FACTORS AFFECTING THE CONTINUED USE OF THE MOBILE FLASH DRYERS BY FARMER CO-OPERATIVES, NUEVA ECIJA, PHILIPPINES

A thesis submitted in partial fulfilment of the requirements for the degree
Master of Applied Science (Agricultural Systems Management)
Massey University, Palmerston North, New Zealand

AMELITA C. RODRIGUEZ

April 1999

ABSTRACT

Harvest of the Philippines second and larger rice crop occurs during the end of the wet season. For members of the rice industry this wet season harvest poses a problem: grain cannot be dried reliably using traditional sundrying methods. Poor drying results in quality reductions and hence farmers receive lower returns. To address this situation the Philippines Government introduced locally manufactured mechanical dryers. This study was undertaken to examine variables which enhance or limit the continued use of the mobile flash dryers in farmers' co-operatives in Nueva Ecija, the Philippines.

Two case studies, each consisting of three farmers' co-operatives were investigated using semi-structured interviews. One case comprised co-operatives that continue to use the dryer while the other comprised those that have stopped using it.

Results showed that a combination of factors influenced the adoption decisions of the co-operatives. Economic factors, especially the volume of rice handled by the co-operative appeared to be most important. Furthermore, the way that the dryer fitted with the other postharvest systems in the co-operatives was a determinant of adoption decisions. In particular, the co-operatives with rice milling operations or with inadequate alternative drying options utilised the mechanical dryers. The leadership and management of the co-operative appeared also to be a factor. These results indicate that both organisational factors and the characteristics of a technology need to be considered in the development and extension of innovation.

Overall the results of this work support the individual and organisational adoption literature. Further work could explore this issue on a wider basis across more co-operatives within the region and across more regions in the country.

Key words: Technology adoption, co-operatives, mechanical grain dryer.

Title: Factors affecting the continued use of the mobile flash dryers by farmer co-operatives, Nueva Ecija, Philippines.

Author: Amelita Rodriguez, 1999

Degree: Master of Applied Science (Agricultural Systems Management)

ACKNOWLEDGEMENTS

The author wishes to extend her gratitude to all the people who have made her stay in New Zealand fruitful and memorable:

To The New Zealand Ministry of Foreign Affairs and Trade for the NZODA scholarship grant; to Charles Chua and Margaret Smilie for their administrative support;

Special thanks to the Bureau of Postharvest Research and Extension, especially to Dr. Silvestre C. Andales and Dr. Rosendo R. Rapusas for giving me the opportunity to pursue my masterate degree in New Zealand.

To my supervisors, Ewen Cameron, Linus Opara and Terry Kelly for their valuable and constructive comments, their wholehearted understanding of my moods and patience in checking my endless drafts.

To Denise for her kindness, unwavering assistance and concern.

To Elsa, Beth and Vicky, for being my close friends through thick and thin...most especially to Vicky for giving me her precious time and helping hand during my data collection, in spite of her busy schedule. Her never-ending assistance is worth mentioning...

To all my friends in New Zealand who have made my stay here happy and memorable, most especially to Carlo and Shinta for the friendship, advice, laughter and tears; to Regina for her patience in reading and editing my final draft and; to Val for his unselfish assistance and willingness to lend a "driving" hand.

To the Carambas family, Manong Angel, Manang Myrna, Manang Linda and Gigi for their love and genuine care.

To Tatay and Inay, my brother and sisters for believing in me, for their constant love and motivation... their endless prayers and encouragement will never be forgotten.

Above all, to Him who showered me with all the blessings that I am enjoying now...THANK YOU...

Amy

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

Chapter 1 INTRODUCTION

1.1 Background

In the Philippines as well as in other Asian countries, the land reform programme promotes small land ownership to farmers throughout the countryside. With very little access to technology, and scarce capital resources, small farmers often generate insufficient or marginal income for their households. Due to the volume of grain sold by an individual farmer, his/her ability to take advantage of higher prices, achieved by having higher volume, is limited.

The development of high-yielding varieties coupled with improved irrigation systems has paved the way to an increase in grain production. However, the expected increase in production has been held back by postharvest problems, particularly those related to grain losses due to poor drying conditions during the wet season harvest.

It is to the farmers' advantage to sell their grain dry rather than selling it wet. Grain properly dried to 14% moisture promptly after harvest can retain its good quality, and can be safely stored without significant deterioration. On the other hand, grain that is not dried promptly deteriorates rapidly and the returns to farmers are significantly reduced. Postharvest facilities such as multi-purpose pavement dryers do not have the capacity to accommodate all farmers' grain for drying with the result that, in some places, cemented national roads and highways are used for sundrying. Thus, due to the fact that farmers can neither wait for their turn to use the dryer facilities nor risk a delay in drying brought about by unpredictable weather conditions, they are forced to sell their grain wet.

To overcome these problems, and to assist small farmers to maximise their income by gaining access to improved postharvest facilities, the Philippine Government encouraged creation of farmers' co-operatives. By organising themselves into co-operatives, farmers have been able to pool their scarce resources so that they can afford large capital investments such as grain drying facilities which are necessary on the farm, and thus have improve their returns. The Government has further assisted farmers' co-operatives by giving them access to cheap finance.

In 1993, to support the needs of these farmers' co-operatives, the Philippine Government launched the Grains Production Enhancement Program (GPEP) now known as Gintong Ani Program (GAP). "Gintong Ani" means "golden harvest". The programme aimed to address issues throughout the production and postharvest processing of grain, that is, from production, harvesting and processing grains through to marketing.

One of the key components of the programme is the introduction of postharvest technologies. The Bureau of Postharvest Research and Extension (BPRE), formerly known as NAPHIRE[1], aims to spearhead the development of the country's postharvest industry, and minimise postharvest losses by engaging in research and technology-transfer activities for this industry. Technologies such as a mobile flash dryer, an in-store dryer, outdoor storage techniques and moisture meters are among those developed by BPRE to help minimise grain deterioration and loss. The successful adoption of these technologies by farmers and/or co-operatives may prevent postharvest losses and may possibly increase the reserves of grain available for human consumption.

---

[1] NAPHIRE stands for "National Postharvest Institute for Research and Extension".

Since BPRE identified that the farmers' main postharvest problem is grain drying, the GAP-Postharvest Component first provided multipurpose drying pavements (concrete pavements) for those deserving, newly-created or existing co-operatives that did not have any drying facilities at all. Then later on, to give extra flexibility, BPRE provided mechanical dryers for distribution to co-operatives which already had multi-purpose drying pavements (Department of Agriculture 1996).

One of the major constraints in the adoption of mechanical dryers by farmers is the high initial capital cost (Cardiño 1985). To address this problem and speed up adoption, the Government distributed the dryers at minimal cost to approved co-operatives.

The mechanical dryer provided to the farmer organisations is locally manufactured. It is a mobile-type flash dryer designed to allow farmers to pre-dry their grain from field condition to 18% moisture content, regardless of weather conditions, so that it can be safely stored before sundrying. The pre-drying achieved with the mechanical dryer is an effective method of preserving wet grains from deterioration by immediately reducing the grain moisture to a level at which the deterioration rate is slow enough to allow safe temporary storage. Grain which has been dried to about 16 to 18% moisture content will last for several weeks without significant deterioration (Tumambing and Bulaong 1986).

By 1997, a total of 385 mechanical dryers had been given to farmer co-operatives. Table 1.1 shows that 332 co-operatives (86%) were mainly rice-based, while the rest (14%) were involved with either maize or a combination of rice and maize handling. Most importantly, however, the table shows that 191 out of a total of 385, or 49%, of the mechanical dryers given to co-operatives are no longer being used.

Table 1.2 reveals that for rice co-operatives alone, 194 co-operatives (59%) continue to use their mechanical dryer while 134 (41%) have stopped using it.

Table 1.1 Number of mechanical dryer co-operative recipients by crop type and utilisation, December 1997.

Region/Province	No. of Co-operative Recipients				Mechanical Dryer Status	
	Rice only	Rice & Corn	Corn only	Total	Used	Not used
Philippines	328	16	41	385	194	191
CAR	2	0	0	2	0	2
Ilocos	14	2	0	16	0	16
Cagayan Valley	39	3	6	48	2	46
Central Luzon	202	0	0	202	149	53
Southern Tagalog	12	1	0	13	8	5
Bicol	8	0	0	8	7	1
Western Visayas	28	0	0	28	10	18
Central Visayas	2	0	0	2	2	0
Eastern Visayas	5	0	0	5	4	1
Western Mindanao	0	0	6	6	3	3
Northern Mindanao	1	0	0	1	1	0
Southern Mindanao	11	1	10	22	4	18
Central Mindanao	2	3	6	11	3	8
ARMM	2	1	11	14	0	14
CARAGA	0	5	2	7	1	6

Table 1.2. Mechanical dryer status for co-operatives handling rice only.

Region/Province	Mechanical Dryer Status				
	Used		Not used		Total
	No.	%	No.	%	
Philippines	194	59%	134	41%	328
CAR	0	0%	2	100%	2
Ilocos	7	50%	7	50%	14
Cagayan Valley	2	5%	37	95%	39
Central Luzon	149	74%	53	26%	202
Southern Tagalog	8	67%	4	33%	12
Bicol	7	88%	1	13%	8
Western Visayas	10	36%	18	64%	28
Central Visayas	2	100%	0	0%	2
Eastern Visayas	4	80%	1	20%	5
Western Mindanao	0	0%	0	0%	0
Northern Mindanao	1	100%	0	0%	1
Southern Mindanao	3	27%	8	73%	11
Central Mindanao	1	50%	1	50%	2
ARMM	0	0%	2	100%	2
CARAGA	0	0%	0	0%	0

Based on this background information, it is evident that while some of these mobile flash dryers are used, others are no longer being used by the co-operatives. The question is "why do these co-operatives continue/or stop using the mobile flash dryers"? Anecdotal evidence suggests that there are several factors that account for this. To enable appropriate action to be taken, better information about these factors needs to be obtained.

1.2 Hypotheses

This study focussed on identifying reasons why some farmers' co-operatives are continuing to use the mobile flash dryer while others are not. It explores issues regarding the use of the mobile flash dryer by these co-operatives.

The study's specific hypotheses are:

1. The utilisation of the mechanical dryer is affected by the fit between the mobile flash dryers' technical factors and the postharvest system at each co-operative.
2. The decision of a farmer co-operative as to whether or not to use the mobile flash dryer is affected by the way the board of directors, manager and staff run the co-operative business.

1.3 Objectives

The study aims to examine both the variables enhancing and limiting the continued use of the mobile flash dryer by farmers' co-operatives.

Specifically, the study's objectives are to:

1. Describe co-operative businesses and their organisational structure;
2. Identify the personal characteristics of the board members, manager and staff of the co-operatives, and the way these groups of people interact to run the co-operative; and
3. Determine the factors affecting farmers' co-operatives' decision to continue to use or not use the mobile flash dryer in their business operation.

1.4 Significance of the Study

The results of the study will enable research agencies not only to re-evaluate the design and allocation of mobile flash dryers examined in this study, and to re-evaluate the design and allocation of mechanical dryers in general. Moreover, the results will also guide the extension agents in the planning of their programmes, and in the formulation of policies and guidelines in the implementation of the technology transfer programme with regard to agricultural machinery and equipment. Specifically, it will enhance the formulation of guidelines in the selection of beneficiaries, and in the nature of assistance to be extended to farmers through their organisations. Finally, results will be helpful in determining the kind of information to be disseminated by extension agents to farmers to strengthen and broaden their knowledge regarding technology.

The results of this study will likewise be inputs in the formulation of strategies on how to increase productivity, improve the rice postharvest industry and raise the quality of life of the end-users. Finally it is envisaged that this research will help in the reduction of postharvest losses in the rice industry, and in the increase of production through the use of efficient machines.

1.5 Thesis Outline

This Chapter has provided a brief overview of the grain postharvest problems in the Philippines and of the way in which the Government has provided assistance to farmers through establishing farmer co-operatives. Specifically, it focussed on the drying problem and the utilisation of mechanical dryers given to farmer co-operatives. The overview of the Philippine rice industry, and the place of the GAP within it follow in Chapter 2, while technology adoption and factors affecting adoption by individuals and organisations are discussed in Chapter 3. The methodology used in this study, including the research design, selection of cases, data collection and how the data were analysed, is presented in Chapter 4. Chapter 5 includes the results and discussion while Chapter 6 presents a summary of the results of the study and the conclusions that may be drawn from it. Recommendations and related areas for further research also are presented.

Chapter 2 PHILIPPINE RICE INDUSTRY

2.1 Introduction

Rice (*Oryza sativa*) is the most important cereal crop in the Philippines. It is the main staple food of more than 70 million Filipinos, and expenditure on it comprises about 11% of the average household budget (Juliano 1993). It is the cheapest source of food energy and protein for Filipinos.

From 1992 to 1996, the total rice production of the country increased by 23% with an average annual increase of 5%. In Central Luzon, which is the main rice producing area, an increase of 152,000 metric tons, roughly an 8% increase, was recorded from 1993 to 1996 (Figure 2.1). However, production decreased in 1992-1993 and 1994-1995, which is attributed to drought brought by the El Niño phenomenon (Appendix 1). This problem was exacerbated as water supplies were reduced during the rehabilitation of irrigation dikes and canals in the Region. In 1995, yields in this area were badly affected by a strong typhoon (Provincial Planning Development Office 1998).

Most farmers cultivate a small area, between one and three hectares of rice and achieve an average of 2.86 metric tons per hectare. Central Luzon has the highest yield per hectare, with an average of 3.45 metric tons while Central Visayas growers achieve only 1.93 metric tons per hectare (Appendix 1) (Bureau of Agricultural Statistics 1996).

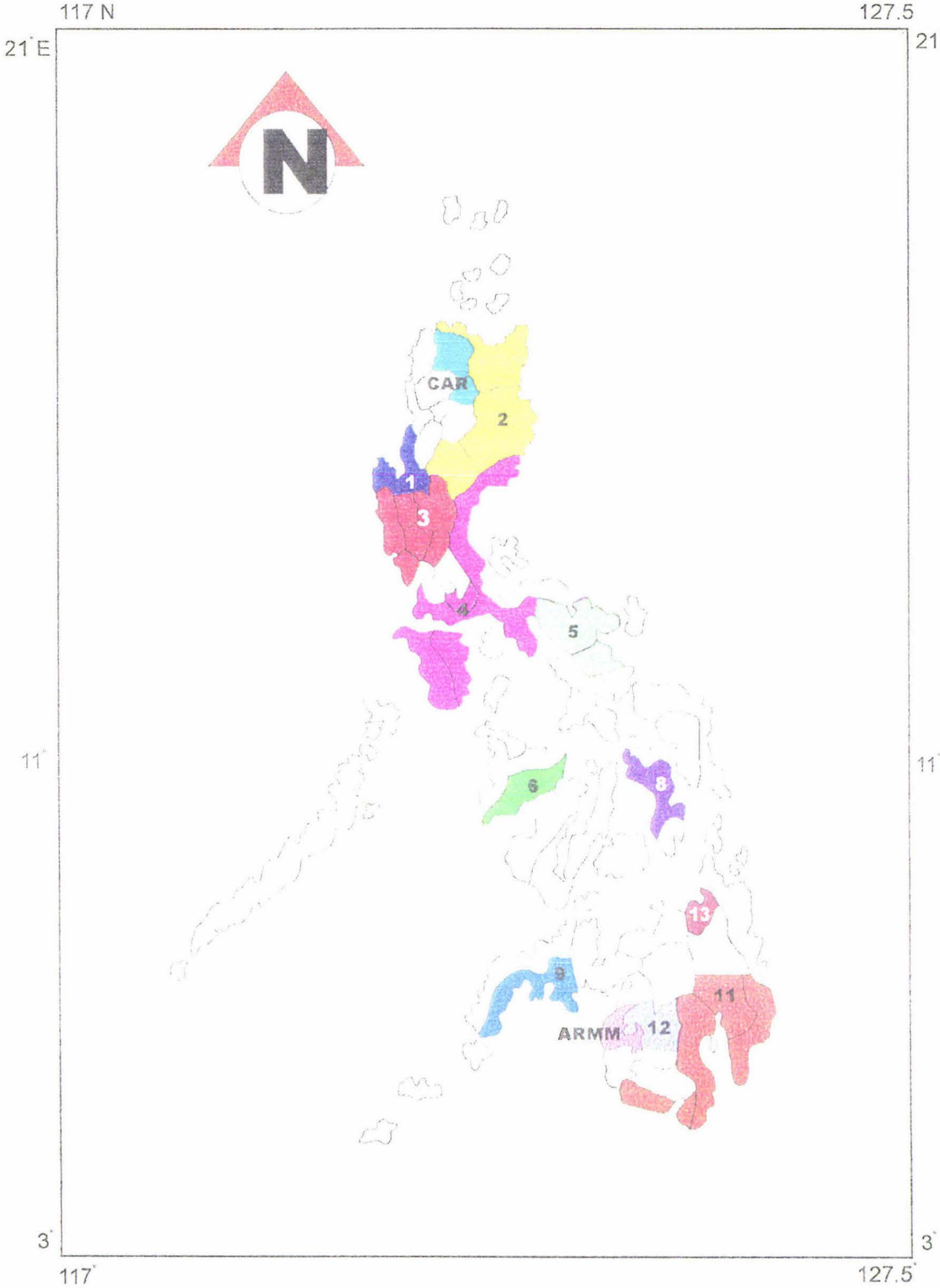


Figure 2.1 Rice production area, by region, Philippines.

2.2 On-farm Seasonal Pattern

As it is part of everyday meals, the demand for rice is constant throughout the year. However, its production is seasonal in nature. Rice is grown either once or twice a year, depending upon the availability of water in the area. For fully irrigated areas, rice is cultivated twice a year. For non-irrigated areas such as in upland areas, it is planted only once a year. The dry season harvest falls in the months of March to May while the wet season harvest falls in the months of September, October and November (Table 2.1). During these harvesting months, the supply of rice is abundant.

Table 2.1. Rice planting and harvesting schedule per cropping.

Cropping Season	Planting Months	Harvesting Months
1st (Wet season)	May-July	September-November
2nd (Dry season)	December –January	March-May

Source: Philippine Bureau of Agricultural Statistics 1996.

One of the major issues facing the Philippine rice industry is that rice paddy harvested in the months of September to November needs to be dried during this wet season. The traditional method for drying grain, sundrying, which works well for the dry season harvest, is unreliable. Grain, when harvested at high moisture content, deteriorates rapidly if stored wet. With this situation, farmers have no choice but to dispose of their wet grains immediately or suffer the consequence of delays in drying. Whatever the situation, either selling wet grain or dried grain that has deteriorated, farmers achieve a low price for their produce.

2.3 Rice Postharvest Operation

"Postharvest operations" refer to the processes involved in the primary processing of the grain. They include the individual operations as well as the total system from harvesting to marketing (NAPHIRE 1994). Postharvest handling and processing of rice includes harvesting, threshing, drying, storage, milling and marketing operations. In

1996, statistics showed that postharvest losses ranged from 0.54% to 4.50% per postharvest operation or a total of 14.84% of production. The highest losses in the postharvest chain of operation were found to occur at the sundrying stage, the next highest at milling (Table 2.2). However, most of the losses at the milling stage are the result of problems that have occurred during drying (PCARRD 1987; NAPHIRE 1994).

Table 2. 2. Rice losses in different postharvest operations.

Operational Components	Losses in percent
	1994-1996
Harvesting (manual)	1.81
Handling/piling	0.54
Threshing (mechanical)	2.17
Sundrying	4.50
Storage	2.72
Milling	3.10
Total	14.84

Source: Postharvest losses per operation findings by Maranan C. et al 1996.

In the Philippines, the typical postharvest flow for rice produced on a small farm is presented in Figure 2.2 and is described in the next sections. The solid lines represent the normal flow of operations while the broken lines are the alternative routes.

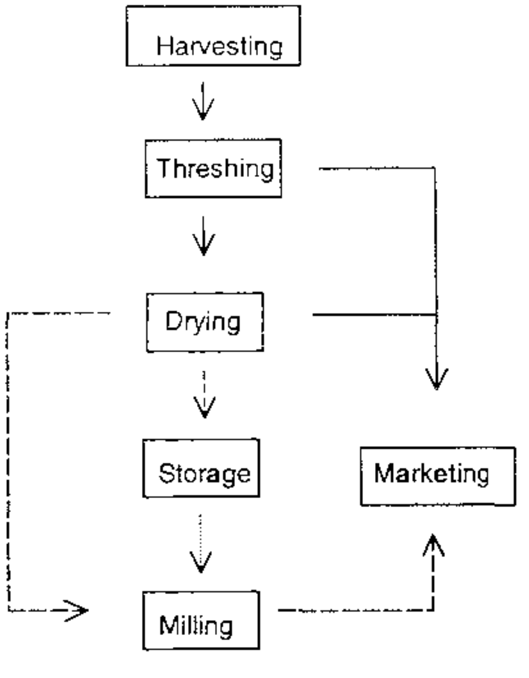


Figure 2.2. Typical rice flow of operation at the farm level, Philippines.

2.3.1 Harvesting

To ensure the best quality grain is produced, farmers need to assess the maturity of the grain on their farms. Every rice variety differs in the dates of maturity. There are varieties that are early maturing, and varieties that are late maturing. The optimum harvest time for rice can be determined by the physical appearance of the plant, the dryness of the panicle leaves and the colour or hardness of the grain kernels (NAPHIRE 1994). However, the generally-accepted indicator of maturity is when the hulled kernels on the upper portion of the panicles are clear, translucent and firm or when 80% or more of the grain panicle is fully ripened, yellowish or straw coloured (Toquero 1983). A moisture content of between 20 to 24% is said to be the optimum moisture for rice paddy ready to harvest (NAPHIRE 1994). However, this still varies depending on the variety of rice.

Harvesting of paddy involves cutting the rice stalks, laying out the stalk paddy on the stubble to dry and stacking. In many developing countries, harvesting of paddy is highly mechanised, however, in the Philippines, manual harvesting is still the most common approach. Although mechanical harvesters, such as reapers and strippers are available, farmers prefer to use traditional tools such as *yatab*, *lingkao* and sickle.

Methods of harvesting

There are two methods of harvesting: panicle harvesting which uses the *yatab* and the conventional method which uses *lingkao* and sickle. Panicle harvesting is done by cutting the mature panicles before placing them in a basket. It is used for varieties which are difficult to thresh, in areas where roads are inaccessible and the thresher cannot be carried easily.

In conventional harvesting, the plant is cut including the straw, then laid on a stubble, gathered and stacked near the threshing area. The length of the cut straw depends on the method of threshing to be employed. If a pedal thresher is to be used, the plant should be cut close to the ground. If mechanical threshing, the straw should be 40 - 50 cm long (NAPHIRE 1994).

After cutting, the plants can be gathered immediately and transported to the threshing site or, in sunny weather, the plants can be left on the stubble to dry for one or two days before threshing. Afterwards, the grain is transported from the field to the thresher area. If the thresher is not ready, the plants are stacked and piled. Small stacks allow good aeration which helps to prevent grain from yellowing.

2.3.2 Threshing

Threshing is the separation of the grain from the plant panicle which can be achieved by rubbing action, impact or stripping action. At the field, threshing is done either manually or mechanically.

Manual threshing such as trampling, threading or pedal threshing is still performed by some farmers. On the other hand, mechanical threshers use an engine as the power source, and these dominate the threshing of paddy in the country (PCARRD 1987; NAPHIRE 1994). Different types of mechanical threshers, such as single drum flow thru thresher, and the double drum axial flow thresher are available in the country (PCARRD 1987; NAPHIRE 1994).

2.3.3 Drying

Drying is the removal of excess moisture from the grain. It is the most critical among the postharvest operations. It is an effective method of preserving the quality of grains for it prolongs the shelf life of the grain and, at the same time, maintains the viability of seeds (Chelkowski, 1991). At harvest, the moisture content of the grains is still high (above 20%) and so grains are susceptible to microbial activity. Thus, the excess moisture must be removed quickly before deterioration sets in. After threshing, grain must be dried at once to a safe moisture content level of equal or less than 14% moisture content. If grains are not dried at the earliest possible time, grain deterioration, caused by heating of wet grain brought about by both microbial activity and grain respiration, occurs (Phillips et al 1989).

Farmers are aware of the importance of drying to maintain grain quality. But, due to the seasonal wet weather and lack of sundrying facilities, most farmers either hold their grain until sundrying facilities become available, or sell their grains wet. Using a mechanical dryer which can dry grain regardless of the weather conditions is an option which farmers who have access to such equipment can pursue.

There are two methods of drying practised in the Philippines; conventional sundrying and mechanical drying.

2.3.3.1 Sundrying

For farmers, sundrying that is used worldwide, is the most common way of drying grain. Grain is spread in a layer (4 to 5 cms thick) on concrete pavements, or other flat areas to dry.

The uncertainties of weather conditions, coupled with increased production as a result of the introduction of high yielding varieties and adoption of other production technologies, make the sundrying method ineffective especially during the wet season. Because of limited pavement drying space, delays to drying grain are inevitable. Since the moisture of grain needs to be reduced at the earliest possible time, artificial dryers or mechanical dryers have been proposed as better alternatives to pavement drying. These are more flexible, reliable and allow faster drying than sundrying.

