters made up most of the rest of the difference. Thus, dairy income can make a significant contribution to total household income, and accounts for the largest part of income differences between adopters and non-adopters. The observation that adopting households have higher incomes than non-adopters, and higher income from non-farm employment in particular, has been used to argue that adoption of G/C dairy cattle is accessible only to the relatively wealthy or those with non-farm income sources (Leegwater et al., 1991). In contrast, the results from the Adoption Survey indicate that the percentage of adopters is fairly evenly spread across income categories, although a larger proportion of adopting households have incomes that fall into the higher income categories.

Impacts on the Number of Hired Labourers: Employment generation is another potential impact of adoption, in part because the care and feeding of G/C animals requires more labour. It is common for G/C owners to hire labourers to help with the increased workload; more than three-quarters of households responding to the Detailed Survey indicated that they hired more permanent labour as a result of adopting G/C animals. Hired labourers generally come from the areas surrounding the adopters' farms, and the financial benefits of dairying are thus shared among both owners of G/C and others in the local community.

Sixty percent of the adopting households reported employing at least one permanent labourer compared with 15% of non-adopting households (Table 5). Thus, although only slightly more than half of adopters employed a permanent labourer, they employed permanent labourers much more often than their nonadopting counterparts. In contrast, roughly equal numbers of adopting and non-adopting households employed casual labourers. Households with G/C cattle employed between one and two permanent labourers on average, compared to one permanent labourer hired for every five households without G/C cattle. In addition to the number of labourers employed, permanent labourers working for adopting households appear to be paid more per month than permanent labourers, employed by non-adopting households. This may be due in part to more hours worked, but the end result is higher income received by labourers employed by adopters. Not all of the employment on adopting household's farms can be attributed to the presence of grade and crossbred animals. As noted with income, other factors will influence the number of hired labourers, employed; subsequent econometric analyses will examine the influence of the number of G/C animals owned by the household on the number of permanent labourers, employed.

Impacts on Household Nutritional Status: Dairy development efforts are often justified based on the assumption that higher milk production will increase household milk consumption. Increased milk consumption is usually assumed to improve nutritional outcomes for households. In addition, to the extent that dairy production increases incomes, households with dairy cattle can afford to purchase more food and a wider variety of foods. This 'income effect' is also expected to contribute to improvement of nutritional status in households with G/C cattle. Most studies have long recognised the complexity of the relationship among agricultural production systems, alternative means of generating household income,

household food consumption patterns, and nutritional status (Low, 1991). Studies of nutritional outcomes by social scientists often rely on summary indicators of nutritional status rather than direct measures of nutritional status itself (Randolph, 1992).

Anthropometric measures for children 0 to 59 months of age often are used as indicators of nutritional status for households in societies with significant levels of protein-energy malnutrition (Low, 199 1; Quinn, 1992). Children are measured because they are presumed to be the most vulnerable members of the household, and thus provide a sensitive indicator for the household as a whole. The interpretation of anthropometric measurements is also easier for children than for older members of the household because there are fewer genetic differences among children in different ethnic groups and reproductive status of females can be ignored. The measures typically used include 'weight-for-height' and 'height for age'. A low value of weight-for-height indicates that the child is very thin for his or her stature, and thus provides a measure of acute malnutrition (often referred to as 'wasting')., A low value of height-for-age indicates that the child is shorter than one would typically expect for a child of the same age because of the accumulated effect of periods of morbidity and inadequate food intake (often referred to as 'stunting'). The measures are typically converted to z-scores (the number of standard deviations from the mean of a reference population) using the U.S. National Center for Health Statistics (NCHS) growth percentiles as a reference (WHO, 1983). Because they are standardised measures, the z-scores can be compared for different age groups and for the two indicators of nutritional status (Quinn, 1992).

Comparison of the weight-for-height and height-for-age z-scores provides an indicator of the impacts of adoption on the nutritional status of households. As with the income and employment impacts, differences in nutritional status cannot be entirely attributed to the adoption of G/C animals; subsequent econometric analyses will assess nutritional outcomes controlling for other variables in addition to G/C cattle ownership.

The mean weight-for-height z-scores do not differ significantly for adopting and non-adopting households (Table 6). This indicates that the prevalence of acute malnutrition appears to be little affected by adoption status. Consistent with previous studies of nutritional status in coastal Kenya (Leegwater et al., 1991) over one-quarter of children measured were considered to be at least somewhat acutely malnourished. The percentages of children suffering from different degrees of wasting differed only in that somewhat fewer children were severely malnourished in adopting households (a $X2$ test for differences between the distributions for adopters and non-adopters was not significant at the p=0. 10 level).

The mean z-score for height-for-age was higher for children in adopting households than for non-adopting households (Table 6), indicating that ownership of G/C cattle may have some impact on chronic malnutrition (the difference was significant at the p=0. 13 level). Despite the potential benefits of G/C adoption, more than two-thirds of children in adopting and non-adopting households showed some degree of stunting. Leegwater et al. (199 1) also observed that stunting was much more common than wasting among households in coast Kenya. Moderate and severe stunting was more common for children in households without G/C cattle, but a $X2$ test for differences between the distributions for adopters and non-adopters was not significant at the p=0. 10 level. Thus, although the comparisons involve relatively small numbers of children and do not control for other factors influencing outcomes, the ownership of G/C cattle appears to have a relatively minor impact on average household nutritional status.

4.5. Econometric Analyses of Impacts

Simultaneous statistical models of the extent of adoption can be used to examine impacts of adoption – for example, how the number of G/C animals affects household income or the number of hired labourers. As in the case of the adoption decision, economists often use econometric models to relate the extent of

adoption to various exogenous factors. In the case of G/C cattle, the extent of adoption refers to the number of G/C animals owned. For Napier, the number of acres planted is an indicator of the extent of adoption. One approach to estimating the impact of exogenous factors on the extent of adoption would be to estimate a linear regression of number of G/C cattle or acres of Napier on the exogenous variables, using data only for adopters. When the number of non-adopters (who by definition have no G/C cattle or any planted Napier) forms a substantial part of the sample, a linear regression of this type is inappropriate (Greene, 1993). In this situation, a censored regression, or Tobit model, is appropriate. The Tobit model accounts for the zero observations of non-adopters in estimating the relationship between the exogenous variables and the observed extent of adoption.

Using the data from the Adoption Survey, a system of five simultaneous Tobit equations was specified and empirically estimated. One equation each was specified for the number of G/C animals owned, number of acres of Napier planted, cash income from agriculture (income from dairying, crop sales, and poultry production), non-agricultural income (income from wages, salaries, non-farm businesses, and 'other income') and the number of permanent hired labourers employed by the household. The exogenous variables explaining the extent of adoption are the same as those used in the probit models. In addition to the exogenous variables, predicted values of the four 'other' endogenous variables estimated by individual Tobit models were included in each of the five simultaneous equations. The discussion that follows emphasises the inter-relationships among the five endogenous variables because these focus on the impacts of adoption.

The system of simultaneous Tobit models indicates that relatively few factors have a statistically significant influence on the number of G/C cattle owned by a household. Agro-ecozone, religion, and whether the farm owner is the household head have a positive influence on G/C cattle owned that is statistically significant at the $p<0.05$ level. District of residence, and membership in NDDP also had marginal effects greater than one, but these were insignificant. Consistent with the probit model results, the perceived availability of veterinary services had a negative marginal effect greater than two, but this was also statistically insignificant. A key result of the model for number of G/C animals is that none of the other endogenous variables influence the extent of G/C adoption. In particular, the results support the hypothesis that non-agricultural income is not an essential determinant of the number of G/C animals owned. The coefficient for non-agricultural income in the equation for G/C cattle numbers owned is nearly zero, and is not statistically significant. The implication of this empirical relationship is that adoption of G/C cattle, although it may require a substantial cash investment, is not accessible only to the relatively wealthy with income from non-agricultural sources.

The factors that have a statistically significant influence on the amount of Napier planted are agro-ecozone and whether the farm owner is the household head. District of residence,, religious affiliation, and membership in NDDP have positive marginal effects of at least one (acre) on the amount of Napier planted, but are statistically insignificant. Consistent with the probit model results, the number of household members has a negative effect on amount of Napier planted, although the result is not statistically significant. There is also no strong relationship between the amount of land farmed and the amount of Napier planted. There is little relationship between income from agricultural or nonagricultural sources and the amount of Napier planted. Perhaps surprisingly, there is also little relationship between the number of G/C cattle owned and the number of acres of Napier planted; the coefficient of G/C cattle in the Napier equation is negative and insignificant. This result may seem to contradict the finding of the bivariate probit model with regard to the relationship between adopting crossbred cows and adopting Napier. However, this result indicates that the amount of Napier per cow is relatively independent of the decision to adopt the technologies, and that at least some G/C owners do not rely heavily on Napier as a fodder source. This is consistent with the number of G/C cattle owned and acres of Napier planted for the 15 adopting households responding to the Detailed Survey (Figure 1), and with the findings of Swallow (1998) with regard to feed sources used in Kilifi district.

The results of the agricultural income Tobit model also appear to emphasise the importance of the farm management and the complementarity of dairy technologies and practices. The small coefficient for the number of G/C cattle owned indicates that it is not the number of cattle per se that generates income. Rather, good management, which apparently includes the use of Napier and hired labourers, increases the income generated from a given number of G/C animals. Further research into the underlying reasons for differential farm financial performance in coastal Kenya would provide insights into the relationship between management and profitability suggested by this analysis.

Non-agricultural income is influenced primarily by characteristics of the household head. Age and migrant status had a statistically significant negative effect on non-agricultural income. In contrast to the results for the other equations, sex of the household head had a statistically significant effect on nonagricultural income: non-agricultural income was 770 Ksh per month higher for male household heads than female household heads. Household heads who were also the farm owner had significantly higher non-agricultural income than those who were not farm owners. None of the other endogenous variables had a statistically significant impact on non-agricultural income

The number of permanent hired labourers was significantly influenced by only two characteristics of the household head. Education of the household head and whether the household head was the farm manager both had positive effects on the number of permanent labourers hired. When the farm owner was also the farm manager, the number of hired labourers decreased, although this effect is not statistically significant. The results indicate that the effect of the other endogenous variables on the number of permanent labourers hired is small and statistically insignificant. Agricultural or non-agricultural income has essentially no impact on the hiring of permanent labourers. The small impact of G/C animals and acres of Napier on the number of hired labourers is in part confirmed by the observation that only 60% of adopting households have hired permanent labourers. Leegwater et al. (199 1) found that only half of households participating in NDDP (and therefore owning G/C cows) had hired labour. Thus, there may be subsets of adopters for whom hired labour is essential, whereas other adopters are able to handle the increased workload without hired assistance. Although the coefficients for G/C animals and Napier are small, they indicate that one permanent hired labourer is engaged for every six adopting households. At a minimum, adoption of G/C animals and Napier (controlling for other factors) is associated with the hiring of 12 permanent labourers by the 75 adopting households surveyed.

4. SUMMARY AND CONCLUSIONS

This study examined the factors associated with adoption of three dairy-related technologies and practices in Coast Province, Kenya: grade or crossbred (G/C) dairy cows, Napier grass production, and the 'infection and treatment' method for protection of cattle against East Coast fever. As grade and crossbred dairy cattle have higher feed requirements and lower disease resistance, these three technologies should be highly complementary. The principal conclusions of the analyses to date are summarised as follows:

Adoption of a G/C animal is not a simple one-off binary decision. Households adopt and de-adopt G/C dairy cattle, primarily because of the expense of replacing an old or diseased animal. Grade and crossbred dairy cattle are adopted in the first place primarily because the sale of milk increases and stabilises household income, while allowing household milk consumption to increase. This is in spite of perceived disease, feed supply and milk marketing risks.

The probability that a household will adopt a G/C animal depends on location, characteristics of the household head, sources of information, and characteristics of the farm. The probability increases if the household is located in Malindi and Kilifi rather than Kwale. Migrants to the coast from other areas of Kenya are also more likely to adopt G/C cattle, probably because of previous experience with smallholder

dairying in the highland regions of the country. Probability of adoption decreases with increasing age of the household head, but increases with increasing number of household members, presumably related to the increased size of the labour for dairy-related activities. The amount of land available to the household does not apparently constrain adoption of G/C animals. Participation in NDDP increased the probability of adoption, indicating that the project was effective in involving many coastal households in dairying. This was at least partially because smallholders in coastal Kenya may experience difficulty in gaining access to money with which to purchase a G/C animal and this problem was bypassed in the past through participation in dairy development projects such as NDDP. Such involvement is clearly reflected in survey analyses, where it is shown that the decision to adopt a G/C animal is strongly associated with the decision to adopt Napier. As noted above, this suggests that future efforts to promote dairy adoption should pay close attention to the provision of fodder for these higher-producing animals.

Survey results support the notion of the basic substitutability of dairying and other economic activities. This is consistent with the continuous nature of the adoption decision, the diversity of household that have adopted G/C animals, and the fact that households adopt despite perceived disease risks. This substitutability means that keeping a G/C animal is just one activity of many that the household might engage in, as and when conditions within the household are conducive to it. For some households, purchase of a G/C animal does not necessarily involve a long-term commitment to dairy production. If the household has sufficient cash, then dairying clearly can be profitable, even on the Kenyan coast, but it takes management input. The Adoption Survey data indicate that ownership of a G/C animal *per se* does little to increase household income.

Adoption of dairy increases household incomes. Adopting households' perceptions of increases in income due to adoption of G/C cattle are borne out by the large differences in cash incomes from dairying reported by adopters and non-adopters (one-third of total cash income for adopters versus less than 3% for non-adopting households). Dairy income comprised the largest part of the difference in total cash incomes between adopting and non-adopting households. Survey results confirm the heavy reliance of all households in Coast Province on non-fanning activities. In addition, results indicate that the percentage of adopters is fairly evenly spread across all income categories, implying that adoption of G/C dairy cattle is accessible to many households, not just the wealthier ones.

Adoption of dairy generates employment. Although only slightly -more than half of adopters employed a permanent labourer, they employed permanent labourers much more often than their non-adopting counterparts. Households with G/C cattle employed between one and two permanent labourers" on average, compared to one permanent labourer hired for every five households without G/C cattle.

Adoption of dairy appears to have positive impact on the nutritional status of pre-school children. The incidence of chronic malnutrition appears to be lower for children in adopting households than for those in non-adopting households. Although not all the difference can be attributed to milk consumption or dairy income, this result provides a starting point for future multivariate analyses of nutritional status. Despite the potential benefits of G/C adoption, more than two-thirds of children in adopting and nonadopting households showed some degree of stunting. The prevalence of acute malnutrition seems to be little affected by adoption status; over one-quarter of children measured were considered to be at least somewhat acutely malnourished.

