Section 12 - Country presentation

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BANGLADESH

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On farm storage, pest control, drying and prevention of mycotoxins in Bangladesh

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and
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Introduction

Bangladesh is predominantly an agricultural country with more than 80% of its people engaged in agriculture. Beset with the problems of a huge population to support and relatively a small area available for cultivation, this country faces the problem of chronic food shortages to the tune of 2.0-3.0 million tons every year.

The Government has already embarked upon projects to minimise this food deficit within the shortest possible time. It is imperative that efforts of increasing food production should be more directed towards finding ways and means to increase the production per unit area of cultivated land available. Total demand for grains in Bangladesh is 16.5 million tons while production is 15.2 million tons with net production of 13.7 million tons (production of food grains-losses and seeds (15.2-1.5 = 13.7 million tons). This food deficit is 2.8 million tons. This shortfall is met by the Government by imports through food aid, purchases, grants etc.

Imports and procurements from domestic sources amount to only 15% of the total requirement of food grains which is administered by the Government through the Ministry of Food. The rest (85%) is stored, handled and distributed by the private sector at farmers traders and millers levels.

Off-farm storage

Total volume of off-farm storage is approximately 1.8 million tons of which bag and bulk storage are 1.58 and .28 million tons respectively. Internal procurement is 0.5 million ton and external procurement is 1.8 million tons. This quantity (2.3 million tons) is stored and maintained in 4 silos and 1012 C.S.D. (Central Storage Depots), L.S.D. (Local Storage Depots) and TPC (Temporary Purchase Centre). Capacity of 4 silos is 0.25 million ton. They are generally used for bulk storage as transit depots for imported grains.

Types of godowns, numbers and capacities are given below:

Type	No.	Capacity (million tons)
C.S.D.	12	0.45
L.S.D.	600	1.00
T.P.C.	400	0.10

The aforesaid types of godowns are used for bag storage of grains imported and locally produced. In Bangladesh mainly paddy and wheat are stored in silos, and godowns are both used for both internal purchase and imported grain and seeds of pulses and oilseeds are stored only when those commodities are imported.

Pests occuring in food-godowns

Pests occuring in food-godowns are categorized by following types:

Pest	Slightly important	Important	Very important
Fungus, Bacteria			*

Mites, Psocids	*		
Birds		*	
Rodents			*
Insects			*

The Ministry of Food and Department of Food have given priority only to insect pest damage. Mojor storage insects in Bangladesh are rice weevil,Sitophilous oryzae (Linnaeus), lesser grain borerRhizopertha dominica (Fabius), rice meal mothCorcyra cephalonica (Stainton), Angoumlis grain mothSitotroga cerealella (OIivier), red flour beetle-Tribolium castaneum (Herbs"), flat grain beetle-Laemophloeus oninutus (Olivier), saw toothed grain beetleOryazephilus surinamensis (Linnaeus) pulse beetleCallo sobruchus chinensis (Linnaeus), flour or grain mite and psocids.

Important storage moulds are-Aspergillus flavus, A. glaucas, A. niger, A. clavatonanica, A. flaviceps, Aspergillus spp., Penicillium spp., Epicoccum sp., Chaetomium spp., Alternaria tenuis, Fusarium spp., Cladosporium spp., Curvularia spp., Rhizopus sp., Dorotomyces, etc.

The summary of annual cost of pesticides and pest control equipment for Ministry of Food storage system is as follows:

CSD capacity	= 450,000 tons
	= $ 450,000 (@ $ 1.00/ton)
LSD/TPC capacity	= 1,100,000 tons
	= $ 550,000 (@ $ 0.50/ton)
Silo capacity	= 225,000 tons
	= $ 56,250 (@ $ 0.25/ton)
	= $ 1,056,250

Traditional farm storage strucutres

The traditional farm storage practices and storage containers use in Bangladesh are:

i) Earthen vessel

- **Made of burnt clay or mud**

ii) Mud bins

- **Made of unburnt clay, clay is mixed with long bits of straw or grass for tough consistency**

iii) Kerosine tin

- **Made of tin**

iv) Gunny bags

- **Made of jute fibre**

v) Bamboo bins (Dole)

- **Bins made of bamboo matting or matting of stem of Sachharum anundinaceum (known as Nal)**

vi) Pura

- **Made of straw rope, used for unhusked paddy**

vii) Gola

- **Made with bamboo matting**

vill) Pucca Godown

- **Brick built with tin roofing.**

Loss estimation

The Department of Food assumes that the approximate rate of losses occuring annually is about 58% WFP assumes that lossed in rice will be constant throughout the year at roughly 0.8% month with losses in wheat at the 0.6-0.8% range/ month for the period July-Feb and 1.3-2.0% month for the months of marchJune. Losses occur due to pest damage, transport loss, handling loss and losses due to long term storage.

Present approach

The Bangladesh Agricultural Research Institute (BARI) sucessfully completed a 3-year "Legume Postharvest Technology" Project financed by IDRC and which was started in July, 1981. An important feature of the project was that a number of disciplines such as Entomology, Plant Pathology, Agronomy, Agricultural Economics and Agricultural Engineering were involved to implement the various post-harvest studies. During this period, detailed studies on the incidence of insect pest, storage fungi, seed viability, evaluation of traditional storage containers, newly fabricated mechanical drier, marketing costs and margins of different pulses were carried out. After termination of this project, BARI included some important crops for post-harvest studies. The crops are groundnut, maize, kaon, wheat and onion.

Facilities regarding training programmes and extension activities till now have not been initiated but it is considered an urgent need.

Ministry of Food

Bangladesh agricultural research institute

All Director General's are directly related with the Secretary, Ministry of Food.

Constraints to current loss reduction practices

The following have been identified: (1) Lack of appropriate farm level post harvest machinery such as threshers (2) Lack of farm level storage facilities for groundnuts and grain legumes (3) Deficiency of trained manpower in Post-harvest technology. Country wide post-harvest loss reduction assessment was done only in paddy.

Needs in terms of project development

Training:

i) Two short term training/year (not exceeding 3 months)

ii) One M.S. degree

iii) One Ph.D. degree

National level Co-ordination: Organization/ Institutes those involved in post-harvest technology work have no notional level co-ordination.

Resource availability

Human

BARI-Technologists 3, Agricultural Engineer-6, Pathologists-5, Entomologists-5 Bangladesh Rice Research Institute-12, Institute of Nutrition Food Science-17, Bangladesh Sugarcane Res. Institute-2, Institute of Food radiation Biology-14, Bangladesh Agri. University-19, Institute of Food Science & Technology, BCSIR-48

Physical

Storage facilities, capacity and design already mentioned;

facilities: well furnished laboratory

Financial needs: Not adequate but needs Tk. 1.00 million/year

Training Facilities: Not available both in Department of food and research Organizations.

Involvement of private sector in activity under review There is at present no involvement of the private sector in storage of Government handled food grain but 85% of grain is being handled by the private sector under traditional systems.

Integrated pest management strategies in grain storage systems in Myanmar

(Union of Burma)

By MAUNG MAUNG K,

INTRODUCTION.

This paper is a brief description of the grain industry of Burma, with a particular statement of the storage and pest control activies practiced in Burma.

Steps taken up for the improvement of storage and pest control activies are entirely those taken up by the Myanma Agricultural Produce Trading (MAPT) (formerly known as the Agricultural and Farm Produce Trade corporation.)

Integrated Pest Management Strategies in Grain Storage Systems, is entirely a new subject for the grain industry of Burma. It is learnt that the Agricultural sector of this country has introduced this system a few years ago. Therefore, it is expected that useful knowledge could be gathered from this training workshop and the Integrated Pest Management System can be introduced into the grain storage practices of this countly and the benefits of it can be enjoyed.

THE COUNTRY.

Burma, having a land area of 676,577 sq.km (261,228 sq.miles) lies between Latitudes 10N and 2831'N. Longitudes 92E. and 101E. It lies east of India and Bangladesh, south-west of China and west of Thailand and Laos. It is largest country in mainland South-East Asia.

THE ECONOMY.

Burma is a tropical country, the climatic conditions of it is favourable to grow various crops.

The climate of Burma comprises of a wet season (rainy season) from mid-May to mid-October and dry season from mid-February to mid-May. In the rainy season, most parts of the country get adequate rain to grow various crops.

The land under cultivation in Burma occupies about 20 million acres (8.0 million hectares) which is about 11.6% of the total area of the country. 9.39 million or 63.5% of the countrys' total active labour force of 14.79 million was employed in the production of agricultural crops in 1984-85. Hence, due to these favourable geographical and climatic conditions, the economy of Burma depends on the agricultural sector.

THE MYANMA AGRICULTURAL PRODUCE TRADING (MAPT)

Fomerly known as the Agricultural and Farm Produce Trade Corporation (AFPTC), the Myanma Agricultural Produce Trading was the only organization authorised for the procurement, transporation, storage, milling and export of agricultural products and other government controlled items such as maize, beans and pulses.

About 15,414 permanent and 16,642 temporary staff is employed by AFPTC. It procures 4 to 4.5 million tons of paddy, about 70,000 tons of pulses about 20,000 tons of maize and about 4,000 tons of oil cakes through 1031 paddy buying depots and 172 buying depots for other crops. AFPTC owns 53 rice mills, the total capacity of which is 3742 tons per 24 hours. In addition, it also hires 21 co-operative rice mills and 962 private mills having capacitives of 664 tons per 24 hours and 27972 tons per 24 hours respectively. The Corporation processes about 2.5 million tons of rice from the paddy purchased.

A provincial and national review of current practices and problems related to Pest Control

Activities in Burma.

The Myanma Agricultural Produce Trading is one of the (11) organisations formed under the Ministry of Trade. It is infect the largest organnisation under the Ministry, covering a very large field of business. Technical deparments such as the Rice Mill Engineering Department, the Rice Bran Oil Milling Department and the Pest Control Department are included in the organisational set-up of this organisation. The formation of the Postharvest Technology Application Centre (PTAC) is the latest addition to the set-up of this organisation. PTAC is purely a research department under taking the research and development activities in the field of rice milling, rice bran oil extraction, quality control, storage and pest control of agricultural products.

The Pest Control Department.

The MAPT is the only organisation which has the Pest Control Department in its' organisational set-up. This department was founded more than 40 years ago, and it has since taken the responsibility of prevention and control of pest infections required for the agricultural products handled by MAPT. In 1977, the department undertook the fumigation of stocks onboard vessels according to the contract terms laid down between the buyers and the seller. Furthermore, also in 1977, the department rendered pest control services for government departments, co-operatives and foreign missions, for which the department earned a regular income for MAPT. Within the period from 1977 to

1988, the department has carried out fumigation of 4,720,468 metric tons of rice and broken rice onboard 646 vessels, and within the same period, the department has earned a sum of K14,577,059/($718,533.59) through the execution of pest control services.

The Pest Control Department is headed by a team of managers who have gained an experience of more 20 years in the field of pest control. These managers were trained at distinguished institions in countries which have a high reputation in Pest Control Technology. The trainings and the countries attended by these Managers is given in Annexure (I).

There are 32 Pest Control Teams formed under the Pest Control Department and Stationed at various parts of the country. These teams tour round the buying departments, storage warehouses and rice mills and carry out pest control operations according to programme, Thus, pest control operations are carried out at the time grains were purchased, at time of storage and at time of export.

The capacity of the Pest Control Department can be estimated from the performances it has been undertaking.

The method of pest control adopted by the Pest Control Department is the chemical control method. All the chemicals used are imported items. Only a few of the equipments used are manufactured locally. Procedures followed in carrying out pest control

operations were first tested in the laboratory and then under commercial scale and dosage rates were established so as to be most effective under the prevailing conditions of the country.

Types of pest control are divided into two as follows:

(a) prophylactic or the preventive and

(b) curative type

The preventive types of pest control include the disinfestation of warehouses and dusting of open piles of paddy and stacks of bagged grain. The curative measures include the space treatment and the fumigation method.

As Bruma is a tropical country, the battle against stored product insects is an everlasting campaign. As insect infestation can be present both in the field and at time of storage, losses occur at both these points. But, as this report is a view of the postharvest activities, only the losses that occur after harvest will be discussed.

It is learnt that substantial losses occur at the various stages such as at buying depots, on transportation and at time of storage. The losses that occur at the storage level consist of both quantity and quality losses. Quantity losses are caused by birds and rodents, insects,

moisture, and spillages. quality losses are caused by insects, moulds and fungis and suncracking.

PRESENT APPROACH TO OVERCOME PROBLEMS

Heavy losses both quantitative and qualitative in the storage sector. This is a serious threat and the authorities are taking up steps for the improvement in the following areas of paddy and rice storage.

- **Maintenance of quality grades and standards.**
- **Control of temperature and moisture contents in grains.**
- **Pest Control Measures.**
- **Storage designs and structures**
- **Training in warehouse management.**

In the implementation of the above, local training programmes such as rice milling, storage management and pest control were organised.

Maintenence of the existing godowns and rehabilitation of storages capacities in the rice producing areas were carried out.

The Postharvest Technology Application Centre is now effectively carrying out less

reduction and upgrading of quality actively both within its' capacity and with the aid of the various organisations. The following research projects and pilot studies related to bulk handling and storage of paddy have been undertaken by PTAC since 1986. (Table 1)

Technical cooperation with various organisations for research and development on Pest Harvest Technology of Foodgrains has been also implemented. (Table 2)

A team of technicians, comprising of a pest control technologist and a chemist, visited Burma, and made a short term field survey of the activities of the PTAC and the Pest Control Department. Monito ring of insecticide residues and the determination of dosage rate of funigants were carried out by this team is cooperation with PTAC and the Pest Control Depertment.

The MAPT therefore possess a competent group of technicians such as laboratory technologists, pest control technicians, and entonologists who are trained overseas and who have a long experience in the respective fields. But, technology is a subject, which is advancing with the passing of time. Therefore, it is expected that these technical workers have a good access to the fastest developments in technology by having a chance to attend the various training seminars and workshops held in the respective fields.

Pest control activities cannot be carried out efficiently due to the lack of good storage practice. Sometimes grading of beans and pulses is done in the same warehouse where

fumigated stacks are stored. Also, separation of insect fragments dusts and impurities is carried out using a mechanical blower. This causes insects to spread to all places within the warehouse.

Interest and dicipline of the storage personnel play a vital roll in the storage and pest control systems. Sometimes, fresh arrivals are stacked on top of those which have been fumigated. Also, sometimes, high grade grains are stored very near to these stocks which are very heavily infested, such as bran, broken rice.

Old stocks lying in the warehouses for a long period are also major constraints in rendering insect free condition for commodities that are meant for export. When fumigation is done only to these stacks which are selected for export; these old stocks become the main source of reinfestation.