2.3.3.2 Artificial/Mechanical Drying

Artificial dryers make use of heated forced air for quick drying of grain. The ambient air is artificially heated to increase its temperature and reduce its relative humidity. The temperature of hot air varies depending on the intended use of the dried grain. Grains for seed purposes are dried with an air temperature of 43°C so that the final moisture content is 14% yet the grain is damaged as little as possible. The temperature for drying paddy for food and feed purposes can reach as high as 85°C depending upon the initial moisture content.

Basically, artificial dryers consist of a drying bin, blower, burner and air ducting. Auxiliary equipment such as elevators and conveyors, are also used for high capacity units to convey grain to and from the dryer. The holding bin is where the grain is contained and dried, while the burner is the heat source.

Two types of mechanical dryers are used in the Philippines: flatbed (batch type) dryers and continuous flow dryers. The most common batch type dryers are horizontal with grain depth limited to about 60 cm (Figure 2.3). During the drying operation, the grain is contained in a bin or compartment, and hot air is forced through the stationary grain mass until the desired moisture content is attained. The capacity of these machines ranges from one to two metric tons per batch of wet paddy.

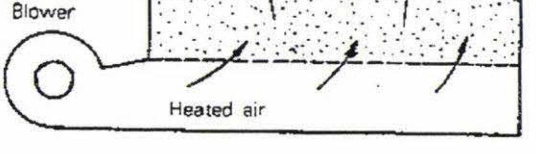


Figure 2.3. Flatbed batch type dryer (Adapted from PCARRD 1987).

On the other hand, continuous flow dryers, such as the Louisiana State University (LSU) type dryer have a bigger drying capacity of one to ten metric tons per hour, a shorter drying time and allow more uniform drying of grains (McLean 1989). This faster drying is achieved by movement of both the paddy and the air, in either across the grain flow or counter-flow manner. While the first batch of mechanically dried grain is being unloaded, another batch of grain can be loaded and dried at the same time (Figure 2.4). In a batch type dryer, a load needs to finish drying and be unloaded before another batch can be dried.

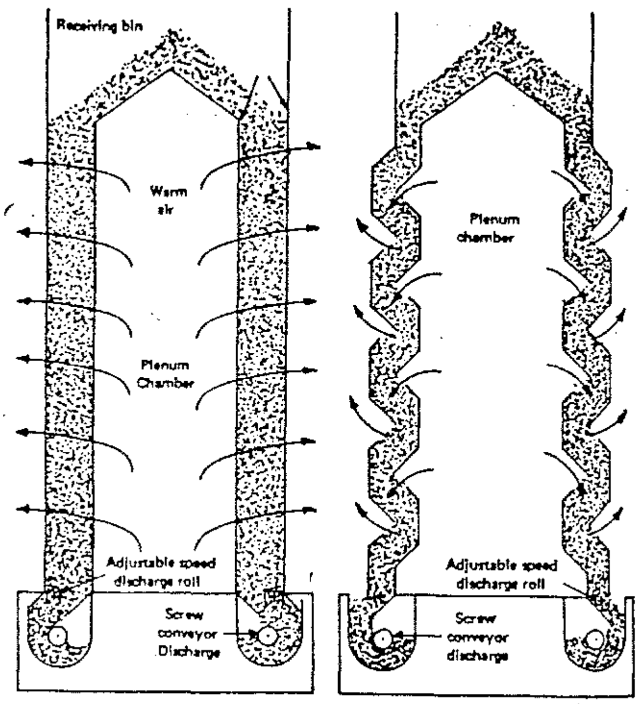


Figure 2.4. Columnar continuous flow type dryer.

Many of these batch type dryers are locally manufactured in the Philippines. The majority of the continuous-flow dryers are imported, and have large capacities appropriate to the needs of traders who handle large volumes but are not suited to the needs of farmers. In order to meet the average volume produced by an individual farmer, NAPHIRE designed and, through various manufacturers, fabricated a 0.5-metric ton per hour capacity continuous flow dryer (Figure 2.5).

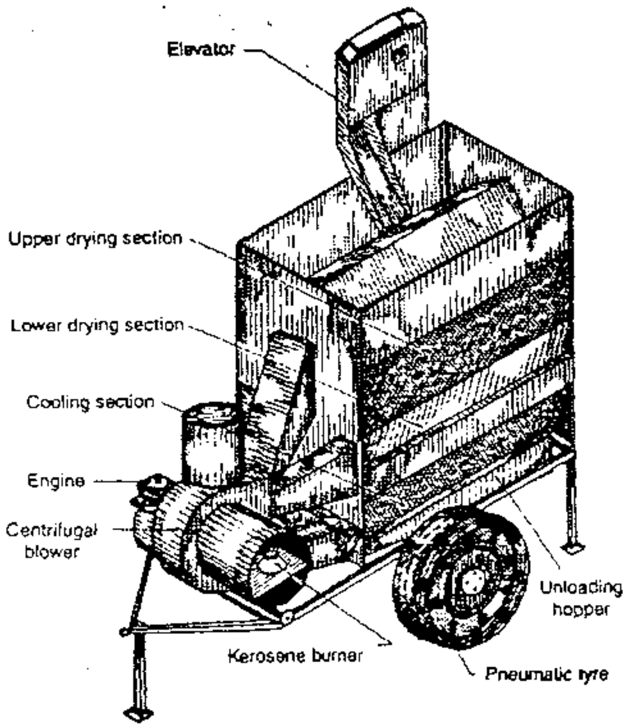


Figure 2.5. Diagram of the mobile flash dryer.

The NAPHIRE mobile flash dryer was designed as a first stage dryer to allow farmers to pre-dry (to 18% moisture) their paddy during rainy days so that it may be safely stored while waiting for the sun to shine to finish the process (to 14% moisture content) on a pavement dryer. Pre-drying is an effective method for preserving grains against quality losses by reducing the grain's moisture to a level where the deterioration rate will be slow enough to allow safe temporary storage. Past experiments have demonstrated that paddy pre-dried to between 18% and 16% moisture will last for several weeks without significant deterioration (Tumambing and Bulaong 1986; Bulaong et al 1990). Thus, the dryer is designed to skin dry grains to 18% moisture content by removing the initial moisture from the crop. Although the dryer can be used to dry the grain fully, it is much more expensive to do this than the first stage only, because water inside a highly moist grain is easier and cheaper to extract than water from a less moist grain. This dryer is commercialised now, and, is utilised by some farmers' co-operatives.

A farmer cultivating between one to three hectares of paddy cannot afford to purchase a mechanical dryer. By pooling their capital, a group of farmers can obtain such a resource. Once every farmer has access to a mechanical dryer, grain deterioration due to delays in drying can be minimised.

2.3.4 Storage

Due to the seasonality of the rice production and its constant demand throughout the year, storage is needed. Storage is defined as "the process of keeping grains, whether in bags or in bulk, in a storage structure designed to protect the stored product from inclement weather and pests for a short or long period of time, to await processing or movement to another location" (NAPHIRE 1994, p.118). Standard 48-50 kgs plastic/jute sacks are used to hold and transport grains. Storage can be categorised as either on-farm or off-farm.

On-farm

Storage accommodates temporary delays in between processing operations, and deliberately keeps the product on a medium or long-term basis for future use and consumption. Normally, farmers store grains in small quantities, sufficient for the household consumption in one season. As the need arises, grains are withdrawn from storage for milling (PCARRD 1987).

Off-farm

Storing of food grains is one way to ensure a uniform supply. In most cases, farmers' co-operatives dispose of their grain at the earliest possible time due to limited storage space and immediate need for cash to be used in their daily operations.

2.3.5 Milling

Milling is the process whereby "rough rice is transformed into a form suitable for human consumption" (NAPHIRE1994, p.101). During milling, the rice hull is removed from the whole kernel and the kernel is polished. It has to be done with care so that kernel breakage is prevented and high milling recovery is attained.

Losses in milling are both quantitative and qualitative. Quantitative losses are manifested by low milling recovery while qualitative losses are manifested through low head rice[1] recovery or a high percentage of broken kernels. The quantity and quality of milled rice is affected by two major factors: grain factors and machine factors. Grain factors include field operations in production and postharvest and varietal characteristics of the grain such as length, thickness of the grain, amount of chalky and immature grain and others. If there is a delay in harvesting, threshing or drying, or when drying has been too rapid or re-wetting of grain takes place, grain cracks occur during milling (NAPHIRE 1994; Blakeney 1996). This is because changes in temperature and moisture content cause the outer portion of the grain to expand more quickly than the centre, resulting in the formation of cracks along the grain endosperm (Blakeney 1996). In addition, if grains are milled at a high moisture content, milling recovery will be low.

The type of machine used, machine adjustment and the system used in the operation are considered as machine factors (NAPHIRE 1994). During milling, dehulling is the first operation in which paddy is subjected to severe pressures to remove the hull which may result in broken kernels thus decreasing milling recovery. After dehulling, the silver skin and bran layer of the brown rice is removed. This is the whitening operation and in doing this, the grains are also subjected to pressures and heat, which make the grain

[1] Head rice is the "milled rice particle with a length of 6/8 or more of the length of the whole unbroken milled rice kernel" (NAPHIRE 1994, p.70).

prone to breakage. Breakage can be minimised by proper selection and adjustment of the hullers, and, by the combination of different whiteners (NAPHIRE 1994).

Rice milling in the Philippines is a fully mechanised operation. The traditional usage of mortar and pestle is found only in remote villages, and is fast declining due to the availability of huller mills (Andales, Mañebog and Bulaong 1994). Engelberg steel hullers or *kiskisan* are the common rice mills in villages. Mills that dehull and whiten simultaneously produce a high percentage of broken grain and have low milling recoveries (NAPHIRE 1994). However, this type of mill produces a high percentage of bran and is preferred by villagers since they use the bran as feeds for raising their livestock (Geron and Ramos 1989).

On the other hand, commercial millers use multi-pass rice mills. This type of mill uses a pair of rubber rolls as a dehuller, and combinations of horizontal abrasive and friction whiteners. Moreover, this rice mill contains grading machines which separate the whole grains from the broken.

2.3.6 Marketing

In selling grains, buyers consider the physical properties of rice, such as low moisture, variety, grain size and head rice recovery for milled rice as important attributes (NAPHIRE 1994). If the paddy is dried down to 14% moisture content or lower, grains are more likely to obtain the premium price. The Philippine Government through the National Food Authority (NFA) provides a subsidy for the grain produced by the farmers, and absorbs less than 10% of the total grain yield of rice farmers. During the peak harvest season, the farm price offered by traders can be as low as P3.00/kg (NZ$0.15/kg). So during this time, farmers are better off selling their grain to the NFA at P8/kg (NZ$0.40/kg). However, farmers still prefer to sell their produce to traders at a lower price as the government agency has strict quality standards and does not pay as promptly as the traders.

Since local traders do not apply the strict grain quality standards that the NFA imposes, there appears to be little incentive for the farmers to produce good quality grain. As long as traders will continue buying the grains of low quality, farmers will not be encouraged to improve their production (Paz et al 1989).

Farmers who are members of farmers' organisation can have a chance to improve their quality of production. By using the resources of their co-operative, including a thresher, multi-purpose drying pavement and mechanical dryer, farmers can minimise delays in processing their grain, thereby improving their production and returns. Grain produced by these farmers is more likely to be acceptable under NFA standards, and fetches a higher price per kilogram. Moreover, with good quality, these co-operatives can also sell their grains to grain wholesalers in the main trading centre at the highest price available for good quality grains (Paz et al 1989).

2.4 Gintong Ani Program (GAP)

Because of these issues in the postharvest system, the government has set up programmes to improve the Philippine grain industry. The *Gintong Ani Program* (GAP) is "a national rice and corn production programme aimed at ensuring food security and helping organise subsistence farmers into functional groups or co-operatives and transforming them into viable producers and entrepreneurs" (Department of Agriculture 1996, p.12).

To achieve this goal, the Department of Agriculture co-ordinated and implemented strategies to mobilise various agencies to participate in the programme. Agencies involved in seed production, research, training, and extension were tapped. The following are the areas of concern for the programme and the corresponding agencies involved.

Research and development: Research institutions can either be government, non-government, or private. Under the GAP, Government research institutions, namely the Bureau of Agricultural Research (BAR), Bureau of Plant Industry (BPI), Philippine Rice Research Institute (Philrice) and Bureau of Postharvest Research and Extension (BPRE) and private seed institutions such as Cargill Philippines and Pioneer Hybrid Corn, are involved in the programme. Research and development activities such as varietal development of grain hybrids, testing pest and disease resistance and determining whether varieties are high yielding or early maturing are the concern of the BPI and private institutions (Department of Agriculture 1996). Research and development of farm machinery such as mechanical threshers, shellers, reapers, dryers, rice mills and corn mills are the concern of BPRE, Philrice and accredited local manufacturers/fabricators. On-farm machinery development is the task of Philrice while the design and development of postharvest facilities is carried out by BPRE. Accredited manufacturers are privately-owned manufacturing shops deputised to fabricate locally designed and developed facilities by BPRE. As of 1995, there are 23 fully accredited local manufacturers (NAPHIRE 1995). Under the GAP, the Bureau of Agricultural Research co-ordinates all the research and development activities.

Information campaign: Under the GAP, an information campaign was established to create awareness among the public regarding the programme. Slogans written in different dialects were popularised through the print and broadcast media. The package of technologies was reproduced in print and given to trainers, agricultural technicians and farmers. The Department of Agriculture spearheaded this activity (Department of Agriculture 1996).

Marketing and agribusiness assistance: Aside from providing technical support to the farmers, the GAP provides marketing services to enable farmers to receive a better price for their produce. This service is the responsibility of the National Food Authority.

Postharvest facilities and technology assistance. Farmer co-operatives that are in need of postharvest facilities, like mechanical dryers can seek assistance through the Department of Agriculture (DA) Regional Offices. The distribution of these dryers to co-operatives is the responsibility of the DA Regional Office where the co-operative is located.

Infrastructure and irrigation support. The establishment of rural infrastructure and irrigation facilities in strategic areas to improve farm productivity will be done jointly by the Department of Agriculture (DA), Local Government Units (LGU's), the Department of Public Works and Highways (DPWH), and the Bureau of Soils of Water Management (BSWM). Construction of farm to market roads will be implemented by LGU's while the small water impounding projects (SWIP) and diversion dams for irrigation will be constructed in co-ordination with the BSWM.

Access to credit. Individual farmers may not be able to cope with the high interest rates imposed by banks when applying for loans. Better access to credit was facilitated by the Land Bank of the Philippines, an agricultural bank mandated to provide loans to farmers through farmer co-operatives. With the creation of co-operatives, farmers can now borrow production loans from the co-operatives for use in their farms.

Training and extension support. In order to ensure that the package of technology be readily understood by the farmers as well as extension agents, training has to be undertaken. The Government's Agricultural Training Institute will spearhead the training activities. Training modules will be prepared by this agency to suit the target participants. Different modules will be prepared for extension agents, technical staff, and farmers.

2.5 Summary

In the Philippines, rice is always part of the everyday meal. For every grain produced, it has to be properly harvested, threshed and dried to maintain its good quality. That is why the development of appropriate postharvest technologies and proper postharvest handling is emphasised in order to reduce postharvest losses, thereby improving grain quality and increasing returns to farmers. With the development of postharvest facilities such as threshers, mechanical dryers and rice mills, losses in the postharvest operation can be minimised.

Drying, which is a critical operation in postharvest, should be done at the earliest possible time in order to preserve the grain quality at harvest. In addition, regulating the temperature during drying has to done to come up with a high head rice recovery during milling. The traditional method of sundrying grains may not be always possible during the wet season. Mechanical dryers provide an alternative drying option. However, their adoption has not been as widespread as originally hoped for. The following chapter discusses technology adoption, how individuals and organisations make adoption decisions, and the factors that affect these decisions. In order for technologies such as the mobile flash dryer to be widely accepted and utilised by farmers, how farmers and/or farmer organisations make decisions in adopting technology and what affects their decision to adopt must be understood.

Chapter 3 TECHNOLOGY ADOPTION

3.1 Introduction

This chapter reviews the technology adoption process, and factors affecting adoption. The role of extension agents and farmer co-operatives in technology adoption, plus possible effects of the Gintong Ani Program (GAP) in the adoption process are also discussed.

3.2 Definition

Technology is defined as "a scientific method of achieving a practical purpose" (Gowda, Faris and Maniruzzaman 1994, p.504). In agriculture, it refers to one or more crop/animal management techniques, which can improve traditional practices, such as yielding variety seeds, farm implements or new machinery (Lindler 1987). Technologies can either be hardware or software. The hardware refers to physical objects such as the tools and equipment, while the software consists of the method, skills and information base for the specified tools or equipment (Roling 1990; Rogers 1993). Computers, tractors and disk harrows are examples of hardware technologies, while the knowledge about how to best operate a computer, or tractors, is an example of software technology.

An innovation is "an idea, practice or object that is perceived as new by an individual or another unit of adoption" (Rogers 1995 p.11). In developing countries, mechanical rice threshers used by farmers with medium-sized properties can be an innovation to those still using pedal threshers. Similarly, small-scale farmers who have not used mechanical dryers, because they are mainly used by traders in the main trading centres, can treat dryers as an innovation. If soil conservation practices designed for sustainable agriculture are introduced in an area where nobody knows about the technology, or soil conservation practices designed for sustainable agriculture, then these too are innovations (Rogers 1993).

Often we hear the terms "technology" and "innovation" used interchangeably. For this study, we will treat these two terms as one.

For a technology to be regarded as being useful, it has to be known and utilised by the end-users. Potential benefits from development of new technologies can be realised only once they are adopted. The following sections discuss the ways in which farmers learn, and the process of adoption by individuals as well as by organisations and groups.

3.3 Adoption process

3.3.1 Introduction

Adoption is a process whereby an individual or a group decides to use a new production technique. It is the phase wherein the individual has enough information about the technology and he or she is willing to try to use it. (Rogers 1993).

The adoption process begins with the recognition of the problem. Farmers who believe they have a problem look for solutions to solve it (Taher 1996). Once a problem is detected, it induces the farmers to search for information, ideas and options to solve it. The greater the amount of information available to the farmer, the greater the farmer's options will be. Farmers' ability to perceive and understand the problem can be enhanced further if they obtain advice from other farmers or extension agents (Ohlmer 1998). To enable farmers to come up with a better solution to the problem, they need to define the problem clearly.

The adoption process as defined by Rogers (1995) is a mental process through which an individual or organisation goes from first hearing about the innovation to *final* adoption. If farmers are interested in a technology, their attention will be triggered to discover and know more about that particular technology. Later on, a decision whether to try that technology or not will follow. Final adoption, as defined by Feder and Zilberman (1985, p. 256) is "the degree of use of a new technology in long-run equilibrium when the farmer has full information about the new technology and its potential". Likewise, technology adoption can be viewed as a continuous process involving a lengthy time period, rather than a discrete adopt/non-adopt choice (Schultz 1975). This implies that frequency of usage of the technology is considered when determining technology adoption.

There are similarities and differences between the ways in which individuals and organisations adopt technologies. These are discussed in the next sections.

3.3.2 Individual Adoption

3.3.2.1 Adult Learning

"Learning" is a word often used by writers when referring to information absorbed by an individual. As stated by Christodoulou and Gray (1997), "learning" is a term which does not have any precise definition because of its "multiplicity of uses". In classrooms, a teacher can facilitate learning; in practical training and technical seminars, extension agents and resource speakers can impart knowledge which can lead to audience learning. Boyd, Apps and Associates (1980) said "an educator or tutor is the agent of change who introduces stimuli and reinforcement for learning and designs activities to induce change". In the case of farmers, the extension agents serve more as the educator.

Whether learning occurs depends on the individual. Educators are there only to facilitate learning, but true learning is "by doing" or "by self-discovery" (Rogers 1989; Jarvis 1995; Christodoulou and Gray 1997). One person cannot learn for another person, but a person can influence the learning of another person (Jarvis 1995). Learning depends upon the individual's behaviour and choice to learn.

An effective way for an adult to learn is by doing. As a person grows old, he is more likely to retain only information which is meaningful to him, and integrate it to the knowledge he has (Rogers 1989; Jarvis 1995). Adults tend to absorb information which, they feel is helpful in the long run. But ideas and information learned by adults have to be applied; if not, they tend to stagnate (Millar and Curtis 1997). Therefore, in order for learning to stick, and to be stored for a long time in an adult's mind, active involvement in tasks is the most effective way of learning.

Thus, adults learn more through experience and active involvement in an activity (Jarvis 1995). Let us consider a non-driver who wants to learn how to drive. There are three options: go to a lecture where a teacher tells you how to do it, watch a skilled driver at work, and practise in a real car where the teacher is at your side. Although the first two methods will give you an idea of how to drive, doing the real thing would help you learn easily how to drive. In the same manner, a farmer who conducts his own on-farm experiment to determine the optimum amount of fertiliser which will maximise yield, learns more quickly than those farmers who just listen to the advice of extension agents, other farmers and chemical company representatives, without actually trying it on their own field. In order for farmers to adopt technologies, they have to learn first what the technology is all about. Attending training, seminars and trying the technology in their own farm are the different means of learning. And in the process of learning, adoption of technologies may take place. The following section presents the stages by which an individual makes a decision leading to adoption.

3.3.2.2 Individual adoption process

An individual's decision to adopt a technology follows certain stages. According to Van den Ban (1988) the adoption decision-making process follows these stages:

1. Awareness – this is the stage where an individual hears and learns about the innovation. Potential sources can be media such as radio, television, leaflets and brochures. An individual can also hear about it from extension agents, or from another individual.
2. Interest – once the individual finds out something about the technology, he/ she seeks further information about it.
3. Evaluation – the individual weighs the pros and cons of the innovation, the advantages and disadvantages of it.
4. Trial – the individual tests the technology himself/herself on a small scale.
5. Adoption – the individual applies the technology, fully replacing the old one.

Rogers (1993) also discussed the process of making decisions. Rogers (1993) viewed the adoption decision process as part of the "innovation decision process". This process starts with the individual's first knowledge of the innovation, then proceeds to their forming an attitude about that innovation, which leads to a decision to adopt or reject the technology. Once a decision to adopt is made, the individual will trial the innovation. But the individual can reverse his previous adoption decision if the innovation doesn't meet his/her expectations during the trial (Figure 3.1).

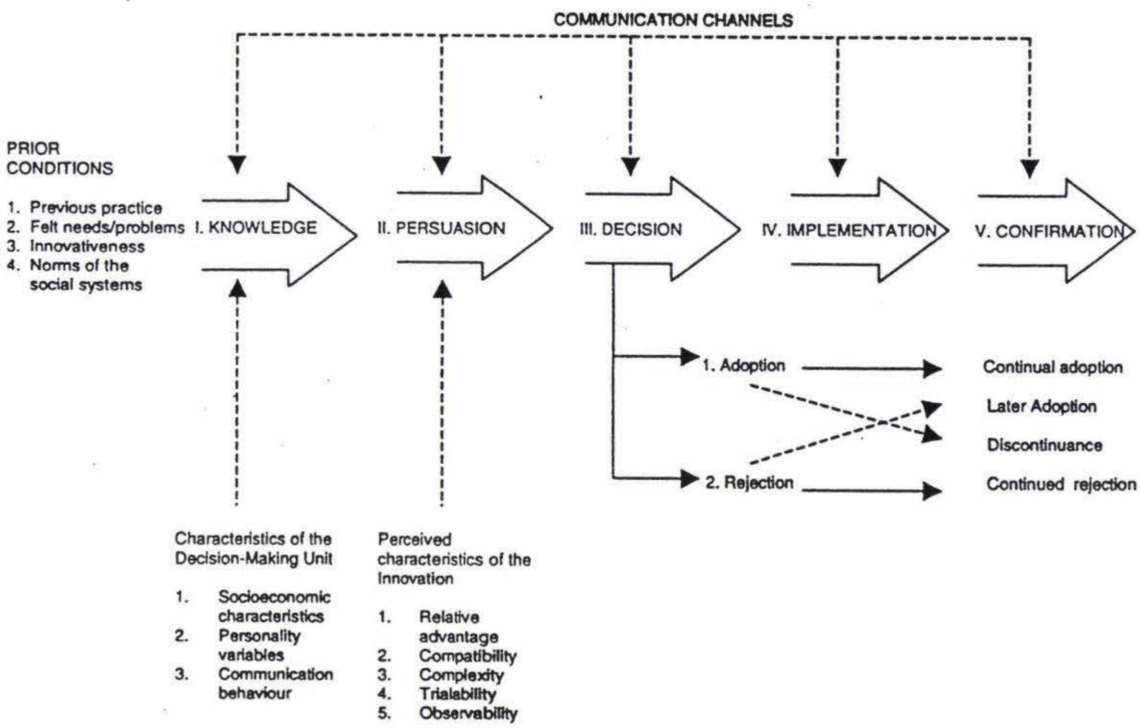


Figure 3.1 A model of the stages in the innovation-decision process (Adapted from Rogers, 1995).