The milieu for smallholder dairy production at the coast is highly complex. While adoption levels seem not to be increasing, adoption of a G/C dairy animal can lead to substantial impacts on household income, can generate employment, and can have a beneficial impact on the nutritional status of pre-school-age children in the household. Households have various non-farm options for generating income that may serve the same purposes, however, and dairying seems to be treated as one of these options, to be engaged in from time to time as the opportunity arises. Previous dairy-related research has identified management

options and practices that are viable and can be profitable for smallholders wanting to adopt or increase dairy production. Taken in the context of a risky production environment and competing opportunities for investment, the results of this study would suggest that neither the adoption nor productivity of dairying are constrained by poor availability of technology options. In terms of dairy development activities on the coast, there would seem to be two areas in particular that merit attention: mechanisms for easing access to grade and crossbred dairy cattle, either through credit schemes or through self-help smallholder co-operatives, and reducing the disease risks associated with G/C animals. Developments in both these areas would increase the propensity of smallholders to go into dairying. Whether or not such activities are viewed as worthwhile by development agencies is a question that requires a full appreciation of the opportunity costs involved and the policy goals of government.

In conclusion, the medium rainfall coastal lowlands of east Africa represent a difficult and risky production environment, yet one with access to two principal and rapidly growing urban markets, Mombasa and Dar-es-Salaam. These markets offer smallholder dairy producers, actual or potential, large margins for their milk. However, these markets and their environs also offer many other opportunities for the investment of smallholders' scare capital. Many of these investment opportunities require smaller initial investment than dairy cattle, require fewer specialist skills and are less constantly demanding of family labour. Nevertheless, as smallholder agriculture in the coastal lowlands intensifies in response to human population pressure, dairy production and marketing, with its large potential direct financial returns and its indirect benefits for crop production, will continue to be an important enterprise for some resource-poor families. Their success will depend in no small part on the products arising from the publicly-funded R&D investments made during the 1980s and 1990s.

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Table 1. Households, Adopters, and Number of Survey Respondents by Division

District	Division	Households	Total surveyed	Number of Adopters	Adopters surveyed	Non-adopters surveyed
Kwale	Matuga	11,010 •	18	53	6	12
	Kubo	6,434	10	20	2	8
	Msambweni	30,272	47	73	8	40
Kilifi	Kaloleni	26,167	41	115	12	29
	Bahari North	23,250	36	185	19	4
	Bahari South			89	9	4
Malindi	Malindi	30,243	48	184	19	28
Total		127,376	200	719	75	125

Table 2. Characteristics of Adoption Survey Households, by District

Characteristic	District		
	Kwale	Kilifi	Malindi
		(Means)	
Household characteristics			
Number of household members	7.5	9.2	14.0
Female head of household, %	38.2	21.5	29.8
Education of household head, years	4.8	6.5	4.3
Head has non-farm activity, %	44.7	41.8	36.2
Cash income from			
Dairying, KSh/month	1,149	3,537	1,885
Poultry or eggs, KSh/month	700	1,950	49
Crop sales, Ksh/mont	1,163	1,440	3,532
Wages, Salaries, Non-farm, KSh/month	2,453	6,514	6,222
Remittances, KSh/month	461	324	450
Other, KSh/month	200	522	330
Total, KSh/month	5,913	14,045	10,753
Farm Characteristics			
Households owning G/C cattle, %	18.4	51.9	36.2
Number of G/C cattle owned	1.09	2.75	1.36
Acres of Napier planted	0.4	0.5	0.2
Total land area, acres	12.4	11.3	13.6
Permanent hired labourers	0.5	1.1	0.4
Casual hired labourers	1.2	2.0	1.3

Table 3. Summary of Factors with a Statistically Significant Influence on Adoption Based on Probit Model Results

Independent variable	Probability of adoption of:		
	G/C cattle	Napier	ECF Immuni-sation
Locational Variables			
Kilifi district dummy (Kilifi=1, Other=0)	+	+	NS
Malindi district dummy (Malindi=1, Other=0)	+	+	NS
Agro-ecozone dummy (CL3=1, 0=Other)	-	NS	NS
Characteristics of the Household Head			
Ethnic group dummy (1=Migrants, 0=Coast)	+	NS	NS
Age of household head, years	-	-	NS
Information Sources			
Listen to or watch agricultural programmes on TV or radio (1=Frequently, 0=Rarely)	NS	+	NS
Learned about new practices from own family (1=Yes, 0=No)	NS	+	NS
Characteristics of the Household			
Number of household members	+	-	NS
Land area farmed, acres	+	NS	NS
Member of NDDP	+	+	NS
Farmer Perceptions of Accessibility of Inputs, Services, and Technology			
Veterinary services available in your area? (1=Yes, 0=No)	-	-	NS
Easy to obtain grade or crossbred cows in your area? (1=Yes, 0=No)	-	NS	NS

'+' indicates that the variables has a positive influence on the probability of adoption, '-' indicates that the variable has a negative influence on the probability of adoption, and 'NS' indicates that the independent variable did not have a statistically significant impact on the probability of adoption.

Note: As indicated in the text, none of the variables above has a statistically significant influence on adoption of ECF immunisation.

Table 4. Reported Cash Income, by Type of Income and Adoption Status[1]

Income Type	Adopters	Non-adopters	Tests for equality of means
Percentage of households with cash income from:			
Dairying	87	5	
Crops	76	73	
Wages, salaries, or non-farm activities	65	65	
Cash income from:			
Dairying, KSh/mo[2]			
Mean	6,809	124	(p<0.001)
(s.d.)	(7,836)	(764)	
Crops, KSh/mo[2]			
Mean	1,629	934	(p=0.11)
(s.d.)	(2,967)	(1,604)	
Wages, salaries, or non-farm activities, KSh/mo[2]			
Mean	9,259	2,787	(p<0.01)
(s.d.)	(17,080)	(5,080)	
Total income, KSh/mo[2]			
Mean	20,912	4,962	(p<0.001)
(s.d.)	(23,762)	(6,338)	

[1] Adopters are households currently owning at least one grade or crossbred animal. Non-adopters currently own no grade or crossbred animals.

[2] In early 1998, 62 Ksh = $1.00.

Table 5. Hired Labourers, by Adoption Status[1]

Hired Labour Characteristic	Adopters	Non-adopters	Test for equality of means
Households with permanent hired labour, %	60	15	
Households with casual hired labour, %	48	42	
Number of permanent hired labourers per household			
Mean	1.51	0.22	(p<0.001)
(s.d.)	2.29	0.60	
Number of casual hired labourers per household			
Mean	1.87	1.33	(p=0.26)
(s.d.)	4.32	2.46	

[1] Adopters are households currently owning at least one grade or crossbred animal. Non-adopters currently own no grade or crossbred animals.

[2] In early 1998, 62 Ksh = $1.00.

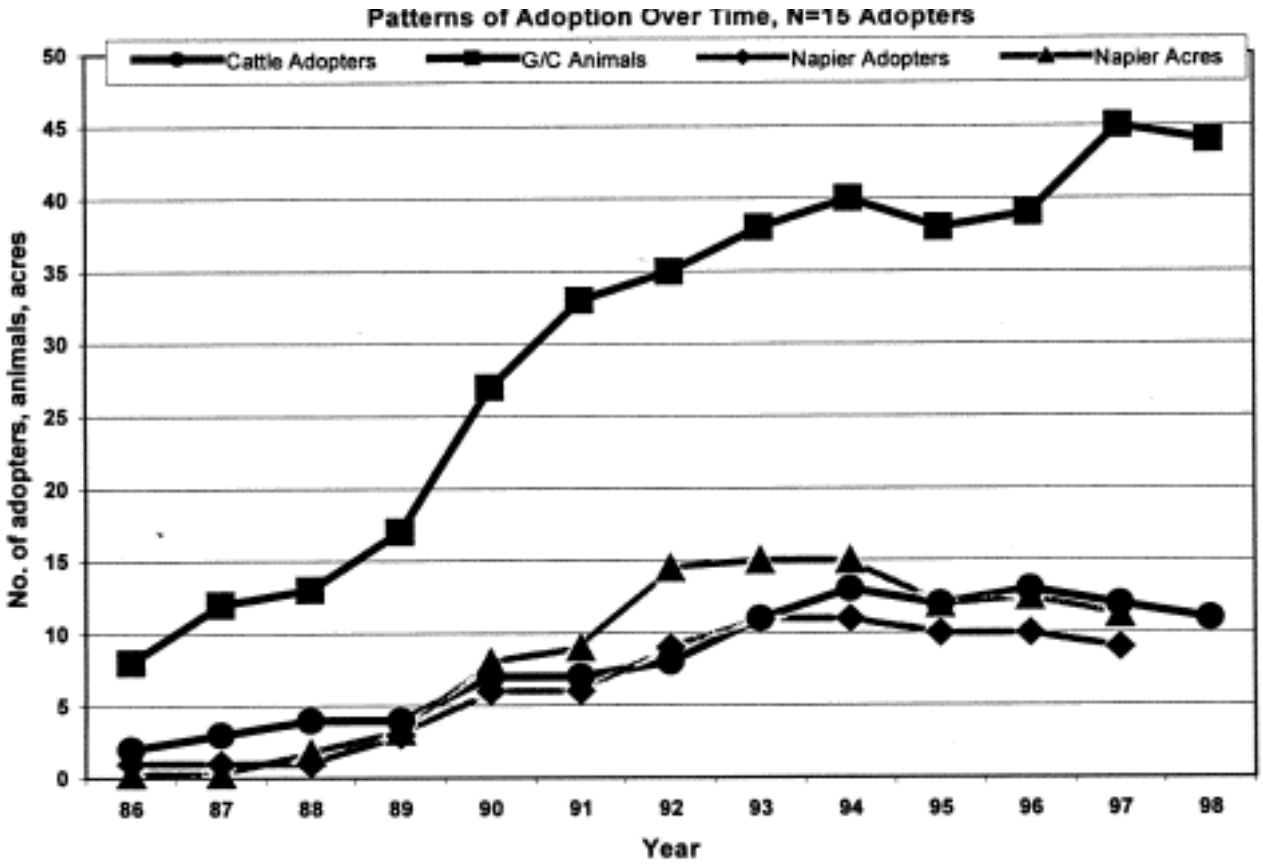
Patterns of Adoption Over Time, N=15 Adopters
Cattle Adopters
G/C Animals
Napier Adopters
Napier Acres
No. of adopters, animals, acres
0
5
10
15
20
25
30
35
40
45
50
86
87
88
89
90
91
92
93
94
95
96
97
98
Year

Table 6. Nutritional Status of Pre-school Children and Adoption Status[1]

Nutritional Indicator	Adopters	Non-adopters	Test for equality of means or distributions
Weight-for-height (indicates wasting)			
Mean z-score	-0.32	-0.35	(p=0.90)
(s.d.)	1.30	1.12	
Number of children	39	65	
Percentage of children:			(p=0.23)
Normal	71.8	72.3	
Mild wasting	20.5	21.5	
Moderate wasting	0.0	4.6	
Severe wasting	7.7	1.5	
Height-for-age (indicates stunting)			
Mean z-score	-1.56	-1.95	(p=0.13)
(s.d.)	1.33	1.27	
Number of children	41	71	
Percentage of children:			(p=0.33)
Normal	31.7	21.1	
Mild stunting	34.1	28.2	
Moderate stunting	19.5	33.8	
Severe stunting	14.6	16.9	

[1] Pre-school children are those 0-59 months of age. Adopters are households currently owning at least one grade or crossbred animal. Non-adopters currently own no grade or crossbred animals.

[2] Categories of wasting and stunting are based on z-scores, where $z>-1.00$ is normal, $-1.00>z>-2.00$ is mild malnutrition, $-2.00>z>-3.00$ is moderate malnutrition, and $z<-3.00$ is severe malnutrition Quinn (1992).

Source: KARI-ILRI Nutrition and Health Survey, April-May 1998.

Case Study on Adoption of IPGRI's Crop Descriptor Lists

By

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1. INTRODUCTION

1.1. The IPGRI Descriptor Lists

Accurate documentation of information related to plant genetic resources is essential for their effective conservation and use. Through the production of crop descriptor lists in collaboration with NARS, CGIAR collaborators and other crop research institutes, the International Plant Genetic Resources Institute (IPGRI) aims to stimulate the documentation of plant genetic resources collections by providing uniform and unambiguous guidelines for the documentation of information on germplasm accessions. To date, IPGRI has produced Descriptor Lists for more than 80 crops.

The IPGRI Descriptors were the subject of a preliminary impact assessment study[5] in 1996 and the results have shown that they have a high visibility. However, information is incomplete on perceptions of their quality and their impact when used as guidelines for germplasm documentation. Little is known on how widely they are adopted, on the decisions of priorities. The highly technical nature of the terminology and method of scoring the descriptors have been suggested in a first assessment as possible obstacles to adoption. The suitability of the descriptors in general to score heterogeneity of germplasm accessions and for discriminating between different accessions of the same species, have also raised concerns during internal discussions[6] and in a recent paper[7]. The fact that the IPGRI Descriptors are a well established product and have a strong use component, make them particularly suitable as a model for an impact assessment study on adoption of IPGRI innovations in general which illuminates the issued raised.

1.2. Methodology of the case study

This case study sought to evaluate the extent of adoption of the IPGRI Descriptors and examine the factors affecting adoption in order to help increase their impact on the conservation and use of plant genetic resources. The study concentrates on qualitative aspects of the use of the Descriptors and focuses on three crops, namely banana, coconut and maize, selected for the diversity in cases that they present, e.g. in terms of type of crops, economic importance, geographic distribution and use of the germplasm, and networking activities. The present case study uses the "illustrative" approach, as defined by Sechrest et al. 1996[8]. This approach describes in detail a process or series of events in order to obtain a clear understanding of the cause and effect relationships involved.

Data collection Data were collected from existing sources such as archives, reports and other documented feedback received over time from collaborators and users of the IPGRI Descriptors. New information was derived from various sources including interviews with individuals and groups of users and questionnaires. The major source of information was an extensive questionnaire sent to the germplasm collection managers for each of the crops selected. A total of 456 genebank curators were targeted and 36% (165) replied.