A temperature of about 21 C and 75% R.H. is not uncommon is most of the grain producing areas. Therefore, the fight against the storage insects is naturally more severe than in these countries which have a temperate of cool climate.

INVOLVEMENT OF PRIVATE SECTOR IN ACTIVITY UNDER REVIEW

Very recently, there was a change in the economic policy of the country. Most of the controlled items were released, and the private sector is allowed to participate in the

purchase, transportation and sales of these items. This open door policy is bringing in private organisation into the new trading system. The assets belonging to the government departments will be available to the private sector either on loan or joint venture basis. Thus, there were be an expansion in the volume of business transaction in the country. This will mean an increase in the demand for pest control services for items handled by the private sector. Up to some extent of time, the requirement, both for domestic and export pest control services the government will be the only organisation that will have to undertake the job.

The other factor that hinders the effectiveness of pest control activities is the climatic factor of the country. As Bruma lies in the tropics, is an ideal condition for the breeding and spreading of storage insects.

Table 1

Sr.	Research Titles	Organization	Years.
1.	The effect of moisture content level and matting cover on the quality of paddy stored in heaps on the ground.	ODNRI	1986/87
2.	The study on the effect of dusting on stored paddy with different insecticides.	ODNRI	1986/87

3.	Survey of anthroped pest in food commodities stored in DHS godowns, Rangoon.	ODNRI	1986/87
4.	Replicated storage trials on paddy Impurities.	ODNRI	1988
5.	Preliminary study on the performance of mechanised warehouses of bulk storage of paddy.	ODNRI	1988
6.	The use of mobile flexible plastic silos.	FAO	1988
7.	A preliminary trial on quality of modified traditional field practice.	ODNRI	1988

Table 2

Resources	**Research Areas**	**Duration**	**Remarks.**
ODNRI	Pest Control, storage	4 years	United Kingdom.
FAO	Temporary storage	1 years	United Nations.
JICA	Quality control	6 months	Japan.

ODNRI Overseas Development National Resources Institute
FAO Food and Agriculture Organization
JICA Japanese International Cooperation Agency

ANNEXURE (1) - TRAINING ATTENDED BY THE PEST CONTROL MANAGERS AND STAFFS

SR. No.	NAME OF TRAINING	COUNTRY	YEARS OF TRAINING	SPONSOR
1.	PRESERVATION OF STORED CEREALS	AUSTRALIA	1975	COLUMBO PLAN
2.	TRAINING PLANNING WORKS SHOP FOR			
	AGROPESTICIDES DISTRIBUTORS	BURMA	1980	ESCAP
3.	PRESERVATION OF STORED CEREALS	AUSTRALIA	1981	COLUMBO PLAN
4.	DETERMINATION AND PRESERVATION OF POST			
	HARVEST FOOD LOSSES	U.S.A.	1981	I.D.A.
5.	SPECIALIST COURSE IN APPLIED STORED			
	PRODUCT ENTOMOLOGY	U.K.	1982	COLUMBO PLAN
6.	GRAIN STORAGE AND MARKETING	U.K.	1982	I.D.A.
7.	CONSERVATION OF MARKETED GRAINS IN			
	BURMA	U.K.	1986	I.D.A.
8.	CONSERVATION OF MARKETED GRAINS IN			

	BURMA	U.K.	1986	I.D.A.

Management of grain storage in the republic of Korea

1. The Status of Grain Storage

The grain loss in post harvest occurs mainly during the storage period. Many experts assume a 35% loss storage on the farm. Annual rice production amounts to six million metric tons. About 13-18% of production is handled by the government and merchants, while the rest remains at the farm and stored in warehouses.

During storage, a lot of grain is lost due to inadequate drying of grain and poor storage facilities by rats, birds, insect pests, and microorganisms.

The farm warehouse for grain.

(1) The present status of farm storage:

Generally, the method of grain storage is of two types: sack method using a storage bag etc. and storage method of grain in bulk. The type and place of farm storage is variable in Korea, but government grain is stored in bags. (See Table 1,2)

The warehouses for government procured and stored grain

(1) The present status of storage for government:

In 1982, there were 4,642 warehouses with a total floor space of 1,669,612 m. There was a storage capacity of about 4 million metric ton in 1986; provided by 7,578 warehouse with a total floor space of about 6 million m. In addition to the increase in grain storage facilities, there have been significant changes in the quality of such facilities. When the storage capacity and different grades of warehouse in 1982 is compared with those of 1986, has shown a positive improvement in quality. Increase in capacity of special grade and a decrease in third grade and subgrade facilities, has occurred.

Table 1. Changes of grade in grain warehouse

	Year	**Special Grade**	**Grade 1**	**Grade 2**	**Grade 3**	**Sub Grade**
Number	1982		25	327	950	3,340
	1986	136	6,235	1,207		
Floor space (m)	1982		74,711	167,743	260,762	566,396
	1986	188,100	2,237,400	369,600		

Storage capacity M/T	1982		143,200	202,977		
	1986	290,100	3,268,000	428,000	176,080	514,002

Table 2. Farm Storage Methods in Korea

Storage in Bulk	**Storage using bag**
(1) Flat bulk storage	(1) Warehouse having flat roof
(2) Bulk storage of a small cylinder type	(2) Flat bulk storage
(3) A rice chest making of bamboo	(3) Wooden floor
(4) A wooden rice chest	(4) Room
(5) Steel silo	

Table 3. Location of Farm Storage

2. Administration system of government storage: 1guide system for the storage administrator

The Ministry of Agriculture and Fisheries appoints the following storage administration officers for the warehouses in their districts.

These personel will be in charge of admimstaring this guide and other instruments for the specific warehouse concerned.

2- Ouality inspection of government stored grain

Supervision of national agricultural products is done by the Inspection office National Agricultural Products Inspection Office (NAPIO)

For Inspection The grain is stored in accordance with a contract with government and the subsequert a contract with government and the regulations concerning warehouse management.

Items to be inspected

- **Inspection of quality**
- **Management Situation warehouse facilities**
    - **storage equipment**
    - **fire fighting equipment**
    - **management technique**
    - **administration business about storage**

Inspection period:

The method of quality inspection: The quality of grain shall be checked by using the method of sample test. Samples shall be taken by type of grain, location, and stacks in the warehouse. If there is some possibility or indication of discoloration, degeneration, rotting and insect damage, all grain shall be tested.

Classification	Period	Hulled grain	Unhulled grain
Safe period	Nov. - Apr.	Once a month	Once a month
None-Safe period	May - Oct.	Twice a month	Once a month
Danger period	June - Sept.	Twice each	Once a month

Note: All warehouses should be checked regardless of the period when unusual weather condition such as storm and unusual high temperature occurs.

C. Control of insect and microrganisms during the storage period.

Grain is alive; it always breathes and consumes nutrients. The quality and quantity of gran have been reduced by the proliferation of microorganisms. Besises this, the quality of grain is influenced by moisture, temperature, and storage condition. Under the same warehouse, the metabolism of the grain increases rapidly with higher temperatures.

The rate of respiration is reduced by approximatey half for every 10C reduction. Insect

pests reguire moisture the level of which is dependent on the species concerned, and ambiert conditions Populations are generally restricted below 12C moisture content, but multiply rapidly asove 14%. Insects are latent below 5C, active over 15C.

If microorganisms are present in the grain during storage, discoloration, biochemical change and decrease of germination rates occur. Microorganisms such as some moulds produce mycotoxin. For microbial growth in rice, temperatures af 30C and moisture contents of 16% are required.

The growth of microorganisms is restricted below 15C but increases rapidly over 25C.

(1) Insect in stored grain.

High temperature and humidity occur from July to September in Korea. A lot of insects and microorganisms are found at this time. There are approximately 19 species of insect. Sitophilus Oryzae (L), Oryzaephilus surinamensis (L), Tribolium confusum (J. du V.) Cryptoletes ferrugineus (Steph), Callosobruchus chinensis (L), are some of the most conernonly occurring species of stired products insects infesting rice beans and legmes. The following list of insect identifications refers to table 4.

1. **Sitophilus oryze (L)**
2. **Sitophilus sasakii (Takahashi)**

3. **Callosobruchus chinensis (L)**
4. **Rhyzopertha dominiica (Fab.)**
5. **Tenebroides mauritanicus (L.)**
6. **Oryzaephilus surinamenis (L)**
7. **Cryptoletes ferrugineus (Steph)**
8. **Trogoderma granarium (Ev.)**
9. **Attagenus megatoma (Fab.)**
10. **Tribolium confusum (J.du.v)**
11. **non-identification**
12. **Alphitobius diaperinus (Span.)**
13. **Alphitophagus bifasciatus (Say)**
14. **Tenebrio obscurus (Fala)**
15. **Sitotroga cerralella (Olive)**
16. **Plodia interpunctella (Hubn)**
17. **Pvralis farinalis (Zell)**
18. **Carpophilus hemipterus (L)**
19. **Acarus siro (L)**
20. **Nemapogon granella (L)**

(2) Microorganism occurrence in Korea

Sixty samples of deteriorated rice which were collected all over Korea were classified

according to their color. The causitive microorganisms were then isolated and identified.

(A) 62 samples of deteriorated rice were classified according to color into 7 types: reddish yellow, light reddish yellow, light gray yellow, lightish light gray, dark gray and rice weevil type.

(B) The isolated microorganisms form 62 specimens of deteriorated rice were 44 species, 5 genera of molds, 1 species of yeast, and 14 species, and 4 genera of bacteria.

(C) The frequently observed microorganisms which caused the deterioration were A. glaucus group,A. oryzae, A. candidus and A. versicolor. Among bacteria, Bacillus was dominant.

These insects are very prolific. Tribolium confusum (J. du V.) and Sitophilus oryzae (L) etc. can survive despite low temperature, dryness and coldness from Decenber to January.

Table 4. The status of insect occurrence

Isolated Microorganism from Reteriorated Rice and their Frequencies

1) Moulds:			
1) Moulds:	156	P. commune	6

A. repens	154	A. carneus	3
A. candidus	125	A. niger	3
A. royzae	105	P. cased	3
A. chevalier)	96	P. miczynskji	3
A. fumigatus	83	Scop. brevicaulis	3
A. fumigatus	58	A. raperi	2
P. iolandicum	58	P. janthinellum	2
P. simplicissimum	30	P. purpurongenum	2
A. montevidensis	24	P. frequentans	2
A. wentii	23	P. waksmani	2
A. clavatus	18	P. funiculosum	2
P. jensej	16	P. duclauxi	2
Phizopus nigricans	16	Tricholerma lignorum	2
A. flavus	16	A. nutans	1
P. solitum	15	ASP. ochroceus	1
P. citrinin	13	A. roqueforti	1

Rhizopus arrihizus	9	P. resticulosum	1
A. penicilloieds	8	P. stekii	1
P. lanosum	7	P. lanoso-coerulum	1
P. viridicatum	7	unknown	12
A. nidulans	7		
	6		
2) Yeast:			
Trichosporon berendii	1		
3) Bacteria:			
B. cereus	103	Brev. tegumenticolon	6
B. coagulans	69	Stap. epidermis	5
B. subtilis	59	B. circulars	3
B. licheniformis	53	B. lentus	2
Pseudomonas caviae	40	B. firmus	1
B. pumilus	37	Brev acetylicum	1
B. megoterium	16	Brev incerlium	1

A. = Aspergillus
P. = Penicillium
Scop. = Scopulariopsis
B. = Bacillus
Stap = Staphylocoocus
Brev = Brevibacterium

Control of insects and microorganisms

The moisture content of grain is decreased to 15% in order to continue to store grain for a long time. When government buys paddy rice, moisture limit must be below 15%.

Temperature and moisture content of stored grain are provented from increasing by ventilating the warehouse because of so much rain and high temperature in the summer season. Managers must observe relative humidity, grain temperature.

(c) Dosage and Exposure time by Aluminium phosphide (PH3)

Dosage and exposure time

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Farm level grain storage pest management in Nepal

GANESH KR. K.C.

1. BANKGROUND INFORMATION

1.1 Introduction

Nepal is situated on the Southern slopes of the mid-Himalayas bounded on the North by the Tibetian region of China and on the South-West and East by indict. It is located between 26 22' and 30 27' North latitudes and 80 40' and 88 12, East longitude. It has an area of 147,181 Sq. Km. (14.72 million hectares). Out of this total land, about 3.24 million hectares are arable area. Agroecologically, the country is broadly divided into three parallel zones viz. Mountains, Hills and Terai (indo-gangetic alluvial plain). About 35% of the total area lies in Mountain/zone, 43% in Hill zone and rest 22% in Terai zone. The total/cultivated area is about 2.9 million hectares. The average land holding is less than 0.5 ha. in Hills/Mountains and 1.5 ha. in Terai. Temperature ranges from 15C - 40C in Terai, about 5 - 25C in Hills and below 0C - 10C in Mountains.

The precipitation occurs mostly (80%) in summer (June September) and the annual rainfall ranges approximately from 300 mm to 3500 mm with an average of about 1600 mm. The average annual rainfall received in dry seasons (October May) is 300 - 500 mm. About 14% of the total cultivated land is under irrigation (seasonal/annual and gravitational/underground).

The population growth rate is 2.66% and about 33% of the total population is literate. Population density is about 120 persons/sq. km and 6 persons per hectare of cultivated land. Administratively the whole country is divided into 5 Development Regions, 14 Zones and 75 Districts.

Agriculture is the main stay of the national economy, which contributes about 60% of GDP and 60% of national export. Nore than 90% population directly derives their livelihood from it. Mainly because of topographic features, it has been widely conceptualized to encourage livestock farming in Mountains (at an altitude of 3000 m) above MSL) and horticulture is Hills (at an altitude range of 1000 M-3000 m MSL) and cereal and cash crops (sugarcane, jute, cotton, tobacco etc.) with altitude range between a hundred to 1000 meter MSL.

Farming in Hills in concentrated in valleys and around small plateaus, river banks and terraced slopes. Hill farming is mostly of subsistence and/or subsubsistence nature. The productivities of the crops are also low with an average yield of 2.016 mt/ha. for Paddy,

1.55 mt for Wheat and 1.446 mt/ha. for Maize and 0.922 mt/ha. for Millets.

2. FOOD PRODUCTION AND CURRENT LEVEL OF POST-HARVEST SYSTEMS

2.1 HMG/N is committed to fulfil the basic needs of the people by the year 2000 A.D. Based on the results of different studies on food requirement, the minimum average per capita daily calorie requirement of Nepalese people has been fixed at 2250. Rice, Wheat, Maize and Millets, Barley (cereals) pulses and potato have been identified as major food sources to supply the 1964 calorie of the total minimum calorie requirement of the people. The rest of the calorie requirement will be supplied from vegetable, root crops, fruits, milk and milk products, meat, eggs and fish etc.