The five main steps in the innovation-decision process as outlined by Rogers (1995) are:

1. Knowledge – this occurs when an individual is exposed to the new idea and gains an understanding of it.
2. Persuasion – an individual forms an attitude towards the innovation. This can be either a favourable or an unfavourable attitude but the individual can be persuaded either by himself/herself or by others surrounding him/her.
3. Decision – this is the stage wherein an individual will either reject or accept the technology.
4. Implementation – the individual tries the innovation. At this stage, re-invention is likely to occur. Modification of the technology can be done at this stage to suit the needs of the individual who adopts it.
5. Confirmation – the individual still questions his/her decision to adopt the innovation. Uncertainty is still in the mind of the individual. If the individual

finds that the technology is in conflict with what he/she thought about it, for example, if the technology's specifications do not conform to the actual performance, then the individual may still reverse his/her decision to use the technology continuously.

3.3.3 Organisation/Group adoption

The adoption process of organisations differs in certain key ways from the adoption process of individuals (Rogers 1995). Adoption by a group or organisation depends on individuals' learning, but is enhanced through interaction or sharing within the group.

3.3.3.1 Organisation/Group Learning

Covey (1991 p.284) said that "personal change must precede or at least accompany management and organisational change". This implies that a change in an organisation will occur only if there is a change in the individuals comprising the group making the decision. In order to create change in a group, change must start first from the individuals composing that group.

Similarly, learning must emanate first from an individual before he/she can share his/her learning with others. To nourish, sustain and be effective, individual learning has to be applied and shared with other individuals. One way to do this is by learning in a group.

A group is composed of individuals who interact with one another to explore areas of common interests (Schein 1980; Christodolou and Gray 1997). Based on this definition, individuals in a crowd walking together on the streets are not considered as a group because, generally, they do not interact with one another and are not aware of each other. Work teams, committees and cliques fall under the definition of a group.

Individuals join a group to fulfil their needs, and they feel that these needs can be fulfilled in collaborating with other people. A sense of belongingness, the need to learn from others, to share ideas, feelings and beliefs with others are the common reasons for joining groups (Schein 1980; Jarvis 1995).

According to Schein (1980 p.15), an organisation, on the other hand, is defined as "the planned coordination of activities of a number of people for the achievement of some common, explicit purpose or goal, through division of labour and function and through a hierarchy of authority and responsibility". It is composed of individual members who have aggregated themselves to attain a common goal. Often, the objectives of the organisation determine its structure and function. All positions within the organisation do not have equal authority; instead, positions are structured in a hierarchical manner specifying "who is responsible to whom and who can give orders to whom" (Rogers 1995 p. 376).

For farmers, group learning is an integral part of their learning processes. In order to effect group learning, individuals belonging to a group should be able to facilitate the learning of others (Christodoulou and Gray 1997). Sharing each other's experiences for farmers relies strongly on observation, trial and error, intuition and the environment in which the sharing evolves (Kloppenburg 1991). For example, a farmer who has actually tried using Integrated Pest Management (IPM) on his own farm can effectively share his own experience with the group. In this way, he can facilitate the learning of others through sharing what he had experienced which could later on influence others' behaviour.

3.3.3.2 Organisation adoption process

Once the members of a group have learned about a technology, they are then in a position to adopt the technology. According to Rogers (1993), the process of adoption in an organisational set-up is divided into two phases: initiation and implementation. Within these two broad phases, certain specific stages can be identified, and these are described below (Figure 3.2):

Initiation is the phase wherein information gathering, conceptualising and planning activities are done, leading to the decision to adopt. The initiation phase is composed of the agenda setting and matching stages.

- Agenda setting: every organisation sets an agenda and plans ahead on what to do over some future time period. In doing this, needs, problems and issues are identified within the organisation. These needs and problems are then prioritised. Once a problem has been identified, one or more individuals within the organisation will seek an innovation which will solve the problem.
- Matching is the stage wherein a problem from the agenda setting is fitted with the innovation which has been discovered. The matching of the problem with the innovation is planned and designed. The members of the organisation attempt to determine if the innovation is feasible in solving the organisation's problem.

If the agenda setting and matching are satisfied, a decision to adopt will follow. Once the decision has been made, the implementation phase will commence.

Implementation is the phase wherein all the actions and decisions involved in the innovation are put into use. Implementation usually comprises three stages: redefining/structuring, clarifying and routinising.

- Redefining/restructuring occurs when either the innovation undergoes re-invention to answer the organisation's needs or the organisation's structure is modified to fit with the innovation. In some instances, both the innovation and the organisation are modified.
- Clarifying is the stage where the innovation is widely used in the organisation and the new idea becomes clearer to the members of the organisation.
- Routinising is the stage in which the innovation is already a part of the organisation's regular activities and, thus, loses its separate identity.

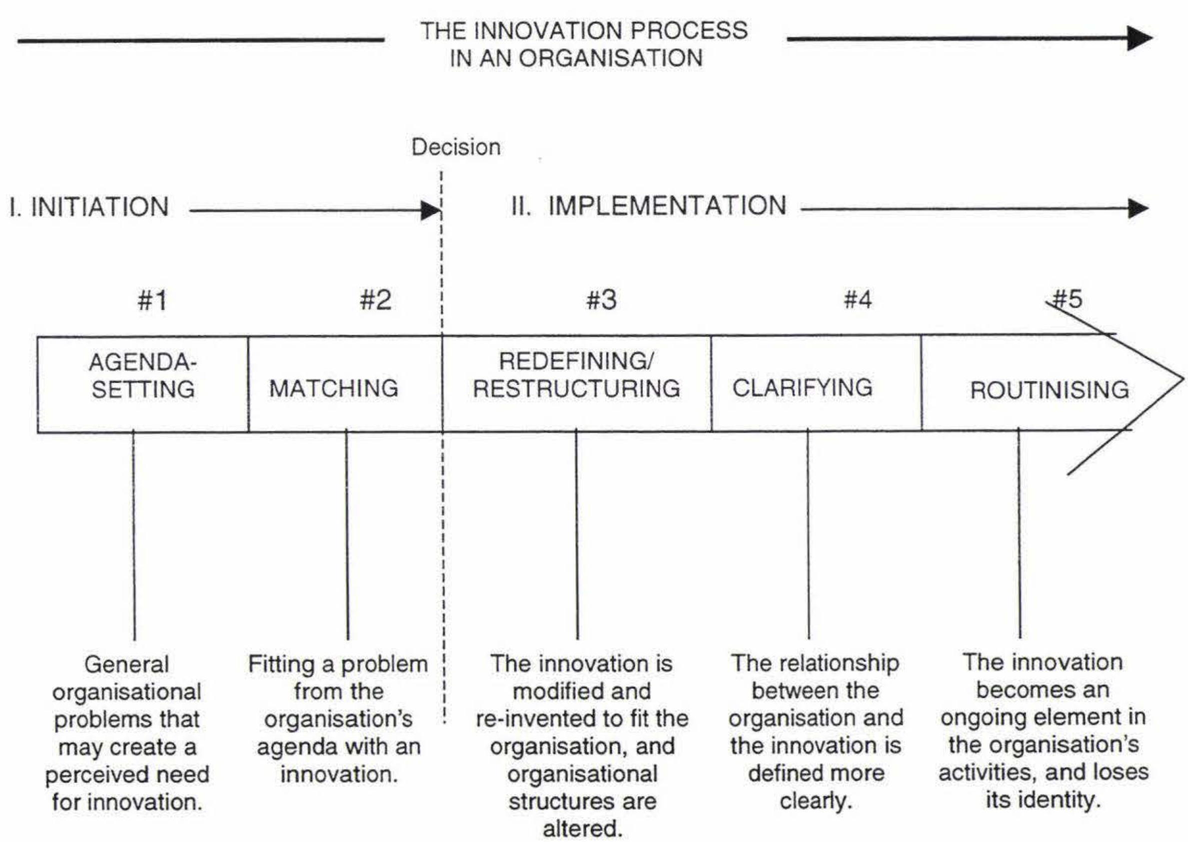


Figure 3.2 Five stages in the innovation process in an organisation (Adapted from Rogers (1995).

The processes of adoption for an individual and for an organisation are similar in the stages of the process, but differ in the actors involved and the manner in which they are undertaken. The initiation phase of the organisation's adoption process is equivalent to the knowledge and persuasion phases of the individual's adoption process. Once a problem has been identified, both processes tend to involve looking for information to solve the problem. In an organisation, however, the nature and effectiveness of the innovation/adoption process depend very much on the structure of the organisation and the relationships between actors. In a private or business firm, a management or directorate group governs the decision. In a farmers' co-operative setting, however, there are two independent decision making units having the power of veto, the General Assembly and the Board of Directors. Co-operatives may have a slower and more cumbersome decision-making process as compared to private firms but once a decision is taken, it can be implemented rapidly (Hendrikse 1998).

There are many factors which govern an individual's or a group's decision regarding technology adoption. The effectiveness of technologies introduced to farmers depends on the factors which influence technology adoption. Therefore, extension agents and researchers need to understand these factors in order to target and deliver effective programmes. In the next section, factors affecting the individual's or group's decision to adopt are discussed.

3.4 Factors affecting adoption

Although new technologies and innovations (that is practices, products, equipment, etc) are constantly being introduced into the agricultural sectors, not all farmers/farmer groups adopt all of the available technologies. Traditionally, it has been thought that farmers select innovations which suit their needs, status and attitudes from a package of technologies developed by scientists (Chamala 1987).

Chambers, Pacey and Thrupp (1989) indicated that in 1960s, farmers' limited knowledge about any technology introduced and the inability of extension agents to educate farmers were cited as reasons for non-adoption of technology. Socio-economic factors were pointed out as being the main reason for slow adoption in 1970s. But in the 1980's, it was said that the problem was neither the farmer, nor the farm, but the technology itself and the processes of its generation (Chambers 1989).

A farmer's decision to adopt new technologies is governed by many factors. Understanding the factors responsible for adoption or rejection of technology enables agricultural scientists and researchers to identify strategies to overcome some of the hurdles slowing adoption (Gowda, Faris and Maniruzzaman 1994). The following sections discuss factors affecting both individual adoption and organisational adoption.

3.4.1 Factors Affecting Individual Adoption Decisions

Adoption by individuals can be affected by the following: economic factors, farm size, technological and technical factors, training, personal factors such as age, educational level, attitude/perception, and the social/cultural factors. Each of these factors is discussed below.

3.4.1.1 Economic Factors

The decision to adopt a technology is influenced mainly by its effect on profitability. This means that the new technology must promise either an increase in yield and returns or a reduction in costs, to be acceptable to farmers. For Ontario hog farmers, it was found that the technology must be able to increase their profit, showing reasonable cost and improved efficiency in production before the farmers would adopt it (Gill and Weersink 1991). In Pakistan, imported seed transplanters were not adopted because they had high operating costs and achieved no significant increase in yield (Iqbal, Younis, Ahmed, Sabir, and Sial 1992).

Investment levels, costs, and net returns are the main concerns of the farmer when considering whether or not to adopt a technology. If the investment cost and operating cost are high, a slow rate of adoption will occur. If the perceived net return from use of the technology and the return on investment are high, the technology is more likely to be adopted. The perceived low returns of a technology lead to a slow rate of adoption (Nowak 1992).

A high investment may not be a problem for large-scale farmers but for small farmers, it can be a serious problem. A study in the Philippines revealed that high investment costs of any postharvest technology reduces the possibility for small farmers to adopt it (PCARRD 1990). For example, mechanical drying offers a better alternative to sundrying for it is independent of weather conditions and can effectively preserve grain quality. However, its high investment and operational costs, as well as high repair and maintenance costs are major drawbacks to its adoption (Cardiño 1985).

Because the actual economic benefits of technologies are difficult to determine, and oftentimes accrue only years after the technology has been applied, it is often hard for an individual farmer to make decisions on technology adoption (Culver and Seecharan 1987). Furthermore, if the financial risk is high when an individual farmer invests by himself or herself in technologies, and those facilities are used seasonally, so that the returns are realised only during and after harvest time, farmers are unlikely to adopt (Cardino 1985). By grouping themselves into an organisation, farmers may facilitate the acquisition of these technologies by overcoming some of these investment and cost constraints.

3.4.1.2 Technological factors

The development of a technology is a continuous process. In order for it to be adopted successfully, it must offer a solution to the problem which a farmer faces in increasing productivity (Gowda et al 1994).

Farmers prefer to adopt technologies which satisfy their security needs, are less complex, require less time to use and are less labour demanding than their existing practices (Bangura 1983). Innovations, which are simple and relatively easy to understand, are more likely to be adopted than those which are complex and difficult to comprehend (Guerin and Guerin 1994). The more complex a technology is, the slower will be its rate of adoption (Rogers 1993).

Technologies which can easily be integrated into the existing farm production system are more likely to be adopted than those which would require a significant change in the farm operation (Culver and Seecharan 1987; Barao 1992). For example, inclusion of forage crops in soil conservation measures would imply that a grain farmer either raises cattle or can find a suitable market for the crop. Adding livestock to the farming system would require year-round supervision, which cash crop farmers may be reluctant to do (Culver and Seecharan 1987).

The technical specifications of technology are important to adoption, particularly on how these technical factors relate to the farming system. Studies from India and Pakistan revealed that quality control in making equipment, availability of spare parts and manufacturer's service capabilities are the major constraints in the adoption of agricultural machinery (Iqbal et al 1992; Ray 1993).

3.4.1.3 Personal factors

Age

The age of the farmer is one of the factors associated with technology adoption by an individual (Kumar and Wasnik 1989). In Utah, older farmers were reported to be more resistant to adoption of low input sustainable practices than were the younger ones. Older farmers perceived these practices to be not feasible and impractical. Moreover, they felt that, as the transition to sustainable practices might not occur in their lifetime, there was some doubt that sustainability practices would be either beneficial to, or sustainable to them (Drost et al 1996). A study in Ohio of computer use by commercial farmers revealed similar results. Older farmers were less likely to adopt computer technology as they found it less useful and applicable to their businesses (Batte, Jones and Schnoitkey 1990). Likewise, a study by Lasley and Nolan (1981) has shown that age is related to the adoption of conservation practices. In this work, it appears that younger farmers perceive erosion as a problem, and conservation practices to avoid erosion as being profitable and therefore, they are more willing to accept the associated financial risks.

On the other hand, a study by Taher (1996) showed that the age of smallholder cocoa producers in South Sulawesi, Indonesia has no relationship to the farmers' decisions to use fertiliser and pesticide technology. Likewise, a study by Lexmon and Anderson (1998) on adoption of minimum tillage practices indicates that farmers' ages were not related to their decision to adopt the technology. Furthermore, Adugna (1997) revealed that the farmers' ages do not affect their fertiliser adoption decision.

It appears that age as a factor in technology adoption depends on the nature of the technology. If the outcome of the technology takes years to see as being sustainable as, for example, the effects of conservation practices, then older farmers may not be keen on adopting it. But if the effect of the introduced technology is immediate, or can be seen in the near future such as seed, fertiliser or any other chemicals which can improve yield, then older farmers seem willing to try it.

Education and Training

Research shows that farmers' education levels are associated with their decision to adopt technology. In Northern Tanzania, most farmers who had more than 6 years' formal education adopted the improved seed maize variety introduced to them as compared to those who did not have any formal education (Nkonya, Schroeder and Norman 1997). In South Sulawesi, Indonesia, young, more highly educated cocoa farmers, who had started their businesses recently, adopted pesticide and fertiliser technology at once so as to increase the level of farm soil fertility (Taher 1996).

Rahm and Huffman (1984) presented a model of adoption behaviour and econometric evidence about determinants of reduced tillage adoption and adoption efficiency. The empirical results obtained by fitting the model to microdata for Iowa farms showed that, among other things, investments in farmers' schooling enhances the efficiency of the adoption decision. Farmers who had received formal education adopted reduced tillage practices more easily. In the same manner, the educational level of commercial farmers in Ohio is positively associated with computer adoption. An increase in the farmers' level of education increased their awareness of the capabilities of computers, and their usefulness in the business (Batte et al 1990).

Aside from formal schooling, informal education such as that obtained by attending seminars and training can enrich one's knowledge about a particular technology. Rogers (1995) revealed that 77% of the research studies he reviewed support the generalisation that exposure to training was positively associated with adoption of innovations. Similarly, Estigoy (1997) found out that training is a factor in the utilisation of the mechanical corn sheller in Mindanao. He pointed out further that training in corn production related courses might have emphasised the value of mechanical shelling.

On the other hand, findings of Valdez (1994) showed that educational attainment did not influence the behaviour of farmers in relation to the adoption of Integrated Pest Management (IPM) methods. Similarly, the level of farmer education had no significant impact in the adoption of hybrid cocoa (Boahene 1995). Moreover, a study by Estigoy (1997) in Southern Mindanao revealed that there is no significant relationship between the formal education of corn farmers and utilisation of the improved mechanical corn sheller.

It appears that education could possibly be a factor in farmers' decisions to adopt new technologies. In general, educated farmers are more open-minded to new technology as compared to farmers who have less or no education. But other studies refute the claim that education affects the adoption decision, and this could be attributed to the type of technology to be adopted.

Attitudes/perception of farmers

The term "attitude" has been defined by many social psychologists in different ways. As early as 1935, Gordon Allport referred to it as social psychology's most indispensable concept because it involves an individual's positive or negative evaluation of performing the behaviour (Fishbein & Ajzen 1980). An individual's positive or negative evaluation is termed "attitude". Himmelfarb and Eagly (1974) described attitude as "a relatively enduring organisation of beliefs, feelings and behavioural tendencies towards socially significant objects, groups, events or symbols". Before an attitude is formed, an individual has many things to consider, including his personal beliefs as well as the beliefs of others around him. This definition suggests, that once an attitude is established, it is relatively permanent, and will tend to persist across time and situations.

Chamala (1987) demonstrated that beliefs, values and fears are all factors affecting farmers' attitudes. "Beliefs" are the building blocks upon which an attitude is structured (Fishbein & Ajzen 1980). Chamala (1987) defined belief as "the knowledge and information that a person assumes to be true about the environment". Musser et al (1984) defined belief as "information one holds about a particular object". If a farmer believes that traditional practices are better because they are less risky compared to the numerous innovations around him, then chances are that he or she will not adopt the new technology (Nowak 1992). An example of a belief statement is "IPM does not increase returns". Because of this belief, a farmer might state later on that "I don't like IPM" which, in turn, is a form of attitude (Musser et al 1984).

One of the main catalysts for adoption of any innovation is the farmer's attitude towards change (Chamala 1987). Attitudes are learned rather than innate. They may occur through direct experiences, or through interaction with others (Fishbein & Ajzen 1980).

Applying the technology in actual situations, and continuous interaction with knowledgeable individuals about the technology will influence an individual's belief and, later on, attitude. But for adoption to occur, it is preferable that a farmer should have a positive attitude towards change.

A negative attitude isolates an individual from any information which is seen as inconsistent with beliefs, values and needs. This view was further strengthened by the findings of Duldulao (1975) and Araral (1981) which identified individual values and experiences which influence an individual's attitude. An unpleasant experience may tend to produce unfavourable attitudes, and these are shown by the tendency to avoid the situation or the object (Araral 1981).

On the other hand, an individual develops a favourable attitude or feeling towards objects, and people who, satisfy his or her wants and needs (Araral 1981). A positive attitude prompts a farmer to seek new ideas and information (Chamala 1987). For example, a farmer may try using a high yielding variety (HYV) to replace his traditional variety. If the HYV gave him a higher return, then he may try planting it again.

3.4.1.4 Social/Cultural

In the Philippines, cultural attitudes, values and practices are important considerations in evaluating technologies. They serve as critical measures for appraising society's acceptance of technologies and the perception of the cost of food loss (National Academy of Science 1978). Maize farmers' strong family ties may hinder the adoption of technologies which might tend to displace labour. For example, an employer with his own trading business who has a long established relationship with his staff may feel that his staff have contributed to the success of the business and therefore, he feels obliged to retain the staff rather than shifting to a mechanised operation (Cardiño 1985).

3.4.2 Factors Affecting Organisational Adoption Decision

According to Rogers (1995), diffusion research began with the study of the way in which individuals make decisions. At first, researchers had overlooked the fact that individuals belong to groups or organisations, but later on, studies on diffusion of innovations included organisations. These researchers considered the organisation as one entity in technology diffusion and adoption, and thus, applied to the organisation the same models and methods of investigating innovativeness used for individuals.

Many early studies revealed that the characteristics of an individual adopting new technologies are similar to the characteristics of an organisation (Rogers 1995). For example, depending on the technology, the ages and educational levels of individuals comprising the decision-making group may be important. Economic factors such as investment and operating cost can influence the decision by both a group and an individual. However, there are adoption factors identified in organisations that may not be factors in individual adoption because organisational factors are related to organisational innovativeness (Rogers 1995). These factors include leadership characteristics, the presence of an innovation champion, organisational structure, and organisational size.

3.4.2.1 Leadership characteristics

An organisation has a leader or a policy making body that governs how the organisation acts. The type of organisational leadership affects the adoption of technologies. If the power and control of the system is held by relatively few individuals, then there is a lower probability that the organisation will adopt a particular technology (Rogers 1995). As

Rogers (1995) further explained "the range of new ideas in a centralised organisation is restricted when a few strong leaders dominate the system".

While the literature is not conclusive as to the best type of leadership for effective technology adoption in organisations, a democratic and participative leadership style is generally recommended to enhance organisational adoption (King and Anderson 1995). A study by West and Wallace (1991) revealed that there is a positive association between a participative leadership style and group innovativeness. Groups in which the leader encourages participation are more likely to be open to innovation. On the other hand, Dunphy and Stace (1988) argue that the leadership style appropriate for innovation depends on the environment of the organisation, and members' attitude towards change. If an organisation has members who are threatening the organisation and are suspicious of change, then the leader has to be authoritarian rather than participative to implement innovation.

3.4.2.2 Innovation champion

This is an individual who introduces innovations to an organisation, who feels a strong bond to a particular idea related to the innovation and is able to sell the idea to the organisation. The innovation champion need not be a senior member of the organisation, but can be a technical expert who can persuade powerful and influential people of the value of the innovation which he is selling (Rogers 1995). Technologies with the support of such a person are more likely to be adopted than those technologies without any support at all.

3.4.2.3 Organisational structure and size

Adoption of technologies by an organisation is affected by the way in which the organisation is structured. The more centralised the decision-making is in an organisation, the less innovative the organisation is. This is because the range of ideas flowing is restricted to the few members of the decision-making group (Rogers 1995). Organisations with a flatter structure, where leadership is close to all the members, are more likely to be innovative.

On the other hand, Rogers (1995) said that the larger the size of the organisation, or the greater the number of members in an organisation, the more innovative an organisation is. A study by Morch and Morse (1977) conducted in US hospitals showed that size has a significant impact on the adoption of new technologies for diagnosis and treatment. Size, in terms of more specialists in a hospital, the more user of the technologies. But size as a factor in organisational adoption depends on the kind of innovation being adopted.

3.5 Farmer Co-operatives and Technology Adoption

The definition of a co-operative, the types of co-operatives and their organisational set-up are discussed in this section. Specific roles of agricultural co-operatives and the services which they provide to their members will also be discussed.

3.5.1 Definition

According to the co-operative laws of the Philippines, a co-operative is defined as "a duly registered association of persons, with a common bond of interest, who have voluntarily joined together to achieve lawful common social or economic end, making equitable contributions to the capital required and accepting fair share of the risks and benefits on the undertaking in accordance with universally accepted co-operative principles" (Co-operative Development Authority 1990, p.1)

A co-operative is one form of an organisation and as such is composed of individuals having one common goal, having division of labour and functions and positions structured in an hierarchical manner. Members' needs relate to improvement in their physical, spiritual, and economic situations, which they cannot access as individuals but can attain jointly (Nafari 1981; CDA 1990). Needs such as acquiring loans at low interest rates and purchasing grocery items at a lower price than is changed by commercial stores are examples of starting points for the creation of co-operatives.

In order for co-operative members to attain their goals, they transform their common needs into objectives, which they strive to achieve through common activities. To do this, they impose rules, rights and obligations upon themselves and conduct their business voluntarily in the form of self-help, self-responsibility and self- administration. The benefits and profits that they realise are proportionally divided among themselves (Texer 1974).

A co-operative is an association of persons with common interests. It begins with the people who wish to provide themselves with the goods and services they need. Although capital is not the foundation of a co-operative, it is the lifeblood of its successful operation. A co-operative must have adequate funds, and these must be managed efficiently for the maximum benefit of its members. Much of the success of the co-operative depends on how its financial resources are used and allocated (CDA 1990).

3.5.2 Organisational set-up

A co-operative is composed of four entities: members or general assembly, board of directors, operating management and employees.

1. *Members.* The members are the legal owners of their business. In principle, the members, and not the Board of Directors have the controlling authority over the co-operative. The members are the ones who plan and benefit from the co-operative. In reality, the board of directors has a major influence in the decision-making of all the members. In the Philippines, since most of these ordinary members have reached only high school, they elect boards of directors who are university graduates for the members believe that they know what is best for the co-operative (Roy 1976;CDA 1990). The general assembly meets at least once a year to elect the board of directors.