The distribution of the IPGRI Descriptors is done systematically through the Institute's Mailing List when the descriptors are published, by IPGRI staff when travelling and attending meetings, and through specific requests. A second questionnaire investigated the reasons for requesting copies of IPGRI Descriptors and

[5] As part of the IPGRI Information Services Impact Assessment Case Study undertaken for the External Programme Management Review (EPMR) 1996.
[6] Particularly the Programme Planning and Review Committee 5, 1993
[7] K. W. Riley, V. Ramanatha Rao, Z. Ming-De and P. Quek, MAFF (Japan). Characterization and Evaluation: New approaches for the improved use of plant genetic resources. Proceedings of the 4th International Workshop on Genetic Resources held at the National Institute of Agrobiological Resources in Tsukuba, Japan 22 24th October 1996
[8] Sechrest, L., Stewart, M., Stickle, T.R. and Sidani, S. 1996. Effective and persuasive case studies, Jaguar Graphics,
Tucson, Arizona.

the use being made of them. This questionnaire was sent to 146 people who requested a copy of the IPGRI Descriptors during 1997 and received a rate of reply of 40%. A target group for distribution through the IPGRI Mailing List are libraries and documentation centres. A third questionnaire sent to these recipients of the IPGRI descriptors investigated the extent to which the descriptors received were being used, by whom and how frequently, with implications for continuation of distribution to this target group in the future. This questionnaire was sent to 56 institutions9 and 15 replies were received (27%).

Interviews were conducted with staff from institutions that collaborated in the development of the banana and the coconut descriptors and with IPGRI staff. During the First *Musa* Germplasm Information System (MGIS) training workshop, held at CIRAD10, in Guadeloupe in October 1997, a focus group discussion was held with 10 genebank curators of the major *Musa* collections around the world. MGIS has been developed in conjunction with the IPGRI-INIBAP/CIRAD Descriptors for Banana (Musa sp.) published in 1996, which has also been used to develop the identification software MUSAID11. The MGIS workshop also provided the opportunity to test and evaluate the Descriptors for banana on the field collection of CIRAD.

2. RESULTS AND DISCUSSION

2.1. How are the IPGRI Descriptors developed? Drafts are developed by renown international experts for specific crops. These drafts are then used by IPGRI as a basis to develop a new or revised crop descriptor list. IPGRI is mainly responsible for coordinating and managing the production of the Descriptor from establishing list of priorities, reviewing existing list of descriptors, making appropriate contacts, selecting reviewers, supervising drafting, scientific input, coordinating, editing, and proof-reading text in different languages, reconciling reviewers' comments, printing and distribution of the publications. Each step in the development of descriptors is done in consultation with the staff responsible for the activity within IPGRI Thematic and Regional Groups, with genebank documentation staff, and with crop experts. The challenge in developing crop descriptor lists is to ensure that as a result of wide consultation and a transparent production process, the final result can rely on a broad support or consensus by the majority of intended users. In recent years, IPGRI has produced on average 3 Descriptor Lists per year in English, Spanish and French.

A decision taken to revise a Descriptor List is based on the same consultative approach and has been carried out, on average, 10 years after first publication. Revisions represent clear improvement according to the feedback received on the Banana descriptors and should be continued. The results from the maize12 and to some extent the coconut descriptors indicate however that revisions should preferably be undertaken at shorter interval, e.g. nearer to every 5 years.

2.2. How well known are the IPGRI descriptors? The IPGRI Descriptors are considered to be very well known by the plant genetic resources community [13] especially the target users: genebank curators, crop specialists and plant breeders. This was further confirmed by the high proportion of respondents to the questionnaires who knew about the IPGRI

9 Libraries and documentation centres selected from the Mailing List for the Descriptors for Banana (Musa sp.), 1996.
10 The Centre de cooperation internationale en recherche agronomique pour le developpement (CIRAD), Montpellier, France
11 MUSAID has been developed by CIRAD
12 Feedback from the maize collection managers indicate that the majority feel that the descriptors need to be improved (61 %), after 6 years.
13 Information gathered from 152 country reports produced for the International Technical Conference on Plant Genetic Resources, Leipzig, Germany, June 1996.

Descriptors (on average 78%14). Many of them find out about the Descriptors by receiving a printed copy directly from IPGRI (46%15), through contact with IPGRI staff (23%) or through newsletters and other publications (20%). The survey reveals the complementarity of the different means of publicising and distributing the Descriptors. The results of the distribution of the Descriptors for Banana 1996, where 48% of the total distribution was done by IPGRI staff, highlights the importance of personal contact with IPGRI staff in raising awareness of the IPGRI Descriptors.

2.3. How widely used are the IPGRI Descriptors? The majority of the germplasm collection managers surveyed16 maintain a documentation system/database for their accessions (84%). These documentation systems are either fully computerised (26%), partly computerised (46%) or completely manual (28%). Of the respondents who hold germplasm accessions for the three crops studied (143), 80% use descriptors of some type to document their collections; 69% of the 143 use the IPGRI Descriptors, 45% making exclusive use of them. The remainder I I% do not use the IPGRI Descriptors but either their own descriptors, or developed by other organisations such as UPOV17 or COMECON". Therefore there are 69% "adopters" and 3 1 % "nonadopters" of the IPGRI Descriptors, for one reasons or another, including the possibility of not knowing about the publication.

2.4. What are the main reasons for adopting the IPGRI Descriptors? The germplasm. collection managers surveyed 9 specifically- adopt the IPGRI Descriptors because they meet their needs for germplasm. documentation (50%) and/or because the IPGRI Descriptors are the only descriptor lists available for the crop they are interested in (32%20). In the case of banana, the compatibility with MGIS and MUSAID has been a very important factor, mentioned in focus group discussion and noted in responses to the questionnaire.

2.5. In what way are the IPGRI Descriptors used? The majority (62%) of collection managers for the three crops studied select from the lists only the most useful descriptors for their specific needs; 49% modify or adapt the descriptors; 26% use the complete list and 2 1 % use the lists only as a reference or guidelines for documentation. An interesting distinction is found in the case of banana where a high proportion (47%) of collection managers use the complete list21 of IPGRI Descriptors, most likely as a result of the compatibility with MGIS and MUSAID.

2.6. Why are the IPGRI Descriptors adapted? In response to the specific question on the reasons why users found it necessary to modify the IPGRI Descriptors, the reasons were either because: the characters observed cannot be described adequately using the IPGRI Descriptors (32%), some institutes already have their own documentation systems (30%) and/or there are no descriptors for the characters they consider important (28%22) From 1992, IPGRI

14 Results for each crop were: banana (1984 or 1996) (64/85) 75%, maize (47/61) 77% and coconut (15/16) 94%. Total is 126/162 = 78%.
15 Average for all crops and does not differ significantly from region.
16 In this case also including the germplasm collection managers who requested a copy of any of the IPGRI descriptors in 1997, therefore a total of 188.
17 Union for the Protection of New Varieties of Plants, Geneva.
18 The Council for Mutual Economic Assistance
19 The total number of respondents who hold germplasm collections for the three crops studied is 188.
20 The breakdown for each crop is as follows: 28% for Banana 1984, 19% for Banana 1996, 29% for Maize, 50% for Coconut and 45% of the collection managers who requested a copy of an IPGRI Descriptors in 1997.
21 From the focus group discussion with the Musa germplasm curators, it was realised however that when they say the complete list of descriptors is used, they are mainly referring to the "characterisation" descriptors.
22 Specific results for the three crops studied were: banana 3 1%, maize 5%, coconut 25%. The proportion of users of descriptors who requested a copy of an IPGRI Descriptors, that adapt them for translation purposes is 17%.

Descriptors were already published in English, French and Spanish. However, individual results for each crop studied indicates that there is also a need from the users to translate descriptors in languages other than these major languages. In 16% of cases, the respondents indicated that they have translated the Descriptors to suit local needs.

2.7. What descriptor categories are most commonly used? The most commonly used category of descriptors for the crops studied, is passport *data.* In the case of coconut, less use is made of the further *characterisation and evaluation data* compared to the other crops and this might be explained by the preference for the Stantech23 list of descriptors for this category. For maize collections, *seed management, multiplication and regeneration data* are the most used descriptors; for banana, *pest and disease susceptibility data* are particularly important. The relatively small proportions of respondents using the descriptors for *biochemical composition* and for *cytological characters and identified genes* could be explained by the expertise and resources required to score these, rather than reflecting on their usefulness.

2.8. How useful are the IPGRI Descriptors to the target groups? Users consider the IPGRI Descriptors in general to be "very useful" or a series of activities24 such as: characterisation (71 %), standardisation of information (70%), the establishment of databases (66%), documentation of accessions (65%), creation of core collections (57%), data exchange (55%), evaluation (53%), increase in requests for germplasm through better documented accessions (53%), networking activities (52%), to provide increased access to information (49%), and collection/accession management (39%). The revised version of the banana descriptors produced in 1996 was mentioned as "Very useful" in identifying duplicates in collections (56%), due to the link with the identification
software MUSAID of CIRAD. In general, the 1996 banana descriptors are found to be more useful for
all of the activities listed above when compared with the 1984 version, confirming that the 1996 revision
is a clear improvement.

2.9. What are the limitations and difficulties in using the IPGRI Descriptors? Some of the difficulties in using the IPGRI Descriptors are just an inconvenience to users whereas others seriously affect the decision to adopt. For example a list that lacks certain descriptors of interest might limit the use without necessarily be a major constraint to adoption whereas difficulties in understanding the terminology or the language of the publication can hinder adoption altogether. Furthermore, some limitations, such as the suitability of particular descriptors and the accessibility to the publications are under the control of IPGRI. Others such as users' lack of documentation systems, financial and human resources to undertake the documentation work are not.

The adopters: Most of the adopters (as defined above) have experienced some limitations in using the IPGRI Descriptors (87% for banana, 60% for maize and 75% for coconut). However, most constraints would apply to using crop descriptors in general (rather than specifically to those of IPGRI) and may also affect plant genetic resources activities in general. These are due to a lack of financial resources (53%) and human resources (39%) to undertake the work, a lack of training and expertise available in documentation (44%), and a lack of a documentation system (32%). Problems that are specific to the IPGRI Descriptors, include use of the recommended colour charts26 (27%), scoring certain descriptors27

23 Manual on Standardised Research Techniques in Coconut Breeding, published in 1995.
24 The questionnaires contained a list of different activities where respondents were asked to give a score of usefulness (on a 0-3 scale where 3="Very useful", 2 = "Useful", 1 = "Moderately useful" and 0 = "Not useful".)
25 Based on results obtained from the Musa germplasm curators only.
26 Referring to constraints such as the relative high cost of the recommended charts and their accessibility but also to the difficulty in selecting particular colours because of the great choice and small difference between them.

(25%), the length of the list (22%), difficulties with terminology (14%), selection of descriptors states (I I%) and the language of publication (10%). The languages for which translations would be required will depend on the group of users of a particular crop descriptor list being developed. A survey of the potential users would help to determine the appropriate translations.

The non-adopters: The surveys reveal that the main reason for not adopting (31% of the germplasm collection curators) the IPGRI Descriptors is either because the respondents had already documented their collections before the descriptors were published (33%) or because they simply did not know about or have access to the IPGRI Descriptor publication (28%). These points would need more investigation to find out exactly why potential users do not know about the IPGRI Descriptors to better target their distribution. Only in a few cases were the descriptors unsuitable for their purpose (11%) and/or not available in the first language of the user (9%)[28]. A very small proportion of non-adopters (6%) find the IPGRI Descriptors not to be compatible with documentation system they already had in place.

2.10. How can future IPGRI Descriptors be improved? Regular reviews seem to be essential to keep up with users' needs. From the surveys, 53% of the respondents felt that the IPGRI Descriptors could be improved in one way or another. The individual results for each crop studied (38% for banana 1996, 61% for maize 1991, 80% for coconut 1992) indicate, as expected that for the recently reviewed descriptors for banana, the proportion of respondents who felt improvements were necessary was much lower than the older crop descriptor lists of maize and coconut, confirming that revisions are effective. Some suggestions are made in this report to improve future descriptors and reduce the cost of production, making more efficient use of available resources.

The process of developing crop descriptors: The production of IPGRI Crop Descriptor Lists is currently limited to 3 a year. There is pressure to complete the production within the same year because of the institutional 'budget management procedures. Furthermore, there is a risk of conflicts between different parties, mainly rising from different perceptions of each other's role or breakdown in communication, particularly under time pressure. The capacity to produce Descriptor Lists could be increased either through sharing tasks with other organisations, increasing the number of IPGRI personnel working on descriptors or modifying current production procedures. Crop networks could be encouraged by IPGRI to develop descriptors lists, IPGRI itself concentrating on developing descriptors for which no formal network exists. The development of descriptors might benefit from including a larger proportion of end users such as genebank curators29 or be tested in the field by a representation of this target group before publication to remove potential problems that might occur in the practical use of the descriptors. In the case where a complete revision is not feasible, an up-date leaflet could be produced to be inserted into the publications. New publications could also include a feedback questionnaire at the back for users to fill in suggesting improvements which could be considered by IPGRI after 5 years for the production of an up-date before a complete revision is undertaken. When possible, descriptors need to be compatible with descriptors documentation methodology being developed by crop networks and where a documentation system does not already exist, integral development of both could be advantageous as illustrated in the case of banana. IPGRI could also move away from producing specific descriptor lists to producing guidelines for networks and working groups to develop their own descriptors. This would help collection managers take decision as to the kind of descriptors to develop, and generate a final product

[27] The difficulty here would be mainly in measuring a particular character following the recommended methodology in the publication. The difficulty can be due to just a very difficult character to measure and /or to errors introduced in the methodology. For example, to measure 50 coconut palm trees in the wild when collecting the fruits and returning the site periodically can be impossible in most cases.

[28] This proportion is pulled for all three crops studied but is significantly higher in the case of coconut, with 25%. The coconut descriptors were only published in English.

that may better suit their needs. However, IPGRI should have to ensure that decentralised development of Descriptors does not lead to compatibility problems across different networks or crops.

The content and comprehensiveness of the IPGRI Descriptors: *The* IPGRI Descriptors need to provide clear, detailed explanations of scoring methodology so that data can be recorded in a standardised way in all locations. The use whenever appropriate and possible of photographs or drawings facilitates a common understanding of characters and states to score. Most respondents (74% for banana, 68% for maize and 58% for coconut) felt the number of descriptors in the lists should not be changed. However some felt that the lists may be too long (22%), indicating that IPGRI's recommendation to users to select the most useful descriptors for their individual needs and not use the entire list is not clearly understood by all users.