To cope with the food demand by 2000 A.D. the present production levels of cereals, pulses and potato (4,312,000 mt, 95,000 mt and 387,000 mt) need to be raised to 8,651,000 mt of cereals, 27,000 mt of pulses and 86,900 mt of potato. The projected production of the increased cereals and grain legumes (approx 8.618 million mts) will demand a corresponding increase in the postharvest loss reduction activities/facilities, as the increased food production will naturally exert tremendous strain on and manifest problems in existing methods of handling, storing and processing. This will lead to unwarranted increase in post-harvest food losses, and will decrease enormously overall food availability. Establishment and maintenance of adequate facilities for harvesting, storage, processing and other post-harvest operations at different levels wil be essential

as it is estimated that 70-80% of produce in Terai and about 100% in the Hills and the Mountains is retained by the farmers in Nepal for needs of the family, lalour seed and cattle. Balance quantity which constitutes the marketable surplus passes through the hands of grain stockists, private traders and retailers.

2.2 The reduction of post-harvest losses at the level of stockists and private trade (2-3%) becomes more difficult because of their unmindful attitude and behaviour in view of the fact that their profits are not significantly affected by wastage/losses and therefore, contributes to general apathy towards improvements. The cooperative societies have also not gone much beyond the traditional method of handling and storage. However the Nepal Food Corporation and Agricultural Inputs Corporation have attempted to modernise the techniques of handling and storage of foodgrains and seeds.

Considering the fact that more than 70% of the production is retained on farm and this is where the larger part of losses (7-10%) occurs, the farm level storage clearly emerges as an area of priority for implementing the loss reduction activities.

2.3 In view of the need of development and diffusion of post-harvest loss reduction technology (LRT) to improve the availability and quality of foodgrains, this was established in 1980 under the Ministry of Agriculture (MOA) with the assistance of FAO. At present the various agencies involved in postharvest sector in Nepal are as follows :

(i) Rural Save Grain Project.

(ii) Nepal Food Corporation - Ministry of Supply (MoS).

(iii) Sajha Cooperative.

(iv) Salt Trading Limited - Pvt. (STL).

(v) Private Millers and Traders.

(vi) Bi and Multi lateral projects- MOA/MPLD. (Ministry of Panchayat and Local Development)

3. ON-FARM GRAIN LOSSES

Besides losses in storage, losses also occurs in harvesting, threshing, processing and milling of various foodgrains both in quantity and quality. The details are given below:

3.1 Harvesting

All three crops (Paddy, Wheat and Maize) are harvested manually. Paddy and wheat are harvested by cutting at the base of plants. In some parts of the country wheat is harvested by picking up the ear heads only. Maize is harvested by lashing the cobs from the stalk.

The average harvest losses in paddy, maize and wheat have been found 1.63%,3.33% and 1.76% respectively. The harvesting loss includes mainly the shattered grains, leftover panicles and cobs.

3.2 Threshing/Shelling

In Mountains/Hills paddy and wheat are threshed by beating the plants on the floor or stones kepy on the threshing floor, whereas in Terai the threshing is done by trampling with ox or by tractors or with rare exception by the power thresher. Un warranted delay occurs in paddy threshing particularly with big and medium farmers due mainly to lack of efficient means of threshing. They often stack paddy for 1-3 months after reaping, depending upon the sizes of their holdings and the resources they possess. This delay in threshing causes consider ble lossos due to rodents, birds, animals and pilferages. These stacks also allow the rodents to survive the lean period.

Maize is generally stored unthreshed/ unshelled. It is shelled as and when the farmer requies it. Maize is shelled either by beating the cobs with stick or stripping in paddy, maize and wheat have been found to the extent of 2.19%, 2.85% and 3.70% respectively. The losses includes the shattered grains and ungleaned grains.

3.3 Transportation

Grains are transported from threshing yards to storage either on the human back after packing it in the bags or baskets or carried as head load or by bullock-carts or mules. The transportation losses have been found to be 0.32% in paddy 1.04% in maize and 0.34% in wheat. This loss occurs due to grain dropping/shattering and spoilage.

3.4 Drying

Sun drying is the most prevailent method of drying crops. Hence the extent of drying depends on the season and temperature. Farmers generally dry the threshed grains on rice-straw wooven mats or on the ground especially prepared for it. Farmers who have access to metalled road, also dry the grains on the road. The drying loss has been observed 1.5% in paddy and 2.07% in wheat.

3.5 Storage

The farmers store the major portion of their production (70-80%) for their consumption. Storage practices vary with the types of crops grown, climatic conditions and local customs. Paddy and wheat are commonly stored in structures made of bamboo splits and strippings (Bhakari), Dhukuti, mud Dehari and wooden granary (Kothi) and recently the metal bins of different sizes are in use. In general management of stores is traditional.

Maize is usually stored on Thangro (made on vertical-pole) or stacked on floors or wooden

platforms. Hanging of Maize cobs in bundles under the eaves is also common. Insects, rodents and birds are important storage pests. The average storage period of paddy, maize and wheat are 7 months, 8 months and 4.5 months respectively. The loss due to insects/rodents are respectively 6.22%, 7.3% and 5.92% (by weight) of paddy, wheat and maize.

3.6 Processing/Milling

Quern, leg pounder, hand pounder, water mills, Engleberg steel huller and modern sheller/ plate mills, all are found for food processing. The traditional technologies are simple, and labour intensive.

The out-turn of brown rice in pounder ranges from 50-60%. Recovery rate in Quern/water mills ranges from 95-97% but flour is coarse compared to flour obtained from modern flour mills. Results of loss assessment study done in huller mills showed that 4.4 Kg. of milled rice is lost for every 100 Kg. of Paddy milled.

4. PREVALENT STORAGE STRUCTURE CONTAINERS AND SYSTEMS

Various types and sizes of storage structures and containers are traditionally in use. They are being made with different types of locally available materials and skills. These structures are mainly for the storage of different grains in various forms in different

ecological conditions and socio-economic situations. They also differ in sizes, shapes and construction materials. A summary of these structures are:

(a) Traditional Out-Door Storage Structures

Bery/Bhakari (Made of bamboo splits and timber).
Muja-ko Bhakari (made of straw/reed.)
Suliout-door raised platform with proper roofing for maize storage.
Thungki (wooder-granary with roofing).
Thangro (timber/bamboo drying/storage rack).
Dhansar (a separate house made of timber and planks for storage, few big farmers are only using it).

(b) Traditional In-Door Storage Structures/ Containers

Kath-ko Bhakari (made of wooden planks and plat form).
Gundari-ko Bhakari (made of straw/ bamboo mats).
Chitra/Choya-ko Bhakari (make of bamboo splits and strippings).
Kotho -(made of bamboo splits and strippings).
Doko -(made of bamboo stripping and splits).
Dalo/Bamboo basket (made of bamboo strippings and splits as well as reeds).
Dehari and Kothi (Mud-bins-respectively smaller and bigger in sizes).

Gagro and Ghyampo (clay pots-respectively smaller and bigger in sizes
Dhukuti -(mansonary structure-brick wall Bhakari).
Eaves of the houses (mostly for drying and storage of maize, garlic, chillies, etc.).

5. STORAGE STRUCTURAL IMPROVEMENTS

The existing structures do not provide sufficient safety to stored grains against insects, rodents and birds. Therefore, some efforts have been made to improve these structures. These improvements need further in-depth studies. They are as follows:

Proper plastering of mud-cowdung-straw mix from both the sides - inner and outer - of structures made of bamboo splits/strippings/bamboo and straw mats/reeds and regular sanitary measures for their disinfection.

- **Sandwiching polythene between two layers of mud-bins (Dehari).**
- **Cement plastering on mud-bins Dehari/Kothi) from outside.**
- **Bitumen painting of mud-bins from outsides**
- **Placement of these structures in the house on at least 30 cms raised platform and 30-40 cms away from the sides/walls of the house to allow enough ventilation and light to reduce the chances of rodent attack and increase aeration to get rid of dampness.**
- **Sanitary/preventive measures and maintenance of these structures by regular replastering and repairing/sealing the cracks and crevices as well as dusting /spraying**

them for the prevention of insectinfestation.

- **Improvement in "Thangro" by providing thatch/tin/Plastic roofing and nylon netting of the stored cobs, obstructions (made of tin/bushy thorns and spines) on the poles of Thangro for blocking respectively the access of birds and rats.**
- **Earthen/clay pots are bitumen painted and lids are also painted and smeared/sealed with the dough of wheat and/or maize flours/cow-dung-mud mix to make it airtight and moisture proof to study the effective storage periods of grains under this condition with and without use of fumigants.**

Results obtained from these demonstrated improvements are greatly gratifying and their management is also comparatively easier and cheaper.

Any successful and manageable improvements in Mud-bin will bring revolution change in the saving of grains in storage particularly in Terai.

6. INTRODUCTION OF MODERN STORAGE STRUCTURES

Efforts were also made to demonstrate the efficiency and effectiveness of metal bins and Pucca Kothi/Dhukuti (Bhakari made of brick and cement mortar) and Ferro-cement bins of different capacities. These structures have proved completely effective against rodents and birds. If handled and managed properly, foodgrains could safely be stored against insects and molds without the use of any chemicals. Among these structures Ferrocement bins

have not been liked by farmers because of handling problem and Pucca-Kothi is costlier. But, metal bins are getting popular and wider acceptance by the farmers. The major problem associated with metal bin was of transportation both by truck and porter. To overcome this problem, this project was be able to develop packable kits of metal bins. These packable kits have increased 4-6 times transportation efficiency by truck and 3-4 times by porters.

7. FARM-LEVEL GRAIN STORAGE PEST MANAGEMENT

Much of the post-harvest foodgrains losses can be attributed to rodent and insect pest. So it is necessary to workout appropriate rural storage technology which will reduce the harm caused by these pests. Among the most destructive are:

(1) Rodents:

(a) Rattus Sp
(b) Mus museulus
(c) Bendicota bengalensis

(2) Insects:

(a) Sitophilus Sp

(b) Rhizopertha dominica
(c) Oryzaephilus Surinamensits
(d) Tribolium castaneum
(e) Sitotroga cerealelia
(f) Plodlia interpunctella

(3) Molds:

(a) Aspergillus Sp
(b) Penicillium Sp

(4) Birds:

(a) Passar Sp and

(5) Mites etc.

The common grain storage pest management methods exercized in the country includes (i) Inspection (ii) Sanitation (iii) Physical and mechanical (iv) Chemical. Much of the emphasis has been placed on sanitation and inspection. However the use of chemical is gaining popularity rapidly among the farmers, and so the principle of prevention first and the employment of both prevention and treatment at the same time is also recommended.

Some of the safe, economical and effective means to be taken include maintaining proper storage hygiene, physical and mechanical and chemical control methods, as all these methods are closely related to and supplement each other. The aim of the sanitation is to create an unfavourable environment for the growth and breeding of insects.

Suggestions are made to farmers on giving a thorough cleaning of bins to keep free of holes, cracks, and also litters around the stores to be removed to eliminate the hiding places for insects and rodents.

Further, as the proper utilization of chemical. play an important role in IPC, farmers are given training on the judicious use of chemical, in order to ensure good results and avoid contaminating the grain.

As large scale or collective farms are rare in Nepal, the economics of large-scale operations at farmlevel may not be possible. It is, therefore, imperative that whatever technologies are adopted or recommended, these should be simple, low cost and continuous type.

The storage structures, drying and aeration play a very important tole in on-farm storage of foodgrains. Effects have been made by Rural Save Grain Project to develop new designs as well as improvement of existing storage structures. Some of the designs and metal silos have been well accepted by the farmers in Nepal. The metal bins of variable capacities ranging from 100 to 300 kgs. are being supplied to the farmers through District Agricultural

Officers at 25% subsidy.

The moisture in foodgrains at the time of harvesting vary from region to region and season to season. The farmers generally are aware of the important of drying and they do undertake drying before storage. The maize cobs are tied with rope for hanging around the house under the roofs for drying. Control measures recommended by RSGP for safe storage of grains at farm-level include:

(i) Discourage accumulation of grain and/or grain product residue in and around all farm structures.

(ii) Use of sound structures for storage of grains.

(iii) Clean and remove residues of grains from storage structures 4-6 weeks prior to placing new harvest for storage.

(iv) Spray storage structures/surroundings (with recommended residual insecticides) after cleaning 4-6 weeks before arrival of new harvest.

(v) Storage of clean and dry grains.

(vi) Aeration (if possible) to cool grain and maintain temperatures.

(vii) Inspection of grains regularly, (at least monthly) to see.

a. temperature increase,

b. insect activity,

(viii) If insects are detected, grain should be fumigated. Fumigation of bags can be undertaken with polythene sheets under on-farm conditions.

(ix) Rodent control measures:

(a) Use of traps,
(b) Use of chemical.

However, in Nepal, the selection of appropriate storage technology and management of grain storage are influenced by various factors such as:

- **Bulk or bag handling,**
- **Period and purpose of storage,**
- **Type of grain,**
- **Need for cash,**
- **Storage losses,**
- **Preservation cost**

- **Transportation facililies.**

8. FUTURE APPROACHES ON POST-HARVEST LOSS REDUCTION PROGRAMMES

8.1 The existing post-harvest loss reduction activities of RSGP which is implemented in 17 districts, will be extended to all 75 districts on priorities basis. Staff of this central unit will assist the technical divisions and extension unit for basic research and subsequent field testings.

8.2 Dessimination of technical message on loss reduction through the model village approach will be continued in addition to existing extension units of DOA.

8.3 Training of farmers SMS, JT/JTA will be carried out in cooperation with regional training centres of DOA.

8.4 The research activities will be concentrated on the following areas of PHS.

8.4.1 Storage structures development and improvement on existing structures.

8.4.2 Testing and evaluation of small scale thresher, driers, reapers designed and developed in the country or in neighbouring countries.

8.5 Stimulation of local manufacturing base will be continued. Small scale entrepreneurs at local level will be encouraged to multiply technological improvements developed by government agencies. Government support for research, credit and creating demand for their product will be continued.

8.6 The loss assessment and survey of major crops will be conducted as per need.

8.7 External assistance for the establishment of Post-Harvest Field Stations, exchange of technological achievements and development of local manufacturing units will be sought in future for efficient management of post-production losses.

8.8 Preliminary studies on storage feasibility of perishable food at farm levels will be initiated and on the basis of the result of the study appropriate programmes will be formulated for implementation.

8.9 Demonstration and distribution of improved post-harvest equipment (thresher, bins, driers etc.) and other extension materials like pamphlets, bulletings/brochures etc. will be carried out as per need.

8.10 Women in the rural household are to a large extent responsible for many of the postharvest operations, including harvesting, threshing and safe storage of foodgrains and seeds and so the training to the women on the post-harvest loss reduction technology is

provided in close coordination with Women's Training Centre WTC) under Ministry of Panchayat and Local Development (MPLD) will be continued.