2. *Board of Directors.* They are the governing body of the co-operative. The directors employ the manager, establish specific operating policies and supervise the management of the co-operative. The directors are the elected representatives of the members. Boards of Directors shall be composed of not less than five but not more than fifteen persons. Board members are elected for a period of two years. A board member can be re-elected but can serve only for a maximum of three consecutive terms (equal to six years) (CDA 1990). The board members shall elect among themselves the chairman and vice-chairman.

3. *Operations manager.* He or she is the one in charge of the day to day operational activities and business of the co-operative, and supervises the employees hired by the co-operative (CDA 1990).

4. *Employees.* These are hired personnel who may be also members of the co-operative. They are responsible to the manager (CDA 1990).

3.5.3 Types of Co-operatives

Rogers (1995) classifies organisations according to their objectives. In the Philippines, co-operatives are categorised according to their key functions and services, and according to the level at which they operate: (Wuyts-Fivwo 1996; CDA 1990). These are:

1. *Credit co-operatives.* These co-operatives promote thrift among their members, and create funds in order to be granted loans for productive and provident purposes. Members are granted loans for their farm inputs as well as for education and health purposes. If one of their family members becomes sick, the co-operative can provide money for health care.
2. *Consumer co-operatives.* The purpose of these co-operatives is to procure and distribute commodities to members and non-members. They are grocery stores selling food and basic items which are commonly used in every household.
3. *Producer co-operatives.* These are co-operatives which undertake joint production of either agricultural or industrial commodities. They are similar to a consumer co-operative except that the items which the co-operative buys and sells are fertilisers, pesticides and other agricultural inputs needed in agricultural production.
4. *Marketing co-operatives.* These organisations engage in the supply of production inputs to members and market their produce. The co-operatives provide production inputs to the members in kind. After harvest, the co-operatives gather and pool all the members' produce and then sell their produce to the highest bidder or usual buyer.

5. *Service co-operatives.* These co-operatives engage in medical and dental care, hospitalisation, transportation, housing, insurance, housing, labour, communication and other services.
6. *Multi-purpose co-operatives.* These co-operatives combine two or more of the business activities described above. Normally, agriculture-based co-operatives fall under this type, for they provide inputs as well as marketing and financial services to their members.

The CDA (1990) have also described three types of co-operatives based on the level at which they operate.

1. *Primary co-operatives.* These are small local groups, such as community groups with individual membership. In the Philippines, farmer organisations operating mostly in one or more barangays[3] or in one municipality[4] fall into this category.
2. *Federated co-operatives.* These are co-operatives having two or more primary co-operatives as their members.
3. *National unions.* These co-operatives operate at a higher level. Members can be both primary and federated co-operatives. The coverage can be nationwide.

The services provided by co-operatives may be similar to one another. Both primary and federated co-operatives may operate as marketing co-operatives but they differ in the scope and location where they operate and the type of members they have. Under the Philippines set-up, there are many primary co-operatives, particularly agri-based multi-purpose co-operatives, located in the barangays and municipalities. These primary co-operatives can be members of one federation operating in one province. Moreover, these

[3] Smallest political unit in the Philippines
[4] Second smallest political unit in the Philippines

categories are not exclusive. If a primary co-operative is a member of a federation, then the primary co-operative can still operate independently.

3.5.4 Role of farmer organisation/co-operatives in technology adoption

In the Philippines, farmer organisations and/or agricultural co-operatives play a significant role in the adoption of technologies. Though not many information are published regarding co-operative adoption of technologies, this section highlights the farmer organisations' role in technology adoption.

Technical assistance and technology acquisition. Farmer organisations such as co-operatives provide agricultural extension services to their members, with the help of Government and non-Government extension agents and research institutions. Services such as the dissemination of technical information on new production techniques, farm management, disease prevention and control, marketing and processing are provided (Narayanan 1991). In Western Australia, a study by Marsh and Maling (1997) revealed that a joint activity between a research centre and a farmers' organisation was valuable in promoting the transfer of research results to the farming community. The research centre, while in close contact with the farmer organisation, developed an alternative grain legume in answer to the farmers' problem about crop rotation. The co-operative conducted trials and demonstrations in the farmers' field sites.

In the same manner, equipment such as trucks, power tillers, mechanical shellers and dryers provided by the Government to farmers are channelled to co-operatives in order to maximise utilisation and benefit to as many farmers as possible (Paz et al 1989).

Educating farmers does not have to be always through formal schooling. Researchers and extension agents are also sources of information. Training, seminars, field days and demonstration farms have long been the sources of informal education. Attending training is not enough for farmers to understand the technology fully. Understanding and learning about the technology has to be shared with others. Farmers view their own experience as well as other farmers' experience as the main source of learning. In some cases, farmers stressed the importance of continuous learning, and the variety of sources of learning (Bamberry, Dunn and Lamont 1997; Millar and Curtis 1997).

Establish linkages to other institutions. Most of the farmers' organisations, particularly agricultural co-operatives in developing countries, specialise in collecting, processing, marketing specific commodities and in providing members with inputs, credit and technical services. These functions can be performed by either primary or federated co-operatives. To implement these activities more effectively, and to disseminate these technologies at the right time and place, links between research and extension have to be established (Ewell 1990; Wuyts-Fivawo 1996).

Farmer organisations can use different strategies when linking with sources of technology. According to Wuyts-Fivawo (1996), farmer organisations studied in Kenya have three main strategies for linking with sources of technology, these are (1) through extension, (2) providing private or semi-private technological services to the members and, (3) combining the two with planned training programmes. These types of linkage are also being adopted by other farmers' organisations. To ensure an effective dissemination of technology to farmers, a combination of these three strategies can be employed. Farmers' organisations can extend extension services, technological services plus training to their members by linking with the government, non-government agencies and private chemical companies.

3.7 Role of government in the technology adoption process

The primary goal of the Government in establishing farmer co-operatives is to improve farmers' lives by increasing income. The role of the Government lies mainly in presenting viable opportunities, in stimulating and supporting farmers' groups, in investment where the physical environment is a constraint and in necessary technical support. In Iran, the main objectives of the Government for the establishment of co-operative farms in the 1980's were "consolidation of land, acquainting farmers with modern techniques, land development and providing employment opportunities for rural labour in the processing and rural industries which would necessarily lead to an increase in agricultural production and farmers' income" (Najari 1981). This is also the purpose of the Philippine Government in establishing co-operatives.

The Government has to know how to diagnose the situation of the farmers. It is essential to find out what is technically possible in a particular situation, what is profitable to the farmer, how it will fit into their farming systems and what attitudes and responses to expect from them (Hunter 1974; Deininger 1996). The Gintong Ani Program (GAP) has been used by the Philippine Government to diagnose the farmers' needs and has developed programmes to meet these needs.

The programme is a collaborative work of almost all Government research, training and extension offices. It provides all technologies needed by farmers starting from production right through to marketing. It is a programme aimed at "ensuring food security and helping organise subsistence farmers into functional groups or co-operatives and transforming them into viable producers and entrepreneurs". With this programme, the Government is hoping that it can really help the farmers increase their farm income in the way in which they envisage it.

3.8 Summary

The target users must adopt a technology for it to be classified as useful. But before an individual or farmer organisation will adopt agricultural technologies, there are certain requirements governing their decision which have to be met. These requirements have to be taken into consideration carefully so that successful dissemination of technology follows.

Extension and extension agents have a significant role in the adoption of technologies by farmers and farmer organisations. They serve as learning facilitators for farmers as well as being the link between research and extension. Extension agents should always be updated with the latest technology so that immediate dissemination of technology to the farmers will be possible. But for dissemination to occur however, farmers should first learn and know what the technology is all about and how they can benefit from it. Without learning, adoption will not occur.

A better way to disseminate the technology to farmers than one at a time is through farmer organisations. Farmers as a group can learn more easily by sharing each other's ideas and experiences. The learning of one farmer can possibly influence the learning of another. With the help of extension agents in promoting new ideas and information through continuous education, bearing also in mind various factors affecting adoption decisions, technology adoption will improve.

Although numerous studies have investigated organisational decision making, limited research has been done on the reasons for farmers' organisations decisions to adopt technologies. The processes and factors discussed above form a theoretical framework that guides this research.

Chapter 4 RESEARCH METHOD

4.1 Introduction

Various approaches can be adopted for research depending on the types of research questions to be asked. Each research approach has its own distinctive characteristics, advantages and disadvantages. Each differs in the collection and analysis of empirical evidence following its own logic (Yin 1994).

The primary question which this study aims to answer is "why do farmer groups/co-operatives either continue to use or no longer use the NAPHIRE flash dryer provided by the Philippine Government?"

Common types of research strategies, research design and reasons for choosing the research design are discussed in the following sections. The research design suited to this study is presented and justified. Possible sources of information are discussed and the process of analysing the data is explained.

4.2 Types of research strategies

Yin (1994) identified five main research strategies in social science, namely experiments, surveys, archival analysis, histories and case studies. Each of these is differentiated based on the "(1) form of research questions, (2) control of the researcher over the behavioural events, and (3) extent of focus on the contemporary as against historical events" (Yin 1994 p.4). Table 4.1 shows the differentiation of these research strategies. Each research strategy is compared to the others based on the forms of questions asked, the control over behavioural events, and whether or not they focus on contemporary events.

Table 4.1. Forms of research questions and distinctive characteristics of the different strategies used in conducting research.

Strategy	Form of research questions	Requires control over behavioural events?	Focuses on contemporary events
Experiment	How, why	Yes	Yes
Survey	Who, what, where, How many, how much	No	Yes
Archival analysis	Who, what, where, How many, how much	No	Yes/No
History	How, why	No	No
Case study	How, why	No	Yes

Source: Yin 1994 (Adapted from COSMOS Corporation).

"What", "who", "where", "how" and "why" are the questions frequently asked by the researcher. Questions starting with "what" can be answered by any of the five research strategies-e.g. "*what* are the steps followed by the co-operative in making decisions?". "Who" and "where" questions can be dealt with by survey and archival analysis- e.g. "*who* are your sources of technology information". Lastly, the "how" and "why" questions can lead to the use of case studies, histories and experiments since these questions deal with operational links which have to be traced over time, rather than just frequencies. In experiments, the researcher has control over relevant behavioural events, while in case studies, there is no control. If the researcher is concerned with contemporary events, then the case study is the preferred strategy (Yin 1994).

Both survey and case study approaches gather information through interviews, however, they differ in how these interviews are executed. Survey methods use questionnaires in which the questions are well structured, and questions are asked precisely in the form in which they are written (Parker and Hudges 1989). A case study, on the other hand, utilises semi-structured interviews in which guide-questions are written like a checklist. Questions asked, and the order in which the questions are asked, flow from the respondent's replies rather than having the interviewer proceed strictly according to a pre-determined list of questions (Sapsford and Jupp 1996). Survey methods involve conducting interviews with large samples that are representative of an entire population while the case study focus is on small samples. Data collected from surveys are analysed statistically while the case study method uses qualitative analysis (Patton 1990).

4.3 Research design

In this study, in-depth answers to the question "why do farmer co-operatives continue to use, or no longer use the mechanical dryer provided by the Philippine Government" are needed. In experiments, control is required by the researcher to determine if the effect of one variable is related to another variable (Hedrick et al 1993). But in this study, the experimental method is not suitable and *control* was not possible because the study focused on what the farmer organisation does in its natural setting. The researcher has to exhaust all the possible reasons as to how and why the co-operatives arrived at their adoption decisions.

Although survey methods could answer the "who" and "what" questions which are important in obtaining background information about the agricultural co-operative, they were not appropriate for gaining the detailed information on the adoption process which occurred within the farmers' co-operative. In addition, archival analysis can provide historical data, which include the initial and present agricultural area covered by the co-operative, and the initial and present volume of paddy processed in the co-operative, but it does not provide relevant data on what the organisations are doing in terms of their decision making process. Therefore, a case study approach is employed in this research because it can better satisfy the data requirements.

A case study method is defined as "a research strategy which focuses on understanding the dynamics present within a single setting" (Eisenhardt 1989, p.533). This means that, aside from answering the *who, what* and *where* questions, the case study method can also satisfy the *how* and *why* questions.

A multiple case study approach using semi-structured interviews was chosen for this study. A multiple case study was selected because it was assumed that a range of factors would be identified as to why co-operatives continue to use the dryer, while other factors may be related to those who have not continued to use the dryer. A multiple case study is designed to "either predict similar results (literal replication), or produce contrary results (theoretical replication)" (Lockhart 1997,p. 202). This method is particularly useful when the study will generate different ranges of solutions to a particular problem. Also, the multiple case study technique is appropriate because it replicates findings, and therefore increases the robustness of the research (Yin 1993).

The case studies are intended to provide an in-depth understanding of decision-making within the co-operatives; and how the board of directors, staff, dryer operators and members perceive the use of the mechanical dryers in the co-operative's business operation. Moreover, the case studies may be used to derive an explanation of the factors which influenced the co-operatives' decisions to continue, or discontinue using the dryers.

From 1994 to 1997, 385 multi-purpose co-operatives received mechanical dryers. As most of the co-operatives are located in remote areas, collecting data from all of these co-operative dryer recipients was considered too expensive and time consuming for this research. Considering the limited time and budget for the research, analysing selected case studies was the best solution for achieving the objectives of this study (Dillon and Hardaker 1980, cited in Taher 1996).

4.4 Initial data collection

Before beginning any fieldwork, it is helpful to gather whatever secondary data are available from both published and unpublished sources. Secondary data which provide an initial overview of the study area and general information on the resource base, land use, problems and opportunities were collected both to provide a background and to assist with the selection of cases. Once the study area was selected, existing information specific to the region, and the particular local problems or issues, was collected from a range of sources including files, official documents, and previous articles (Cornwall 1992). Secondary data were derived from publications of the Bureau of Statistics, National Food Authority, Department of Agriculture, Bureau of Postharvest Research and Extension and other sources having data related to the rice industry. Other sources were key informants such as extension agents assigned in the specific region or the head/leader of the barangay where the co-operative is located.

Key informants were interviewed informally. This is an interview technique which does not have pre-determined questions; rather it is conversation which is guided by a checklist of topic areas judged by the researcher to be worth exploring (Kumar 1993). Since the interview process was open, there was an opportunity to explore and probe areas that the researcher needed to clarify, and to include questions in relation to topics which had not been anticipated (Kumar 1993). Information obtained from publications was validated and further explored with the key informants. For example, historical data from publications showed that the Philippine Government had introduced many agricultural technologies to the co-operatives prior to the GAP implementation. Unpublished reports revealed that some of these technologies had been easily adopted and some had not. The key informant's opinion as to the reasons why co-operatives have adopted some, but not all, of the technologies introduced to them also was considered.

4.5 Selecting cases

One of the critical stages in the case study method is the selection of cases (Stake 1995). As Yin (1993, p. 8) claimed, selecting the case or cases to be studied is "one of the most difficult steps in case study research". Cases can be selected either randomly or purposefully (Patton 1990). For the benefit of this study, a purposeful sampling has been adopted.

Purposeful sampling is used for studies which focus typically on relatively small samples where cases are selected deliberately to enable the researcher to learn about the issues of central importance to the study (Patton 1987). The purpose of this study is to determine the factors affecting adoption decisions by farmer organisations. The researcher can learn a great deal by focusing in-depth to understand the learning process and adoption decisions and of a small number of carefully selected co-operatives, rather than gathering standard information from a large statistically representative sample of the entire co-operative population.

In qualitative methods, the strength of purposeful sampling lies in selecting information-rich cases for in-depth studies. Information-rich cases are those from which "one can learn a great deal about the issues of central importance to the purpose of research, thus the term *purposeful* sampling" (Patton 1990, p.169). As for this study, the co-operatives chosen have all tried using the mechanical dryers. Co-operatives, which had not used the dryer at all, were eliminated from the selection.

A list of the mechanical dryer recipients per region was obtained from the Bureau of Postharvest Research and Extension (BPRE). The Central Luzon Region specifically Nueva Ecija was chosen as the study site (Figure 4.1).

There are six provinces in the Central Luzon region. The province of Nueva Ecija was chosen as the case study site because it has the highest area planted in rice, highest yield per hectare and highest number of mechanical dryers from the nationwide distribution (Appendix 1). Each co-operative was given one dryer. Two hundred and two mechanical dryers were distributed in Central Luzon, of which 145 were given to the province of Nueva Ecija. Nueva Ecija received the highest number of dryers because it is the main rice-producing area of the region. Out of the 145 units, 115 dryers have been utilised by the co-operatives since 1995. While no figures were gathered as to how many are still using or not using the dryers, estimates based on the status report obtained from BPRE revealed that more than 50% of these dryers in Nueva Ecija are no longer being used (BPRE 1998). This research focuses on why this has occurred.

Criteria for choosing case co-operatives were formulated to serve as a guide in determining the number and the specific co-operatives to be studied. Co-operatives, which had ceased their business operations, were not considered in this study.

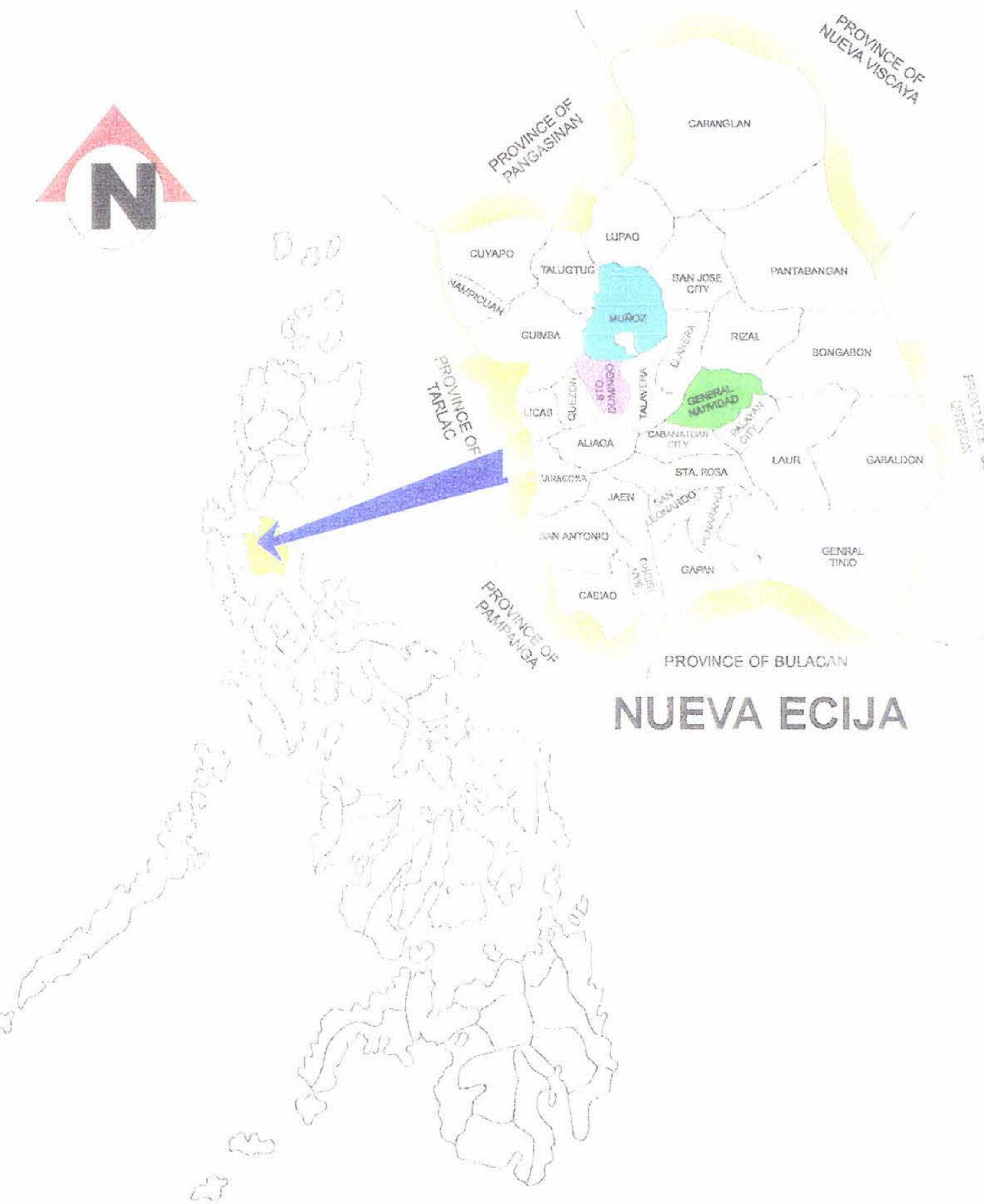


Figure 4.1. Map of the case study site, Nueva Ecija, Philippines.

Two groups were identified: utilisers (Case One) and non-utilisers (Case Two) of the mechanical dryers. Case One co-operatives are those which have used the technology at least every wet season for the last three successive cropping seasons (1995-1997) preceding this study and have dried at least 25% of their total wet paddy procured. These co-operatives provided the data/information needed to identify the factors, which promote the continuous utilisation of the dryer. Case Two co-operatives used the technology for the first cropping season only. To ensure that they know how the dryer works, they must have dried at least 200 bags of their total wet paddy procured. These co-operatives gave information about the factors which hindered their continued utilisation of the dryer.

In determining the specific co-operatives to be studied within each case, additional criteria were formulated, which enabled particular cooperatives to be selected for investigation.

1. Technology-related criteria

- Dryers had been acquired by these co-operatives within the same year and cropping season.
- The dryers are the same brand and model.
- Besides the mechanical dryers, the co-operatives have a multi-purpose drying pavement (cemented dryer).

2. Climatic criteria (to minimise the effect of the weather factor)

- The co-operatives are located in the same region having a distinct wet and dry season.
- The co-operatives have the same planting/harvesting season.

3. Operational criteria

- All co-operatives are in the rice trading business.
- They handle at least 2,500 bags/season[5] of wet paddy.

Considering the criteria above, six co-operatives for study from the list of those which are active and still operating were selected. Three of these were current users of the dryers and the three have stopped using them. The co-operatives were chosen with the assistance of the Department of Agriculture's agricultural technicians or extension agents assigned in the area, and with the input of the Regional Area Co-ordinator of the Gintong Ani Program (GAP) postharvest component.

During the case studies and interviews, the following were used as respondents: co-operative staff/officers, boards of directors, mechanical dryer operators, labourers, members and key informants. The key informants interviewed were extension agents and area co-ordinators assigned to the area. In addition, informal conversations were held with the elders who are also members of the co-operatives.

4.6 Information gathering

Before the researcher went to the field, a letter from her research supervisor was prepared stating the purpose of the research. The letter served as an introduction for the researcher to the different agencies which were contacted during the implementation of the research.

The primary data were gathered through personal interviews and direct observation of the co-operative business operations. The interviews with respondents were

[5] This is the minimum number of bags that the cooperative is processing per season.

undertaken in groups. In some cases, an interpreter was used so that the researcher would have a clear understanding of the answers given by the respondents. A group can be interviewed in such a way that participants discuss ideas, issues, insights and experiences among themselves and each member is free to comment, criticise or elaborate on views expressed by others (Kumar 1993). The respondents were classified into four groups: boards of directors, management staff, dryer operators and labourers, and ordinary members. Groupings were done so that the respondents would be at ease with the researcher, and would feel free to voice their opinions. Because of seniority considerations, the grouping of ordinary members or labourers with others such as members of the boards of directors was avoided.

Primary data are first hand information obtained from individuals or representatives of organisations. Information such as the co-operative's background, organisational structure, acquisition of agricultural facilities and establishment of paddy trading were obtained from the co-operative staff. The processes of how decisions are made in the co-operative were gained from both the staff and the board members. Personal details such as age, educational attainment and training were asked of the individual concerned where appropriate. Perceptions, views and comments on the use of the mechanical dryer in the co-operative were gathered from the board members, staff, labourers and members. Labourers and staff were questioned also about the adequacy of the postharvest training (See Appendix 2 for the topic checklists that guided the interviews).

Since the majority of the farmer co-operatives are located in remote areas, most of the dryer operators, labourers and farmer members have little if any formal education, and can speak only their native dialect. Thus, an interpreter was required in some of the areas so that the researcher could understand the respondents' answers. An interpreter who acted also as guide, was hired for each of the case study sites.

The research party, comprising the researcher, together with the interpreter and extension agents visited the selected co-operatives two to three times. Information regarding the backgrounds of the co-operatives and their present operations were gathered on the first visit. Also, the groups consisting of the board of directors, staff and labourers were interviewed on the first visit. Validation and clarification of information which had been unclear during the first visit, and observing the co-operative business operation as well as the drying operation were carried out during the second and third visits. There were no criteria to select who, among the members, would be interviewed. The interviewer spoke to whoever was available, and willing to be interviewed.