Describing heterogeneous accessions: The surveys show that 62% of the collection managers experience difficulties in describing heterogeneous accessions. The problem lies in describing the diversity of a trait within a particular accession and therefore in managing this information. Methods are available but it is believed that very few curators apply them. However, there is a need for awareness to be raised to make sure that the curators themselves are convinced they should document this variability.

Improving on suitability of IPGRI Descriptors to discriminate between accessions: A study of the IPGRI Descriptors for Barley produced in 1982, showed that the list was only moderately useful in discriminating between accession?. Using molecular markers in checking that descriptors flagged by IPGRI as being the most discriminating are indeed highly heritable would increase the reliability of the information, facilitate the users in being able to make selection based on a small number of discriminating descriptors. Research is therefore needed to determine the correlation between these key descriptors and their genetic background.

Colour charts and collecting forms: Feedback on the 1996 list of descriptors for banana confirms that the detachable colour chart was useful but still represented a problem for many users. Some of them felt restricted in the choice of colour, indicating that they did not have a good understanding of its main purpose. Once this was clearly explained during the focus group discussion, most users could then see its great advantage in facilitating the choice of colours. One limitation is also that it cannot be obtained separately from the publication or be photocopied when it needs to be replaced. The collecting form included in recent descriptors is useful in indicating the minimum number of Descriptors to use but most curators will recreate their own form to use in the field.

Need for training: Many of the difficulties and constraints affecting the adoption and usefulness of the IPGRI Descriptors could be addressed through training. The need for training has been expressed in several discussions and through the questionnaire surveys where 82% of users feel that they would benefit from more training, especially in the area of data analysis and exchange. In the case of data analysis, IPGRI has realised this need and is developing project proposals to produce guidelines for data analysis. IPGRI is very active in documentation training which includes descriptors. The type of training that is particularly needed, according to the focus group discussion, is training on the use and selection of adequate descriptors, in the field, particularly the characterisation and evaluation descriptors. Training can be done through different approaches such as short-courses, workshops, videos, through on-site visits to collection managers and by producing guidelines and tool kits on descriptors' use.

[29] For example, over 24 contributors and reviewers of the banana descriptors 1996, 6 are presently managers of Musa collections and involved testing the MGIS.

[30] Cross, R.J. 1990. Assessment of IBPGR morphological descriptors in determining pattern within crop germplasm collections. A thesis submitted in fulfilment of the requirements for the degree of Doctorate in Philosophy at the university of Lincoln, Canterbury, New Zealand, October 1990.

Distribution and reaching the target groups: Of the total number of copies of the Descriptors distributed from IPGRI-HQ, 52% are sent in an initial mass mailing based on the institutional Mailing List and a remaining 48% are distributed by IPGRI staff, usually during meetings and workshops. A small proportion are distributed in response to specific requests (e.g. 3% of the distribution of the banana descriptors was done through requests). The results highlight the important role of IPGRI staff in distributing and publicising the Descriptors., Whilst IPGRI reaches 50% of the important target group represented by genebank curators through the Mailing List3l, the distribution by this means could be targeted more effectively by giving priority to the germplasm collection managers listed in the IPGRI Germplasm Database. For example: for the initial mailing of the Descriptors for Banana 1996, 1611 1236 institutes were selected from the IPGRI Mailing List. From the Germplasm Holdings database, 96 institutions are listed as having Musa or *Ensete32* germplasm collections, i.e. primary target group. Of those collection managers, 34 only were covered by the IPGRI Mailing List.

Distribution to libraries and documentation centres: Distribution of publications to libraries and documentation centres is believed in principle to be more effective in reaching a greater audience and is now part of the IPGRI distribution policy. The case of the banana descriptors produced in 1996 was analysed in detail. The results show that 10% of the total number of publications were sent to libraries and documentation centres. Of that number, 73% were retained by the libraries, almost all of whom would like to continue receiving the descriptors (93%), preferably in a printed (71%) or printed and .electronic (29%) as opposed to only in electronic format. It has been difficult to obtain data on the use of the publications held in these library collections and this should be investigated further by sampling a few libraries and studying their records. However, based on the results obtained for this study, IPGRI should continue this strategy as this only represents a small proportion of the total mailing and gives the IPGRI Descriptors good visibility.

Publicising the IPGRI Descriptors : *Taking* into consideration that 22% of the germplasm collection managers surveyed did not know about the IPGRI Descriptors for their crop. More publicity could be made for the series of IPGRI Descriptors. Greater attention could be given to providing information in several languages for use by partners in publications. A leaflet advertising the series of descriptors could also be produced and systematically sent to the collection managers in the IPGRI Germplasm Holdings database. IPGRI is already using the Internet to advertise the series of Descriptor Lists and some of them (banana, coffee and tomato) are available for downloading from the IPGRI Web site. However, the survey shows that only 6% of the respondents to the banana questionnaire who have Internet access have looked at the IPGRI Web site* where the publication is advertised. This proportion is very low and confirms that a diversity of approaches is still needed to make sure that the main target groups are reached.

2. CONCLUSIONS

The methodology followed for this case study was successful in collecting feedback from the end users of the descriptors. The analysis of the feedback provides a clear understanding of the use of the IPGRI Descriptor Lists in general through the strategic choice of crops studied. The IPGRI descriptors are developed in close collaboration with other organisations involved in crop genetic resources conservation and use. They illustrate well the importance of involving the target beneficiaries in developing such innovations to insure suitability for end users. The credit for the achievement of the IPGRI descriptors summarised below is therefore attributed to all partners.

3 1 The percentage of respondents who find out about the Descriptors by receiving a printed copy directly from IPGRI is 46%.
32 Genus of the Musaceae family.

3.1. Achievements

IPGRI Descriptors are well known international standards for the detailed description of specific crop genetic resources and are used by a majority of germplasm collection managers.

IPGRI Descriptors are most of all used because they meet the needs of the users and in many cases are used because they are the only descriptors lists available. Most users modify the list and select only the most relevant descriptors for their specific needs.

The main reasons for not adopting the IPGRI Descriptors are because collections were already documented before the IPGRI Descriptors were published or because potential users were not aware of them.

- Users of the IPGRI Descriptors consider them to be very useful for a range of applications such as (in order of importance): characterisation, standardisation of information, the establishment of databases, ,documentation of accessions, creation of core collections, data exchange.

0 The major limitations in using IPGRI Descriptors relate to the lack of financial and human resources to undertake documentation activities33, lack of training and expertise in documentation and lack of documentation systems. Many collection managers also experience difficulties in-describing heterogeneous accessions which is a general documentation and management problem.

- Difficulties that are experienced less frequently and that are under the control of IPGRI include constraints in using the colour charts, in following the methodology to score particular descriptors and in understanding terminology.

3.2. Suggestions

Periodic revisions of the IPGRI Descriptors offers the clear potential for improvement and should be continued. The current cycle of 10 years seems quite long and could be complemented with an up-date every 5 years. In the light of the results of this case study, further suggestions for improvements have been made for consideration by IPGRI as summarised in the following:

- To increase the proportion of collection curators in selected group of reviewers of the publication.

- To take advantage of opportunities that arise to test the IPGRI Descriptors in the field by representative groups of users before publication (e.g. during crop network meetings, workshops etc.).

- To improve the comprehensiveness of the IPGRI Descriptors by including more illustrations where possible and including more reference material.

- To increase accessibility and usefulness by publication in a wider range of languages.

- To continue to seek solutions to facilitate the use of the recommended colour charts for the crops where colour traits are very important.

- To stimulate and promote training activities on the use of descriptors through short-course, videos and production of "tool kits".

- To be pro-active in promoting the development of descriptor lists within existing networks and provide advice to facilitate development.

- To stimulate research in determining highly discriminating descriptors that have a strong genetic basis using molecular techniques.

- To encourage research and application of methods to facilitate scoring of heterogeneous characters.

33 Which also can be reflected in a wider range of genetic resources activities.

- To reach more germplasm collection managers when targeting the distribution of printed copies of the IPGRI Descriptors.

- To closely monitor and document the development and application of the IPGRI Descriptors to support continued effort to enhance them and assess their impact.

Adoption Case Study:

International Musa Testing Programme of

INIBAP - IMTP

By

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1. INTRODUCTION

This report provides summarised information on one of two case studies carried out by IPGRI during 1997-98 as part of its work in impact assessment. The study examines the International *Musa* Testing Programme (IMTP) of the International Network for the Improvement of Banana and Plantain (INIBAP). It assesses the effectiveness of the IMTP as a system for providing *Musa* (banana and plantain) breeding programmes with information on the performance of their new varieties under a range of environmental conditions and varying pest and disease pressures, while at the same time allowing National Agricultural Research Systems (NARS) early access to improved varieties. The study looks critically at the motivation underlying the participation of the various partners in the programme. It also attempts to examine the links that must be in place for new varieties developed by breeding programmes to be adopted by small holders. The study describes the constraints which have been identified as affecting the operation of IMTP and documents how the programme has evolved in response to the changing needs of participants.

1.1. Goal of the International Musa Testing Programme (IMTP) The IMTP was set up by INIBAP in 1990, in response to the needs of NARS to provide farmers with banana and plantain varieties that were resistant to the major disease affecting Musa production around the world at the time, i.e. black Sigatoka. The specific purposes of the IMTP are to coordinate the global evaluation of improved germplasm produced by *Musa* breeding programmes, to increase knowledge on resistance and tolerance mechanisms to some of the major diseases affecting Musa, and to identify resistant *Musa* cultivars that can be recommended to NARS for further evaluation and possible release to small-holders. The IMTP also seeks to contribute to increasing the capacity of national institutions to evaluate improved varieties and to carry out research on banana and plantain for local consumption.

The first phase of the IMTP from 1990 to 1993 was funded by UNDP (United Nations Development Programme). One breeding programme, FHIA (Fundacion Hondurena de Investigacion Agricola, Honduras) provided 7 hybrids, which were evaluated in 6 sites'. Following the global analysis of the results of the IMTP Phase I, three hybrids from the FHIA programme (FHIA-01, Fl-RA-02 and FHIA-03) were recommended for further distribution and evaluation. Following requests from NARS, to continue the programme, a second phase of the IMTP was developed by INIBAP and funded by UNDP. Despite the fact that funding for the establishment and maintenance of the evaluation sites was not provided in this second phase, a greatly increased number of NARS and breeding programmes decided to participate. The project is now entering its third phase and the evaluation, which in the first phase covered only black Sigatoka resistance, now also includes yellow Sigatoka, Fusarium Wilt and nematodes. Thus the scope of the IMTP has expanded significantly over time, evolving and adapting to the changing needs of its participants. Several breeding programmes are now providing improved germplasm for testing and many NARS are participating in the evaluation trials.

2. METHODOLOGY

The case study used a variety of complementary approaches, gathering new information by questionnaire, interview and focus group discussion. The precise target groups for the study were the IMTP trial site managers and the people involved in further evaluating the IMTP varieties released as a result of Phase 1, that is, the National Evaluation Programme (NEP) managers. The present case study

1 The IMTP Trial Sites for Phase I were held in Honduras (FHIA), Costa Rica (CORBANA), Colombia (ICA, now CORPOICA), Nigeria (IITA), Cameroon (CRBP) and Burundi (IRAZ).

uses the "illustrative" approach, as defined by Sechrest et al. 1996 [2] . This approach describes in detail I a process or series of events in order to obtain a clear understanding of the cause and effect relationships involved.

2.1 Questionnaires

Information for the study was obtained mainly from two questionnaires. The first was aimed at the 20 IMTP trial site managers of the IMTP Phase 11 and had a reply rate of 90%. The second, which had a reply rate of 53%, was aimed at the 50 institutes which had requested, between 1993 and 1996, the hybrids recommended from IMTP Phase I for further evaluation; i.e the NEPs. The questionnaire for the IMTP trial site managers was designed to provide information on the effectiveness of the IMTP and asked site managers to indicate how well they thought breeding programmes understood their needs for improved material and how well they believed relevant information was fed back to breeding programmes. The questionnaire also investigated the motivation and benefits from participation and the constraints encountered. The questionnaire for NEPs aimed to collect feedback on the performance of the IMTP varieties and gathered information on other Musa evaluation activities by NARS. The data analysis and percentages obtained from the questionnaires are expressed on the basis of proportion of the total number of respondents to the entire questionnaire and in some cases to particular questions.

2.2. Interviews and focus group discussion A focus group discussion and individual interviews were an essential part of the methodology for collecting information and feedback from participants in the IMTP. They provided a unique opportunity to explore certain issues in depth, adding value to the data gathered through questionnaires, and providing an opportunity to have direct contact with users and involve them in the study. The focus group discussion was held during the First *Musa* Germplasm Information System (MGIS) training workshop, held -in Guadeloupe from 10- 16 October 1997. Interviews with IPGRI-INIBAP staff were also undertaken to identify critical issues.

3. RESULTS AND DISCUSSION

3.1. Main benefits of participation in the IMTP The most important reasons for the participants to take part in the IMTP were to acquire improved *Musa* germplasm and to respond to farmers' needs for varieties with improved performance (72% of respondents gave a score of "Very important" to both reasons). The IMTP allows NARS to evaluate the material under their own conditions and make appropriate recommendation for farmers in their respective region. For 4 1 % of the IMTP trial sites surveyed, no other national *Musa* evaluation trials are taking place in their country, leaving the IMTP as the sole mechanism for evaluating improved varieties. Another important reason to participate in the IMTP especially mentioned by NARS was to establish links with other researchers fro International/Regional Agriculture Research Centres and other Advanced Research Institutes (53%). The opportunity to influence future strategies of *Musa* breeding programmes was also cited as an important reason for participating (40%).

For breeding programmes donating germplasm, the most important reason for participating was to get international publicity for their best hybrids and to get them evaluated as widely as possible. While breeding programmes may have other opportunities to evaluate their material locally, the IMTP is unique in its global coverage and capacity to facilitate the transfer of Material between regions. In addition, for the participating breeding programmes, IMTP provides an opportunity for their materials to be compared with interesting hybrids from other programmes.

[2] Sechrest, L., Stewart, M., Stickle, T.R. and Sidani, S. 1996. Effective and persuasive case studies, Jaguar Graphics, Tucson, Arizona.