9. AREAS FOR COLLABORATIVE PROGRAMMES WITH REGIONAL NMC

Nepal would like to share experience and expertise on the following areas on PHS with regional network member countries:

9.1 Development of information systems for sharing experience on PHS and loss reduction technology (LRT).

9.2 Development of appropriate post-harvest equipment and machines suitable for small farmers.

9.3 Collaborative establishment of local manufacturing units for PH equipment and machines.

9.4 Development and implementation of community rodent rodent control programme.

9.5 Development of suitable package of message for extension workers on loss reduction activities.

9.6 Development of programmes on perishable food materials.

9.7 Trainings of subject matter specialists on PHS.

9.8 Farm level potato seed storage.

9.9 Exchange visits amongst NMC countries by PH/LR Technologists to identify areas for collaborative programmes.

10. NEPAL FOOD CORPORATION (NFC)

20.30% of the total produced foodgrains enters the trade channel (off-farm) for internal distribution to urban consumers, food deficit areas, export and retention with various marketting agents. NFC under Ministry of Civil Suppies (MOS) is one of the major public institution handling the food at off-farm level. At present NFC deals mainly with Paddy, Rice, wheat, Maize and Oil Seeds. Its one of the main activity is to purchase the grains from the surplus areas and distribute them to the deficit districts in the country. NFC at present has a storage capacity of about 86,O00 MT.

11. SAJHA COOPERATIVES

Cooperative is a multi-purpose organization at the grass root level for the promotion of rural developmental activities. It is managed by locally elected board of directors and supervised, guided and assisted by Department of Cooperative Development (DCD).

Cooperatives in Terai districts act as procurement agents for NFC and salt Trading Limited. They have about 50,000 MT capacity godowns which are mostly located in Terai and a few in Hills. They are mostly engaged in procurement of Paddy. They store only for a short period.

12. SALT TRADING LIMITED (STL)

STL is also involved in foodgrain business. But it handles only wheat grain. The capacities possessed by STL is about 28,000 MT.

13. PRIVATE MILLERS AND TRADERS

Private millers and traders are major agents involved in the post-harvest foodgrain operations. They procure from farmers and middlemen, to supply to NFC of Sajha for local distribution and exports. Almost all big traders/millers have their wn godowns/storage facilities. They do not have any trained technician but have well experienced administrative staff, who handle the grain at all levels. It is estimated that presently the private traders and millers have about 463,O00.

RECOMMENDED STORAGE PEST CONTROL METHODS

Method	Recommended	Dosage %	Ratio & Time of

Recommended			Application
Protective method			
1. Chemical	Spraying of 50 EC	0.5	3 Lit. per 100 M
	Malathion		before storing the
	50 EC and Nuvan		grains.
	(DDVP)	0.5	
2. Sanitation	Cleaning/drying	Pre Storage	
Curative			
1. Mixing	Malathion 5% dust	29 m/Kg of Seed	
2. -Fumigation			
(a) Bulk		3 gms tablet of	
(b) Bag		Almunium phosphide	
		per ton of orain	As necessary

In addition farmers use the local herbs and plant products to protect their seeds grains, commonly used plants are as follows:

(a) Neem leaf (Azadirchta Indica) mixing the grinded leaf in the grain.

(b) Timur (Xanthoxylum armatum) mixing leaf as well as seeds in the stored grains at the rate of 10 gms/Kg of seeds.
(c) Similarly Titepati (Artemisia vulgaris) is also used in different parts of the country.

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Public sector storage of wheat in Pakistan and the associated problem of insect pests

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By Hafiz Ahmed, Mubarik Ahmed, Mohammad

Sardar Alam and Siraj Uddin Ahmed**

INTRODUCTION

With its population fast reaching the 100 million mark, Pakistan is still predominantly an agricultural country. It has a total land area of 79.61 million hectares out of which 20.3

million hectare is cultivated. Of the cultivated area, about 70 per cent is irrigated and the balance is mainly rainfed. Agriculture accounts for approximately 30 per cent of the country's Gross Domestic Product and employs a little over 50 per cent of total labour force to earn about 70 per cent of the country's export revenue. The Punjab and Sind provinces are relatively densely populated and are also the main grain producing areas. Surplus grain produced in these provinces is procured and stored by public sector agencies (Table-l) to provide the deficit areas. The main foodgrain crops are wheat, rice, maize and pulses. Wheat is the staple food of the people of Pakistan and is therefore, the most important foodgrain crop. Of the total production of about 19 million tonnes of foodgrains this yesr (1985-86), wheat contributed a record portion of 14 million tonnes. The country has reached a self-sufficiency level for the present in this vital commodity but our needs for wheat are likely to keep growing with our fast growing population. It is projected that despite some limitations, wheat production will increase to about 18 million tonnes by the year 1992-93. Rice is the second important foodgrain crop of Pakistan but its production is nearly static for the last few years varying between 3.0 to 3.5 million tonnes annually of which about 1.0 million tonnes is exported.

PROCUREMENT, STORAGE AND LOSSES:

1. Agencies involved:

From early 50s, government is involved in the procurement, storage and distribution of

foodgrains. For this purpose various agencies have been created. The Federal Ministry of Food, Agriculture and Cooperatives (MINFA) formulates policy and sets the minimum prices and procurement targets for public sector agencies. In case of shortfalls in production, MINFA also decides about imports. Other public sector dagencies involved are:

a) Four provincial Food Departments (FDs) having the following functions:

- **to purchase wheat of specified qualities from producers and other suppliers;**
- **to maintain stocks of wheat for market intervention to stabilize prices at a level determined by Government of Pakistan and to supply wheat to government controlled mills to sevice the rationing systems;**
- **to procure wheat for supplying deficit areas and other agencies;**
- **to handle imported wheat within the system;**
- **to procure rice on behalf of the Rice Export Corporation of Pakistan (RECP) in Sind and Punjab.**

b) The Pakistan Agricultural Storage and Services Corporation Ltd. (PASSCO), a joint stocks company established in 1973, entered in operation of cereal grain procurement like wheat, paddy, pulses and other agricultural commodities like onion and potatoes on required basis under the direction of the Federal Government.

c) Rice Export Corporation of Pakistan (RECP), is a public sector limited corporation established in 1974. The corporation works on monopoly basis for exporting rice from Pakistan and undertakes all operations connected with the procurement, milling, cleaning, storage, packing and sales of rice for export.

d) National Logistics Cell (NLC), operates a road transport fleet which carries some of the public sector grain stocks. It also undertakes the construction of storage facilities.

Table-II gives the extent of grain storage facilities available with these agencies in the four provinces of the country.

2. Types of storage facilities:

Grain storage facilities in the country are of many types but are mostly horizontal sheds called house type godowns. There are also binishells, hexagonal bins and some silos. These types account for roughly 70, 9, 6 and 6 per cents respectively of the total under cover grain storage capacity in the country. Some details of these storage structures are as under:

i) House type godowns vary in design and capacity form 500 to 16000 tonnes, constructed in different parts of the country to suit local climatic and other requirements. The size of a 500 tonne unit measures 30.48 m x 12.19 m whereas the 16000 tonnes measures 239.6 m x

36.3 m. The size of a standard unit of PASSCO type constructed under IDA aided programme is 30.48 m x 18.90 m with a unit capacity for storage of 1100 tonnes of bagged commodities. The height of units varies between 6.1 7.6 m. The godowns are built on plinths of a height to range between 0.76 - 1.07 m. Wheat is stored in these godowns in bags but in some parts of Punjab bulk-cumbag operational system is also undertaken to increase the storage capacity of the unit.

ii) Binishells are the dome shaped structures made of reinforced concrete, built recently to increase covered storage capacity on an emergency basis. The height of the dome in the centre is about 10 m while floor area has a diameter of about 32 m. Each binishell has a storage capacity of 1500 tonnes of bagged grain.

iii) Hexagonal bins are structures of bee-hive shape with pre bin capacity of 35.7 tonnes and the total single site capacity ranging between 500 and 3000 tonnes. The bins are supported on columns 2.6 m above ground level. Each bin teas a conical hopper at the bottom made of reinforced cement concrete to facilitate the flow of grains through a 15 cm diameter spout, fitted with locking arrangements. The upper access of each bin is by a centrally positioned manhole in the common roof which is about 9 m above floor level. Each site is provided with a 1.2 m wide stairs for carriage of grains to the top in bags for emptying into the bins.

iv) Silos. Previously there were only metallic silos constructed in early 1960s for 42000

tonnes storage at Multan. Recently some concrete silos have also been constructed with each complex of about 50,000 tonnes capacity. These are constructed in double rows of 7 bins in each case. Each bin has a flat base about 0.6 m above ground level. Bagged grain is tipped into the intake pit and fed to the individual silo via a chain and flight conveyer.

3. Extent of losses:

Storage losses in public sector godowns occur mainly due to inadequate covered storage space as well as shortage of trained manpower to manage proper procurement, warehousing and the pest control operations during storage. Basic quality parameters affecting storage such as moisture content of grains, segregation of lots according to the age of the stocks and biological cleanliness of the warehouse etc. are given little credence in the practices being followed. The result is that serious losses take place quite often.

Published estimates about wheat storage losses vary widely and there is even controversy about any weight loss taking place at all. Agencies responsible for warehousing of wheat do not show any losses in their books. They accept such losses only on occasional basis occurring due to exceptional circumstances. However, entomologists visiting public sector godowns firmly believe that losses in quality as well as in quantity of the stored wheat have to be there in view of the heavy insect pest populations. As such, occurrence of losses should be accepted so that the need for loss reduction programmes could be duly stressed with the policy makers.

GRAIN STORAGE RESEARCH:

1. research on extent of losses:

Only recently, MINFA provided funds to PARC for a coordinated research programme to determine storage losses in all the four provinces of Pakistan. A year long study based on actual sample analyses undertaken at Karachi has confirmed heavy losses particularly in quality as well as quantity losses. Country may be different because the climate of Karachi is particularly suitable for the development of insect pests. The study at Karachi has also shown that a part of the weight loss get obscured due to moisture gain by the grain during monsoon season which follow the hot and dry wheat harvest season. Some results of this study on the over all Pakistan situation are presented in Tables lll and IV. On an average wheat was stored for a period of 5.4 months in that year (1984-85) in the various public sector godowns during the course of which it suffered weight loss to the extent of 3.5 per cent (Table-El). The public sector agencies thus suffered a cumulative loss of about 141,600 tonnes of wheat due mainly to the insect activity (TableIV). The most dominant insect species contributing to these losses were the Rhizopertha dominica, Trogoderma granarium, Sitophilus oryzae and Tribolium castaneum.

2 Research on the development of loss reducing technology:

The Grain Storage Research Laboratory (GSRL) of PARC at Karachi are engaged in the

development of technology for reducing losses in the public sector grain warehouses as well as for farm level storage of grains. One of the important findings of this laboratory concerning public sector storage of wheat is the discovery that whole godown phosphine fumigations, as being practiced by the Sind Food Department as well as RECP to control insect infestation, are only partially successful. Few live insects were detected in wheat and rice samples taken immediately after phosphine fumigation operations in the godowns at Karachi. The present practice is that doors, windows and ventilators of godowns are closed and mud plastered to make the structures gaslight for phosphine fumigation. Using locally made 0.2 mm thick polyethylene sheets for comparison, it was demonstrated that sufficient phosphine gas was not being retained in such whole godown fumigation operations even for three days compared to the essential five day's exposure requirement. Under sheet fumigation was therefore recommended in 1984 as a substitute to the whole godown fumigating.

Under sheet fumigations only of individual stacks would however, lead to the problem of reinfestation as soon as the sheet was removed for use elsewhere. This fear led us to the testing of under sheet storage of bagged commodities.

An experiment was undertaken in the year 198485 where 2000 tonnes of bagged wheat was stored for 9 months in a godown of the Sind Food Department at Landhi (Karachi) under transparent low density polyethylene sheets. The four stacks of 500 tonnes each were fumigated right from the start of the storage period and the sheets were left on the

four stacks to act as physical barriers preventing insect reinfestation. Doors and ventilators of the experimental godown were kept closed throughout the storage period to prevent winds blowing out phosphine from underneath the sheets and also to prevent entry of birds etc. A second fumigation was also undertaken at a later stage when some insects were sighted under the sheet. For both fumigations, half the dose of phosphine was used compared to the dosage generally applied by the Food Department (0.5 gram phosphine gas/cubic meter of under sheet space as against 1.13 gram phosphine/cubie meter internal space of the godown). The cost effectiveness of the technology is shown is Table-V. It will be seen that considerable amount (2.81%) of weight loss took place under the traditional practice of whole godown fumigation despite two fumigations as compared to the very little weight loss under polyethylene sheets. A saving of about 54 tonnes of wheat over a period of 9 months storage was thus demonstrated without incurring any additional expenditure for the under sheet storage and fumigation technology.

In the experiment discussed above, polyethylene sheet was sealed with floor of the godown using sand snakes and entry of insects in the head space of the godown was kept under check by repeated fogging. Spraying with insecticides of the floor area between the stacks was also undertaken to prevent insects from creeping into the covered stacks. To simplify the technique further, large scale replication of the experiment was undertaken in year 1985-86 with modifications of laying polyethylene sheet underneath individual stacks. Another modification was that a polyethylene cap made to size of the stack was used instead of using a sheet to cover it. The sides of the cap were sealed with the under

laid sheet thus reducing or even eliminating the need of sand snakes. The use of caps also resulted in saving of polyethylene. After such gaslight polyethylene enclosure, fogging and spraying operations were also not needed. Taking advantage of the rodent proof design of the godown buildings, rat control operations were also eliminated. Simple polyethylene enclosure and phosphine fumigation (PEPF) technique was tested and achieved excellent results. No heating of the grain took place in any of the experimental stacks because the grain was quite dry and was fumigated at the start of storage which had eliminated possible (although very low) resident insect population. No aeration of stocks was thus needed. Phosphine gas also ultimately leaks out of the enclosure in about two weeks time thus making fumigation fully successful even at reasonably low dose rate of 0.5 gram phosphine per tonne of the bagged wheat (A dose rate of 1.0 gram phosphine per tonne of stored grain is however, recommended to ensure control of resistant Rhizopertha dominaca and Tribolium castaneum and the diapausing Trogoderma granarium larvae). The cost per tonne of the treatment is related to the size of the stack as shown in Table-VI.