Because some people felt intimidated, the interviews with labourers and staff were conducted without any questionnaire or recording device, while most of the board members allowed their interviews to be recorded. Some respondents preferred that their answers not be tape-recorded. In order to create a relaxed and informal atmosphere, interviewing resembled an informal conversation. Note-taking was done immediately after the interviews so that information obtained was still fresh in the researcher's mind. Furthermore, a discussion between the interpreter and the researcher immediately after the interview was helpful to recall what information was obtained, and to discuss and evaluate between themselves the quality of this information. The taped discussions between the researcher and interpreter were transcribed.

4.7 Data Analysis

The data gathered were analysed qualitatively. Qualitative analysis focuses on finding how the systems operate, and how people behave rather than on examining the cause and effect relationship within the system (Dey 1993). The process of how co-operatives make decisions and why they arrived at such decisions, is the focus of this study. Using qualitative analysis, the similarities and differences between the study co-operatives were investigated. According to Miles and Huberman (1984) qualitative data analysis is similar to detective work wherein the investigator makes sense of the facts he/she has on hand by comparing, contrasting, classifying and cataloguing these data before arriving at a conclusion. In multiple case studies, data analysis is done in order to find differences and similarities between cases (Dey 1993).

In the process of qualitative data analysis, Dey (1993) presented three steps which must be followed: description, classification and connection. Description is the detailed result of interview transcripts. It is an overview of the raw data which highlights important and relevant aspects related to the research. The profile of the each of the co-operatives, such as its number of years in existence, total number of members, and estimated volume of wet grains for drying; and the profile of the board of directors and staff such as age, education level, number of years occupying the position were established and described.

Classification is the sorting of the data (composed of words, sentences, paragraphs) taken from semi-structured interviews into different groups. This involves reducing the data contained in the verbatim transcripts and field notes into data bits so that it can be categorised. In the classification process, categories are developed to allow identification of comparisons and differences between data bits. If needed, subcategories can be formed and comparisons can also be made between sub-categories (Dey 1993).

Connection, which is the third and last step, can be done once the classification has been completed. This involves identifying links and relationships between categories. Establishing relationships can be based on similarities and differences between categories or on cause and effect which normally links dissimilar categories (Dey 1993).

Three co-operatives formed one case. Data were grouped and classified according to the answers of the board of directors, staff and labourers/operators. Answers were categorised according to the decision-making process and factors identified by the present utiliser, and non-utiliser, of the mechanical dryer. The resulting categories will be compared within and across co-operatives. Similarities and differences amongst factors which affect a co-operative's adoption decision to use or to stop using the mechanical dryer are examined. Once similarities have been established and differences explained, conclusions will be drawn.

Chapter 5 RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents the information gathered from the field including general information about the co-operative organisation, how co-operatives make decisions, the sources of income and specific services provided by the co-operative to its members. Most importantly, the factors influencing adoption of the mobile flash dryer are also presented. Finally, the results are discussed and analysed.

5.2 Background

5.2.1 Sources of income and co-operative services

All co-operatives in both Cases One and Two are registered by the Co-operative Development Authority (CDA) as multi-purpose co-operatives, because they are involved with production and processing as well as with the marketing of agricultural and/or non-agricultural commodities. Their common sources of income are trading activities, such as sales of fertilisers and agri-chemicals, interest earned through the re-lending of production loans to members, and the renting of facilities including multi-purpose pavement dryers and trucks to the members.

The primary purpose for establishing co-operatives was to obtain capital for production loans, which are used to fund each season's crop for members. Secondary to this is the provision of technologies and production and postharvest facilities for use by the members.

Production loans are given to the members to a maximum of ₱12000 (NZ$600) per hectare. The loan is released on a staggered basis, and is given as cash as well as in inputs for production such as fertilisers and pesticides. The cash portion is used by farmers to purchase seeds and for the payment of labourers during planting and transplanting. The co-operative purchases the chemical inputs in bulk from chemical companies and sells them to the members at a cheaper price. A production loan is good for only one season (6 months), and is payable to the co-operative at harvest time.

Co-operatives finance grain production by the members, and the payment is made in the form of wet or dry paddy. This payment system assures the co-operative of a constant supply of grain for processing. Aside from the co-operatives, local traders or private lenders also finance some of the members' production in the same manner, but at a higher interest rate than is offered by the co-operative.

A generalised postharvest system of operation is shown in Figure 5.1. After harvest, farmers thresh the paddy, after which they can sell it as either wet or dry grain. Farmers who choose to dry grain before selling may use the co-operative's multi-purpose drying pavement (MPDP). If there is a long queue for the MPDP, farmers may also use the barangay's cemented basketball courts, feeder roads and national highways for drying. If they use the co-operative's MPDP to dry their grain, members pay a rental fee to the co-operative.

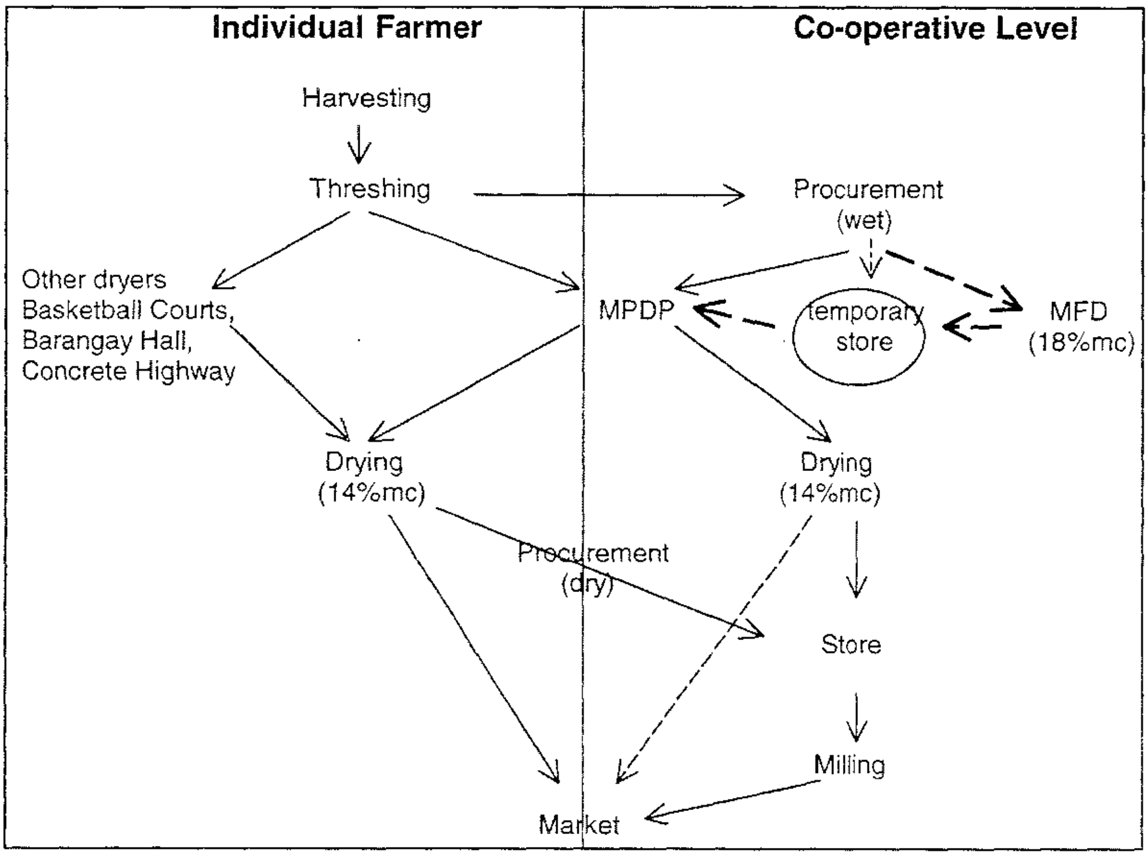


Figure 5.1. Individual and co-operative level postharvest system of operation.

The members can use the MPDP at a fee of P0.50 to P1.00 per bag, wet basis. The member provides the labourers (who stir and turn the grain every 30 minutes to 60 minutes). In the same manner as the MPDP, the mobile flash dryer (MFD) also is available for rent to members. However, different schemes for payment are imposed by each co-operative. Aside from the MPDP and MFD, other equipment owned by the co-operatives is used to generate rental income.

Farmers can sell their produce as either wet or dry grains to the co-operative. In drying grains, the co-operatives use both their multi-purpose drying pavement (MPDP) and mobile flash dryer (MFD). If intense and continuous sunshine is available throughout the day, then the co-operative maximises the utilisation of the MPDP. If the weather is cloudy or rainy and there is a large quantity of wet grain for drying, the co-operative uses the MFD to pre-dry the grain down to 18% moisture. The grain could be temporarily stored for a maximum of two weeks before sundrying the same grain down to 14% moisture content. After drying the grain to 14% moisture, the co-operative can either sell the grain or store then mill the grain before selling (Figure 5.1).

Harvesting of paddy grain is seasonal. There are two harvest seasons for rice in a year. The dry season harvest is from March to May while the wet season harvest is from September to November (refer to Chapter 2). The dry season harvests do not encounter many problems in drying compared with the wet season, as the number of rainy days is low so paddy grain can be spread on the MPDP and sundried in one day. The wet season harvest is when the major problem occurs, because frequently, rain and typhoons occur, thus forcing the co-operative members to seek alternatives to sundrying to avoid grain deterioration.

Table 5.1 shows the average number of days a co-operative operates in a year, and the approximate number of rainy and sunny days per month. During the wet season harvest months of September to November, the average number of rainy days are 46 days, with 37 sunny days. The overlap of the main procurement of harvested grain (coop1 data) with the rainy season is illustrated graphically is Figure 5.2. Although the rainy days are decreasing when the procurement season peaks, the number of rainy days are still significant, suggesting that sundrying is not reliable. It is during this time that a mechanical dryer such as the MFD is very useful.

Table 5.1 Average number of working days, rainy and sunny days per year, 1988-1997.

Month	Coop working days	Ave. Rainy* days	Ave. Sunny days
January	27	3	24
February	24	2	22
March	27	2	25
April	26	5	21
May	27	12	15
June	26	17	9
July	27	24	3
August	27	21	6
September	26	23	3
October	27	15	12
November	26	8	22
December	27	3	24
Total	317	133	186

* Include traces.

Source: PAGASA, CLSU, Nueva Ecija, Philippines.

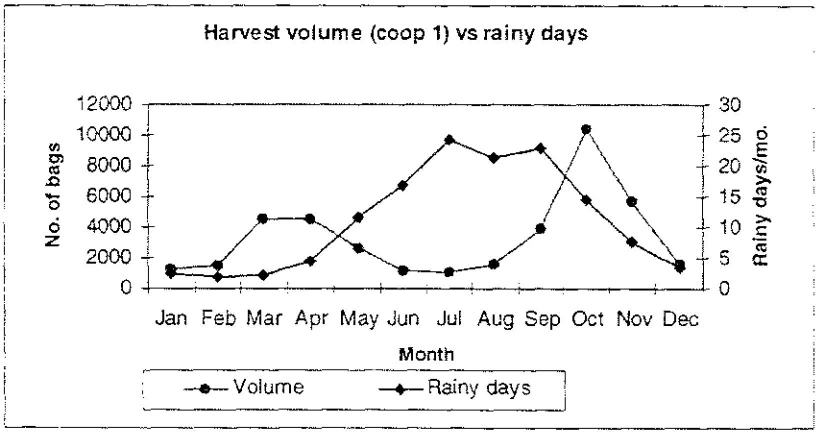


Figure 5.2 Average volume of procurement by Coop 1 and number of rainy days.

5.2.2 Co-operative organisation and decision making

In all the co-operatives studied, the board members make the majority of the decisions regarding co-operative policies, loan applications from banks and facilities acquisition. For example, if there are innovations being introduced by the Government which are provided at no cost, the board, in consultation with the manager prepares the necessary papers without informing or asking the general assembly. The general assembly is informed either once the decisions have been made, or when the technology arrives at the co-operative. In all the co-operatives studied, the boards of directors alone decided to acquire the MFD, about which they had heard from extension agents, staff of government offices, and neighbouring co-operatives. However, the management staff knew about the decision before the units were delivered to their respective co-operatives. The managers of the co-operatives make the decisions regarding the operation of the dryers.

Basically, there are at least four main staff maintained by each co-operative: the manager, who is in charge of the day to day decisions regarding the co-operative's business operation; the secretary/bookkeeper who keeps the records; the treasurer who disburses the money, and a warehouseman who takes charge of the grain stock inside the warehouse. In the co-operatives involved in this study, the warehouseman was responsible for operating the mechanical dryer. No specific dryer operator was employed by any of the co-operatives visited.

The Chairmen of all Boards were interviewed. Succession of board members is implemented in the six co-operatives. To ensure that there is never a complete change in board membership, half of the board are replaced each year. In this way, work carried out by the board can continue regardless of changes in membership.

Every co-operative differs in the amount or volume of grain handled, available facilities and capacity, and style of management. In the following section, the co-operative under each case will be described briefly.

5.3 The Cases

This section is divided into two cases: Case One as the utilisers of the mobile flash dryer and Case Two as the non-utilisers. Each case presents the general profile and the factors which may affect the co-operatives' decision to continue to use or not to use the mobile flash dryer.

5.3.1 Case One (Utilisers of the dryer)

The summary profile of the individual co-operatives under Case One is presented below. Moreover, factors affecting the co-operatives' decision to continue to use the mobile flash dryers are identified.

5.3.1.1 Co-operative profile

All Case One co-operatives have used their mobile flash dryers for three consecutive years (1995 to 1997) and are engaged in two types of rice processing: paddy trading and rice milling. "Paddy trading" is procuring wet paddy from the farmers, drying it, and marketing the dried product. Rice milling involves the further processing of dried paddy into milled rice before marketing.

In Case One, the boards of directors of two co-operatives comprise nine members while one co-operative had ten. In all the three co-operatives, the Chairman is the eldest. He has continued to hold this office since the co-operative was formed. The managers of Coops 1 and 2 have been in their positions since the co-operative started their business, while the original manager of Coop 3 resigned and was replaced in August 1998.

All three co-operatives have similar facilities such as truck, warehouse, MPDP, MFD and rice mill. However, Coop 1 is the largest with the highest membership, largest area planted, largest volume of grain handled and largest MPDP capacity. Moreover, Coop 1 has the highest volume of grain mechanically dried. Unlike Coops 1 and 3, Coop 2 uses the mechanical dryer solely for drying the co-operative's procured grain. On the basis of 37 sunny days during harvest and procurement (refer to Table 5.1), the calculated MPDP utilisation is indicated in Table 5.2.

5.3.1.2 Factors affecting adoption

The factors which possibly affect the adoption-decision by co-operatives are enumerated in this section. These are grouped as economic, technical, training and leadership factors.

Economic factors

All respondents of the three co-operatives complained that the mobile flash dryer has a high operating cost. They said that the highest component is the kerosene, which is roughly 40% of the total operating cost of drying. The dryer operators in the three co-operatives revealed that mechanical drying costs ranged from P20-35 per bag while sundrying costs ranged P10-30 per bag. The cost of sundrying increases if the grains are not dried in one day.

Table 5.2. General profile of the Case One co-operatives.

Coops	Present Members	Area Planted (ha)	Facilities	Volume Handled (Bags)	MPDP Capacity (Bags)	Calculated MPDP Utilisation	Mechanical Dryer	
							Total No. of Bags dried	Drying Fee (P/bag)
Coop 1	386	687	Office, truck, warehouse, MPDP, MFD, rice mill, moisture meter	15000 to 20000	400	14800	5,000	P20/bag** P5/bag***
Coop 2	190	350	Office, truck, warehouse, MPDP, MFD, rice mill, moisture meter	10000 to 12000	200	7400	3,000	MD used solely by The co-Operatives
Coop 3	163	275	Office, truck, warehouse, MPDP, MFD, rice mill, moisture meter	3000 to 6000	150	5550	2,000	P4/bag***

* Accumulated volume mechanically dried from 1995 to 1997
** Co-operative pays the cost of labour, gasoline, and kerosene
*** The member pays the cost of labour, gasoline and kerosene

According to the staff of Coops 2 and 3, their co-operatives incur additional labour cost in sundrying during the rainy season. Moreover, Coop 1 staff said *"in actual* [mechanical dryer] *operation, we maximise labourers' utilisation during the rainy season. Labourers working on the pavement dryer are the same labourers utilised on the mechanical dryer. The labourers are paid daily with, or without, doing sundrying so it's better to utilise them in operating the mechanical dryer as well"*.

Another issue raised from the three co-operatives specifically by the dryer operators and labourers is that the use of the mobile flash dryer reduces drying losses, that is, the volume of mechanically dried grain recovered is higher than that of sundried grain. In sundrying, losses, such as grain left in-between the cracks of the MPDP, incidence of mixing foreign matter such as small stones with the grains, accidental "milling" of grain when grain it has been spread on the highway (Figure 5.3), bird infestation and possible re-wetting of grains due to rain, may occur.

Figure 5.3. Sacking of dried grain after sundrying in highways.

Technological factors

Three issues are revealed when technical aspects of using the dryer are considered. These are its design, durability and ease of operation.

All the co-operatives mentioned that the dryer capacity is small for their volume handled. During the peak harvest season, the dryer capacity (10 bags per hour drying from 24% to 18% moisture content) is not enough to accommodate their volume intended for drying (Basic features of the mechanical dryer are detailed in Appendix 3). The staff of one co-operative said that *"the flash dryer has a small capacity, good for only one farmer with four to five hectares; for 800 hectares, it is not enough"*. Another operator said that *"a dryer with 200 bags capacity per batch is suited for their operation"*.

Design specifications were also a concern. According to the labourers and dryer operators, the grain spills over the sides of the bin when the drying bin is almost full. This happens when grains are being loaded into the bin. To reduce spillage, some of the labourers placed a sack at the end of the elevator spout. In addition, staff from two co-operatives (Coops 1 & 3) mentioned that impurities such as rice stalks are blown and stuck on one side of the drying bin. There is no opening in that side of the dryer for the removal of the rice stalks.

As cited by two operators of the mechanical dryer, the joints and body of the flash dryer tend to overheat with continuous operation of more than eight hours in a day. There is a need to rest the dryer after four hours operation for at least half an hour before using it again. If this is not done, then the economic lifespan of the dryer might be reduced. The dryer operator of Coop 2 revealed that the bearing and fan belt loosened after the machine had been used for few times. The co-operative changed the bearing twice and the fan belt once. As added by Coop 3, *"the welding from angle bar to flat bar at the bottom part of the dryer always needs repair. After drying around 200 bags, the weld had broken".*

As a safety precaution, the operator and labourers of Coops 1 and 2 suggested that belt guards should be installed near the moving parts to avoid accidents. There was a time when the pulley near the engine caught the shirt of one labourer working in the dryer in Coop 1. In order to prevent a recurrence of this type of accident, safety guards should be installed.

All the dryer operators of the three co-operatives pointed out that the dryer is easy to operate. As one operator said, "as you come to know how to operate it, everything will be easy. Just pay attention to the temperature so that the grains won't get burned". Another constructive comment made by some staff and dryer operators of the three co-operatives is *"our co-operative can dry at whatever time we want if we have a mechanical dryer*". In addition, one staff member from Coop 1 said that "*apart from being able to use the flash dryer at any time, it occupies a smaller space as compared to the MPDP*".

Training

Training is an informal way of giving farmers both theoretical knowledge (features of the mobile flash dryer) and practical experience of operating the dryer. Before the training was conducted, the operators of Coops 2 and 3 thought that the operation of the flash dryer was really very easy to understand. After the training, the participants realised that it was not as easy as they had thought. One dryer operator (Coop 3) said "*the training was* *very useful and it is not just a simple lighting of the burner and the dryer will work. It needs skill and practice to operate it properly".*

The operator of Coop 3 said that when the grain is almost dry (18-20% moisture), *"just bear in mind to check and maintain the temperature from 55 to 65°C. Check the kerosene burner every fifteen minutes"*. The dryer operators of Coops 2 and 3 added that attendance at the training gave them a better understanding of how to operate the dryer properly. Though they had already gained basic knowledge by means of the dryer's operator's manual, the participants were able to understand the instructions on its operation more easily and clearly after they had attended the training.

On the other hand, the operator of Coop 1 refuted the statements of the other operators saying...*"no formal training is needed, just follow the operations manual and all will be easy. You always have to pay attention to the temperature gauge so as to maintain the right temperature of 55° to 65° C. If not, grain will get burned if the temperature is not regulated properly".*

From the training, the operators also learned how to trouble shoot in case any minor breakdown occurs in the dryer.

Management and Leadership

A participatory approach to decision making within the board of directors was observed in Coops 1 and 3. The researcher chanced upon observing the meeting of the board of Coop1. The Chairman led the meeting and presented the agenda to be discussed for the day. Varying opinions and issues were raised in which all board members participated and shared their ideas. There were no observed barriers among them and they all seemed free and relaxed in voicing their opinions. The Chairman, as moderator, welcomed all the questions and comments voiced by the board members, showed patience, interest, respect, and listened without interrupting. He appeared to be a good moderator and was able to handle the discussion within the board effectively and was able to arrive at a decision which was acceptable to all of them.

The participatory approach in making decisions was further illustrated when one of the board members in Coop 3 shared how, as a group, they arrived at the decision to accept the flash dryer.

> *"...In one of our meetings in 1994, Mr. Chairman informed us of the Government's programme, that is, of providing mechanical dryers to those qualified farmers' co-operatives. Our Chairman enumerated the criteria used by the Government in the selection of potential co-operative recipients, then issues such as size, capacity, drying time and so on were raised by my co-board members. Afterwards, the Chairman asked our views on what we thought of the mechanical dryer. But since we didn't know much about the unit, we still kept on asking some more about it. But it's worth asking, because our Chairman answered all our queries as long as he could. Funny thing is, when Mr. Chairman finally said that it will be sort of a grant, all of us suddenly decided to go and get one unit..., better ask the Provincial Government's office about it..."*

Furthermore, the Chairmen of Coops 1 and 2 revealed that they are working closely with their manager. One chairman said *"our manager and I have been partners for years in operating the co-operative business"*. The other chairman stated that *"our manager is very active in looking for sources of funding and technology either from private or Government agencies, which will be useful for the co-operative's business. In fact, he is now asking when will the in-store dryer promised by BPRE be delivered to the co-operative"*.

According to the board of directors and managers interviewed from the three co-operatives, their sources of information regarding technologies are radio, leaflets and extension agents of Government and non-Government agencies. They have a strong linkage with the provincial Government offices as well as in non-government agencies. Once they have heard from agricultural programmes over the radio about innovations which are relevant to their co-operative operation, they inquire from the extension agents. Once the technology is available, they inquire how they could avail themselves of the technology, and when they could possibly obtain it. One board member said, "*the mechanical dryer is already here and given for free, so why don't we just make the most out of it and use it*"?

Innovator champion

Most of the board of directors and manager of Case One co-operatives are very open to the technology introduced to them especially those technologies that will be given for free. In most cases, when the manager knows about new technologies offered by any government or non-government offices that can possibly be useful in their co-operative operation, he will discuss this with some of his staff or go directly to the board and inform the board members. There are times that if the managers hear innovations from agricultural programs over the radio that is relevant to their co-operative operation, they inquire from the extension agents. Once the technology is available, they inquire how they can avail of the technology and when they can possibly avail of it. If the technology sounds convincing, they, the board members and managers, will ask other co-operatives or agricultural technician regarding the technology.

With regards to the mechanical dryer, the manager of Co-operative One knows that it will be costly before they accepted the unit as compared to the traditional method of drying. But his main concern is on how to save and minimise grain losses especially during rainy season and later on, improve grain quality which may lead to an increase in the cooperative's and individual member's income.

5.3.2 Case Two (Non-utlisers of the dryer)

The summary profile of the individual co-operatives under Case Two is presented in this section. In addition, factors affecting the co-operatives' decision to stop using the mobile flash dryers are identified.

5.3.2.1 Co-operative profile

All the three co-operatives under Case Two are engaged in paddy trading only; they do not do any rice milling. They buy grain, either wet or dry, from the members, and sell it as dried paddy to the rice millers and wholesalers who abound in the area. Grain procured wet was sundried straight down to 14% moisture content. Though they tried using the flash dryer, the co-operatives utilised it only for a year.

The three co-operatives have similar facilities. They also have similar MPDP capacity and more or less similar volumes of grain are handled. They differ in the number of members, area planted and amount of mechanically-dried grain. The MPDP utilisation also is calculated based on 37 sunny days during the wet season harvest. Coops 4 and 6 rent out the MFD to interested members who want to use it (Table 5.3).

Table 5.3. General profile of Case Two co-operatives interviewed.