3.2. Difficulties encountered in participating in the IMTP Of the trial site managers surveyed, 87% encountered some problems during their participation in the IMTP. For the national institutes surveyed, the most serious limitation was difficulty in multiplying sufficient planting material to establish trials. Difficulties in collecting evaluation data, often due to lack of personnel, the presence of off-types in material received and delays in receiving germplasm were also important factors affecting participation. Other difficulties were caused by lack of information on the management of the varieties being evaluated and the poor suitability of the varieties for local conditions and tastes.

3.3. Links between the IMTP, breeding programmes, NARS and farmers The IMTP links Musa breeding programmes to NARS who then have direct contact with farmers. For the IMTP to be efficient, it is important that all participants have a good understanding of each other's roles and needs through an effective two-way flow of information.

Characteristics that should be addressed by Musa breeding programmes: National institutes evaluating the IMTP varieties consider that very important characteristics that should be addressed in developing improved varieties, in order of importance, are: disease resistance (88%); high yield (86%); pest resistance (71%); taste in general (68%); adaptation to local tastes (54%); improved shelf life (50%); export quality (41%); cooking/processing quality (33%); growth habit (e.g. height (39%) and suckering (22%)); drought resistance (25%); cold tolerance (18%); and suitability for multipurpose use (10%). Participants in the IMTP feel that breeding programmes have a "very good" understanding of NARS' needs in terms of disease resistance and yield improvement whereas their understanding for pest resistance, fruit flavour, post-harvest characteristics, growth habit, type and uses, and drought resistance have been rated as "moderately good".

Farmers and the IMTP: Over 80% of the institutions participating in the **IMTP** are also responsible for national extension activities related to evaluation trials, such as germplasm multiplication and distribution, information dissemination, and continued maintenance and evaluation of demonstration plots. However, the link between the IMTP and farmers will depend on the specific mandate of the institutes carrying out the evaluation i.e. international, regional or national. In cases where programmes have a regional or international mandate, the link with farmers is through the NARS, whose responsibility it is to provide planting material to farmers. Therefore farmers have faster access to improved IMTP varieties when the evaluation trials are carried out directly by NARS. According to the surveys, 44% of the **IMTP** trial sites are visited by farmers (58% in the case of national institutions and 17% in the case of breeding programmes). Of these sites, 86% are asked for planting material by farmers. It is therefore an efficient way of publicising the material. However, in only 42% of the cases could planting material be supplied directly to farmers. This was because sites either do not have enough planting material to satisfy farmers' demands or site managers feel that the material needs further evaluation before distribution to farmers.

Farmers and National Evaluation Programmes (NEPs): The involvement of farmers in the NEPs provides a mechanism for feedback to the breeding programmes through the NARS, of information on the potential acceptability and performance of the varieties tested. The survey shows that 72% of NEPs involve farmer participation. In 72% of cases evaluation is carried out in farmers' fields and in 44% of cases carried out on-site at the station, with farmers being invited to participate in field days. As in the case of IMTP trial sites, NEPs are frequently (62%) asked by farmers visiting for planting material and 45% of NEPs charge for it.

3.4. Role of INIBAP in variety evaluation

Feedback from NEPs indicates that INIBAP makes its most important contribution in variety evaluation through providing information on improved varieties, providing virus-indexed planting material to

national programmes and providing training and information on evaluation techniques (mentioned by 88%, 75% and 67% of NEPs respectively). The importance of the role of INIBAP in providing information was further confirmed by the fact that 42% of NEPs select *Musa* varieties for testing on the basis of this information.

Capacity building: The IMTP Phase I is felt to have had little impact on building capacity of participating institutions. However, institutions were selected on the basis of their existing breeding and research capacity. Nevertheless, since a significant proportion of the site managers for IMTP Phase II are from NARS, there is a need to give more attention to capacity building. This need is expressed in the survey where 64% of participants in IMTP 11 feel that they would benefit from further training particularly in documentation/database management, 57% in in vitro propagation (tissue culture) and 50% in data analysis.

3.5. IMTP released varieties One of the assumptions of the IMTP was that the release of improved germplasm to the *Musa* community would stimulate the further testing of material through the establishment of NEPs. The study found that there was indeed a great willingness from NARS to evaluate the IMTP varieties further. INIBAP has received many requests from NARS for the three FHIA varieties recommended by Phase 1, and by the end of 1996, they had been distributed to more than 50 institutions; 82% of respondents feel that the area planted with these varieties was likely to increase in the future. In general, the respondents feel that the FHIA hybrids, especially FHIA-01, were or would be well accepted in their country because of their resistance/tolerance to diseases and pests and for their yield and vigour. However the acceptability of the flavour of the fruit varied according to local preferences.

Impact of improved hybrids: Although farmers may be involved in the evaluation trials, by and large, the new varieties have not yet reached farmers' fields. This is mainly due to the nature of the crop with its slow multiplication rates by conventional means and long harvest cycles. However there are a few countries where more concerted efforts have been made to promote the production of these new varieties. Cuba, for example, began a massive testing programme of the FHIA varieties that performed well against black Sigatoka. The area covered with FHIA hybrids, in 1997 around 6,000 ha, is expected to double by the end of 1998. Australia released FHIA-01 as the commercial variety "Goldfinger" where it is showing good potential for production in sub-tropical areas. In Costa Rica there has been an initiative for organic production of bananas and plantains using the FHIA hybrids.

Increased income to farmers: Information on farmer's income was very difficult to obtain because most of the varieties were still being evaluated, the release to farmers being planned for a later stage. However, some information is available. In the Seychelles, it is reported that farmers obtained doubled profit compared to the native variety. In Australia, it is reported that sales of FHIA-01 have been at $10-20 per 13 Kg carton, which is about $5-$10 better than for Cavendish in the subtropics. The disease resistance of the FHIA hybrids means that farmers can have improved yields without having the high cost or negative environmental impact of pesticides. An independent study from IITA showed that a resistant variety to Black Sigatoka could have a comparative advantage of 10:1 to 5.5:1 over fungicide treatment and can lead to a 225% yield increase.

3.6. Overcoming constraints identified within IMTP

Budget of the IMTP: Due to a shortfall in the budget allocated for the IMTP Phase 1, certain activities that had been originally planned could not be developed. These include research for improvement of rapid screening methodologies, production of a catalogue of selected hybrids, and training of regional scientists and technicians in Musa germplasm evaluation. An annual global meeting for review of the IMTP results was replaced by the global meeting at the end of the Phases (after three years). Funding for Phase 11 did not include the evaluation trials themselves. Training activities were organised on an

informal basis and were limited to exchange of expertise during meetings and site visits of the IMTP and regional coordinators. Phase III is already beginning and funding is still uncertain. If resources are very limited, this will impact on the functioning of the programme and on the future structure of the IMTP.

Collection of evaluation data and feedback to INIBAP: At the present time, the feedback of evaluation data from the IMTP trial sites to INIBAP Headquarters is slow and this hampers global analysis of data. Of the respondents experiencing difficulties in participating in the IMTP, 54% found difficulty in collecting data. This can be related directly to the lack of financial and human resources available to undertake germplasm evaluation (38%) and/or problems in following the IMTP technical guidelines (33%). It also depends on the understanding by users of those guidelines and the quantity of data required for the IMTP. In the light of the recommendations from the second IMTP Global Meeting in March 1997, the evaluation protocols were revised in anticipation of a third phase of the programme. Two levels of evaluation have been introduced, in-depth and simplified. A larger number of NARS will be able to participate in the simplified evaluations, which require only a minimum level of expertise in disease evaluation and a low level of resource allocation. At the same time, in depth evaluations will be carried out at sites where the necessary expertise and resources are available.

Facilities for mass propagation of the IMTP varieties: Difficulty in multiplying sufficient planting material is the greatest constraint faced by 57% of the national institutes surveyed in establishing IMTP evaluation trials, and this also affects the rapid dissemination of good varieties to farmers. In 62% of cases, where facilities are available for in vitro propagation of planting material, they are not devoted solely to bananas; funds may not be available to use private propagation labs. To help overcome this latter bottleneck, INIBAP is now establishing Regional Multiplication Centres.

Information related to the candidate varieties and their selection criteria: Improved germplasm volunteered for the IMTP had, in the past, been insufficiently documented. The possibility is also recognised that, in order to gain publicity, breeding programmes may offer varieties to the IMTP before they have been sufficiently evaluated and documented. Furthermore, the selection criteria used to include germplasm in the IMTP have not always been clear to the participants. In response to this, the IMTP coordinator is developing a database of information on IMTP candidate clones, which will be made available to all IMTP participants. A lack of documentation was reflected in the surveys as an important limitation to effective participation by 38% of the IMTP sites.

Regional preferences for particular germplasm characteristics: The fact that some of the varieties included in the IMTP were not suitable for local needs has been a limitation to effective evaluation for 41% of respondents. This was because in the past, all IMTP varieties were tested at all sites. The problem will be addressed with the expansion of the IMTP in Phase III when a greater number of varieties and evaluation sites will be included, and sites will be allowed to select for testing only those varieties most appropriate in terms of local consumer demands.

The increasing number of participants: The expansion of the IMTP could result in its becoming more difficult to manage. While an evaluation programme with an increasing number of sites may be good from the point of view of statistical analysis, large global IMTP meetings may be difficult and very costly to organise. Furthermore, as the programme expands to take on more of a regional focus, the usefulness of holding global meetings is being questioned. To take this into account, regional IMTP meetings could be organised separately or within the context of regional network meetings.

4. CONCLUSION

4.1. Achievements of the IMTP

The credit for the impact of the IMTP is attributed to all partners and collaborators involved, from farmers to breeders. No single institute could achieve such results on its own; the IMTP is a very good example of the collective effect being greater than the sum of its parts. Participants feel that the IMTP is achieving its objectives particularly in:

- providing information to breeding programmes and to plant pathologists
- establishing links between researchers
- facilitating the flow of germplasm between countries
- providing information on banana varieties to NARS
- influencing banana breeding strategies
- identifying potential constraints to the adoption of new varieties by farmers

Although it is too soon to be able to measure the effect of improved varieties on global banana and plantain production, some major achievements of the IMTP to date can be stated based on the results of this case study:

- The IMTP is the **only mechanism to allow the world-wide multilocational evaluation** of improved germplasm for resistance to the serious diseases affecting Musa production and forms a valuable link and mechanism for feedback between and to breeding programmes. The IMTP has been incorporated into the research strategy of breeding programmes and is complementary to existing national evaluation systems. The participants in the IMTP have a very good understanding of the goal and purpose of the IMTP and there is a high willingness of present participants to continue to participate.

- As a result of the IMTP, there is now an **increased exchange and evaluation of germplasm at the international level.** The contact between breeding programmes is particularly significant considering that only ten years ago, such programmes were reluctant to distribute their best hybrids.

- The IMTP **facilitates feedback from the NARS to breeding programmes** and *vice versa,* and encourages closer collaboration between the partners in *Musa* improvement. As a rule, Musa breeding programmes are considered to have a good understanding of NARS' needs for improved germplasm in terms of disease and pest resistance and yield. The IMTP also provides a forum for the exchange of information and expertise on evaluation of improved germplasm between the *Musa* community, and provides breeding programmes with the opportunity to link with other advanced research institutes.

- The IMTP allows **NARS early access to disease-resistant and highly productive Musa germplasm,** an important step in the process by which **farmers have access to a wider range of varieties** of improved banana and plantain germplasm. NEPs conducted by NARS are the key to the adoption of improved varieties by farmers. The IMTP varieties may stand to have an **important impact at the farmer's level** in terms of increased income and reduced use of pesticides.

4.2. Improved Phase III of the IMTP

Following discussions at the Global IMTP Meeting in Guadeloupe in 1997, it became clear that the objectives and modus *operandi* of the IMTP were no longer appropriate for meeting the needs of the growing number of national programmes wishing to participate. Phase III of the IMTP has been designed in such a way as to address many of the constraints related to earlier phases, with the following suggested improvements:

- The **introduction of two levels of evaluation;** in-depth evaluations to be carried out at a limited number of sites where expertise and resources are readily available, and simplified evaluations which can be carried out by a larger number of NARS.

- **Development of simplified evaluation guidelines** requiring a minimum level of expertise in disease evaluation and a low level of resource allocation by national programmes, thus allowing a larger number of NARS to participate.

- **Creation of a greater incentive for trial sites to feed back evaluation data for global analysis.** INIBAP should seek ways of encouraging the use of the suggested evaluation guidelines and ensuring that the evaluation data be collected and provided to INIBAP.

- **Collection of adequate information on candidate clones prior to their inclusion in the IMTP.** This issue is being addressed by INIBAP and a database structure for information on the IMTP candidate clones has been finalised.

- **Regionalization of the IMTP.** INIBAP acknowledges that there is little to be gained from evaluating varieties outside of the regions where they are likely to be cultivated. In future phases of the IMTP, NARS will select the material they wish to evaluate according to local needs and preferences.

- **Facilitation of mass propagation of planting material for IMTP trial sites.** INIBAP is encouraging the establishment of regional multiplication centres, which receive in vitro cultures of the varieties in highest demanded in each region. Three centres have been established which are able to mass propagate the material and supply NARS with larger numbers of plants than can the INIBAP Transit Centre (ITC) in Leuven.

- **Capacity building and training.** With an increasing number of national institutes participating in the IMTP, it is felt that formal training/workshops are needed to assist participants in the IMTP to interpret disease symptoms, follow evaluation guidelines correctly, and ensure correct data collection and interpretations for all sites.

Future monitoring of the IMTP. Future impact assessment studies should be an integral part of the project and should focus on adoption of varieties by farmers and on the economic impact of new varieties once they have been widely distributed to farmers. The IMTP Logical Framework should be used as a tool for evaluating its progress. Feedback should be systematically collected based on impact indicators from participants and the main beneficiaries.

The present case study highlights the importance for effective participation of involving target beneficiaries at the project planning and developing stages. Regular contacts with the IMTP participants and global meetings have proven to be good mechanisms to evaluate and assess the effectiveness of the IMTP. The case study has provided the qualitative and quantitative data to support recommendations deriving from these contacts.

CGIAR and NARS Post-Production Innovations in The Philippines and Vietnam

By

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1. PURPOSE AND METHODOLOGY OF THE PROJECT

Farmers in Southeast Asia increasingly need a wider choice of labor-saving technologies to help them cope with growing labor shortages and higher labor costs. However, the private sector in the region often lacks the financial resources and technical knowledge to acquire new technology and adapt it to local conditions. Moreover, there is little incentive to adopt and adapt new technology because manufacturers are often unable to secure the patent protection necessary to recoup their research and development costs.