The polyethylene enclosure and phosphine fumigation technology or PEPF technology, as we call it, is based on the assumption that wheat grain in Pakistan always carry some insect infestation even if it is coming into the godowns straight from the threshing floors. It must be emphasized that very low infestation levels may not be easily detectable at the beginning of storage stage. If such resident low infestation is eliminated with phosphine fumigation and the entry of fresh insects is prevented by the physical barrier provided by

the gaslight polyethylene enclosure, the grain shall remain free of insects and heat/mould damage provided wheat moisture content is below 11.0 per cent (average) and the stack is made in-doors to save phosphine gas from blowing out of the enclosures through wind action. PEPF technology is particularly suitable for public sector storage of wheat in Pakistan because:

It eliminates the need for spraying of storage building or grain fabric of the wheat stacks which could be misused to add un-necessary amount of moisture into our otherwise dry wheat grain in Pakistan.

- **It eliminates the possibility of toxic residues in wheat.**
- **It ensures complete control of insect pests, even resistant and diapausing species, at a reasonably low dose rate of phosphine gas.**
- **It eliminates the chances of grain getting reinfested (provision of a second fumigation is subject to actual detection of insects from under the transparent polyethylene sheet which could be from the build up of the pupulation possibly surviving initial fumigation)**
- **It compares well cost-wise with the traditional pest control practice in public sector godowns.**
- **It makes long storage of wheat possible in a developing country like Pakistan.**
- **Grain preserved using PEPF technology remain fully viable for use as seed in the following season.**

Table - I. APPROXIMATE SHARE OF AREA, POPULATION, PRODUCTION OF FOODGRAIN AND STORAGE CAPACITY IN THE FOUR PROVINCES OF PAKISTAN.

Province	Area	Percentage of Total		
		Population	Production of foodgrain	Grain storage capacity
Punjab	26	55	72	54
Sind	18	22	15	33
N.W.F.P.	13	18	11	9
Baluchistan	43	5	2	4

Table - II. EXISTING PUBLIC SECTOR GRAIN STORAGE FACILITIES (IN THOUSAND TONNES) IN PAKISTAN.

AGENCY	PROVINCES				PAKISTAN
	PUNJAB	SIND	NWFP	BALUCHISTAN	
Provincial Food					
Departments	2,054	644	368	159	3,225

PASSCO	414	76	9	2	501
RECP	79	915	—	—	994
NLC	—	—	75	60	135
Federal					
Agencies	171	—	—	—	171
TOTAL	2,718	1,635	452	221	5,026

Table- III. AVERAGE WHEAT STORAGE PERIODS AND RATES OF LOSSES IN PUBLIC SECTOR GODOWNS IN THE PROVINCES OF PAKISTAN DURING 1984-85.

Province	Average storage period (months)	Percentage weight loss			Total
		Insect Pre-storage*	Storage	Moulds	
Sind	6.4	0.1	2.9	0.3	3.3
Punjab	6.3	0.1	1.8	0.3	2.2
N.W. F. P.	6.5	2.9	2.6	0.7	6.2
Baluchistan	2.6	0.5	1.2	0.5	2.2

Pakistan	5.4	0.9	2.1	0.4	3.5

*** Wheat received at the site of the study had been stored earlier elsewhere.**

Source: Losses in Public Sector Storage in Pakistan. A report of Crop Sciences Division (1986), Pakistan Agricultural Research Council, Islamabad.

Table - IV. STORAGE LOSSES IN WHEAT CALCULATED FROM PROVINCIAL RELEASES DURING 1984-85.

Province	**Loss tate (%)**	**Quantity released (Million tonnes)**	**Quantity lost (Million tonnes)**
Sind	3.3	0.842	0.0277
Punjab	2.2	1.603	0.0352
N.W.F.P.	6.2	1.149	0.0712
Baluchistan	2.2	0.342	0.0075
Totals		3.936	0.1416

Source: Losses in Public Sector Storage in Pakistan. A report of Crop Sciences Division (1986), Pakistan Agricultural Research Council, Islamabad.

Table-VI. Cost per tonne in relation to the size of stack for Polyethylene Enclosure and Phosphine Fumigation (PEPF) technology for the safe storage of bagged wheat (or other grains) in a rodent proof godown.

Description of Material/operation	**Estimated for Materials and costs**	
	Bag stack of 500 tonnes	**Bag stack of 200 Tonnes**
Dimensions of stack	30mx 6m x 4m	13m
x 6m x 4m		
Weight of 0.2 mm		
thick polyethylene street required	115 Kg	56 Kg
Total depreciated value of polyethylene		
sheet	Rs. 2,200.00*	Rs. 1,075.00*
Heat sealing and envelop making charges	Rs. 300.00	Rs.
200.00		
Cost of fumigant at the dose rate of 1.0		
gram phosphine/tonne @ Rs. 1.20/ALP		
tablet for two fumigations required during		

nine(9) months storage	Rs. 1,200.00	Rs. 480.00
Total Cost in Pak Rupees	3,700.00	1,755.00
Cost/tonne of grain in Pak Rupees	7.40	8.77

*** Depreciated value calculated from the actual purchase rate of Rs. 27.00/Kg about 30% of which can be recovered by selling back the used sheets for re-processing.**

Table - V. Cost effectiveness of the under sheet storage & fumigation technology using 2000 tonnes of bagged wheat (in four stacks of 500 tonnes each measuring 30.0 m x 6.5 m x 4.0 m) stored for nine months at Sind Government Godowns-ll (Shed No.3 measuring 62.0 m x 14.6 m x 7.0 m), at Landhi (Karachi) during 1984-85.

Operation involved	**Estimated expenditure & loss (-) or savings (+) in Pak Rupees**	
	Whole godown fumigation	**Under sheet storage and fumigation**
- Pre-storage cleaning including wall sprays		
with insecticides	1,240/-	1,240/

- Two Fumigations		
a. Cost of mud plastering of doors, ventilators		
and placement of ALP tablets.	3,040/ -	Not required
b. Cost of four polyethylene sheets each		
measuring 44 m x 22 m plus cost of		
sand snakes and their placement.	Not required	9,000/- *
c. Cost of fumigant (ALP) tablets @ Rs.		
0.68 per tablet.	9,800/ -	2,100/ -
	(@ 7200 tabs/fumigation)	(@ 1560 tabs/fumigation)
- Cost of fogging of headspace @ Rs. 100/		
operation	Not required	400/
- Spraying of the floor area between stacks		

with insecticides	Not required	200/
- Rat control operation	Not done	200/ -
Total expenditure for nine (9)		
months storage	14,080/-	13,160/
- Mean percent weight loss	2.81**	0.13
- Quantity lost in tonnes	56.20	2.60
- Value of wheat lost		
@ Rs.1700/- per tonne	95,540/-	4,420/-
- Net saving (+) or loss (-) in Rupees	(-) 109,620/ -	(+) 92,040/ -

*** The life of the sheets has been taken as one year and only depreciated value for nine (9) months is taken.**

**** Mean percent weight loss in 9 months in control Shed No.10.**

The current storage pest problems and their management in the Philippines

Alexander Joel G. Gibe

Rice and corn have been the major food crops grown in the Philippines. Programs designed for greater production of these commodities have been given priority to meet the growing reguirements of the 56 million Filipinos. Other programs were likewise launched to save foreign exchange by reducing importations. Leguminous and plantation crops such as mungbeans, soybeans, peanuts, sweet potato were gaining more attention from the government because these crops are considered important food supplements.

The production of food has been increased but it is not the main goal of the government. The goal is to preserve what has been produced, in storage.

However, storage pests are continuously causing high losses in stored commodities. Insects have been identified as the most important cause of loss in all types of storage, followed by fungi, rodents and birds. Thus, in order to achieve the goal, further reduction of post-harvest losses should be undertaken.

MAGNITUDE OF LOSSES TO PESTS

Insects

In 1976, losses due to insect infestation in corn stored for eight months in government warehouses withont the appropriate pest control measures were estimated to be 34% of its weight (Caliboso 1977); 11 % in 1984 (Caliboso et al .,1985) and 9% in 1986 can be

attributed to chemicals and the appropriate pest control techniques (admixture) and improved storage structures and design.

In milled rice, loss could be about 148 million kg a year valued at US$ 49.6 M if insect infestation is left unchecked. This volume is about 20% of the government requirement of 783 M kg to meet a 45-day consumption requirement. This is based on the average mean loss of 21 % due to insects for a period of 13 months.

On the other hand, paddy stored for 12 months loses 12% of its weight. This is equivalent to about 57,000 MT valued at US$ 9.98 M based on the assumption that NFA stores 457,000 MT in a year.

Rodents

Vertebrate pests like rodents, present a serious problem in the storage of grain. Sayaboc et al. (1984) reported that approximately, there exists on average of 72 rodents in a government-managed warehouse and 171 rodents in a private single warehouse, consuming 2 kg and 4.9 kg of grain respectively in a day and could spill 18 and 27 kg more respectinely, while feeding. Considering that there are 10,223 government and private warehouses in the country, a daily loss between 39,000 to 312,000 kg can be realized.

Birds

The main bird species present in grain storages is the Passer montanus (Phil. weaver). A single bird weighing 20 9 consumes about 5.6 9 of grain and spills 2.5 times more. Estimated daily loss in each store is about 0.28 to 22 kg. enough to sustain 50 to 400 birds.

CURRENT PEST STATUS

Insects

In the Philippines, Sitophilus zeamais is more dominant than Sitophilus oryzae in maize and sorghum, but it appears Sitophilus oryzae has been displaced by Rhyzopertha dominica as the dominant pest species in paddy negating a previous survey by Labadan (1959) which indicated that Sitophilus oryzae was the major pest of paddy.

The shift of dominance can be attributed to several factors i.e. increase in volume of paddy with low moisture content kept in storage (9-11 %), high moisture, temperature (34C) and sustained selection pressure exerted by the regular and frequent application of malathion. R. dominica is more tolerant to low moistures (9%) and high temperature in store (up to 38C) (Sabio et al., 1984).

Earlier studies have suspected that the lesser grain borer (R. dominica) has already acquired resistance to malation because of its massive use in storage, thus higher density of this pest was observed. This was confirmed by the findings of Sayaboc et al. (1984) in a

resistance test.

The dominance of R. dominica over S. oryzae was further validated by an insect trapping study conducted by the same author on the same commodity (paddy) (ACIAR Project 8307, Progress Report 1987).

Another primary pest observed in the trapping study is Sitotroga cereallela while the secondary pests identified are Cryptolestes sp.. Oryzaephilus sp., Latheticus oryzae, T castaneum and Liposcellis sp.

In milled rice, the most abundant species are the T. castaneum and Corcyra cephalonica while Callosobruchus maculatus and C. chinensis were proven to be the major pests attacking soybeans and mungbean with the former pest as the dominant species.

In copra, Alpuerto (1979) made a survey in the provinces of Batangas and Quezon and found Nicrobia rufipes, Oryazophilus surinamensis, Dermestes ater (Degeer), C. dimidiatus (Fab.) and Carpophilus pilosellus Motsch as the most dominant species infesting the commodity.

The occurrence of Thorictodes heydeni Reitter in local storages presented a new record in the Philippines. This pest was found to be abundant in mungbean, corn, sorghum and paddy.

Rodents

The major species affecting food in storage in the Philippines are Rattus norvegicus, the Norway rat; Rattus rattus mindanensis, the common ricefield rat; and the Mus musculus the house mouse. These species differ in their habits. R. norvegicus is expected to have dominance over other species because of its size (Caliboso 1982b; 1983, Sayaboc et al., 1984).

Mites and Birds

The species of mites found to be dominant and widely distributed was Suidasia pontifica. It is a primary consumer and was found to be frequently present in paddy, milled rice, rice bran and corn (Sabio et al. 1984).

Fifteen other species of mites have been recorded from the survey.

The survey of Genito et al. (1982) recorded only one bird species, Passer montanus. Being seed eaters, its diet comprises 91-97% grains which is 30% of its body weight.

PEST CONTROL METHODS

The National Food Authority (NFA), a government agency responsible for the procurement and maintenance of an adequate supply of food stocks does most of the stored product

pest control. Pesticides are not commonly used by farmers against stored product pests except for seed treatment.

At present, the NFA utilizes a ready to use formulation of bioresmethrin for space treatments using sprayers consisting of a reservoir, high speed blower and buffled nozzles mounted on a movable trolley. The air turbulence physically breaks the insecticides into small droplets of more uniform particle size and in essence is an Ultra - Low-Volume (ULV) or Controlled Drop Application (CDA) system. if properly adjusted, the size of the droplets will tend to fall into 1-30 micronrange with a greater percentage being in the 20-30 micron range, which is considered ideal for impinging on the setae of insects, agglomerating and being absorbed in lethal quantities.

Aluminum phosphide is the common fumigant used while malathion, chlorpyrifos-methyl, tetrachlorvinphos, pirimiphos-methyl, diazinon and fenitrothion are used for residual sprays of facilities. The first four residual compounds are also recommended for sack and seed treatments. The insecticides used for spraying piled bag stacks are malathion, pirimiphos-methyl and permethrin (see Table 1).

Private companies such as flour mills and feed miller, seed producers and other processors that store their raw materials hire private Pest Control Operators (PCO) to fumigate their stocks and storage facilities.

INSECTICIDE EVALUATION AND RESIDUE

Various insecticides are being utilized for application to grains for food and feed and for seed in the Philippines.

Grain admixture on corn and paddy have been tested using single and combinations of insecticides as grain protectant by Sayaboc et al. (1987). This technology (grain admixture) appears to be very promising in the eradication of important storage pests specifically T. granarium as it was proven to be economically viable and workable under Philippine conditions.

Among the insecticides tested, deltamethrin was the best treatment while methacrifos was the least effective treatment in controlling Rhyzopertha dominica.

The same study revealed that combination treatments (chlorpyrifos - methyl + permethrin + piperonyl butoxide (PB); fenitrothion + fenvalerate + PB and pirimiphos-methyl + carbaryl) were better than single treatments against corn weevil, S. zeamais.

Losses incurred during storage of grains can be reduced by 60% if grain admixture using these recommended treatments are adopted.

Residue analysis of grain protectants showed that fenitrothion deteriorated faster than

the other protectants tested while fenvalerate was proven to be the most persistent (Bautista, 1987).

INSECT RESISTANCE

Research made by Sayaboc and Acda, (1986) on stored insect resistance indicated that malathion specific resistance is widespread in Tribolium castaneum (75.5%), while the remaining 24.5% of populations tested were malathion non-specific resistant in addition to being resistant to pirimiphosmethyl.

All populations of Sitophilus zeamais were still susceptible to both malathion and pirimiphosmenthyl. Eighty percent (80%) of populations of R. dominica were malathion resistant and nearly 20% were resistant to pirimiphos-methyl, but the number of populations evaluated at this stage were too low to indicate any permanent trend.

Other surveys of insecticide resistance indicated that Sitophilus spp. and R. dominica, the first insects found to acquire resistance to insecticides in the Philippines (Champ and Dyte, 1976) are resistant to DDT, lindane, carbaryl, but are usceptibie to malathion. (Moralio-Rejesus 1973b; Morallo-Rejesus and Javier, 1978d; Morallo-Rejesus and Virrey, 1978a, b).