Coops	Present Members	Area Planted (ha)	Facilities	Volume Handled (Bags)	MPDP Capacity (Bags)	Calculated MPDP Utilisation	Mechanical Dryer	
							Total No. of Bags dried	Drying Fee (P/bag)
Coop 4	132	150	Office, truck, warehouse, MPDP, MFD, moisture meter	3500 to 5000	120	4440	300	P19/bag**
Coop 5	120	300	Office, truck, warehouse, MPDP, MFD, moisture meter	3000 to 5000	120	4440	700	MFD used solely by the co-operative
Coop 6	153	285	Office, truck, warehouse, MPDP, MFD, moisture meter	3500 to 6000	120	4440	600	P10.50/bag** P4.50/bag***

* Accumulated volume mechanically dried from 1995 to 1997
** Co-operative shoulders the cost of labour, gasoline, and kerosene
*** The members shoulder the cost of labour, gasoline and kerosene

5.3.2.2 Factors affecting adoption

Economic factors

All three co-operatives stated that operating the mechanical dryer is very costly as compared to sundrying. Coop 4 complained that it costs P19 per bag to dry mechanically. Coop 5 added that its cost could be as high as P30 per bag of wet grains. The estimated costs of drying include one operator, two labourers, gasoline, kerosene (highest component) and food, while sundrying costs P5/bag only. The dryer operator of Coop 4 added that, during the operator's training on the operation and maintenance of the dryer, they were told by the trainer that the drying cost amounted to less than P20.00. When it turned out that it was more than P20.00, the board of directors, manager and staff slowly lost interest in using the dryer.

Another issue raised by the users in Coop 4 is double-handling. As one of them said, "*there is double-handling because first, grains are mechanically dried down to 18% moisture, then sundried down to 14% moisture content*".

Technological factors

Two major points were stressed by the respondents regarding the technical factors; the capacity and the operation. All the board, staff and members of the three co-operatives stated that the capacity is small for them.

The operator of Coop 6 commented that the dryer is easy to operate but that he feels very uncomfortable during the drying operation because the exhaust heat being emitted from the engine during the operation is so hot that makes him tire easily. However, the dryer operator of Coop 5 said it is easy to manage its operation. *"Once the dryer is running, you just have to check the temperature and the burner".* As the labourer added "*they can still smoke, relax and rest while the drying operation is going on".*

Similar to Case One co-operatives, one case two operator complained that impurities trapped on one side of the drying bin could not be removed. There is no opening or outlet to remove them. Another dryer operator mentioned that the recycling chute overflows and so the grain spilled onto the floor. To remedy the situation, they place a sack to pool the spilled grain (Figure 5.4).

In September 1997, the mobile flash dryer of Coop 6 caught fire, which spread down to the recycling chute located at the bottom of the drying bin. The dried impurities such as small bits of straw left on the chute, were burned during drying. After this incident, the co-operative ceased using the dryer.

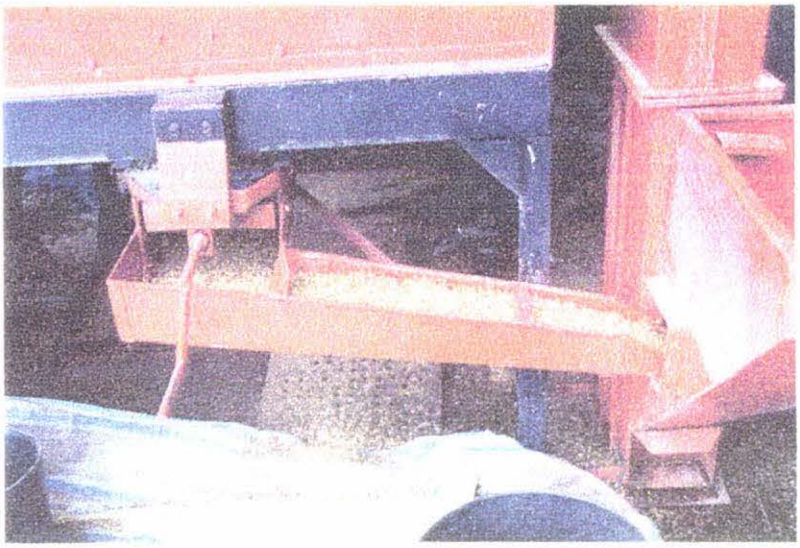


Figure 5.4. Overflowing recycling chute.

The dryer operator of Coop 4 said that the drying time was slow in comparison to the drying time specified during their training and so they used the initial temperature of 90 to 100°C if the grain was dripping wet. If it was almost skin dried (18% moisture content), they used 65°C. This temperature is higher than the recommended temperature for drying paddy grains at that specific moisture (Appendix 3).

Training

The engineers of BPRE gave three-day hands-on training to the board members, manager and designated dryer operators of the different co-operatives. A lecture was given prior to the actual demonstration of drying. Normally, a 10-bag sample of wet paddy was dried and used for demonstration purposes during the training. The participants were the ones who operated the dryer. Since there were many participants, not all of them were able to do the actual operation.

Coop 5 participants of the training revealed that the hands-on training had happened during the off-season harvest of paddy. The agricultural technicians trained by BPRE demonstrated and showed them how to operate the dryer but there was no wet paddy used and so what the engineers did was to simulate the drying operation using dried grains.

The effectiveness of training provided in Case Two was demonstrated by the comments made by the respondents. For example, a statement made by one user was "*the dryer wasn't able to dry my grain completely. Only the skin was dried not the inner portion of the kernel*". In addition, the Chairman of Coop 4 (Section 5.3.2.1) commented that the dryer is the same model as they had before, when he was still at university. Finally, one of the operator tried to dry grains up to 14%MC but the grain was burned.

Management and leadership

Seven members comprise the board of each of Coops 4, 5 and 6. The Chairmen of Coops 4 and 5 are not the incumbents who held the office when the mobile flash dryers were accepted in 1994. As for Coop 6, the Chairman has occupied the position since 1993, which means that the decision to acquire the mechanical dryer in 1994 was made under his chairmanship. The board members interviewed from Coops 4 and 5 were not the board members at the time the mobile flash dryers were delivered to their co-operatives. Board members of Coop 4 reported that "*the previous chairman intimated that a mechanical dryer should be acquired because it could help the co-operative dry their grain at the earliest possible time. Anyway, the dryer is for free*". In addition, the Chairman of Coop 5 said "*our present manager knows better about how they arrived at* *the decision to acquire the mobile flash dryer because he was the incumbent chairman at the time the dryer was delivered to their co-operative*".

As for Coop 6, one member of the board of directors said that "*extension agents from the Government visited us one time, and briefed us about the mobile flash dryer. They informed us of its benefit, that it is free. Afterwards, some of our board members went to other co-operatives and asked if they knew about the flash dryer and if there were other co-operatives using it. Then, during one of our board meetings the issue of the mechanical dryer was taken up and we arrived at a decision to take it. Actually, our present chairman was also the incumbent chairman at the time the decision was made*".

According to the staff and members of Coop 4, their present manager is not *"fitted in the position".* The staff keeps comparing him to the previous manager. As one of them said, "*the previous manager is a professor in a distinguished university in the province. He resigned as a co-operative manager because he wanted to concentrate in his job as a professor. While he was the manager, he studied the co-operative's business operation, and won the respect and help of the general members and staff, that is why he was able to deliver his responsibilities as a manager so well".*

In contrast, the staff commented that most of the time, the present manager of Coop 4 does not face the co-operative visitors such as agricultural technicians and researchers. If the co-operative is expecting technicians or researchers or any Land Bank field personnel who will visit their co-operative, the manager will designate the bookkeeper to entertain them and to give them what they need. As the manager will say to the bookkeeper, *"bahala ka na diyan*" meaning "*take charge*".

As for Coop 5, the staff said "*when the manager was still the chairman of the co-operative, he was very active in attending and participating in agricultural related meetings in the municipality. He was very aggressive in searching out funds and technologies appropriate to, and needed by, their co-operative. He always listened to agricultural programmes over the radio. Whenever he chanced upon technologies to be provided to farmer organisations, he would go and visit the Municipal Agricultural Office and inquire about it. He had a strong linkage with the municipal office. Once he had found any new projects or funds for the co-operative, he would report this to the other boards and immediate action would follow*".

The manager of Coop 6 stated that "*our chairman and I have been working together since the nineties. We often talk about our plans of how to further improve our operation so that we could serve our members better. We often discuss the technologies which are offered to us, and weigh the consequences*".

5.3.3 Summary of Results

Co-operatives under Case One had more members and bigger areas than Case Two, except for Coop 3, which has a small area compared to Coops 5 and 6. In terms of facilities, Case One co-operatives have rice mills and are engaged in rice trading aside from paddy trading, while Case Two has no rice mills. Moreover, Case One co-operatives have larger volumes handled and bigger MPDP capacity as compared to Case Two.

All the co-operatives in both cases stated that there is a high operating cost in using the mechanical dryer. However, some co-operatives in Case One pointed out that a mechanical dryer can minimise losses compared to sundrying. Case Two co-operatives, they mentioned that the drying cost quoted by the trainers was lower than the actual drying cost they had in the dryer operation. Furthermore, one co-operative under Case Two mentioned the double handling of grains if the mechanical dryer is used.

In terms of the technical aspect, both cases agreed that the capacity of the mobile flash dryer is too small for their business operation. In addition, both cases mentioned the grain which spills over on top of the drying bin due to a defect in the angle of the elevator spout. Moreover, one or two co-operatives under both cases experience impurities which were trapped on one side of the drying bin. On the other hand, Case One co-operatives added that the mechanical dryer could not withstand continuous long hours of operation. As for Case Two co-operatives, operation of the mechanical dryer consumes a longer drying time than was specified in the operator's manual.

With regards to training, two of the Case One co-operatives thought at first that there was no need for training, but when they attended the training, they realised that operating the dryer is not as easy as they had thought as one dryer operator under Case One admitted. As for Case Two, the operators mentioned that the actual hands-on training did not use wet grain for the actual demonstration of dryer operation. Furthermore, the operator used a higher temperature than was specified in the manual. Interpretation and analysis of these results across the two cases are presented in the next section.

5.4 Discussion and Analysis of Results

In this section, the results are analysed according to the identified factors affecting the use and non-use of the mobile flash dryer. These factors are categorised as economic, technical, training, and co-operative management and leadership. The operating costs, volume handled and drying losses are part of the economic factors. The capacity, drying operation and serviceability of the dryer comprise the technical factors. Adoption of other facilities such as a rice mill may affect the adoption of the mobile flash dryer. Under leadership factors, subcategories such as attitude towards the dryer, working relationship and succession of the board members are identified (Figure 5.5).

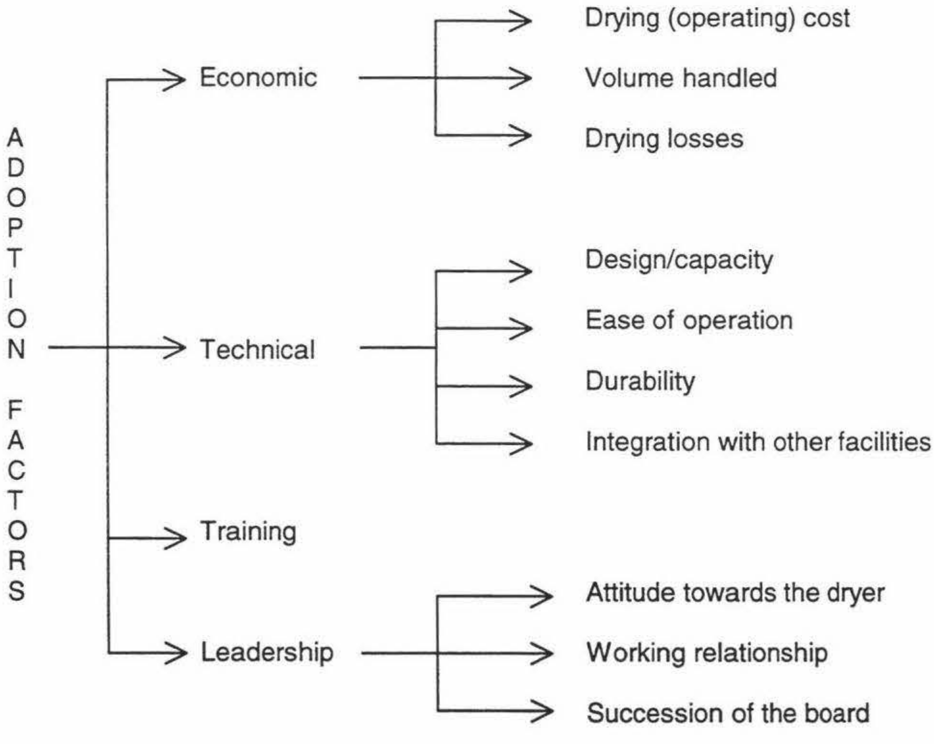


Figure 5.5. Categorisation of factors affecting adoption of the mobile flash dryers.

5.4.1 Economics

Results of both cases reveal that the costs of using the mobile flash dryer are important. For Case One co-operatives, the calculated sundrying cost (P10-30 per bag) as against mechanical drying (P20-35 per bag) overlap. During rainy season, sundrying the grain can be as high as P30.00, depending on the number of days it will take to dry the grain, which is more or less equal to the drying cost of using the mechanical dryer. As for Case Two, sundrying cost can be as low as P5 per bag as against P19 per bag if using the mechanical dryer. Thus, a discrepancy is evident. This shows that drying costs affects decision of farmers' co-operatives in continuously using the mechanical dryer.

The benefit of the mobile flash dryer however, is that it reduces moisture content (up to 18% MC) of the grain during critical wet seasons and prevents deterioration for a maximum period of three weeks. This will give enough time to sundry the grain to the required moisture content for milling. These benefits however, can only be fully realised during an "extreme wet period" but the dryer is likely to be under utilised for the remainder of the season. This could be another reason why Case Two co-operatives did not continue using the mobile flash dryer. This result supports the finding of Cardiño (1985) and Iqbal *et al* (1992) that high cost of operation affects farmer's adoption.

On the other hand, if the volume of wet grain procured by a co-operative is high, then the utilisation of the mobile flash dryer may increase. If there are more members in a co-operative, the more wet grain will be available for drying. Furthermore, if the utilisation of the mechanical dryer increases, the fixed cost per bag diminishes. Moreover, if the grain is properly dried, then a better price can be achieved which may lead to an increase in the co-operative's income.

In comparing the two cases, Case One has more grain to dry and so the need for the mechanical dryer by Case One is higher than for Case Two. The larger the area planted to rice, the larger may be the volume of grain for processing by the co-operatives. And so, as the volume of grain handled increases, the need for a mechanical dryer increases. This suggests that an increase in volume handled is a factor in the utilisation of the mechanical dryer.

Looking back at the calculated MPDP utilisation and volume handled per co-operative under both cases (refer to Tables 5.2 and 5.3), the data show that there is a need to augment the capacity of the MPDP because it cannot dry all the wet grain procured at the earliest possible time. There is a need for an alternative dryer to be sought. This issue however, will be discussed further as a technical factor in the next section.

5.4.2 Technological Factors

Both Cases One and Two said that the capacity of the mobile flash dryer (MFD) is too small for their co-operative needs. Referring to the discussion above regarding the effect of handling large volume on the adoption of the dryer, it can be seen that Case One co-operatives need a higher capacity dryer to accommodate their grain at peak harvest, especially during the wet season. This is one of the reasons why two co-operatives under Case One are considering buying a larger capacity dryer.

There are larger capacity mechanical dryers available in the market which could dry grain straight to 14% moisture content. Most of these are imported and have higher investment costs in comparison to the mobile flash dryer given to the co-operatives, which may mean that the farmers' co-operatives cannot afford to acquire them. However, the fact that they are thinking of acquiring another mechanical dryer shows that the objective of increasing awareness of its usefulness in their operation has been realised.

Flaws in the design, such as the angle of the elevator spout and the opening on the recycling chute, affects the performance of the dryer, resulting in excessive grain spillage. A defective conveyor on top of the grain bin, which causes impurities to be trapped on one side of the drying bin is another issue related to the design of the dryer. This problem of impurities being trapped, which was mentioned by both cases, could possibly be solved by slight alteration to the dryer design by the manufacturer. If the impurities continue to stick, this could possibly reduce the efficiency of the dryer.

A dryer operator in Case Two pointed out that the actual mechanical drying takes a longer time in comparison to what is specified in the operators' manual. The MFD is designed to skin dry grain from 24% down to 18% moisture content in one hour only. However, in actual operation, there are grain loaded to the MFD which has an initial moisture higher than 24%, thus, there will be longer time needed to dry the grain.

Durability of the dryer is another technical factor addressed by the co-operatives. Since the welded portions of the dryer are always separating, the expected life span of the MFD may be lessened. In addition, both Case One and Two said it is easy to understand and operate the mobile flash dryer. This ease in operation could be a factor, which encouraged these co-operatives to try operating the MFD, and for Case One, continue to use the dryer. This result conforms to the findings of Guerin and Guerin (1994) which suggests that innovation, which is simple and easy to understand are likely to be adopted.

In spite of the fact that there are more negative than positive comments on the technical aspects of the dryer, Case One co-operatives continue to use the mechanical dryer. Thus, it appears that these flaws in the design do not dominate the Case One co-operatives' decision to abandon the technology, but could contribute to the overall adoption decision of the co-operatives. Conversely, the decision of Case Two co-operatives to stop using the technology can be attributed to design capacities, and flaws in the dryer.

Integration of other technologies, such as rice mill, with the mechanical dryer may be a factor that affects adoption. It has been observed that all the co-operatives in Case One are involved in rice milling. Selling milled rice gives a better return to the co-operative than selling dried paddy (NAPHIRE 1994). If a co-operative has a mechanical dryer integrated with a rice mill, then a larger volume of grain could be dried, processed and milled even during rainy season. Thus, the fact that a co-operative has a rice mill could enhance utilisation of the mechanical dryer. These results support the findings of Culver and Seecharan (1987) and Barao (1992) who said that technologies which can easily be integrated into the existing farm production system are more likely to be adopted than those which would require a significant change in the farm operation. It seems that in the Case One co-operatives, the mechanical dryer technology fits better with their system than it did with the Case Two co-operatives.

5.4.3 Training

Except for one dryer operator, most training participants appreciated the hands-on training on the operations and maintenance of the mobile flash dryer, and considered that it guided them on how to use the flash dryer effectively. It appears that the training provided to the non-utiliser co-operatives was not as effective as it was for the utiliser group. This might help to explain some of the technical problems experienced by the non-utiliser group.

On the other hand, Case One respondents enumerated several pointers in the proper operation of the dryer. For example, an operator must know how to regulate the kerosene burner properly so that a leak will not incur unnecessary cost, and possibly cause a fire. Also, the operator must monitor the temperature regularly so that the desired temperature will be maintained (Appendix 3). Case One participants are aware that using temperatures higher than 65°C may lead to broken grains during milling (Chelkowski 1991).

Based on the comments of the Case Two training participants, it seems that they need further training. The comment of one Chairman in Case Two reveals that he does not have enough knowledge with regard to the mobile flash dryer. He does not know anything about the features and specifications of the dryer that they have in their co-operative. The Chairman may not be aware that the flash dryer is designed mainly for skin drying, while the old model type of dryers are designed for complete drying. Moreover, the old models are larger in size, while this mobile flash dryer model is compact.

For Case One, the training given to these co-operative recipients encouraged them and made them understand how to use and maintain the flash dryer properly. Moreover, the training helped in facilitating the transmission of the technical knowledge and new ideas to the members of the co-operatives. This indicates that successful and effective training influences adoption of the technology by co-operatives. Studies by Rogers (1995) and Estigoy (1997) produced the similar results.

For those farmers who could not understand or knew nothing about mechanical dryers, using dry paddy in the demonstration would not have provided actual results, and farmers may not have seen its full potential. Thus, the actual drying operation has to be demonstrated using wet paddy so people can understand its operation. Then, further practice and experience will eventually make the designated operators more knowledgeable in operating the dryer.

Based on the reasons and feedback given by those who have experienced using the mechanical dryer, it seems that lack of knowledge of its proper operation is a factor in their decision to discontinue using the dryer. This points back to lack of training in the operations and maintenance of the mechanical dryer.

Literature supports the finding of this research that training is a key factor in technology adoption (Rogers 1995; Estigoy 1997. The knowledge gained by these members of the farmers co-operatives in attending the training on the operation and maintenance of the mechanical dryer has influenced them to adopt the technology.

5.4.4 Management and leadership

According to the literature, the uniqueness of the farmer co-operatives compared to private companies lies in the way in which decisions are made. In private companies, the board of directors are the major decision makers. In co-operatives, the general assembly is the most powerful (Hendrikse 1998). But from actual interviews with the co-operative members, it appears that the board of directors are mostly the ones making the major decisions, without much due consultation with the members. And so adoption of technologies by a co-operative may depend very much on the decisions made by the board of directors.

The two cases differ in terms of the way the co-operatives are managed and in the way people comprising the co-operatives view the importance of the flash dryer. Moreover, the board of directors, staff and members under each case differ on how they interact with one another.

The attitude of the board of directors and manager towards the technology has a great influence on the members. If the leaders of the co-operative have a positive attitude towards the mechanical dryer, members are very likely to adopt the technology. This behaviour can be attributed to the members' respect for the capability of, and decisions made by, their leaders, specifically the Chairman and manager.

The board Chairman of the co-operatives under Case One have been in charge since the co-operative started the operation, while there has been a change of leadership in two co-operatives in Case Two. Therefore, leadership can possibly affect the decision related to the utilisation of the mechanical dryer.

A democratic style of leadership also encourages the adoption of the mechanical dryer. According to the study by West and Wallace (1991), a group having a democratic leader is more open to innovation.

Learning by farmers can occur more quickly and easily if they belong to a group, because sharing farmers' experiences can facilitate the learning of others (Kloppenburg 1991; Christodoulou and Gray 1997). If these farmers belong to one community, they may adopt similar technologies. A bad experience such as the fire incident in Coop 6, however, may influence others not to adopt especially if the person who had that bad experience is very influential, well known or occupies a higher status within the group. As a consequence, bad experience may result to a negative attitude toward the technology, which can affect adoption.

All the factors identified could affect the adoption-decision of decision-makers of the co-operatives. However, one or two among these factors identified may dominate and largely influence an organisation's decision. In the same manner, the combined effects and interaction of these factors can lead to an organisation's decision of either continuing to use or abandoning, the mechanical dryer.

5.4.5 Innovator Champion

The manager has a strong influence and persuasive power over the board especially in Coop 1, and can be considered as an innovation champion. He was the one who introduced most of the technologies adopted by the co-operative. An example of this is the acquisition of desktop computers. At the beginning, the board members denied his request because they considered it as an expensive and unnecessary investment. But after several attempts, and much justification, the board finally consented to his request and later on saw its benefits in their business operation. According to Rogers (1995) an innovation champion is an individual who introduces innovations to an organisation, who feels a strong bond to a particular idea related to the innovation, and is able to sell the idea to the organisation. This person is capable of persuading powerful and influential people of the value of the innovation which he is selling.

Chapter 6 Conclusions and Recommendations

In this last chapter, findings of the research are summarised, conclusions are drawn, and recommendation and future areas of research are indicated.

6.1 Summary

This research was undertaken to examine the variables influencing the continued use of the mobile flash dryer as well as various constraints limiting the utilisation of the mobile flash dryer by farmers' co-operatives. It was hypothesised that the decision by the co-operatives to utilise the mobile flash dryer is affected by the type of co-operative trading business, by the attitude of the board of directors, staff and members towards the mobile flash dryer, and by technical factors and operational issues related to the dryer.

A multiple case study approach was employed in this research. Six farmers' co-operatives which were recipients of the mobile flash dryer in Nueva Ecija, Philippines were considered in this study. Gathering of data was done using semi-structured interviews. Respondents from each co-operative were interviewed as groups namely, the board of directors, staff, dryer operators/labourers and members. Likewise, key informants, such as the agricultural technicians and area co-ordinator assigned in the area of study also were interviewed.

Case One co-operatives were engaged in both paddy trading and rice milling business. They have the basic facilities needed to operate the business and handle a larger volume of wet grain. Case Two co-operatives, on the other hand, were engaged in paddy trading only. They also have the basic facilities needed in their trading operation, but handle a smaller volume of wet grain as compared to Case One. The majority of the board of directors in both cases are older than their staff.

The key to continued utilisation of the mobile flash dryer by the co-operatives is a combination of the following factors: economic factors, technical factors such dryer design, durability and ease of operation; training, management and leadership factors.

6.2 Conclusion

The following conclusions are drawn from the results of the study:

1. The high cost of drying using the mobile flash dryer may affect the adoption of the technology. However, if using the mobile flash dryer could minimise drying losses due to spillage, and could prevent delay in drying, thus saving grain from deterioration, then adoption of the technology may continue.
2. The quantity of wet paddy available for drying affects a co-operative's decision to adopt the mobile flash dryer. With a higher volume of grain recovered from the mechanical dryer, coupled with a better price, the co-operatives could possibly increase their income.
3. The perception of the co-operative board of directors and staff, regarding technical factors such as capacity, durability and ease of operation, affect adoption decisions by co-operatives. In addition, the fitness of the mobile flash dryer in the Case One co-operatives' trading and milling business operation influenced the adoption of the MFD.
4. Training and seminars are vital and powerful tools in disseminating knowledge to farmers' co-operatives. It is in this line that the extension agents can play an important role. Constant feeding of technology information to farmers will greatly improve their knowledge and skills concerning the proper use and importance of the mobile flash dryer in their co-operative operation. Moreover, management and leadership training designed for the board members and managers maybe needed to support the technical training. Making training more appropriate to the circumstances is important as well.