Accordingly, the project, *Agricultural Engineering in Evolutionary Systems (AEES)*, was set up in 1995 to help make public-sector agricultural engineering more effective at filling the gap left in the private sector in these two countries. The AEES project's objectives were to:

1. Gain an in-depth understanding of how the equipment technology research, development, adoption, and adaptation process works;

2. Based on this understanding, identify improved approaches to managing and catalyzing the technology-change -process;

3. Compare this improved approach with emerging approaches in other disciplines and to identify the similarities and differences;

4. Communicate the project's findings to both policymakers and practitioners.

This IAEG-funded project, *CGIAR and NARS Post-Production Innovations in the Philippines and Vietnam (PIPV)*, was set up in 1997 and has substantially contributed to objectives one, two and four, through this project report and a video. The AEES project, finishing in 2000, will contribute to all four objectives by producing a Ph.D. thesis, peer-reviewed papers, and a book entitled *Fertile Feedback.- An Approach to the Successful Introduction of Technology in Rural Areas.*

The PIPV project was carried out in partnership with the International Rice Research Institute (IRRI), the Philippine Rice Research Institute (PhilRice), the College of Agriculture and Forestry (CAF) in Vietnam, with support form the Department of Agriculture, University of Reading, UK, and the University of Arizona, USA.

The methodological approach used was to study the introduction of two technologies - the stripperharvester to the Philippines and a very low cost dryer, the SRR dryer, to Vietnam. Both technologies were chosen because they are relatively new, which made it easier to study the initial adoption process. Both technologies - although limited to date - are likely to be widely adopted in the respective countries.

Less detailed case histories of four other technologies were also prepared to establish whether the main case study findings have wider relevance. Table I shows all six technologies.

2. RESEARCH, DEVELOPMENT, ADOPTION, AND ADAPTATION OF MAIN CASE STUDY TECHNOLOGIES

2.1 Stripper harvester

The stripper-harvester is a walk-behind machine that can harvest about 4 tons of paddy per day with three operators. The machine, costing about $2,100, has been in commercial production for 5 years with 139 machines sold in the Philippines (total value US$290,000).

Research began on stripper harvesting at IRRI in 1990, when the Silsoe Research Institute in the UK allowed IRRI to evaluate their new, and commercially- successful, stripper rotor system in tropical rice conditions. Initial test results were very promising and as a result IRRI began attempting to scale-down the technology (stripper rotors had previously been used only on large combine harvesters in Europe). IRRI and the Silsoe Research Institute received Holdback funding for this from the British Overseas Development Administration (ODA, now DFID). The first prototype harvester, designed for small-farm use, was tested in 199 1. In 1992, an IRRI press release, which gave details of the work generated a great deal of interest, was featured as far afield as Denmark and Latin America. Several Philippine farmers, who had read articles in the local press, or seen a TV program on the work, visited IRRI to see the machine work. This led to the first commercial order, delivered to a farmer in 1993. A number of orders from research institutes in other countries were also forthcoming. IRRI and PhilRice began to jointly evaluate the stripper-harvester with a cooperative in 1993. This collaborative work led to a large manufacturer opting to set commercial production in the same year. In 1994, the German government, through Deutsche Gesellschaft für Zusammenarbeit GmbH (GTZ), funded PhilRice to assume responsibility for evaluation and local adaptation of the stripper-harvester in the Philippines, as well as to provide industrial extension. Unfortunately, neither IRRI nor PhilRice were able to bring the fabrication quality of the large manufacturer up to standard. As a result of this and machine mobility problems in sticky and soft mud, sales were initially disappointing.

In 1995, PhilRice was successful in including the stripper-harvester in a government machinery promotion program. The program provided all 12 Regions in the Philippines with demonstration units,, and provided soft loans for cooperatives to buy the technology. The program encouraged a number of manufacturers, through the promise of government orders, to begin building the machine. By 1996, thirteen manufacturers have built at least one stripper-harvester.

IRRI continued to monitor the adoption of the stripper-harvester after PhilRice assumed responsibility for it in the Philippines. In 1995, partly as a result of this work, IRRI and PhilRice released the Mark 11 stripper-harvester, which included a number of modifications, many of which had been developed by

Table 1: Technologies studied in the project.

Technology	Main source of development	Philippines Adoption status	Vietnam Adoption status
Harvest equipment			
Stripper-harvester	Public sector	Very limited	Rejected
Mechanical reaper	Private and public sectors	Limited	Limited
Drying equipment			
SRR	Public sector	Not introduced	Limited
Flat-bed	Public and private sectors	Very limited	Fairly wide
Flash	Public sector	Limited	Not introduced
Recirculating	Private sector	Fairly wide	Not introduced

Main case study technology

manufacturers, or suggested by farmers. IRRI also carried out research to solve the main emerging problem with the technology - poor mobility in soft and sticky field conditions. There were two aspects to the problem that were reducing machine weight while maintaining strength and durability, and improving the wheel design. An innovative manufacturer tackled the first aspect in 1996 when he developed a version of the Mark 11 stripper-harvester that was 25% lighter. IRRI collaborated with another manufacturer to develop an improved wheel. In 1998, IRRI released drawings of the Mark III stripper-harvester, based on these two developments.

In 1996, PhilRice began developing a smaller, cheaper, and lighter version of the stripper-harvester called the Lite stripper-harvester (LSH). In 1997, they demonstrated the machine to the Philippine Secretary of Agriculture who had become interested in stripper harvesting after reading an IRRI press release that was published in Philippine national newspapers in December 1996. PhilRice subsequently received funding from the Department of Agriculture to provide 15 LSHs and 15 Mark III stripper-harvesters to farmers and', cooperatives. The first commercial production of the LSH was part of this scheme. Early indications are that the LSH will need to go through several more design iterations before farmers see it as a 66 perfected" technology and buy it in preference to the Mark III stripper-harvester.

In addition to working in the Philippines, IRRI has shipped prototypes to research institutes in 14 other countries in North and South America, Asia, and Africa. NARS in China, Indonesia, Thailand, Vietnam, the Philippines, and Senegal have R&D programs on stripper harvesting as a result of these shipments and subsequent IRRI visits.

2.2. SRR dryer

The **SRR** dryer is the cheapest mechanical dryer available in Vietnam, and possibly in the World, selling at $90 for the basic model - the **SRR-1. The SRR-1** has a 1-ton capacity with a drying time of about 60 hours for wet paddy. The dryer uses heat from a domestic coal or electric stove to heat air, which is blown into a cylinder at the center of a traditional cylindrical bamboo mat paddy store.

CAF developed the SRR dryer, based on' the principle of low-temperature drying. Low-temperature drying, like stripper harvesting, was originally developed and commercialized in developed countries. Hohenheim University in Germany, in collaboration with IRRI, evaluated the suitability of lowtemperature drying in the humid tropics. As a result of favorable findings, a GTZ-IRRI project (the same one that funded the stripper-harvester work) funded the evaluation and development of low-temperature drying in Vietnam. The first SRR dryer prototype was built in 1995, in an effort to reduce drying costs by reducing the fixed cost of the machine. The first dryer was sold commercially two months after testing of the prototype.

Compared to the stripper-harvester, the SRR dryer is a very simple machine, with no belt drives and no bearings except those internal to the electric motor. In contrast the stripper-harvester has 21 bearings, 4 belt drives, and 2 chain drives. The stripper-harvester is designed to be driven while the SRR dryer is a stationary machine. The SRR dryer therefore has far fewer degrees of design freedom.

The simplicity of the SRR dryer with respect to its degrees of design freedom has meant that CAF, manufacturers, and users have been able to adapt it much more quickly to meet manufacturers' and users' needs. CAF's very close link with manufacturing and the target group has facilitated this process. Modifications by CAF and the main manufacturer have included replacing the original electric heater element with a coal stove, increasing the height of the SRR- I drying bin to give it a capacity of 1.4 tons, improvements to the blower design, and addition of a starting capacity to enable easier starting in are with poor electricity supply. Owners have made modifications to the recommended operating procedures. For example, they have shortened the drying time by keeping the heater on all the time, and started

mixing the paddy to prevent wet-spots developing. Some owners have experimented drying commodities other than rice.

The overall effects of these modifications have been to improve the performance and potential market for the SRR dryer. About 700 dryers (total value US$63,000) have been sold in 3 years. CAF has shipped SRR dryers to NARS in the Philippines, Myanmar, and Bangladesh. for evaluation.

A project survey of 44 adopters found that the dryer allows women additional time for more profitable activities and children more time for their studies. The private sector alone would never have developed such a technology because it is too easily copied and the profit margins are too small.

3. KEY INSIGHTS

The work produced two key insights. First, manufacturers and farmers often modify or adapt a technology to meet their needs. Second, once farmers and manufacturers know enough about the technology to make sensible modifications and select the Ones that better meet their needs, the technology development process becomes self-perpetuating and leads to wider adoption--without the need for further intervention by the public-sector.

The process is analogous to biological evolution, which adapts living species to local niches - and like biological evolution it can be immensely powerful. For example, the estimated 1,000 flat-bed dryers2 now used in the Mekong Delta of Vietnam have all evolved from a single dryer that was introduced by one researcher into one village. A few farmers started to copy it. As they learned by building and using the technology, they improved it. One of the first important improvements to the *hardware* was to replace the original wood-burning furnace with a version of their local rice hull cook stove. Rice hulls are in greater supply than wood. Dryer operators also made improvements to the dryer *software* (operating procedures, labor arrangements, etc.). Thus, instead of bagging the grain inside the dryer, operators now scrape it out of one side, using a tool borrowed from sun drying. This allows the loading of a second batch much faster and the bagging of the grain after it has cooled while the second batch is drying. This innovation allows farmers in Vietnam to dry three batches of paddy per day, while their counterparts in the Philippines, who bag in the dryer bin, dry only two batches per day. As laborers, farmers, and manufacturers have gradually made the dryer cheaper and easier to use, and as the market for quality rice has co-evolved to favor the adoption of mechanical dryers, the dryer has spread to neighboring provinces. Adaptations continue to be made. Less expensive nylon screen is now being used instead of more costly perforated metal screen, reducing the purchase price by 7.5% and the repair and maintenance costs.

The process described above - in which many small improvements are made by a large number of persons - is quite different from the scenario that occurs in most research institutes. Traditionally, a small team of institute engineers typically build prototypes of new machines with little or no input from manufacturers and farmers. It is assumed the technology is suitable for transfer to farmers. Extension is carried out by a separate extension agency. If the technology fails to be adopted, it is the fault of the fanner for being "backward" or the manufacturer for making mistakes. Researchers usually do not work with manufacturers in the design process to help avoid mistakes, or confer with farmers why they are not adopting a particular piece of equipment.

An exception to this stereotype was an industrial extension program run by IRRI from the mid- 1970s to the mid1980s. Although the program was called "industrial extension," the work carried out did not resemble extension in its traditional sense, i.e., transmitting a message to passive recipients. Rather, it allowed researchers to work alongside manufacturers and farmers during the initial adoption process. The

2 A typical Vietnamese flat-bed dryer can dry a batch of 6 tons of rice in 8 hours. Cost: US$2,000.

program was effective in capturing manufacturers' and farmers' suggestions on how technology could be improved. Partly, as a result of the program, IRRI has been rather unique in achieving widespread impact in this arena. The most successful technology that came out of the program was the axial-flow thresher. Well over 90% of all rice threshed in Vietnam and the Philippines is threshed on variants of the original design, first released to manufacturers in 1973. It is probably the most commonly used rice thresher in developing countries.

In 1986, IRRI terminated this program, partly because the work w as perceived as an extension activity that was outside of the Institute's mandate. NARS, even though they do have an extension mandate, generally do not fund industrial liaison or extension efforts. In some Southeast Asia countries, this has contributed to government-funded manufacture and promotion of institute-designed machinery that has ultimately proved to be inappropriate or poorly adapted.

4. USING A PARTICIPATORY APPROACH TO INCREASE IMPACT

The present study suggests that, to be more effective in adding to farmers' choices of appropriate technology, the public sector must introduce new technology in an evolutionary, participatory process, rather than a top-down one. In other words, instead of dividing the research, development, adaptation, and adoption (RDAA) process into separate, sequential tasks with different stakeholders responsible for each, the public sector should be more of a catalyst or facilitator for the whole process.

Findings from the case studies suggest that research institutes should:

- Adopt fewer hierarchical organizational structures to allow more flexibility and responsiveness to evolving situations;
- Have more flexible mandates that allow research teams to be involved in the initial adoption of a new technology;
- Develop innovations that motivate researchers to work to solve farmers' problems;
- Acknowledge that the innovations of first-adopter farmers and manufacturers are often essential before widespread adoption will take place for complex technologies and/or those being introduced into complex systems;
- Plan projects to allow time and resources to be put into working in partnership with manufacturers and first-adopter users to capture these innovations;
- Take into account that the time necessary for working in partnership will be proportional to the complexity of the technology and the system into which it will be introduced;
- Give much more priority to monitoring, evaluation, and feedback during the course of the project.

Many of these recommendations are inherent in the participatory approaches that are increasingly being used in rural development. Participatory approaches - methods that involve stakeholders early on in the R&D and transfer processes - will create a synthesis between researcher and farmer knowledge that will better solve farmers' real problems.

A very limited number of public sector R&D units have already adopted participatory approaches. One example is the dryer team of the Faculty of Engineering at the CAF in Vietnam. Because of very low salaries for university staff in Vietnam (in 1996, US$40 per month was typical), the group manufactures and sells a small number of dryers each year (about 30 at US$2,000 each). Of the 10% profit, half is reinvested to supplement the group's research budget, and the rest is shared among the staff. The group pays the university 1% of the sales for the use of the university name and facilities. This arrangement is highly beneficial - the researchers, who have a direct link to the users, are highly motivated to improve their product and the findings from their commercial activity help guide their research. CAF's activities,

which have been conducted on a minimal budget, have been instrumental in nurturing the widespread adoption of the flat-bed dryer in Vietnam. The knowledge gained by CAF engineers working on the flatbed dryer undoubtedly contributed to the rapid development and adoption of the SRR dryer.

Not all R&D units in the public sector can set up businesses to commercialize the products of their research, so the CAF approach may not be appropriate in other contexts. However, it shows that institutional innovations that reward researchers for impact in farmers' fields - and that facilitate strong linkages between research and extension - can be very successful.

5. IMPROVED THEORETICAL UNDERSTANDING OF THE ADOPTION PROCESS

The CAF example suggests that, just as new technology needs to be adapted to local conditions, new approaches to developing and disseminating technology also need to be locally adapted, based on a common set of principles or theoretical framework. The IRRI industrial extension approach has not been widely adopted probably because of a lack of understanding and articulation of the reasons why it was successful.