OTHER CONTROL METHODS

Sabio et al. (1984) established that fumigation with phosphine-generating formulations in both maize and paddy, and maintenance of maximum levels of warehouse sanitation will realize potential benefits in terms of reducing losses by insect pests above the cost of implementing the control Technique. Similarly, Sayaboc et a/.(1984) have demonstrated the cost effectiveness of a pest control regimen consisting of chronic poison baiting, warehouse trapping and the maintenance of maximum levels of warehouse sanitation both internally and the immediate surroundings, which reduce losses due to rodents by as much as 87%.

Non-chemical control using CO2, a sealed enclosure technique and a residue-free method for long term storage, has been evaluated in the Philippines. The use of CO2 for control of insects was proven to be effective.

BOTANICAL MATERIALS

Botanical insecticides are being explored. Studies evaluated lagundi leaves both in whole dried leaves and powdered form against S. zeamais. The result showed that whole dried leaves checked S. zeamais population for 90 days (Bhulyah, 1988). Five percent (5%) lagundi leaf powder reduced fecundity of adult female weevils.

Javier and Morallo Rejesus (1982) evaluated ground black pepper against weevils. It was found to be as effective as malathion and residually toxic for 2 to 4 months against O.

surinamensis, R. dominca and T. castaneum.

PREDATOR AND RARASITOIDS

Several biological agents such as pseudoscorpions, parasitic wasps, predatory bugs and spiders were observed in survey studies but their potential economic importance has not been evaluated. Recently, a predatory bug (probably Xylocoris spp.) has been observed to be prevalent in paddy and milled rice (Acda et a/., 1988 Progress Report, Integrated Use of Pesticides), (Sia and Morallo-Rejesus, 1987).

CONCLUSION

High priority has been always given on the use of pesticides to disinfest produce coming from the field till it reaches the consumer. But pesticide use leads to the development of pesticide resistant pests and its indiscriminate use likewise leads to the presence of unwanted toxic residues in treated commodities.

Magnitude of losses to pests has been reduced to a certain extent. However, the government should be more committed to further reducing post harvest losses through an effective plan of action. There is a need to intensify our research in storage pests of existing commodities. This can be done through the use of natural controls, non-chemical methods and checks, and integrating these with the minimum use of chemicals

commensurate with adequate control and reasonable cost. The development of an integrated pest management system will ultimately result in greater pest control efficiency.

Table 1: NFA RECOMMENDED PESTICIDES/FUMIGANTS AND THEIR APPLICATION

OPERATION	RECOMMENDED PESTICIDE/FUMIGANTS	APPLICATION	DOSAGE %	APPLICATION
1. Protective Spraying				
Equipment Used:				
a. Motorized	Malathion 57 EC	Every 2 weeks	1	1 li/40 m
Knapsack	Actellic 25 EC	—do—	0.5	—do—
(Stihl SG-17)	Coopex 25 WP	Every 3 weeks	0.1	1 li/30 m
2. Residual Spraying				
Equipment Used:				
		Every 3		

a.Compressurized	Gardona 75 WP	months	2	2
1 li/30 m				
Power Sprayer	Every 3 months		2	4 li/20 m
(marunaka)				
b. Motorized	Coopex 25 WP	Every 3 months	0.2	1 li/30 m
Knapsack				
(Stihl Sc-17)				
3. Thermal Fogging				
Equipment Used:				
a. Fogging Machine	Malathion 95%	As necessary	2	400 ml/500 m
(Swingfog, Dynafog)	Nuvan 93% Tech.	As necessary	2	400 ml/500 m
4. Ultra low-Volume				
Non-Thermal Aerosol				
Equipment Used:				
a. ULV Aerosol	Bioresmethrin 0.2%	As necessary	0.2	150 ml/500 m

Generator (microgen,				
Leco Mini)				
5. Fumigation	Phostoxin (Exposure as	As necessary		Bagged grains:
	necessary time is 3 to 5			15-45 tablets
	days)			per 1,000 cu.ft.
				Bulk Storage:
				2-5 tablets
				per metric ton
				Space Treatment:
				15-20 tablets
				per 1,000 cu.ft.
	Dowfume MC-2 or Methyl	As necessary		Bagged Grains:
	Bromide (exposure			

	time is			1-4.5 lbs.
	2 to 3 days)			per 1,000 cu.ft.

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Pest control methods adopted for preservation of grain in Sri Lanka

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The use of pesticides for protection of grain is a common practice adopted by farmers of many countries. However, in Sri Lanka, the use of insecticides for protection of stored grain is restricted to a small farming population. Quantity of paddy stored by farmers for consumption, and as seed paddy is small, and they fear to mix insecticides with the grain meant for their consumption as they consider insecticides as highly toxic chemicals.

Cleaned, well dried paddy is stored by the farmers either in bags of in bulk, and by adopting good hygiene, the grain is kept insect free. In some cases, Margosa and Citrus leaves are kept in the 'Bins' or bags to repel the insects. Wood ash obtained from the kitchen is mixed with paddy by some farmers in addition to the use of leaves. Certain farmers resort to insecticidal sprays on the surface of bags and for that purpose the insecticide 'Actellic 50' is used. Besides the emulsifiable concentrate some farmers use BHC and actellic dust to protect bagged grain from insects.

Paddy stored in Central Warehouses of the Paddy Marketing Board is subjected to under mentioned treatments so as to minimize pest populations. Actellic 50% E.C. which contains the active ingredient, Pirimi-phosmethyl is applied ate dilution of 1: 150 as high volume sprays on the surface of bags and the entire warehouses. This treatment reduces the population of insects considerably. Spraying is done at least once in 3 weeks. In addition to spraying, warehouses are fogged with Actellic 50 EC at a dose of 120-240 nl. per 4 litres of diesel. If the insect population cannot be reduced by fogging, the grain is fumigated by using phosphine gas produced in situ by Magnesium Phosphide plates and

Aluminium phosphide tablets. Fumigation is carried out under gas proof sheets when other pest control processes fail to achieve a reasonable level of pest control. 2-3 grams of phosphine gas per ton of grain is used as the standard dose for grain.

In the case of commodities like Rice, Maize, Cowpea, Green gram and Soyabeans the stocks are fumigated within a month of storage so as to prevent any major attack by pests. The stocks are fumigated when first signs of insect attack appear, so that the the quality is preserved.

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Sri Lanka

Integrated Pest Management in Sri Lanka.

Sri Lanka is a developing country with an approximate population of around 16 million. The main food grains are sereals such as rice, maize and millet, and pulse grains such as cowpea, green grams, soya bean and black grams, and oil seeds such as ground nut.

Rice is the main food grain produce in Sri Lanka and it forms the staple diet of both rural and urban population of the country. Pulses also form an important protein source in the diets of Sri Lanka.

Sri Lanka is now on the threshold of self sufficiency in rice. Self sufficiency level is placed at around 110 kg per person per year. The deficit quantity between production and consumption is imported and made available by the Food Department.

Of the total paddy production, 50% is kept by the farmers for their own consumption, future sale and for seed purposes. The rest is sold soon after harvesting to the Paddy Marketing Board. This is the primary statutory grain marketing organization in Sri Lanka engaged in price stabilization and maintenance of food security reserves through procurement, storage processing, and distribution of a major portion of the country's paddy production. It purchases about 15% of the paddy made available for sale by farmers at the guaranteed price fixed by the Government.

Storage losses in paddy alone have been estimated to be 5% specially in countries like Sri Lanka with damp tropical climates favourable to the rapid development of agents of deterioration.

Rice, being structurally a delicate grain, has constantly posed difficulties in long time storage. Milled rice usually has a shelf-life up to one year when stored under the very best

conditions. Under usual conditions it will not keep satisfactorily for a period of over 3 - 6 months.

The Food Department is the main operational arm of the government's procurement, storage, transport and distribution of rice, wheat and wheat flour. The department handles an average about 1.4 million metric tons of food commodities per year. It is responsible for the procurement of around 675,000 metric tons of wheat per year and for the distribution of around 500,000 metric tons of milled flour. The Department procures and distributes over 200,000 metric tons of rice per year. The cost of ali this is Rs. 6 billion a year.

With the Government's abolition of the rationing and subsidy scheme and the liberalisation of the economy in 1979/80, the Food Department, which up to then had been vested with the responsibilities of managing subsidised food distribution scheme, had to operate as a commercial organization. In keeping with Government's food security strateg. The Food Department, in its new role, viz. rice and wheat flour, maintains adequate buffer stocks as well in order to be able to intervene in the market.

For purposes of food security, the Food Department is presently required to maintain the following buffer stocks of rice and wheat flour:

Rice:

A total quantity of 150,000 metric tons, which is a six weeks' consumption requirement of the Country's population, to be maintained jointly by the Food Department and the Paddy Marketing Board.

Flour:

A minimum of eight weeks' requirement, in the form of wheat flour and wheat grain - i.e. approximately 40,000 metric tons of wheat flour and 50,000 metric tons of wheat grain.

The Food Department purchases local rice only from the P.M.B. and its registered millers through the Network of stores in outstations. The Food Department, in consultation with the Ministry of Agriculture, the P.M.B. and the rice millers, formulated appropriate specifications for the procurement of local rice, taking into consideration the local methods of farming, threshing, milling, seed varieties and preference of the people.

With the commisioning of the Prima Mill in Trincomalee in October 1980, direct imports of wheat flour into the country had ceased, and the country's entire consumption requirement of wheat flour is now met by the Prima Mill. The Food Department imports and supplies the wheat grain required for milling by Prima, and wheat flour at an extraction rate of 74 percent is delivered to the Food Dept. by Prima. The Prima Mill is one of the largest and most modern flour mills in the world, and has a production capacity of around 2,000 metric tons per day. This makes it possible for the Food Department to

make available to the consumer freshly milled good quality flour at all times. Since this allows for a quicker rotation of stocks, storage of flour is no longer a problem to the Department.

Farm Level Storage.

In new settlement schemes, grains kept by farmers are stored mainly in gunny bags. However, in old settlement schemes, farmers use indigenous storage bins to store their produce. A recent study completed by the Rice Processing Research & Development Centre (RPRDC) have shown that rectangular clay bins are not suitable for outdoor onfarm storage. This is because of high grain losses caused by insects and mold damage due to wetting of the walls during rain and exposure of greater surface area of the grain bulk to the atmosphere favouring insect multiplication. Straw walled outdoor bins did not afford any barrier against diffusion of water vapour and hence the grain moisture varied with ambient relative humidity changes making the grain susceptible to mold damage during wet weather. Therefore, straw walled bins are not suitable for outdoor on-farm storage. The elliptical clay bin performed best among the indigenous outdoor bins. After 180 days of storage the Clay bin averaged 2.6% less than the losses incurred in the other indigenous outdoor storage bins. The performance of the clay bins could be improved by providing rat guards and outlets for loading and unloading operations. It was found that total dry matter loss during the storage was due to insect infestation.

The cost of the storage indoor bins was, on the average, 2.0% higher than the outdoor bins. However, certain farmers prefer indoor bins over open outdoor structures since they found better security for their grains (palipane et. al 1986).

Commercial Level storage.

Paddy at commercial levels is stored for a period ranging from 3 to 12 months. In warehouses, even though grain is stored mainly in jute gunny bags, lowcost poly-propylene bags are becoming popular in the country.

Cross stacking is the main method of stacking because this method enables easy counting of bags for checking the stock. The normal size of a stack is 9 m. x 6 m. A 1 m. clearance is always between stacks and walls.

The main insect species which attack paddy grains during storage in Sri Lanka are Rhizopertha dominica, Sitrophilus orgzae, Sitotroga cerealella and the secondary insect pest Tribolium Spp.

Major insects attacking rice are Tribolium Spp., Rhizopertha dominica, Sitophilus oryzae, Sitotroga cerealella and Cocyra cephalonica. Mites and Ephestia cautella also appear seasonally in the rice store, but they are not a major problem. Trogoderma and Oryzeaphilus surinamensis sometimes appeared in imported rice but they are controlled

before spreading further and presently, they are not seen in any of the stores.

Prevailing pest control practices.

For controlling insects in paddy and ether grains at farm level, farmers use wood ash and paddy husk ash. A study carried out by the Rice Processing Research and Development Centre has shown that paddy husk ash mixed with cowpea at levels of 4% by weight efficiently controls infestation and damage by the pulse beetle for a period of six months. Mixing of such dusts with the grains cause physical injuries to the insects, resulting in death due to deterioration of their bodies.

Another practice adopted is the use of citrus leaves and magosa which probably have insect repelling chemicals.

In commercial storage in the Paddy Marketing Board, a pest control programme is carried out where stored grains stock surfaces and buildings are sprayed with Primiphos methyl, at least once in three weeks to prevent cross infestation or reinfestation of grain. However, if an infestation sets in, the stocks are fumigated using Aluminium phosphide tablets or Magnesium phosphide plates. The extent of pest control work would vary depending on the duration of storage.

A study done by the Rice Processing Research and Development Centre to compare the

efficency and toxicity of 7 insecticides have shown that the order of effectiveness of the tested insecticides against three insect species at the end of 28 days with significant difference at 95% confidence limit were;

Sitophilus oryzae: Methacrifos = Malathion = Phoxim, Pirimiphos-methyl, Permethrin, Thiodicarb, Cypermethrin.

Rhizopertha dominica: Pirimiphos-methyl, Malation = Methacrifos, Phoxim, Permethrin Thiodicarb, Cypermethrin

Sitotraga cerealella: Phoxim, Methacrifos Pirimiphos-methyl, Permethrin, Malathion, Cypermethrin, Thiodicarb

Pirimiphos methyl, Phoxim and Methacrifos showed greater initial toxicity against the three insect species than the others.

(The effecency and toxicity of seven insecticides against major storage insect pests of paddy and rice in Sri Lanka. Fernando M.D.: Navaratne S.B. (1988) Tropical Post Harvest Technologist vol:1 No:1)

In the Food Department, bagged rice and flour received into stores are stacked according to the stack plan on disinfested dunnage racks in a cross bag system for better ventilation

during the storage. Regular inspections of the Department's store complexes are undertaken by trained personnel to check quality deterioration from insect infestation and rodents and micro-organism. As a pest control practice, fumigation is carried out by competent men using phosphine gas or methyl bromide in strict adherence to the limitaions regarding their use. In addition, fogging is the most common and sucessful spraying method which is used by the Food Department and Paddy Marketing Board in minimizing moth population in warehouses.

Strains of Rhizopertha dominica, Triboliumsp. and Sitophilus oryzae were collected from Flood Dept. stores and sent to ODNRI of U.K. to test the resistance for phosphine. None of these insects from Food Department stores survived the discriminating dose, so it may be assumed that none was resistant to phosphine. It is a result of the high technical standard of fumigation carried out by the Food Department Pest Control teams and the maintenance of a good storage practice.