5. The system of succession by the board of directors in a co-operative influences the adoption decision. A change in the members comprising the board, particularly its chairman may have contributed to the change in the previous decision regarding adoption of the mobile flash dryer.
6. Personal attitudes, particularly those of the board of directors and manager, towards a technology may influence the utilisation of the mobile flash dryer.

6.3 Recommendations

In order to offset the high operating cost incurred by the users of the mobile flash dryer, it is recommended that the dryer be integrated to a rice mill, so that more grains will be dried, then milled before marketing. Immediate and proper drying of grain may lead to better quality and this may be possible if the co-operatives have a mechanical dryer.

It is recommended that machine quality and dryer design be reviewed in the light of the long hours of continuous drying operation required by the co-operative. It is also recommended that feedback from the co-operative users of the flash dryers be taken into consideration so that their suggestions can be incorporated whenever there will be modifications made to the unit. Flexibility in the design has to be looked into. If this is not possible, then the dissemination of this technology has to be carried out carefully by the extension agents. Peculiarities in the design, and pointers in maximising utilisation of such technologies have to be stressed. Also, guidance and training of farmers in relation to the new technology being introduced have to carried out on a continuing basis.

A democratic or participatory approach in decision-making must be encouraged by the co-operative, particularly by the board of directors and management group. If open communication exists within the group, then a fair understanding of the issues raised could be expected to result in a decision by consensus among all members of the group.

The study suggests that agencies such as Agricultural Training Institute (ATI), in collaboration with the Bureau of Postharvest Research and Extension, Philippine Rice Research Institute and other extension agents of the Provincial Agriculture's Office, should strengthen its promotional/informational campaign to bring about adoption of new technology. Interpersonal contact with extension agents through seminars/training and co-operative visits is more effective in bringing about wider adoption of the mobile flash dryer.

6.4 Assessment of method

Time was the restraining factor which limited the degree to which the research objectives could have been met. Interviewing the six cooperatives took a longer time than expected by the researcher to complete. However, interviewing more than six co-operatives could have given the researcher more information and probably identified other adoption factors which could strengthen the findings in this research.

During the data collection, two consecutive typhoons hit the research area which delayed the activities of the researcher. Floods meant that communications were cut off for days which prompted the researcher to change the co-operatives to be interviewed and replaced them with other accessible co-operatives not badly hit by these typhoons. Moreover, only one or two follow-up interviews were conducted with the co-operatives. When the analysis of the data was done, vague information, which needed clarification, was not analysed in depth.

This research could have been better substantiated if the researcher had probed more deeply into the issues such as attitudes of the boards of directors and managers as well as the members. Moreover, the researcher could have visited other members and board of directors outside the co-operative so that a wider array of information was obtained from them.

6.5 Suggestion for future research studies

Considering the results of this research, a similar study should be undertaken on a larger scale. Since this study was conducted in one province only, it is recommended that similar studies at the regional, or possibly at the national level, be undertaken. Replicating the study in other areas of the Philippines is highly recommended so that more concrete information might be obtained. A different co-operative system of operation in various locations may affect the adoption of technology. Furthermore, in-depth study on the attitudes and perceptions of the co-operatives' board members, manager, staff and general assembly, may further explain the adoption decision by co-operatives.

REFERENCES:

Adugna, T. 1997: Factors influencing the adoption and intensity of use of fertiliser: the case of Lume District, Central Ethiopia. *Quarterly Journal of International Agriculture 36:* 173-187.

Anandajayasekeram, P.;Rukuni, M. 1989: Institutionalisation of on-farm research with farming systems perspectives (OFR/FSP) in Eastern and Southern African region: achievements and future direction. *Zimbabwe Journal of Agricultural Research 27*: 67-81.

Andales, S; Manebog, E; Bulaong, M. 1994: Food handling in the Philippines. National Postharvest Institute for Research and Extension, Nueva Ecija, Philippines.

Anderson, N.R.; King, N. 1991: Managing innovation in organisations. *Leadership and Organisational Development Journal 12*:17-21.

Araral, D.K. 1981: Farmers knowledge, attitudes and practices in carabao raising in selected rural communities in Pangasinan. Unpublished Ph.D. thesis, UPLB, College, Laguna, Philippines.

Bamberry, G., Dunn; T., Lamont, A. 1997: The relationship between farmer education and good farm management: implications for extension providers. Pp. 479-491*in*: 2nd Australasia Pacific Extension Conference: managing change-building knowledge and skills conference proceedings.

Ban, A.W. Van den; Hawkins, H.S. 1996: Agricultural extension. Great Britain, The Bath Press.

Barao, S. 1992: Behavioral aspects of technology adoption: the role of on-farm demonstration. *Journal of Extension. 30* :2.

Battad, F.A. 1973: Factors associated with the adoption of rice technology in North Cotabato, Unpublished Ph.D. dissertation, UPLB, College, Laguna, Philippines.

Batte, M.T.; Jones, E.; Schnoitkey, G.D. 1990: Computer use by Ohio commercial farmers. *American Journal of Agricultural Economics. 72*:935-945.

Bebbington, A. 1996: Organisations and intensifications: campesino federations, rural livelihoods and agricultural technology in the Andes and Amazonia. *World Development, 24*:1161-1177.

Bishop, C. 1988.:A comparative review of three farm management support organisations in the South Pacific. *Agricultural Administration and Extension, 30*:221-232.

Blackburn, D.J. *ed.* 1989: Foundations and changing practices in extension. Guelph, University of Guelph.

Blakeney, A. B. 1996: Rice. Pp. *in*: Cereal grain quality, Henry J.; Kettlewell, P.S. *ed.* Cambridge, The University Press.

Boahene, K. 1995: Innovation adoption as a socio-economic process: the case of the Ghanian cocoa industry. Unpublished Ph.D. thesis, Amsterdam.

Boyd, R.D.; Apps, J.W. and Associates. 1980: Redefining the discipline of adult education in the "The adult learner: a neglected species", 3rd edition. Houston, Gulf Publishing Co.

Bulaong, M.; Anchiboy, T.; Manalabe, R. 1990: Drying of high moisture grains using a mobile flash dryer. *Proceedings of the 13th ASEAN Seminar on Grains Postharvest Technology. Brunei Darrusalam.*

Bureau of Statistics. 1996: Annual Report.

Cardiño, A. 1985: A socio-economic study on the utilisation of mechanical grain dyers. Unpublished project terminal report. NAPHIRE, CLSU, Nueva Ecija, Philippines.

Chamala, S. 1987: Adoption processes and extension strategies for conservation farming. Pp400-419 *in* Tillage: New directions in Australian agriculture, Cornish,P. S.; Pratley,J.E. *ed.*

Chambers, R.; Pacey, A.; Thrupp, L.A. *eds.* 1989: Farmer first: farmer innovations and agricultural research. London, Intermediate Technology Publications Ltd.

Chelkowski, J. *ed.* 1991: Cereal grain mycotoxins, fungi and quality in drying and storage. New York, USA, Elsevier Science Publishing Company, Inc.

Christodoulou, N.; Gray, J. 1997: Developing learning groups - a field perspective. Pp.399-406 *in*: 2nd Australasia Pacific Extension Conference: managing change-building knowledge and skills conference proceedings.

Cooperative Development Authority (CDA). 1990: New Cooperative Laws RA 6938 & RA 6939 including rules and regulations. Quezon City, Philippines, Allanae Printing Services.

Cooperative Development Authority (CDA). 1998: 1997 Annual Report. Quezon City, Philippines.

Covey, S.R. 1991: Principle-centered leadership. New York, Fireside.

Culver, D.; Seecharan, R. 1987: Factors that influence the adoption of soil conservation technologies. *Canadian Farm Economics. 20(2)*: 9-13.

Deininger, D. 1997: Public and private agricultural extension:partners or rivals? *The World Bank Observer, 12(2):* 203-224.

Denning, G.L. 1985: Adaptation and adoption of dry-seeded rice in the rainfed lowland of Iloilo and South Cotabato, Philippines. Unpublished PhD thesis. The University of Reading, England.

Department of Agriculture. 1996: Gintong Ani corn program document,Quezon City,Philippines.

Dexter, E. 1986: Strategies in the Transfer of Agricultural Technology, with Reference to Northern Europe. *in*: Investing in Rural Extension: Strategies and Goals, Jones G. *ed.* Great Yarmouth, Galliard Printers Ltd.

Dey, I. 1993: Qualitative data analysis: A user-friendly guide for social scientists. London, Routledge.

Dillon, J.H.; Hardaker, J.B. 1980: Farm management research for small-farmer development, FAO, Rome.

Drost, D.; Long, G.; Wilson, D.; Miller, B.; Campbell, W. 1996: Barriers to adopting sustainable agricultural practices. *Journal of Extension. 34*:5.

Duldulao, A.C. 1975: Kaingeros perceptions and attitudes towards forest conservation in Mt. Makiling, Laguna. Unpublished Ph.D. thesis, UPLB, College, Laguna, Philippines.

Dunphy, D.C.; Stace, D.A. 1988: Transformational and coercive strategies for planned organisational change: beyond the OD model. *Organisational Studies. 9*:317-34.

Eisenhardt, K.M. 1989: Building theories from case study research. Academy of Management Review. 14(4), pp.532-550.

Estigoy, R. P. 1997: Correlates and determinants of improved corn sheller utilisation in three Mindanao provinces. Unpublished Ph. D. Thesis, CLSU, Nueva Ecija, Philippines.

Ewell, P. 1990: Links between on-farm research and extension in nine countries. *in*: Making the links: agricultural research and technology transfer in developing countries. ISNAR. Westview Special Studies in Agriculture Science and Policy.

Feder, G.; Just, R.; Zilberman, D. 1985: Adoption of innovation in developing countries: a survey. *Economic Development and Cultural Change. 33* :255-298.

Fishbein & Ajzen, I. 1980: Understanding attitudes and predicting social behavior. New Jersey, Prentice Hall.

Geron, L. and Ramos, E. 1988: ACIAR Funded Project. National Postharvest Institute for Research and Extension, Nueva Ecija, Philippines.

Gill, R.; Weersink, A. 1991: Why do farmers adopt new technology? Working Paper WP91/13. University of Guelph.

Gowda, C.L.; Faris, D.G.; Maniruzzaman A.F.; 1994: Infrastructural support to promote farmer adoption of improved technologies. *in* Expanding the production and use of cool season food legumes, Muehlbauer, F.J.; Kaiser, W.J. *eds.* Netherlands, Kluwer Academic Publishers.

Hedrick,T.E.; Bickman,L.; Rog, D.J. 1993: Applied research design: A practical guide. Thousand Oaks, California, SAGE Publications.

Hendrikse, G. 1998: Screeening, competition and the choice of the cooperative as an organisational form. *Journal of Agricultural Economics 49:* 202-217.

Hope, M.; Humphreys, E.; Dunn, T. 1997: Using farmer skill and knowledge in agronomic research - a case study. *in* 2nd Australasia Pacific Extension Conference: managing change-building knowledge and skills conference proceedings, pp. 727-736.

Huppi, M. and Feder, G. 1990: The role of groups and credit cooperatives in rural lending. *The World Bank Research Observer, 5(2):* 187-204.

Iqbal, M.; Younis, M.; Ahmed, M.; Sabir, M.; Sial, J. 1992: Implications and prospects of farm mechanisation in Pakistan. *Agricultural Mechanisation in Asia, Africa and Latin America. 23(4)*: 71-76.

Jarvis, P. 1995: Adult and continuing education theory and practice. 2nd edition. New York, Routledge.

Juliano, B.O.; Villareal, C.P. 1993: Grain quality evaluation of world rices. Manila, Philippines, International Rice Research Institute.

King, N.; Anderson, N. 1995: Innovation and change in organisations. New York.

Kloppenburg, J. 1991: Social theory and the de/reconstruction of agricultural science: local knowledge for an alternative agriculture. *Rural Sociology, 56*: 519-548.

Kumar, K. *ed.* 1993: Rapid Appraisal Methods. Washington, DC, World Bank.

Kumar, R.; Wasnik, S.M. 1989: A study of adoption of crop production technologies in progressive and less progressive villages of Uttar Pradesh. *Indian Cooperative Review*, India.

Lasley, P. and Nolan, M. 1981: Landowner attitudes toward soil and water conservation in the grindstone-lost muddy creek project. Department of Rural Sociology. University of Missouri, Columbia.

Lexmon, A.; Andersson, H. 1998: Adoption of minimum tillage practices: some empirical evidence. *Swedish Journal of Agricultural Research. 28*:29-38.

Lindler, R.K. 1987: Adoption and diffusion of technology: an overview. In Technological change in postharvest handling and transportation of grains in the humid tropics: proceedings of an international seminar, Bangkok, Thailand.

Lockhart, J. 1997: Towards a theory of the configuration and management of export dependent land based value systems: the case of New Zealand. Unpublished PhD. Thesis. Auckland, New Zealand.

Maranan, C. 1997: Postharvest loss assessment. National Postharvest Institute for Research and Extension, Nueva Ecija, Philippines.

Mash S.; Maling I. 1997: The benefits of building working partnership between farmers and researchers: the case of the Cooperative Research Centre for Legumes in Mediterranean Agriculture and the Birchip Cropping Demonstration sites. In 2nd Australasia Pacific Extension Conference: managing change-building knowledge and skills conference proceedings: pp. 719-726.

McDermott, J. 1987: Making Extension Effective: The Role of Extension/ Research Linkages, *in*: Agricultural Extension Worldwide, Rivera, W and Schram, S. *eds*. Croom Helm, London.

McLean, K. 1989: Drying and storing combinable crops. United Kingdom, Farming Press.

Miles, M.B.; Huberman, A.M. 1984: Qualitative data analysis: A sourcebook of new methods. Beverly Hills, Sage Publications.

Millar,J.; Curtis, A. 1997: The role of farmer knowledge in group learning:observations from Prograze and Landcare case studies. *in* 2nd Australasia Pacific Extension Conference: managing change – building knowledge and skills conference proceedings, Volume II. 506-513.

Moch, M.K.; Morse, E.V. 1977: Size, centralization and organizational adoption of innovations. *American Sociological Review. 42*:716-725.

Najafi, B. 1981: An experience with agricultural production cooperatives in Iran: a case study. *Quarterly Journal of International Agriculture, 20(3):* 304-312.

NAPHIRE Annual Report. 1996: NAPHIRE, Muñoz, Nueva Ecija, Philippines.

NAPHIRE. 1994: Integrated rice processing enterprise for farmers' co-operatives. NAPHIRE, CLSU, Nueva Ecija.

NAPHIRE. 1994: Technical reference guide on grains postharvest operations. National Postharvest Institute for Research and Extension, CLSU, Nueva Ecija, Philippines.

Narayanan, A. 1991: Enhancing farmer's income through extension for agricultural marketing. *in:* Agricultural extension: worldwide institutional evolution and forces for change. London, Elsevier.

Nkonya, E.; Schroeder, T; Norman, D. 1997: Factors affecting adoption of improved maize seed and fertiliser in Northern Tanzania. *Journal of Agricultural Economics,. 48*(1): 1-12.

Nowak, P. 1992: Why farmers adopt production technology. *Journal of Soil and Water Conservation. 47(1):* 14-17.

Ohlmer, B. 1998: Models of farmer's decision making: problem definition. *Swedish Journal of Agricultural Research. 28*:17-27.

Parker, W., Hughes, J. 1989: An introduction to agricultural surveys. Department of Agricultural and Horticultural Systems Management, Massey University.

Patton, M.Q. 1987: How to use qualitative methods in evaluation. London, SAGE Publications Ltd.

Patton, M.Q. 1990: Qualitative evaluation and research methods.2nd edition. Newbury Park, California, SAGE Publications.

Paz, R.; Dayanghirang, D.; Tiongson, R.; Rodriguez, A. 1989: Control of aflatoxin in maize. Unpublished terminal report. NAPHIRE, Muñoz, Nueva Ecija, Philippines.

Paz, R.;Tiongson, R.; Gamoso, R. 1993: Control of aflatoxin in maize: Phase II. Unpublished terminal report. NAPHIRE, Muñoz, Nueva Ecija.

PCARRD. 1987: The Philippines recommends for rice postproduction operations. PCARRD Technical Bulletin Series No. 63. PCARRD, Department of Science and Technology. Los Banos, Laguna, Philippines.

Philippine agribusiness and food market factbook. 1996: Green Pages Publishing Corporation.

Philippine recommends for corn postharvest operation. 1990: PCARRD Technical Bulletin Series No.71. Philippine Council for Agriculture, Forestry and Natural Resources Research and Development. Laguna, Philippines.

Phillips, S.;Mitfa, R.; Wallbridge, A. 1989: Rice yellowing during drying delays. *Journal of Stored Products Research 25*: 155-164.

Pray, C.; Echeverria, R. 1990: Private sector agricultural research and technology transfer links in developing countries. In Making the link: agricultural research and technology transfer in developing countries. ISNAR, Westview Press, London.

Provincial Planning and Development Office. 1998: Socio-economic and physical profile:Province of Nueva Ecija. Cabanatuan City, Philippines.

Rahm, M.; Hoffman, W. 1984: The adoption of reduced tillage: the role of human capital and other variables. *American Journal of Agricultural Economics 66:* 405-413.

Ray, A. 1993: The present status of agricultural mechanisation and its constraints. *Agricultural Situation in India. 48(4)*: 245-250.

Roberts, N. 1987: Successful Agricultural Extension: Its Dependence upon other Aspects of Agricultural Development. The Case of Public Sector Extension in North-east Africa. *In* Agricultural Extension Worldwide, : Rivera, W. and Schram, S. *ed.* Croom Helm, London.

Rogers, E. 1995: Diffusion of innovations. 4th edition. New York, The Free Press.

Rogers, E.M.; Shoemaker, F. 1971: Communication of innovations: a cross cultural approach. 2nd edition. New York, The Free Press.

Rogers, J. 1989: Adults learning. 3rd edition. Great Britain, Open University Press.

Roling, N. 1990: The agricultural research-technology transfer interface: a knowledge systems perspective. *in:* Making the link: agricultural research and technology transfer in developing countries. ISNAR, Westview Press, London.

Roy, E. 1976: Cooperatives: today and tomorrow. Danville, Illinois, Interstate Printers and Publishers, Inc.

Russell, D.B.; Ison, R.L.; Gamble, D.R.; Williams, R.K. 1989: A critical review of rural extension, theory and practice. University of Western Sydney.

Sapsford, R.; Jupp, V. 1996: Data collection and analysis. London, SAGE Publications.

Schein, E. 1980: Organizational psychology. 3rd edition. New Jersey, Prentice Hall, Engelwood Cliffs.

Schram, S.; W. Rivera. 1987: Agricultural extension worldwide: issues, practices, and emerging priorities. New York.

Schuh, G, 1987: The Policy Environment Necessary Extension and Its Linkages with Agricultural Research: The World Bank Experience. *in*: Agricultural Extension Worldwide, Rivera, W; Schram, S. *ed.* London.

Schultz, T.W. 1975: The value of the ability to deal with disequilibrium. *Journal of Economic Literature. 13:* 827-846.

Scoones, I.; Thompson, J. 1993: Beyond farmer first-rural people's knowledge, agricultural research and extension practice: towards a theoretical framework in IIED. *Rural People's Knowledge, Agricultural Research and Extension Practice,* London: IIED Sustainable Agriculture Programme, Vol. 1 No. 1:1-20.

Senge, P. 1990: The fifth discipline: the art and practice of learning organisation. New York, Doubleday.

Shaner, W.; Philipp, P.; Schmehl, W. 1981: Farming systems research and development guidelines for developing countries. Boulder, Colorado, . Westview Press.

Shrestha, R.; Gopalakrishnan, C. 1993: Adoption and diffusion of drip irrigation technology: an econometric analysis. *Economic Development and Cultural Change 41* : 407-418.

Stake, R.E. 1995: The art of case study research. New York, SAGE Publications.

Taher, S. 1996: Factors influencing smallholder cocoa production, a management analysis of behavioural decision-making processes of technology adoption and application. Wangenigen, Netherlands.

Texier,J.M. 1974: The promotion of cooperatives in traditional rural societies. *in*: Policy and Practice in Rural Development Proceedings of the second International Seminar on Change in Agriculture. London, Overseas Development Institute.

Toquero, Z. 1983: A critical evaluation of alternative rice postproduction technologies, Central Luzon and Bicol Regions, Philippines, Kansas State University.

Torrizo, F.M. 1983: Grain harvesting and threshing equipment. Rice production manual. IRRI, College, Laguna, Philippines.

Tumambing, J.; Bulaong, M. 1986: Drying in bulk storage of high moisture grains in tropical climates. ACIAR 8308 Terminal Report. Australian Centre for International Agricultural Research.

Uddin, S. 1988: Adoption and productivity of the technology generated by cropping system program in two districts of Bangladesh. Unpublished Ph.D. Thesis. CLSU, Munoz, Nueva Ecija, Philippines.

Uehara, G. 1989: Technology transfer in the tropics. *Outlook on Agriculture. 18(1)* :38-43.

Valdez, P. 1994: Adoption of integrated pest management by rice farmers in Nueva Ecija. Unpublished MS Thesis, CLSU, Nueva Ecija, Philippines.

Van den Ban, A. ; Hawkins, H. 1996: Agricultural Extension, Great Britain, Hartnolls Ltd.

West, M.A.; Wallace, M. 1991:Innovation in health care teams. *European Journal of Social Psychology 21*:303-15.

Wirasingh, S. 1977: Adoption of high yielding rice farm practices by farmers in the Ampura District, Republic of Sri Lanka. Unpublished MS Thesis, UPLB, Laguna, Philippines.

Wuyts-Fivawo, A. 1996: Linkages between research, farmers and farmers' organisation in Kenya: a summary. ISNAR Briefing Paper No. 32. International Services for National Agricultural Research.

Yin, R. 1993: Applications of case study research. London, SAGE Publications.

Yin, R. 1994: Case study research design and methods. London, SAGE Publications.

Appendix 1. Philippine rice statistics, 1992-1996.

Appendix 1.1 Rice domestic production, in thousand metric tons (MT), Philippines.

REGION	PRODUCTION (000MT)				
	1992	1993	1994	1995	1996
Philippines	9129	9434	10538	10541	11284
CAR	156	167	191	193	209
Ilocos	826	838	917	887	993
Cagayan Valley	1089	892	1237	1349	1441
Central Luzon	1736	1604	1887	1757	1888
Southern Tagalog	1080	1080	1105	993	1061
Bicol	715	665	690	599	661
Western Visayas	1239	1485	1442	1291	1474
Central Visayas	164	199	208	231	232
Eastern Visayas	362	389	398	446	436
Western Mindanao	310	373	326	345	382
Northern Mindanao	279	326	365	357	312
Southern Mindanao	462	493	547	610	683
Central Mindanao	415	508	645	752	834
ARMM	124	172	328	327	328
CARAGA	172	243	251	402	350

Appendix 1.2 Area planted, in thousand hectares.

REGION	AREA PLANTED (HA)				
	1992	1993	1994	1995	1996
Philippines	3198	3282	3652	3759	3951
CAR	60	60	68	76	76
Ilocos	305	310	318	323	337
Cagayan Valley	326	295	380	403	414
Central Luzon	472	477	533	548	542
Southern Tagalog	411	400	421	410	410
Bicol	285	268	297	281	306
Western Visayas	445	469	507	468	536
Central Visayas	96	109	109	113	108
Eastern Visayas	215	196	198	206	209
Western Mindanao	105	114	116	121	134
Northern Mindanao	93	97	101	98	93
Southern Mindanao	133	154	154	183	218
Central Mindanao	128	156	199	223	263
ARMM	58	96	150	158	161
CARAGA	66	83	100	146	142

Appendix 1.3 Yield per hectare, in metric tons (MT), Philippines.

Region	**Yield (ton/ha)**					**Average**
	1992	**1993**	**1994**	**1995**	**1996**	
Philippines	2.85	2.87	2.89	2.80	2.86	2.85
CAR	2.61	2.80	2.80	2.53	2.77	2.70
Ilocos	2.71	2.70	2.89	2.74	2.94	2.80
Cagayan Valley	3.34	3.02	3.26	3.35	3.48	3.29
Central Luzon	3.68	3.36	3.54	3.21	3.48	**3.45**
Southern Tagalog	2.63	2.70	2.62	2.42	2.58	2.59
Bicol	2.51	2.48	2.32	2.13	2.16	2.32
Western Visayas	2.78	3.17	2.84	2.76	2.75	2.86
Central Visayas	1.71	1.82	1.92	2.05	2.15	**1.93**
Eastern Visayas	1.68	1.99	2.01	2.16	2.09	1.99
Western Mindanao	2.96	3.28	2.82	2.86	2.84	2.95
Northern Mindanao	2.99	3.37	3.60	3.64	3.34	3.39
Southern Mindanao	3.47	3.19	3.54	3.33	3.13	3.33
Central Mindanao	3.26	3.26	3.25	3.37	3.17	3.26
ARMM	2.12	1.80	2.19	2.08	2.03	2.04
CARAGA	2.60	2.94	2.50	2.75	2.47	2.65

Source: Philippine Bureau of Agricultural Statistics, 1996.