The present study contributes to an improved understanding of technology development. Most of the theoretical insights described below come from the stripper-harvester, for which the greatest amount of process documentation exists, and where the sociological/anthropological approach of participant observation was used.

The stripper-harvester case study clearly supports the hypothesis that equipment improvement evolves over time, and that this process - as already mentioned - is analogous to biological evolution. The algorithm that drives biological evolution is *natural selection,* i.e., the strongest survive. The algorithm that drives the evolution of equipment improvement could be called *learning selection,* i.e., modifications are made to the technology, they are tested as part of a learning process, and then **what are perceived to be** beneficial modifications are included in subsequent versions of the machine. The difference between natural selection and learning selection is that the first is direct, while the second is indirect. In learning selection, the modifications that are selected for replication are not necessarily beneficial to the performance of the technology - they are only perceived to be as such by whoever is making the selection. In natural selection, an animal that does not "perform" dies and does not breed.

In an evolutionary view of the innovation process for equipment improvement, stakeholders play one or more of three evolutionary roles:

Novelty generators - making modifications to the technology, both *hardware* and *software;* Selectors - selecting modifications for replication in the next generation; Providers of evolutionary drive - making the whole process happen by doing the work, motivating people, removing or overcoming constraints, and providing incentives to other stakeholders.

Support for the *learning selection* algorithm comes from some of the economic literature attempting to explain the process of technology change. Rosenberg (1982) drew attention to two types of learning - *learning by doing* and *learning by using* - *which* occur after a new technology has been commercialized. Rosenberg showed that the two types of learning could result in incremental improvements to a technology and, when taken together, greatly improve the performance of a technology. *Learning by. doing* takes place when a new product is manufactured, and leads to improvements in the manufacturing process. *Learning by using* takes place when a new product is used.

An essential feature of many *learning by using* improvements is that they cannot be developed by the original designers. Even if they could, the surveys required to understand the fanning systems sufficiently to make the adjustments would be prohibitively expensive. A good example of a critically important *learning by using* innovation comes from the mechanical reaper case study.

Farmers who first adopted the mechanical reaper in the mid-1980s found that harvest laborers saw the machine as a threat to their livelihood. Some laborers even put bicycle spokes and other debris in the crop to break the reaper's cutter-bar. Laborers also refused to harvest in place of the reaper -when the machine could not be used in lodged crops or deep water. Owners saw the machine's performance limitations as major constraints. However, all this began to change in the early 1990s when laborers began to organize themselves into teams that offered farmers an all-inclusive package - harvesting, threshing, and carrying the grain out of the field. The harvest teams began hiring mechanical reapers themselves because they found that, when crop conditions were good, the machines improved their productivity and income. If they cannot use a reaper then they must hand harvest - and charge a higher price. Inability to harvest under some conditions is no longer a problem. So, a management innovation has solved seemingly intractable technical problems and adoption of the reaper has increased.

Biological evolution occurs automatically because natural selection is a direct process. Equipment evolution, on the other hand, only becomes self-sustaining when the perception of the modifiers and selectors begin to match reality -be it scientific or indigenous. The case studies show that equipment evolution does not occur automatically after a technology is first released by the public sector, but only when manufacturers and farmers - the stakeholders with most to gain from new equipment technology - assume the bulk of the modifying and selecting roles themselves. This happens only when they have sufficient understanding of the technology, and motivation. However, once this point is reached, then the "snowballing" process that occurred with the flat-bed dryer in Vietnam can occur. This when technology can said to be sustainably adopted - and requires no further public sector intervention. Prior to sustainable adoption, the public sector has a legitimate role in nurturing the innovation of socially useful technologies by helping manufacturers and farmers acquire sufficient knowledge and motivation for "take-off' to occur.

An important corollary of seeing equipment research, development, adoption,, and adaptation as an evolutionary process is that it implies that the public sector can hope to achieve greater impact by helping manufacturers and farmers reach the "take-off' point more quickly. The stripper-harvester case study suggests some ways the public sector can do this, which include:

- providing a prototype that addresses a real problem and shows market. potential (to provide motivation);
- working closely with manufacturers and farmers during the initial adoption phase to impart necessary scientific knowledge, help avoid costly and potentially de-motivating mistakes, and identify and promulgate beneficial local modifications;
- developing its own innovative solutions with the aid of a better understanding of manufacturer and user reality learned in the process.

The stripper-harvester case study also shows some of the constraints that the public sector encounters when helping a technology reach sustainable adoption. These constraints mainly involve project planning that implicitly assumes extension is a separate activity that occurs after R&D. This will often constrain research engineers from working directly with manufacturers and farmers. For example, the government program that promoted the stripper-harvester in the Philippines implicitly assumed that the technology was sufficiently "perfected" for promotion in all 12 regions in the Philippines. This was only four years after research had begun at IRRI. There were just four NARS engineers responsible for the program and most of their time was spent giving field demonstrations and training regional engineers and

extensionists. This left little time to seek and act on feedback from manufacturers and users. The role of the regional engineers in the program was little more than to carry out field demonstrations. They were not given resources or responsibility to work with local manufacturers and users to solve problems and adapt the machine to local conditions. However, in spite of these constraints, PhilRice and IRRI were able to work closely with several manufacturers and users and together make major improvements to the equipment hardware and software, which are., now the industry standard. The orders for machines placed by the government program helped motivate the most innovative manufacturer to begin production.

One factor that contributed to the success of the IRRI industrial extension program was that the R&D unit at IRRI was funded to follow the technologies as they were adapted. Another factor, also common to the stripper-harvester, SRR dryer, and flat-bed dryer case studies, was a clearly identifiable "product champion" who helped nurture the technology through early problems. In each case, the product champion came from the research team that developed the technology. This finding agrees with a body of innovation literature (e.g., Peters and Waterman 1982, Kaimowitz et al 1989), which concludes that a product champion plays an important role.

Much agricultural engineering in the public sector is conducted within research systems where research and extension are still separate activities carried out by separate organizations, often with little interaction. Most of the pointers already discussed will allow the public sector to help manufacturers and users reach the equipment evolution "take-off' point as quickly and efficiently as possible. They are recommendations for institutional change, which will promote the flow of knowledge among stakeholders, through a better integration of research into extension over time, as well as improve motivation.

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Assessment of Organizational Impacts: Progress report on an ISNAR evaluation in Latin America[1]
by

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[1] The authors thank SDC, Switzerland; IDRC, Canada; ACIAR, Australia, and ISNAR, for funding the study. Thanks also to Luis Dupleich, (ISNAR), for comments on an earlier version of this paper and for help with the data analysis and references to Carmen Siri (Tegucigalpa) and to Jairo, Borges (Brasilia) for providing data and analyses under pressure of time.

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1. INTRODUCTION

1.1. Background

Institutional strengthening is one of the major activities of the CGIAR. In the logical framework being prepared for the CGIAR (TAC Secretariat, 1998), one of the three purposes of the CG system is stated in terms of contributions to the performance of national agricultural research systems (NARS). To date, however, virtually all impact assessment work within the CGIAR has focused on the costs and benefits of new biophysical technology on farm-level production and downstream effects on food security, poverty and the natural environment. The lack of organizational assessment represents a gap in the CGIAR's evaluation and impact assessment work. As a move in the direction of filling this gap, ISNAR has begun conceptual and methodological work in the field of organizational assessment.

The principal objective of ISNAR's work is to provide methods and tools of use to the NARS, ISNAR and other CG centers. As a start, ISNAR conducted an assessment of its own achievements and impacts in 1996 (Mackay et al, 1998). The present paper represents a progress report on studies being undertaken to assess the organizational impacts of a regional project, *"Strengthening the planning, monitoring and evaluation (PM&E) of agricultural research in Latin America and the Caribbean* ". The project, known by the abbreviated title "the PM&E project", was established in 1992 to strengthen the planning, monitoring and evaluation processes and systems of the publicly-owned organizations within national agricultural research systems in the region.

The PM&E project was chosen for study because it is ISNAR's largest regional project, it has made innovative use of a number of strategies for organizational development, and sufficient time has passed for some of these strategies to yield practical results in the field. The PM&E project has involved a variety of client organizations (NAROs), and so provides a range of settings in which to study the impact process.

1.2. Objective of the evaluation and structure of the paper The objective of the evaluation reported on here is to assess the PM&E project's impacts on its clients at two organizational levels – the individual, and the organization as a whole. The paper has 4 sections. This section provides background information on the study and on the PM&E project, and defines some key terms used in the paper. Section 2 outlines the design and implementation of the evaluation study. Section 3 summarizes the results to date of three evaluation studies: a study of changes in PM&E in the region and studies of the impacts of the project's publication and training activities. Section 4 offers some tentative conclusions arising from the study.

1.3. Key terms In this paper, the term "organization" carries the classical connotation of a publicly visible group of individuals formally sanctioned to carry out a specific mandate. "Organizational assessment" refers to the study or evaluation of an organization's performance and of the factors that influence performance. The term "organizational impact" refers to the effects caused by one organization on another (e.g., the effect of the PM&E project on a NARO). The upstream location of organizational impacts is contrasted against the downstream concept of production impacts which are defined as the effects of an agricultural research organization on farm-level yields, production, post-harvest utilization and associated economic, social and environmental aggregates. In the longer term, the downstream impacts of agricultural research will remain limited unless the R&D capacity of national organizations in the South is strengthened. Hence, the importance of assessing the organizational impacts of CGIAR centers on the R&D capacity and performance of national organizations.

1.4. The PM&E Project

The PM&E project had its origin in a request from Latin American agricultural research leaders for assistance in improving strategic planning and research management in their organizations. Declining funding for agricultural research and increasing demands for accountability and enhanced organizational performance made improvements in PM&E essential.

The project has been implemented in 2 phases. From 1992 until 1996 the project team consisted of I research officer, I research assistant and I secretary operating out of ISNAR's headquarters in the Hague. Since 1995, the project office has been located in Quito, Ecuador and currently counts on 3 ISNAR professionals and one project assistant.

Project Objectives *and components*

The main objective of the PM&E project was to strengthen the management of agricultural research by improving PM&E. Based on participatory planning, three complementary project components were developed:

• Training of professionals in PM&E and in the strategic management of change

• Preparation, publication and dissemination of reference and training materials on PM&E

• Strategies for promoting and institutionalizing integrated PM&E systems in four Pilot Cases

[4]

These components reflect the project's theory of action described above . The precise needs of NAROs vary, and project inputs are only one set of variables, among others, contribute to organizational development.

The project developed a contextually sensitive, cooperative learning approach that was transmitted back by participants to their NAROs. All project events can be characterized as *learning events*, in that project personnel and participants engaged in collaborative, purposeful activities from which they learned and to which they made substantive contributions from their own experiences and knowledge. Between 1993 and 1994, about one hundred professionals were trained in: a strategic approach to agricultural research management, strategic planning, research monitoring, and evaluation. Among the trainees was a core group of trainers who then went on to contribute centrally to future project activities including training of an additional of trainers 1,500 persons between 1995 and 1997.

The project produced a series of publications authored by project participants and intended for use in their own organizations for reference and training. These materials drew on specialist literature in the filed, as well as on participants knowledge and experience in PM&E.

The creation of Pilot Cases as a strategy to help institutionalize integrated PM&E systems, represents a tacit acknowledgment that publications alone or accompanied by training are generally insufficient to improve the performance of an organization. Pilot Cases were given practical support as they were engaging in organizational development. Pilot Cases include: Ministerio de Agricultura, Cuba (MINAG); Instituto de Investigacion Agropecuaria de Panama (IDIAP); Fondo Nacional de Investigacion Agropecuarias, Venezuela (FONAIAP); and Comision Nacional de Investigacion y Transferencia de Tecnologia Agropecuaria, Costa Rica (CONITTA).

2. DESIGN AND IMPLEMENTATION OF THE EVALUATION

The evaluation began in early 1997 and is still in progress. All data collection has been completed and preliminary reports on the studies have been prepared and reviewed (Horton, Dupleich & Andersen, 1998). A final report is to be completed by year end.

[4] A theory of action explains how desired results are to be produced. All programs have an underlying theory of action, but often practitioners are unaware of the underlying theory that guides their actions. For a discussion of these points, see Patton (1997).

An evaluation team was formed, made up of evaluation and organizational development professionals from within and outside ISNAR. All were familiar with ISNAR, its international work, and the PM&E project. The terms of reference were to design and carry out an evaluation of the impacts of the PM&E project on its client NAROs. On the basis of feedback received from a full range of stakeholders, a design for the evaluation was agreed upon.

2.1. Conceptual Frameworks

The PM&E project possesses an informal, dynamic *theory of action* which describes how it expects to bring about its results. This theory of action is summarized in a logical framework developed in 1995 (Cheaz, Horton & de Souza, 1996).:

The project's training and information activities are expected to have positive affects on individuals' attitudes toward, and knowledge of, planning, monitoring, evaluation, and organizational change processes. These changes in attitudes and knowledge are expected to enhance individual performance. Enhanced performance, in turn, is expected to have positive effects on the organization's capacity to plan, monitor and evaluate its work and to manage organizational change processes. Furthermore, it is also expected to have a salutary effect on the organization's overall direction and openness to change. These changes in organizational capacity and motivation are expected to lead ultimately to changes in organization performance.

An organizational assessment, a framework developed by IDRC (Canada) and Universalia (Lusthaus, Anderson & Murphy, 1995) was adapted for use as a guide to data gathering and analysis. This framework contains four main "organizational dimensions": **Organizational environment.** The external environmental in which the organization operates including the administrative and legal system, the political environment, technological options, sociocultural setting, economic trends, and the organization's principal stakeholders. ISNAR's collaboration with a NARO would also be a factor in the organization's environment. **Organizational motivation.** Internal factors that influence the direction of the organization and the motivation of its members including the mission, incentive schemes, shared values and norms, and the overall "ethos" of the organization. **Organizational capacity.** Internal resources and systems that bear directly on organizational functions and performance. Key to organizational capacity are its leadership, staffing, financial

resources, physical infrastructure, program and process management, and inter-institutional linkages. **Organizational performance.** The organization's accomplishments in relation to its objectives. Key indicators of performance are effectiveness (goal-attainment), efficiency (cost-effectiveness), relevance, and financial viability.