With the continuous increase in paddy and other food grains it is envisaged that the problems of storage will become evermore serious with large quantities of grain to be handled and stored. Hence it is emphasised that cost effective intergrated pest control procedures are developed in the future to preserve food grains.

CURRENT RESEARCH AND DEVELOPMENT ACTIVITIES:

The Rice Processing Research and Development Centre is the main Institution engaged in research, training, extension and other development activities in post harvest technology of paddy and other food grains. An important area of activity of the Centre is the cost effective pest control practices to suit local conditions. A list of significant research publications of the Rice Processing Research and Development Centre is given in Annex 1. The projects that are presently being carried out by the Rice Processing Research and Development Centre in the area of storage are:

1. **The resistance of recently recommended rice varieties to damage by Rhizopertha dominica**
2. **Storage loss assesment study.**
3. **Identification of Insect pests of stored paddy and study of their population build-up patterns in different agroclimatic zones of Sri Lanka.**

Apart from research, the Centre trains nearly 2000 personnel engaged in medium-to large-scale storage from both public and private sector organisations.

In addition, the Centre trains approximately 4000 farmers on improved Post Harvest Technologies.

The changed role of the Food Department as a buffer stock holder and the resultant need for the maintenance of adequate stock of rice and wheat flour in storage for long periods

has made it increasingly important in recent years to improve and enhance efficiency at the various levels of store management in order to minimize losses as well as ensure proper care over the health and hygiene of the food commodities kept in storage for distribution. The Food Department Training Centre and Quality Control Unit at Narahenpita which was established in 1980 and developed under the guidance of foreign experts from FAO and the ODNRI of the U.K. Government as an essential part of the Department programme to minimize food losses in storage, was further strengthened and new units opened. In its efforts to build up atrained cadre who would be competent in all aspects of grain handling and up-keep of warehouses, the Food Department Training Centre and Quality Control Unit has since conducted several initial and refresher courses on scientific methods of stock preservation, pest control, rodent control, quality control and store management for the benifit of the Department officers as well as personnel from other organizations such as the P.M.B., CARE, and the private sector.

In the context of Sri Lanka's rice production reaching near self-sufficiency levels, and with the prospect now very near for both thee Paddy Marketing Board and the Food Department to be carrying a national buffer comprising entirely of local rice, we of the Paddy Marketing Board and the Food Department have for sometime addressed our minds to the serious problems we may encounter in the matter of procurement, milling, processing and storing. Since the moisture content in local rice is high, such local rice stocks kept in long term storage as the national security buffer, could easily become susceptible to infestation by weevils and micro organisms, resulting in heavy storage

losses.

The health and hygiene of grain and milled products thus kept in long term storage for distribution would require trained personnel possessing specialised knowledge in all aspects of store management. It is only by improving efficiency at the various levels of store management through appropriate academic and practical training that we could hope to check quality deterioration of food stocks in storage, and to minimise food losses.

We would indeed be very grateful for any FAO assistance to help overcome these problems by the introduction of scientific and more modern methods of stock preservation, as well as of more advance milling and processing techniques, and also by affording us suitable training opportunities to enable us to improve and enhance our efficiency levels in store management.

Rice processing research and development centre training course schedule January - June 1988

RPRDC PUBLICATIONS ON STORAGE

1. EVALUATION OF THE BISSA-AN INDIGENOUS STORAGE BIN. RPRDC Report 5/78, Rice Processing Research & Development Canter. Sri Lanka (1978)

2. PADDY HUSK ASH AS A PROTECTANT OF COWPEA AGAINST PULSE BEETLE. RPRDC Technical Note 11/84, Rice Processing Research & Development Centre. Sir Lanka (1984)

3. SUITABILITY OF METAL, BINS FOR INDOOR STORAGE OF PADDY. RPRDC Technical Note 12184, Rice Processing Research & Development Cenre. Sri Lanka (1984)

4. IMPROVEMENT OF FARM LEVEL STORAGE METHODS IN SRI LANKA. Proc. Grantees Seminar on Agriculture and Animal Husbandry, National Resources, Energy and Science Authority of Sri Larka (1986)

5. The Efficacy and toxicity of several insecticides against major insect pests of stored paddy and rice in sri lanka. (To be published in RPRDC Journal)

Activities of the post harvest technology working group on insect pest management research in grain storage in chiang mai university northern Thailand

BACKGROUND

Thailand is a constitutional monarchy encompassing an area of 513,520 square kilometers

and located on the Indo Chinese Peninsula of Southeast Asia. Geographically it is divided into four regions: the southern peninsula, the central plains, the northeast and the north. The climate is tropical, with three distinct reasons: rainy (June-October), cool (November-February) and hot (March-May).

Northern Thailand is composed of 17 provinces divided into two parts: Upper North (9 provinces) with area approximately 10.51 million hectares and Lower North (8 provinces) with 6.72 million hectares. Three types of land are classified in the Upper North; highland (60%7, upland (30%) and lowland (10%).

The Chiang Mai Valley covers an area of 150,000 hectares (ha) situated approximately 700 kilometers from Bangkok at an elevation of 300 meters above sea level. It is the most intensively cropped area in the Upper North. Different cropping systems are utilized with either: one, two or three crops per year but two is the most common. The systems are specific to a particular location or combination of topographic, soil, water supply and socio-economic factors. The twocrops per year pattern is confined to irrigated area in the Valley, the sequence most commonly used being rice-tobacco, rice-garlic, rice-soybean, rice-peanut, rice-mungbean, rice-vegetable and etc. Monocropping such as rice, maize, soybean and etc. is confined to rainfed areas. Triple cropping includes planting sequences of rice-vegetable-vegetable, rice-soybeanvegetable, soybean-garlic-vegetable and etc.

Post harvest grain losses have assumed increasing importance in recent years in Thailand.

There is an awareness amongst both policy makers and technicians that reducting post harvest losses could lead to the achievement of food security ensuring adequate food supples for the increasing population of national level. The Thai government realized the importance of these losses when it ranked as high priority the needs of post harvest technology in the Sixth Five Year Plan (1987-1991). In response to this policy, the Faculty of Agriculture, Chiang Mai University has formed a Post Harvest Technology Working Group since 1984. The Working Group is composed of staff members from various Departments within the Faculty, with staff from other Faculties when considered appropriate. The 18 members of the group are from Agricultural Engineering, Agronomy, Entomology, Pathology, Food Science and Technology, Horticulture, Animal Husbandry, Economics and Agric. Extension. The Group was formed for research, curriculum development and counselling in Post Harvest Technology in the Faculty of Agriculture. Curriculum development from the M.S. Degree and research in post harvest technology is progressing.

The farmers in the north are similar to those of other parts of the country., They normally sell 70-80% of their grains immediately after harvest and some are sold before or during harvest. The rest of the grain is stored mainly for consumption and seed purposes. The amount is usually less than one ton and storage periods up to six months until the next harvest are common. They do nothing to protect their grains from insect damage compared with intensive pest management done in the field. The grains are commonly stored in commercial warehouses of silos for a short period of time before transporting to the market in Bangkok, and exported. Because of lack of understanding or knowledge on

methods of pest control and proper commodity management strategies, problems associated with pests such as damage and loss have been increasing significantly in recent years. Entomologists in the Post Harvest Technology Working Group, Faculty of Agriculture, Chiang Mai University realized this importance and commenced experiments on stored insect pests in recent years with emphasis on Integrated Pest Management (IPM).

PROBLEMS OF STORED PRODUCT INSECTS

Among the various stored insect pests, those most commonly encountered and considered as being most important in term of losses and damage to stored grains in N. Thailand are as follows:

1. **Rice weevil, Sitophilus oryzae (rice)**
2. **Maize weevil, Sitophilus zeamais (rice, maize)**
3. **Lesser grain borer, Rhyzopertha dominica (rice, wheat)**
4. **Cowpea weevil, Callosobruchus chinensis (pulses)**
5. **Southern cowpea weevil, Callosobruchus maculatus (pulses)**
6. **Cigarette beetle, Lasioderma serricorne (tobacco)**
7. **Sawtoothed grain beetle. Oryzaephilus surinamensis (rice, wheat)**

8. **Red flour beetle, Tribolium castaneum (rice, wheat)**
9. **Confused flour beetle, Tribolium confusum (rice, wheat)**
10. **Angounmois grain moth, Sitotroga cerealella (rice, wheat, barley)**
11. **Rice moth, Cocyra cephalonica (rice)**
12. **Tropical warehouse moth, Ephestia cautella (pulses)**

RESEARCH ACTIVITIES

Entomologists in the Post Harvest working Group has commenced research experiments on stored insect pests which consider both pre and post- harvest handling because it will influence subsequent quality deterioration and insect damage after harvest. At present, some of the experiments being implemented are as follows:

1. Harvesting time affecting species and numbers of stored grain insects in wheat.

2. Identification of insect pests associated with stored wheat.

3. Life table studies of Sitophilus spp.

4. Wheat losses caused by Sitophilus spp. in laboratory trials.

5. Type of containers and their affect on Sitophilus spp. infestation.

6. Varietal susceptability/tolerance to Sitophi /us spp. infestation in wheat.

7. Chemical control of Sitophilus spp. on wheat.

7.1 Admixture

7.2 Dipping of jute sacks

8. Observation of non-chemical control of Sitophilus spp

9. Observation of natural enemies of Sitophilus spp. on wheat.

10. Harvesting time affecting stored soybean insect infestation.

RESEARCH NEEDS

It is envisaged that efforts to reduce losses in stored grain will continue to depend on the use of Integrated Pest Management. Research should consider as an immediate priority, pesticide usage which is a fast and reliable means of pest control, but it must be employed

within an established IPM framework. A long term research need should encompass other components of IPM such as biological, physical and mechanical control. Economic important commodities will be mainly rice, maize, soyben, mungbean, peanut and wheat. The research needs for insect pests of these commodities are as follows:

A. Biology and Ecology

- **Identify insect species associated with the commodity**
- **Biological and Ecological Studies**
- **Estimate of losses in various types of storage**

B. Physical Control

- **Drying technology affecting insect survival**

C. Non-chemical Control

- **Plant materials, dusts, and type of containers to be utilized in small scale storage at farmer level**
- **Carbon dioxide application**

D. Cultural Control

- **Evaluation of reachion of various locally grown varieties to major insect pest damage**

E. Chemical Control

- **Screening for suitable chemicals and identification of appropriate techniques of application to bulk storage and bagged stacks**
- **Fumigation techniques for small scale storage**

Table 1. Production of Principal crops grown in Northern Thailand (1983/1984)

Commodity	**Production**		**% Production from the North**
	Country (t)	**North (t)**	
Rice	19,047.000	5,068,000	26.60%
Maize	3,552,000	1,745,000	49.12%
Mungbean	288,337	233,381	80.94%
Soybean	179,126	154,101	86.02%
Peanut	146,550	96,067	65.55%

Source: Center for Agricultural Statistics Office of Agricultural Economics, Ministry of

Agriculture and Cooperatives. Agricultural Statistics No. 213 1983/1984

Survey of stored insect in rice field before harvest

KUSUMA NUALVATNA

ABSTRACT

Survey of stored insect in rice field before harvest was conducted at 2 rice experiment stations for 2 year study. The result of the first year showed that Sitotroga cerealella Olivier was the only insect species found. The number of eggs laid on the panicle were not examined but the adult emerged from the panicle keeping for 30 days after picking was examined and it was 1.16 and 6.9 insects per 10 panicles in RD 7 and Hom Om respectively. In the second year, the result confirmed that S. cerealella Olivier was the only insect found and laying eggs in the field. The number of adult insects found by sweeping had an average of 2.7, 0.9, 1.18 and 2.4 insects per 50 x 50 metre per day in RD 7, RD 15, Kao Dok Mali 105 and Hom Om respectively. The number of adult emerged from the panicles was 3.6, 3, 2.7 and 4.8 per 10 panicles in RD 7, RD 15, Kao Dok Mali 105 and Hom Om respectively.

The need to know whether stored insects lay the eggs in rice field before harvest or not is quite necessary. Since this may cause a serious insect infestation in the storage bin after some time. It is already known that some stored insects lay the in eggs in the field before harvesting time. But does it need any protection before harvest is a problem. If this condition occurs it is possible that protection of agricultural produce may commence in the field before harvest. This may be appropiate of some crops in some countries but in general, it is practice should be discouraged. This is because protection of insect infestation by farmers in Thailand is still dependent on insecticides in the field and if more were to be applied it will add more toxic substances to man and environment unnecessarily. Therefore, this experiment was conducted so as to know the kinds of insect present in the field before harvest and whether the es,gs were laid in the field in large enough number that serious insect infestation would occur in the storage bin there-after.

The insects to be searched for were Sitotroga cerealella Olivier which is the most important insect pest of paddy during storage, Rhyzopertha dominica Hbst. and Sitophilus species.

Materials and Methods

The research was conducted at 2 rice experiment stations in the first year and 1 in the second year during November to December 1982 and 1983. In the first year, 5 rice varieties from Bangkhen and Chainat experiment stations were tested and in the second year 4

varieties were tested at Chainat. The experiment consisted of rice plot of 50 x 50 metre and each plot contained only one rice variety. The plot was divided into 4 parts in which 10 panicles were randomly picking everyday for 15 days before harvesting time of each variety. After picking, the panicles were put in the paper bag and were dried in the room at ordinary temperature for 2 - 3 days because some panicles were still wet and might cause a fungul growth. Then the panicles were put in the glass jar and cover with muslin cloth. Examination of first adult appeared in the jar was recorded until 30 days after each picking. During picking the panicles, the adult insects were also collected by sweeping net to see the kinds and number of insects present in the field.

Results and Discussion

Result of the first year and second year were as followed.

First year

The result showed that Sitotroga cerealella Olivier was the only insect found in the field. But whether it had laid the eggs in the field was still indoubt. This was because the panicles were dried in the room near to the room where the insects had already infested. So, it was possible that insect might lay the eggs during this time. Therefore, the data showed the number of adult S. cerealella emerged from the jar was more in some variety such as Hom Om and RD 7 (see Tabel I). It should be noted that the nearer the harvesting

time the more the number of insects emerge from the jar. As it could be seen in Table I in which the data was from Chainat showed that adult S. cerealella laid the eggs in every rice variety. In sweeping, S. cerealella adult was found in every variety. (See Table II). At Bangkhen very few insects were found and the data is not shown here.