Appendix 2. Outline for semi-structured interviews.

For the co-operative management staff – The co-operative management staff were asked about general co-operative information.

1. Background of the co-operative – brief history i.e how was it formed, when it was started, who started it, number of initial and present members, frequency of general assembly meetings in a year, type of business operation, estimated volume of paddy handled from 1994 to 1997, total agricultural area covered by the co-operative, sources of income, organisational structure, etc.
2. Co-operative sources of information, frequency of contacts with the assigned technician, linkage with GO's and NGO's
3. Board of Directors and management staff positions, number, educational attainment, age, length of service, are they appointed or not, frequency of the board meeting

For the key informants- these questions validated the information gathered from publications and other people i.e. farmers and extension agents.

1. What is the total number of agricultural co-operatives in Region 3 and in Nueva Ecija alone?
2. How many barangays does every extension agent cover?
3. Any local phenomenon that happened in the Region for the last four years i.e. floods, drought, pest infestation, etc.?
4. Did you provide information about the dryer before it was given to the co-operatives? Why?
5. Any feedback regarding the dryer operation?

These are the questions asked common to all the groups: board, staff and operators/labourers.

1. How does the co-operative make decisions? What are the steps followed in making decisions? The interviewer cited different technologies like HYV's, threshers, tractors, etc.
2. Why and how did the co-operative acquire the dryer?
3. Were the operators trained before the dryer was used? If yes, when, how many days, how many times and who conducted the training? Was it a lecture only or lecture and hands-on training?

4. How many cropping seasons was the dryer used?
5. Why are you still using it or why did you stop using it? What can you say about the features and operation of the dryer? Cite specific observations regarding the dryer performance, perceptions before and after the dryer was used.

Specific questions for the following groups:

Board of directors

1. How do you choose or elect the chairman and other members of the board? Any qualifications needed, number of years as member of the co-operative, etc.?
2. What is the maximum term in years by a board member?
3. Are all decisions i.e. co-operative business operations made solely by the board or is it in consultation with the general assembly? Why?

Operators/Labourers

1. How long have you been operating the dryer and why?
2. Based on your own experience in operating the dryer, what can you say about it's performance i.e. ease of operation, durability, and other observations.

Members

1. Have you tried using the mobile flash dryer? Why or why not?
2. What can you say about its performance? i.e. ease of operation, durability, and other observations.

Appendix 3. Features, design and operations manual of the mobile flash dryer given to the farmer co-operatives.

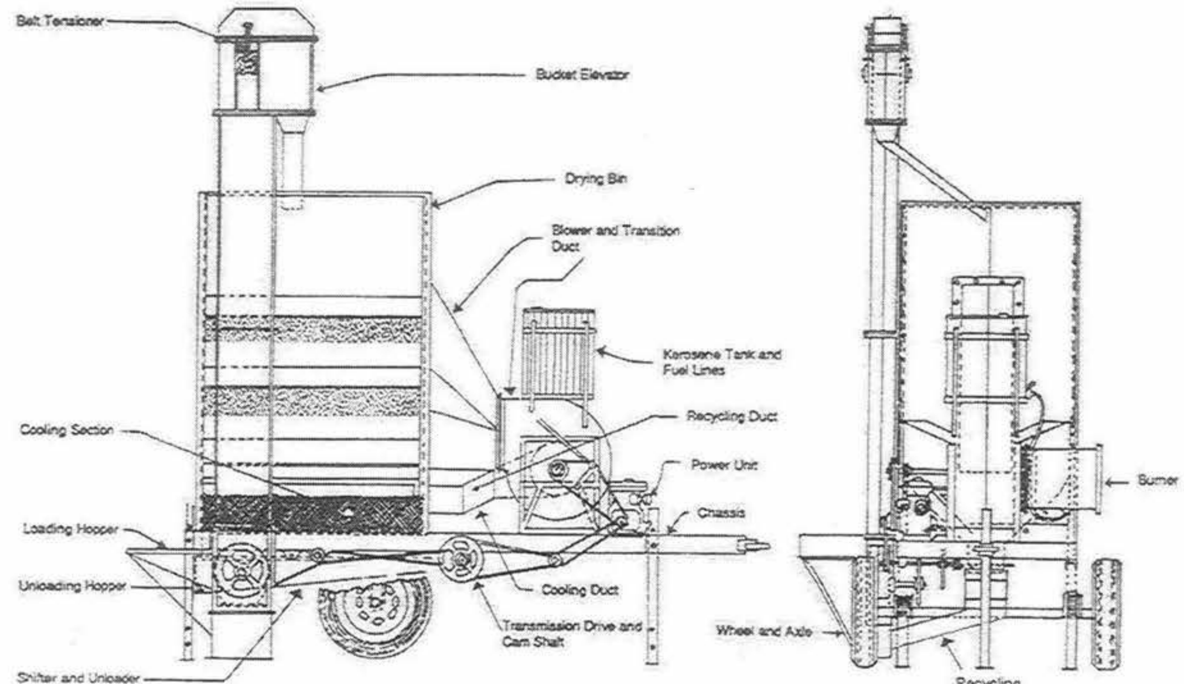
I. Usage and brief description

The Mobile Flash Dryer can be used for paddy, corn and other cereals. It can fast dry high moisture grain to a safe moisture level of 18% for temporary storage. The dryer is intended specifically to arrest grain deterioration during foul weather when sun drying is totally impossible. The dryer does not have sophisticated equipment requiring highly trained operators. It has the capacity to dry about 1/2 ton paddy per hour.

It is equipped with a blower and a kerosene fed heating unit. A grain elevator and an oscillating unloading hopper are other salient features which make grain loading and unloading easy. Designed to be mobile, this trailer type grain dryer can be brought right in front of each farmer's household. The dryer can be transported using light trucks or it could be animal drawn.

II. Benefits to be derived

Farmers level - During foul weather, harvested wet grain such as paddy and corn deteriorate rapidly (darkening, sprouting, fermenting) if not immediately dried. This results to tremendous economic losses reducing the price of the said commodities to as much as 50%. This has a great effect on the national production not only in quantity of damaged crop but as well as on the quality of milled rice and corn. If this dryer could be utilized by small farmers, deterioration of crop can be minimized. Once paddy has been dried to 18% moisture content ("skin dry"), it can be temporarily stored for up to two (2) weeks or more without significant deterioration and can wait for possible sundrying. Hence, the quality is maintained and quantity loss is avoided.



Different Parts of the Mobile Flash Dryer

III. Specification

Height	2.5 m without elevator 4.0 m with elevator
Width	1.0 m grain bin only
	1.5 m including wheels
Length	3.0 meters
Type	Mobile - continuous crossflow-columnar dryer
Power requirement	at least 5 hp gasoline engine or 3hp electric motor
Blower system	3000 CFM at 1 " static pressure
	Backward curve, centrifugal type
Heating system	Evaporating pot type kerosene burner or rice hull furnace
Elevator	1 ton per hour, bucket type
Capacity for paddy	10-12 cavans/hr at 70- 80^{0}C temperature
Gasoline consumption	1.2 to 1.5 lit/hr regular gasoline
Kerosene consumption	3-4 lit/hr at 70-80^{0}C temperature
Labor requirement	at least 3 persons

IV. Other features

a) Exhaust air recycling that increases heat utilization efficiency

b) Cooling section that dissipates heat in grain be- fore it is discharged

c) Simple construction and made of locally available materials.

V. Operation

Before starting the engine

1. Checking engine oil. Be sure it is at the recommended level. Add motor oil if the recommended level is low.
2. Ideally, gasoline tank should be full before starting engine to avoid frequent refilling.
3. The same is true with kerosene. Be sure the tank is filled sufficiently.

Loading

1. Shift the Idler pulley to idle position (Figure 1). This is to prevent the blower from blowing the grains outside the louvers while loading is going on. This will also make the engine easy to start (Figure 2).

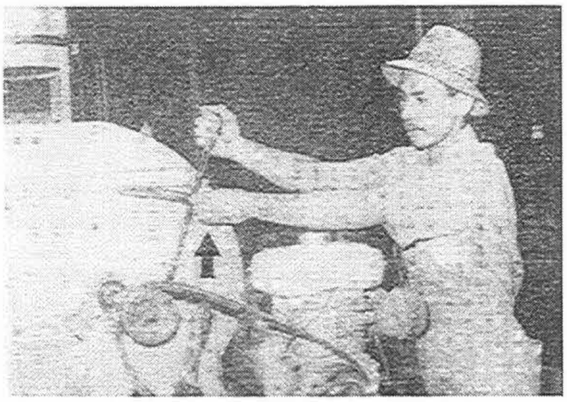


Figure 1. Shifting the idler pulley to idle position.

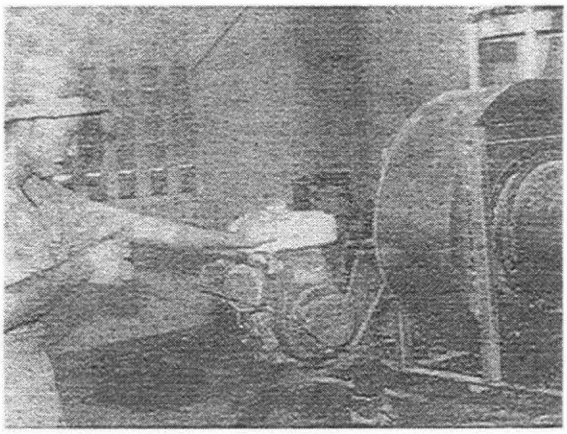


Figure 2. Starting the engine.

2. When engine is running, increase its rpm to normal speed (about 2,800 rpm) or throttle is a little below full speed. At this engine rpm, the blower should be running at about--2,500 rpm.

3. Be sure unloading hopper is closed by feeling under the discharge slots if it is open or not. If found open, turn the unloading crank (Figure 3) to close as indicated by the arrow until the discharge slots are closed, or by observing for grains discharged from the bottom. If there are discharged grains, this indicates an open unloading hopper.

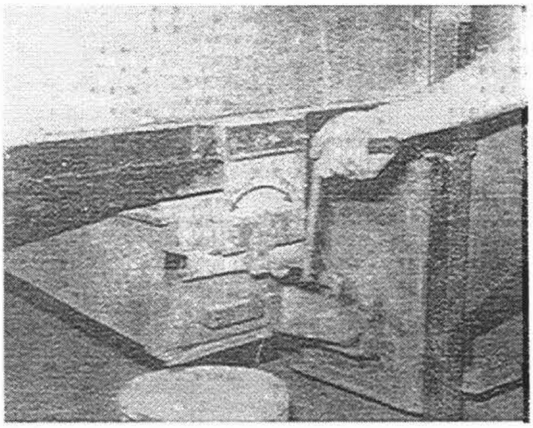


Figure 3. The unloading hopper showing the unloading crank used to adjust the grain discharge rate. The unloading crank is also used to close the unloading hopper and stop grain discharge.

4. Be sure elevator hopper is clear of any trash or obstacle that might clog the grain elevator before pouring wet grains. The elevator hopper is equipped with a regulating damper which controls the intake of grain into the elevator. Do not remove this as the elevator might be overloaded and clogged. Open it to about 3 inches during loading.

If grain is dripping wet, do not use it as initial load as it might clog the unloading hopper. It is advisable to drain dripping wet grain of excess moisture before loading. Load an initial 6 cavans skin dry or wet (24%mc) paddy before loading dripping wet. The initial 6 cavans skin-dry paddy will prevent the dripping wet paddy to come in direct contact with the unloading hopper and cause clogging. This will also allow the dripping wet paddy to pass the drying column first and dry a little before going into the unloading hopper. Loading dripping wet grain will diminish elevator capacity by one-half.

Continue pouring wet grain into the loading hopper (Figure 4) until bin is filled to the rim. The loading process normally lasts for about 20 to 30 minutes depending on the moisture content of the grain being dried.

Figure 4. Pouring the grain into the unloading hopper.

Remove rice straws and other foreign materials from the wet grain during loading. Straws and other trash are high moisture materials which add to the drying load of the flash dryer prolonging unnecessarily the drying time. Rice straws and other foreign materials also disrupt the flow of drying air and decreases the drying efficiency of the unit.

Pre-heating the burner

1. Remove cover and heating fin from the evaporating pan.
2. Release kerosene by turning the valve handle counter-clockwise. Flood the evaporating pan with kerosene.
3. Use a piece of paper to light and spread the flame within the evaporating pan (Figure 5). Do not leave the burning paper inside the evaporating pan as it might clog the air holes.

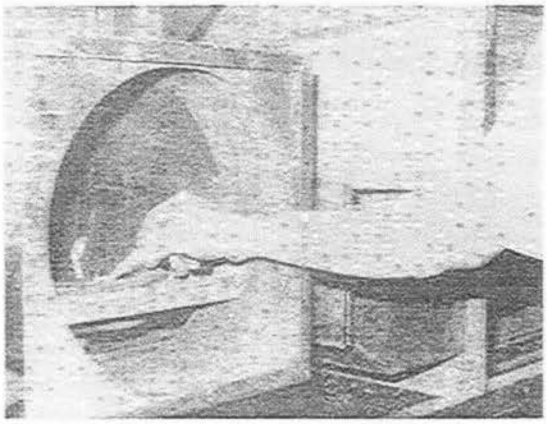


Figure 5. Using a piece of paper to spread the flame in the evaporating pan.

4. Use pliers to hold the heating fin and place it above the burning evaporating pan. Do not fit it yet but leave enough air space between evaporating pan and heating fin to avoid choking the flame.
5. Heat the heating fin (Figure 6) for about five (5) minutes.

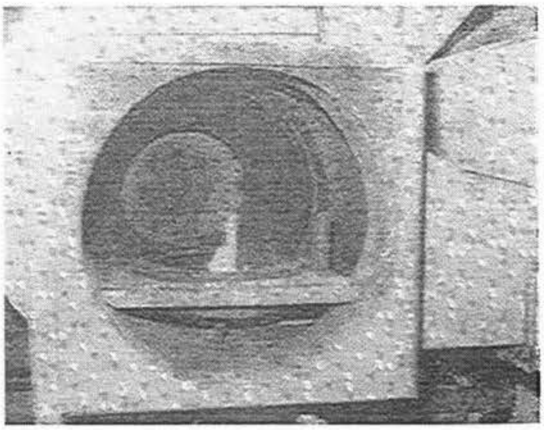


Figure 6. Pre-heating the burner fins before replacing the cover.

6. Using pliers, turn the already hot heating fin until it locks with the evaporating pan. If flame is extinguished, lift the heating fin immediately and let it heat some more before fitting it back.
7. Place the burner cover and make sure it fits snugly into the evaporating pan (Figure 7).

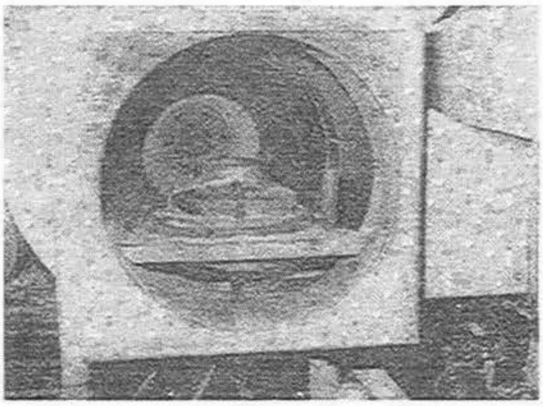


Figure 7. The burner housing showing the burner cover above the evaporating pan.

8. When flame is sustained, engage the two blower drive belts into the blower and engine. After so doing, start the engine.
9. Release the kerosene to sustain the flame while engine is running. When flame has become stable, close the burner damper (Figure 8), shift the idler pulley to engage blower (Figure 9) and increase the engine rpm to normal operating speed (i.e. engine throttle a little bit below full speed).

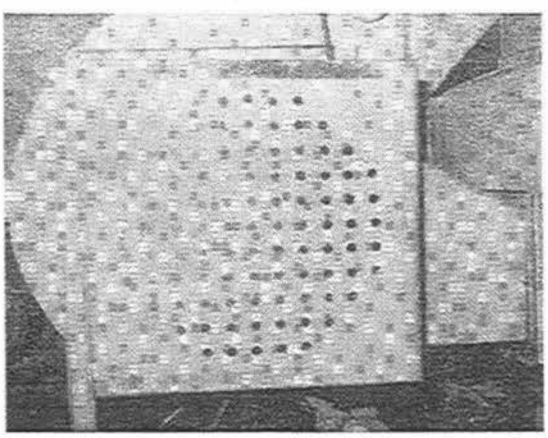


Figure 8. Burner housing showing closed burner damper.

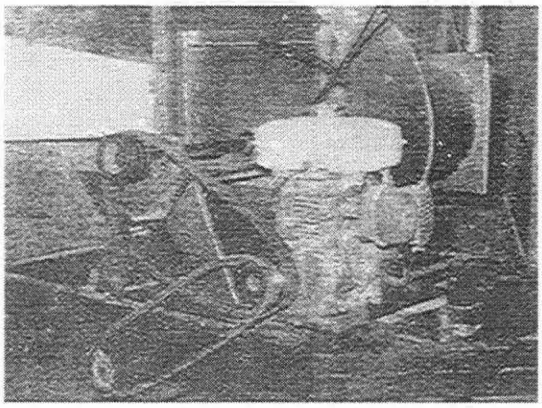


Figure 9. Shifting the idler pulley to engage the blower.

10. Increase fuel feed rate by opening the needle valve counter-clockwise little by little until the desired temperature is reached as indicated by the dial thermometer attached to the blower ducting. At this point, the evaporating pan is still relatively cool and as such, kerosene might overflow and leak at the bottom if much of it is released too early. A raw kerosene smell during drying operation indicates an overflow or leak of unburned kerosene at the bottom of the evaporating pan. When this happens, reduce the kerosene flow until no more leak or overflow is observed at the pan bottom.
11. Use the following recommended temperature settings for drying paddy with different initial moisture contents:

25 - 30% m.c. (very wet)	- 80 - 90°C
23 - 24% m.c. (wet)	- 70 - 80°C
21 - 22% m.c. (NH)	- 60 - 70°C
18 - 20% m.c. (skin dry)	- 50 - 60°C

For seed purposes – 43°C maximum.

Drying operation

1. When desired temperature setting is reached, open the discharge slots to about 1/2 inch by turning the unloading crank to open as indicated by the arrow. Observe the grain flow rate. Normally, it should take about a minute to fill a can. If not, adjust the discharge to this rate.
2. If discharged grain is still too wet, recycle it through the recirculating chute. Continue recycling until discharged paddy is skin dry.
3. When discharged paddy is skin dry (approximately 18 - 20% m.c.), put them into sacks and resume loading wet paddy. It 14% drying is desired, allow the grain to temper for

at least 2 hrs. before reloading into the flash dryer (see procedure F2 for explanations). If paddy is to be dried from 18% to 14%, use a drying air temperature of 60^0C.

Be sure to maintain the grain level filled at the top edges throughout the drying time. The grains at the top act as buffer and prevent air leakage from the top.

4. When moisture gradient is noticed at the discharged grain, do the following:
   a) Increase the air flow by removing the burner damper or cover.
   b) Increase the discharge rate by opening the unloading slots to about 3/4".
   c) Recycle the discharged grain back to the loading hopper.
   Continue the above procedures until the moisture gradient is eliminated.
   d) Close the damper back when grain is skin dry to allow cooling of grain before re-sacking.

NOTE: Upon opening the burner damper, a drop in air temperature will take place. This is because there is more ambient air that is mixing with the hot air. Adjust the temperature back to about 100^0C when paddy is still dripping or very wet. When paddy starts to skin dry, close the damper back and adjust the temperature again (as this will rise back) to the recommended setting in procedure C11.

5. At the end of the drying period, BE SURE THE KEROSENE BURNER IS TURNED OFF FIRST BEFORE THE ENGINE. This is to:
   a) prevent burning of excess kerosene which will produce dark smoke due to insufficient air when blower is disengaged too early;
   b) burn and make use of the excess kerosene at the evaporating pan; and
   c) let the grain in the drying column to cool- off before the blower is stopped.

   When at the end of the day, there is still wet paddy to be dried for the next day, it would be advisable to leave the flash dryer loaded or filled with grain. When drying resumes the next day, the grain left inside the dryer will automatically be unloaded as it will be replaced by wet paddy when loading starts. This will save one (1) hour each day from loading and unloading. Cool the grain for about 20 minutes before turning the engine off

Unloading the grains

1. Be sure the burner is turned off and grain in the drying column has been cooled down for about 20 minutes before unloading.
2. Shift the idler pulley of the two blower drive belts to idling position to lighten the load of engine.
3. Open fully the discharge slots to increase the discharge rate. If it is too fast, close the discharge slots a little to prevent spilling of grain.
4. Be sure no grain is left in the unloading hopper before turning off the engine.
5. Clean the discharge slots of trapped straws and other foreign materials to prevent clogging during the next drying operations.

F1. Additional operating procedure for MFD C-2 model

NOTE: MFL)-C2 model is operated with the same procedure as in Section V (Operation), however, due to its added features the following procedure are hereby recommended.

1. When drying at grain moisture content above 22% at high temperature, the exhaust air is fully saturated with moisture. This could be easily noticed by the appearance of steam coming out from the sides of the dryer exhaust or by moisture condensing at the dryer exhaust walls. However, when the grain moisture content drops to 18-20% range, the steam disappears which means that the exhaust air is no longer saturated with vapor.

2. The C-2 model has a heat recycling feature which is capable of recovering the unsaturated hot exhaust air at the lower drying section. Recycling the unsaturated hot exhaust air will reduce energy consumption by at least 35% especially when the flash dryer is being used to dry grain down to 14%.

To determine if the exhaust air is saturated or not, feel the air coming out of the exhaust door (Figure I0) with open palms. If there is a sticky or damp feeling, the air is still saturated and is not advisable to recycle. If there is no damp feeling, the air is not saturated and can be recycled.

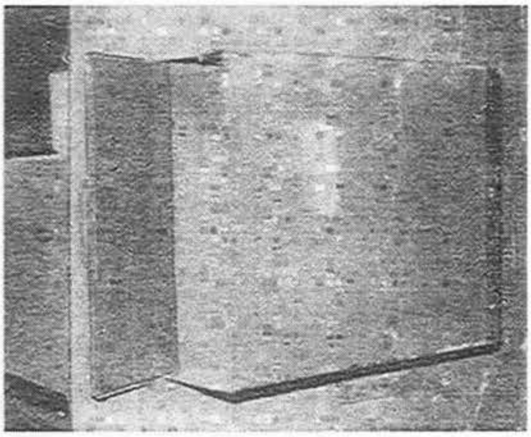


Figure 10. Exhaust air comes out of this opening.

To recycle the exhaust air, close the exhaust door (Figure 11) and pull out the sliding damper just below the exhaust door (Figure 12). This will divert the exhaust air to the cooling duct to be recycled back into the drying section.

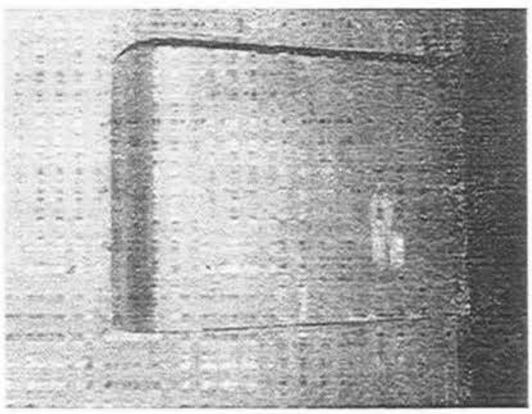


Figure 11. Close the exhaust door to recycle exhaust air.

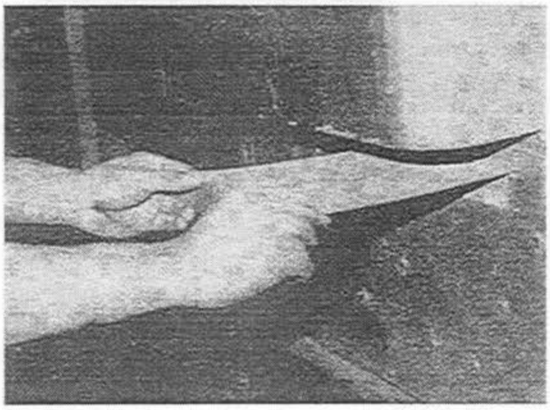


Figure 12. Pulling out the sliding damper just below the exhaust door to recycle exhaust air.

2. TEMPERING DURING MULTI-PASS DRYING

In continuous flow dryers like the Mobile Flash Dryer, the grain is exposed to heated air for about 15 to 30 minutes with about 4 - 6% moisture reduction per pass. Between drying passes, it is ADVISABLE TO TEMPER THE GRAIN FOR AT LEASTTWO (2) HOURS to avoid excessive drying stress. Tempering could be done by re-sacking the grain and setting it aside after each pass, putting it in tempering bins, or spreading into concrete pavement. The tempering process allows the moisture content within the grain to equalize by letting the moisture inside the grain to slowly move to the surface of the grain. This allows easier removal of moisture and shorter drying time as the kernel surfaces become relatively moist.