The framework views an organization's performance as a function of its external environment, motivation, and capacity. It recognizes that a capacity-building project may have direct effects on a client organization's environment, motivation and capacity; but only indirectly on its performance. Performance, viewed as a function of the other three dimensions, is under the control of the organization itself, not of the ISNAR project.

2.2. Evaluation questions

The evaluation studies address the following key questions:
What have been the principal changes in PM&E in the region, since 1992?
What have been the principal effects or impacts of the project on the operating environment, motivation,

capacity and performance of individuals and organizations? How has the project achieved its impacts? What can evaluators learn from this evaluation about methods for assessing organizational impacts or organizational performance?

2.3. Data collection and analysis

Four complimentary studies were undertaken to date to identify and assess the impacts of the PM&E project on client NAROs.

A study of patterns and trends in PM&E drawn from case studies of 9 agricultural research organizations in LAC.

An assessment of the impacts of project training on participating individuals and organizations.

An assessment of the impacts of project publications on participating individuals and organizations.

Self assessments of organizational change in the Pilot Cases[5].

3. RESULTS OF THE EVALUATION STUDIES

3.1. Dynamics of PM&E in LAC

Objectives and methods

The objectives of the study were: to assess changes in PM&E systems in agricultural research organizations since 1992; to identify the main factors influencing these changes, including project contributions; and to identify current priorities for improving PM&E in the region. Nine case studies were carried out to obtain first-had information in changes in PM&E over the last five years. These updated a similar set of studies carried out in 1992 (Novoa & Horton, 1994).

Results to date Changes in PM&E capacity: Already in 1992 research monitoring of one sort or another was routine in many of the region's agricultural research organizations. In contrast, planning was somewhat less routine and systematic and evaluation was considerably less so. In 1992, most of the organizations studied prepared operational plans and budgets routinely. In contrast, few had done strategic planning. Research was commonly monitored through field visits and progress reports; however, procedures for monitoring were seldom standardized and documentation of monitoring processes and results tended to be poor. In most organizations, evaluation was the weakest link in the PM&E chain. Donor evaluation of research programs and units was common, but few agricultural research organizations had organizational their own evaluation systems. In 1992, the planning, monitoring and evaluation activities were often carried out in isolation from one another, but a number of organizations were working to improve the integration of PM&E functions.

Since 1992 considerable progress has been made in strategic planning and related methods for linking research to the market demands and the needs of potential clients. Some progress has also been made in evaluation; more internally commissioned external reviews and impact studies are being carried out. Nevertheless, evaluation continues to be the weakest aspect of the PM&E system in most organizations. Traditional forms of monitoring, which were already routine in many organizations in 1992, have improved relatively little. Numerous improvements have been made in the integration of PM&E functions and processes. Indicators for M&E are being included more routinely in research plans, and evaluation results are being used more commonly in future planning. A notable development is the move to project management in agricultural research organizations. As organizations move toward project management, they tend to develop project-level data bases and project budgeting systems as well.

The researchers and managers consulted in the cases believe that there had been little change in the resources available for PM&E during the study period. It seems that although managers often wish to upgrade their planning, monitoring and evaluation, in many organizations they have not assigned additional staff or resources to these tasks.

[5] This study, initiated in May, 1998, is not reported on here

Factors that have influenced changes in PM&E: The interviews, observations and documentation obtained in the case studies make it clear that strong forces are influencing the way public organizations are being run and research is being managed. In recent years, public funding has been restricted and the role and contributions of public-sector organizations have been questioned. Managers are being requested to set priorities, develop well-reasoned plans, manage resources and programs effectively, and present convincing evidence of achievements and impacts. These broad political and institutional forces have stimulated efforts in many organizations to strengthen ties with productive agents throughout the agroindustrial chain and to improve their PM&E systems.

In recent years, funding sources in such public-sector organizations as **INIA,** Uruguay, **INIA,** Chile and **INIFAP,** Mexico have shifted significantly from the public treasury to competitive project sources, both public and private. In some cases, most notably in **INIA,** Uruguay, public organizations have begun to contract other organizations to carry out research projects. In such cases, organizations have had to modify their PM&E systems in order to cope with changes in research financing and management.

Within this general setting of pressures for change, the ISNAR project has been a source of information, training and to a lesser extent direct support for change initiatives in the area of PM&E. In some cases, including INIA, Uruguay, **INIA,** Chile, and CIAT, Bolivia, local informants indicated that the ISNAR project had been a valuable source of motivation, concepts and information that has been exploited in organizational change efforts.

3.2. Impacts of Information distributed by the project

Objectives and methods

The purpose of this study was to determine who has received project information, how they used it and what impact it has had in their organizations. The task facing the impact assessment team was to determine where the impacts of the project publications might make themselves manifest, and how to measure these impacts in a credible and practicable way.

Project training materials and publications had been made available directly to some 380 individuals who had attended project workshops between 1993 and 1997. They had also been mailed to others in Latin America and elsewhere in the world.

These informational products were geared to the needs and interests of research managers in the region. Reference materials were accompanied by training manuals and visual aids, which provided both general concepts and practical advice for improving PM&E. The materials were in demand not only in Latin America but internationally. In total, about 2800 copies of the materials had been distributed between 1994 and mid 1997, when the information survey was carried out. Most individuals received sets of copies. The total number of recipients was around 500. Because of the large numbers of recipients involved and their geographical distribution, data were collected by means of a postal survey. To ensure that the information obtained would be more substantial than "grateful testimonials," technical features were built into the surveys to increase their trustworthiness. The response rate was 29%. Survey questions elicited information in 4 areas:

- Which publications had been received and how.
- The kinds of use that were being made of these publications.
- The relative usefulness of project publications compared to other publications on the same topics.
- Impacts that respondents were aware of on individuals and on their organizations.

Respondents were asked to rate how project publications had contributed to 22 different areas related to PM&E, using a scale from 0 (no impact) to 4 (much impact). Respondents were asked, in each case where a positive impact was registered, to provide examples of the impact.

Results to date Profile of the respondents: A total of 144 individuals responded to the information survey. Two-thirds of them are employed by agricultural research organizations; the others come from universities, NGOs and regional organizations. Just over 60% of the respondents come from the four Pilot Cases. About 85% of the respondents are from Latin America and the Caribbean region; a few responses were also received from Africa, Asia, Europe and Australia. The average respondent allocates about one-quarter of her time to management activities, another quarter specifically to PM&E and just under a quarter to research; the balance of her time is used for other activities such as extension and training.

Use of project publications: About 70% to 80% of the survey respondents indicate that they have read part or all of the training manuals and 35% to 40% say they have read at least part of the books. Between 60% and 70% of all respondents -- virtually all those who received the training materials -- indicate that they have used them in some way in their work. The manual on strategic management has been used mainly for training others and for writing reports or publications. In contrast, the other three manuals have been used primarily in the day-to-day PM&E work of the recipients. About 80% of those who received the M&E Sourcebook indicate they have used it, mainly in their PM&E work.

Individual and organizational impacts: Responses indicate relatively large impacts on individual motivation and capacity and moderate-to-large impacts on their performance. Individual performance seems to have been enhanced most in activities related to planning and training; and somewhat less in the area of evaluation. About half the respondents provided examples of impacts on individual motivation and performance and 65% provided examples of impacts on their individual capacity. About two-fifths of these examples refer to impacts on individual capacity, one-third to impacts on performance and onequarter to impacts on individual motivation.

Relative usefulness of project publications: Respondents consider project publications to be more useful than other publications available to them in this area, due to the relevance of the topics covered and the clear mode of presentation.

Impacts in Pilot Cases vs. **other organizations:** The impact of information is dependent upon such complementary measures as management training and facilitation of change processes. This is revealed by a comparison of impact scores for Pilot Cases vs. other organizations. For every indicator, at both individual and organizational levels, the average scores for Pilot Cases exceeds those of other organizations. For individuals, the differences in impact scores are greatest for four key indicators: development of research programs and projects; development of organizational plans; motivation to improve PM&E; and capacity to do PM&E.[6]

At the organizational level, there are relatively large and statistically significant differences between scores in Pilot Cases and other organizations for eight of the eleven impact indicators,, The most prominent differences are in such broad organizational variables as the transformation of organizational structures, the mission of the organization, the organization's overall performance and the organization's culture.

[6] These differences are statistically significant at the 0,5% level.

3.3. Impacts of the project's training

Objectives and methods The purpose of this study was to determine the impacts on participating individuals and organizations of the training provided by the project. The task facing the impact assessment team was to determine where in the organization the impacts of the project training could be identified, and how to measure these impacts. The universe for the training survey consisted of individuals who had participated in the project's regional and sub-regional events between 1993 and June 1997 (379 individuals). Data were collected by means of a mail survey. Features were built into the design to increase the trustworthiness of the data. The results reported below are based on analyses of these responses (again 29% of the sample).

Results to date **Multiplication of the training effort:** The training survey indicates that 57 of the 144 respondents have organized a total of 250 training events in which 4,500 professionals have been trained in topics related to PM&E, using the project's training materials. Forty participants have provided training in 150 events organized by others, which have reached 2,508 additional trainees. Around 40% of the project's trainees have provided subsequent training in strategic planning and strategic management, and 20% to 25% have provided training in monitoring, evaluation and management of change.

Individual impacts: The survey instrument solicited information on the degree to which project workshops has had an impact on 43 different aspects of participants' work (indicators of individual impact). Respondents scored each indicator using a five-point scale. Average scores have been grouped under the four dimensions of environment, motivation, capacity, and performance.

The scores for indicators of impact on individual motivation, capacity and performance are relatively concentrated. They indicate relatively large impacts on motivation and moderate-to- large impacts on capacity and somewhat smaller impacts on individual performance. The average impact scores for environmental indicators are more widely scattered. At the high end, respondents indicate a rather large impact on the extent to which their work demands creativity and innovation; at the low end, they report little impact on the size of the budget they manage. In general, the impact scores for indicators of the working environment are lower than those for their motivation, capacity and performance.

Organizational impacts: The instrument solicited participants' views on the extent to which skills and knowledge acquired by them, or by others who have participated in project workshops, had impacted on 42 aspects of their organization. Average scores for these organizational impact indicators have been grouped under the four dimensions of environment, motivation, capacity and performance.

The largest impacts are reported on organizational motivation and progressively lower impacts on capacity, performance and the operating environment. Organizational impacts tend to be lower than individual impacts, particularly for motivation and capacity.

Respondents provided more than 120 examples of impacts on organizational capacity, and nearly 60 of impacts on organizational motivation. In contrast, they provided fewer than 30 examples of impacts on organizational performance and 15 on the organization's environment.

Impacts in pilot cases vs. other organizations: Reported impacts have been larger for nearly half the impact indicators at the organizational level. In Pilot Cases, impacts have been particularly large in such motivational variables as clarity of the organization's mission and objectives, recognition of the value of PM&E, and promoting a strategic culture in the organization. Large impacts are also reported in such capacity areas as availability of information and methodological support for PM&E, management support for establishing a PM&E system and plans for improving PM&E.

3.4. Work still in progress

The self assessment of change in the Pilot Cases began in May, 1998 and is scheduled for completion in November. Project collaborators in Cuba, Panama and Venezuela have compiled relevant documentation on the change process and have organized self-assessment workshops that had similar goals, employed similar procedures, and produced comparable reports. The information collected is now being organized and summarized in country reports, which will provide the source material for a comparative analysis.

An ISNAR Research Report summarizing the methods and results of the entire evaluation exercise is to be drafted by the end of the year, for publication in 1999.

4. CONCLUSIONS

4.1. Organizational impacts of PM&E Project The nature and extent of organizational changes brought about by the PM&E project seem to depend upon the intensity of interaction between the project team and the organization in question. The impact of project publications is greater if they are used in training. Both of these are leveraged into still greater organizational impacts in the Pilot Cases, where project staff interact frequently with key decision makers. The principal effects of information and training tend to be reported at the individual level. In the Pilot Cases, where there is a formal commitment to support organizational change, there are also substantial changes in the organization. There are many sources of change in the environment of NAROs. The PM&E project is only one of these, but one which comes at a particularly opportune time. NAROs are currently challenged by external as well as internal forces, and their leader's are generally receptive to ideas that will promote good performance and sustainability.

The profile of respondents to the information and training surveys indicates that the project is reaching and involving appropriate NARO personnel - those well-placed to disseminate ideas for change.

The PM&E project has enriched the material and human resources available to NAROs in the region, providing them with relevant assistance in their capacity building efforts. Participating NAROs have become more effectively linked with their national equivalents in other countries and are able to exchange and draw upon each others' experience and expertise. The information and training developed by the project is relevant, as indicated by its intense use. A valuable group of highly motivated and competent trainers has been established in the region.

Many organizations, including NAROs, do not have clear-cut performance objectives - clearly identified results for which they believe they should be held accountable. Planning for results requires that NAROs reflect on the meaning of "good performance" and define it in measurable terms. The PM&E project, has promoted the identification of relevant goals and objectives and development of action plans to achieve them. It has encouraged participating organizations to move towards managing for results. The articulation of performance goals will make it easier in the future for NAROs to gauge their performance and also for ISNAR to determine its contributions to NARS capacity and performance.

4.2. Conceptual framework The conceptual framework adopted for the impact evaluation has a number of useful features. It is based on current theories of organizational performance in the literature. It is comprehensive, covering all aspects of the organizations whose capacities are in the process of being strengthened by ISNAR. It has face validity and is intuitively satisfying to organizational managers and staff. It is adaptive in that it can accommodate new considerations as they emerge. For example, with the increasing interest in the "new institutional economics", it is becoming necessary to make a formal distinction between "institutions" - formal and informal rules and regulations, and "organizations" -- organized groups charged with

accomplishing defined goals. The four dimensions of the framework are capable of being operationalized and customized to suit any given organization.

4.3. Methods The use of *multiple methods* (surveys, interviews, self-assessments, direct observations, review of documents) and *multiple sources* (a range of principal stakeholders, informants from different levels of the organization, documents) has permitted the findings of each study to be compared, confirmed, and corroborated. This has resulted in a study more fully explanatory and richer in texture than would have been possible if a single method had been employed.

Complementarily is gained from the wealth of detail provided by the qualitative answers to the survey questions. These provide insights into the factors leading to changes in PM&E and the effects of these changes on research activities and performance.

4.4. Instrumentation

The instruments developed for the evaluation studies generate detailed information on PM&E activities within an organization. As such, they can serve as a checklist for planning improvements in PM&E as well as for measuring improvements over time. For this reason managers in organizations being studied sometimes referred to the study instrument as "an agenda for change."

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