Table I - Data showed average number of Sitotroga cerealella emerged from the jar after 30 days of picking panicles at Chainat and Bangkhen during November to December 1982

Table II - Data showed the number of S. cerealella found by sweeping in different rice variety 50 x 50 m rice plot at Chainat during November to December 1982

Sampling day	RD1 Morning	Afternoon	RD5 Morning	Afternoon	Hom Om Morning	Afternoon
15	-	-	-	-	0	0
14	-	-	-	-	0	0
13	-	-	-	-	2	2
12	-	-	-	-	1	0
11	-	-	-	-	1	2
10	-	-	-	-	2	1
9	-	-	-	-	1	0

8	0	1	-	-	0	0
7	2	1	-	-	1	-
6	1	1	-	-	0	0
5	1	0	-	-	1	0
4	1	1	0	1	1	0
3	2	1	2	3	1	0
2	0	1	1	4	2	1
1	1	0	2	3	2	1

- = No panicle picking

The average number of s. cerealella adult per day which was obtained from the number of adult insects emerged from the jar after keeping for 30 days was very high in Hom Om being 6.8 insects per day at Chainat while other varietes were much less. At Bangkhen, the adult insect emerged was very few and it was 0.14 in RD7, none in Neo San Pa Tong, 0.06 in RD21 none in Kao Dok Mali 105. See table III.

Table III - Data showed average number of adult S. cerealella emerged from jar of each rice variety per day at Chainat and Bangkhen during November to December 1982

	Avg. no of S. cerealella per day	
Rice variety	**Chainat**	**Bangkhen**
RD1	1.18	-
RD11	0.29	-
RD7	1.16	0.14
Hom Om	6.68	
RD5	1.65	-
RD15	-	-
NSPT	-	0
RD21	-	0.06
KDML	-	0

NSPT = Neo San Pa tong
KDML = Kao Dok Mali 105

Second year

Only S. Cerealella was found by sweeping. No other insect such as Sitophilus oryzae Linn. or other Sitophilus species found at all. The adult moth laid the eggs in the field but the

number of the adult insect emerged were so small as compared to the number of seed keeping in the jar. As it could be when that the number of insects emerged from the glass jar were 3.6 insects in RD7, 3 in RD15, 2.7 in Kao Dok Mali 105 and 4.8 in Hom Om per 10 panicles per day. The number of insect caught by sweeping averaged per day per 50 x 50 metre was 2.7, 0.9, 1.18 and 2.4 in RD7, RD15, Kao Kok Mali 105 and Hom Om respectively. See table IV.

From the result of year 2 study it can be concluded that Sitotroga cerealella was the only insect species found and it laid the eggs in the rice field before harvest. But the eggs emerged into adults in very small numbers, and they should not cause serious insect infestation when harvest and stored in the storage bin. Therefore, it is concluded from this study that any insecticidal treatments prior to harvest would not be warranted, and that subsequent drying storage management and treatment, if necessary, in the storage system would prove more cost-effective.

Table IV - Data showed average number of S. cerealella obtained by sweeping and from panicles after keeping for 30 days in 4 rice variety at Chainat during November to December 1983

Rice variety	Avg. no of insect per day	
	from sweeping	from panicles

RD7	2.7	3.6
RD15	0.9	3.0
Kao Dok Mali 105	1.18	2.7
Hom Om	2.4	4.8

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Kusuma, N.1978. Life history of Sitotroga cerealella (Olivier). Annual Report of Entomol. and Zool. Div., Dept. of Agri. Bangkok. 177-179.

Present situation and experience in the socialist republic of Vietnam on pest management

Prepared by Eng. VU QUOC TRUNG

I - Foodgrain Production

Vietnam is one of the agricultural countries in South East Asia. It has a population of about 62 million. About 20% of the land is cultivated and arable (6 million hectare).

For Vietnam, rice and rice products are the major food grain. About 80% of the arable land is utilized for rice cultivation.

The Vietnamese farmers are very industrious and the applications of modern technical and scientific progress in agriculture has always been increasing in recent years, due to these technological improvements.

II - Foodgrain Storage

In the surplus areas about 75-80% of foodgrain production is stored at the farm level. The government handles about 4 million tons of foodgrain, mainly rice and maize.

At the farmers' level the foodgrain is stored in different shapes and sizes of jars, make-shift baskets or wooden boxes.

In cooperatives foodgrain storage is carried out in ventilated brick stores with 20-30 ton capacity.

State-run stores are considered more suitable domed-roof stores are considered the best in Vietnam, then Al stores are also common.

Foodgrain after drying are ventilated, subjected to quality control, and put into stores.

In north Vietnam 100% of the foodgrain is stored in bulk, where as in the south it is stored in bags.

The duration of storage is about 6 months.

"Place prevention first and pay due attention to both prevention and cure" is the policy for foodgrain storage in Vietnam. Comprehensive methods are being used to make stored food grain safe through hygienic control, maintenance of the physical machinery and application of suitable chemical treatments.

Foodgrain delivered to the State by the farmer should be dry and clean. National standards for quality for all staple foodgrain in different areas have been set up.

For many years Vietnam has adopted the practice of keeping "four-free foodgrain stores", i.e. stores should be free from insects, molds, birds and rodents. This has brought about effective results of foodgrain storage.

	Production of Foodgrain in million ton

Year	Rice	Maize	Root and other cereals	Total
1985	14.7	0.5	1.8	17.4
1986	15.9	0.6	1.9	18.4
1987	16.0	0.7	1.9	18.4
1988	16.2	0.8	2.0	19.0
1989	17.0	0.9	2.1	20.0
1990	18.0	1.0	2.0	21.0

With conventional methods of storage annual losses of foodgrain constitute 8-10% of the total production.

III Pest Management

The climate in Vietnam is tropical and humid. The average temperature of the year is more than 20C, the relative humidity (RH) is 80%, thus providing ideal environments for the development and subsequent damage by pests.

The Hanoi Institute of Post-harvest Technology has shown that in VN nearly 50 species of

pests are in stores. The following are the most abundant 15 species:

Alphitobius piceus O
Araecerus fasciculatus D Sitophilus zeamais L
Carpophilus dimidiatus F
Lacmophloeus pusillus K Lophocaters pusillus K
Oryzaephilus surinamensis L Rhizopertha dominica F
Sitophilus oryzae L
Tenebroides mauritanicus L
Tribolium castaneum H
Tenebrio molitor L
Aglossa dimidiata H
Corcyra cephalonica S
Polodia interpunctella H
Sitotroga cerealella H

Two insect species: Sitophilus granarius and Tribolium confusum are prohibited to be imported into Vietnam.

Investigations have pointd out that in VN 26 species of rodents are available in foodgrain stores and the most common ones are Rattus flavipectrs (chuot dan) Mus musculus (chuot nhat), Rattus norvegicus (chuut cong).

Scientific and technical progress has been made in pest management. However, the most economical and important measure has been storage hygiene. All foodgrain stores should be carefully cleaned, and sprayed with insecticide. malathion, dipterex and DDVP are very popular in VN. Home-made insecticides extracted from poison containing plants is also used effectively. These plants are:

- **Elliptica Benth**
- **Quisqualic indica L**
- **Nerium oleander L**
- **Nicotiana tabacum L**
- **Nicotiana rusrica L**
- **Melia azeadrch L**

Kaolin powder (a mixture of Kaolin soil and acid sulfuric) is very effective and suitable under present conditions for the prevention of insects during a period of 6-12 months.

When the density of insects is high fumigation is applied. Aluminum phosphide, the most common fumkgatant chemical in VN, can now be manufactured locally. To enhance its toxic effect stores are kept closed for 96 hours after fumigation, and more CO_2 added.

For rodent control bait pies made from Warfarin mixed with tasty food is widely used together with other traditional methods

We are now making furthur research into and applying up-to-date technological achievements to foodgrain storage and pest management, with a view to reducing 50% of present losses, i.e. 45% of total production. This is of great significance, as it helps increase social products, develop the economy and improve people's living-standards.

Finally, I would like to express my sincere thanks to the host country and RAS/86/189 project for giving me this opportunity. Thank you for your attention.

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Section 13 - Training programme synopsis

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strategies in grain storage june 6-18, 1988

Keynote address by the FAO representative in the Philippines on the opening ceremony of the international training course on training of trainors in integrated pest management strategies in grain storage Naphire, Munoz, Nueva Ecija 6 june 1988

Administrator Emil L. Ong of the National Food Authority, Executive Director, Francisco L. Tua of NAPHIRE, Deputy Executive Director, Jose B. Santos of NAPHIRE, Mr. R. Semple of RAS/861189, Participants, Distinguished Guests, Ladies and Gentlemen.

On behalf of the Food and Agriculture Organization of the United Nations, it is a great honour to deliver the keynote address to this Training Course organized by the National Post-Harvest Institute for Research and Extension (NAPHIRE) and RAS/86/189.

I would like to thank NAPHIRE for co-sponsoring this Course, particularly Mr Tua. We at FAO, are indeed very happy that NAPHIRE has agreed to cosponsor this Training Course, which is an example of TCDC at work, or Technical Cooperation Among Developing Countries. As you are fully aware, FAO supports and encourages such kind of activities,

which will lead towards the mutual advantages of the participating countries. The holding of this Training Course is very timely cosidering that most of the developing countries are in the midst of intensified food production programme, not only in grains but also in other food commodities, as well.

As we all know, the advent of the "green revolution" in the early '70's had ushered a major breakthrough in the production of foodgrains, particularly rice in the Asian region. However, this had also created various problems on the part of beneficiaries, particularly the small farmers, which required concerted efforts to solve, on the part of the governments and the private sector.

A tremendous amount of the incremental production is being lost due to poor post-harvest handling and processing. Most developing countries were caught offguard and very few of them have the necessary infrastructure facilities to minimize post-harvest losses, particularly on the aspects of storage. This was compounded by the losses due to various pests which most farmers are taking for granted. However, if we have to value these losses, these would amount to millions of dollars, as I understand that post-harvest losses could range from 10% up to 37%, from harvesting to milling. I do not want to touch on the more technical aspects of post-harvest handling, particularly on Integrated Pest Management, as I was informed that you will be given a very comprehensive programme, both on the theoretical, as well as on the practical aspects of IPM during your 12-day stay in this Institution.

Due to the enormity of the problems, FAO was prompted in 1977 to launch its Prevention of Food Losses Programme or PFL for short. The basic purpose of this programme is to catalyse awareness of the importance of food loss prevention and to assist developing countries in their efforts to identify the food losses which ocur throughout the post-harvest system and to implement national food loss reduction projects.

The main activities of PFL projects are:

a. **Food Loss Assessment Surveys: The surveys form the basis of action to combat losses. Methodologies of the assessment of grain losses have been developed under the Programme. Pilot surveys are often adequate, provided that data on socioeconomic conditions are collected from farmers and properly interpreted.**
b. **Actual Food Loss Prevention Measures: Once the source of major loss is identified, action is taken to redress the situation. Such action may involve improving drying, reaping, winnowing, threshing, farm, village or community level storage, processing, pest control, handling, transportation and marketing methods.**
c. **Training: There is a widespread shortage of trained manpower in post-harvest loss prevention at all levels and training is a major component of the Programme. Training may be in-service, incountry or external and involves various appropriate institutions up to University and specialized institutions.**
d. **Research, Development and Exchange of Information: Emphasis is placed on strengthening existing institutes and the exchange of information at all levels to**

support training.

e. **National Focal Point for Food Loss Reduction Activities: A central coordinating unit or focal point at the national level is always necessary. The Programme endeavours to assist governments in establishing or strengthening such focal points.**

In the case of the Philippines, several projects were implemented by FAO, such as:

1. **PFL/PHI/001 - Establishment of Pilot Parboiling Plant**
2. **PFL/PHI/002 - Provision of Processing and Storage Facilities for Strengthening Small Farmer Development in Order to Minimize Food Losses**
3. **GCP/PHI/036/NET- Introduction of Improved Grain Grading Systems for the Development of Workable Standards and Grade**
4. **GCP/PHI/038/lTA - Development of Commercial Parboiling.**

These projects, to some extent, had assisted the Philippine Government in its efforts to minimize postharvest losses.

FAO for its part will continue to assist member countries, in particular, the Least Developed Countries (LDCs), Most Seriously Affected Countries (MSA) and Food Priority Countries (FPC) to initiate and strengthen national food loss reduction programmes with the view to increase food availability, safeguard food quality and thereby improve the living standards of rural people.

However, the implementation of much bigger and long-term projects and programmes should be the primary concern of member governments.

Although lately, there has been much emphasis given by governments in the prevention of food losses, the progress in most developing countries in general has been unfortunately sluggish. There is still a lot which remains to be done as most of the small farmers lack the expertise and the needed investment requirement even for the most basic post-harvest facilities. If your respective governments could only reduce post-harvest losses by one-half, that would mean an increase in production of about 18%.

With regard to your Training Course, I should say that you are fortunate enough to be given the opportunity to be trained in this Institution. It has the best facilities in post-harvest operation, in addition to its qualified staff.

NAPHIRE, I was informed, is the first of its kind in Southeast Asia to specialize on post-harvest research and development work. Its present activities which cover food and feed protection, post-harvest facilities design and development and post-harvest systems analysis are all geared in support of the food industry development in the country. I was also informed of research breakthroughs in the prevention of aflatoxins contamination, insect pests control, and the Khapra Beetle, which I understand is the most dreaded pest in grain storage. In addition, it has developed improved post-harvest equipments which are appropriate and economical for small-scale operation. These, I'm sure, would benefit

your respective countries. There are many lessons to be learned and numerous problems to solve, but make the most of your presence here, and profit from each others experiences.

I should only request, that after the completion of your training programme here, for you to initiate a more expanded programme on the prevention of postharvest losses not only for rice but for other agricultural commodities, as well.

FAO particularly, would also be happy to see when you return to your country to please share with your colleagues, the knowledge and expertise that you will acquire in this Institution. I am quite certain that the dissemination of this additional knowledge will accelerate the prevention of food losses in your respective countries.

However, you must always bear in mind that there is no standard method that suits all the needs of the various countries that are represented here. The programme that you should implement must always consider the needs and requirements of the small farmers and must be applicable to the local conditions.

I am confident that this Training Course will adequately prepare you for these challenges. I could say this because your programme, whichk will deal both on the theoretical as well as practical aspects, was planned jointly by post-harvest specialists from FAO, NAPHIRE, and NFA. You will also have the full support and guidance of an experienced training staff

from the academe as well as from post-harvest related agencies.

Let me end by wishing you all a pleasent stay in this Institution and a most productive training course.

Thank you and Good Day!

International training course on training of trainors in integrated pest management strategies in grain storage june 6-18, 1988

I. Background

One of the most serious problems besetting the safe storage of grains particularly in the humid tropics is pest infestation. While there are many technologies on storage pest control, their adoption so far has been very much lagging behind due to limited trained manpower and lack of extension programs on these mature technologies. Therefore, there is a critical need to strengthen the training capabilities of institutions involved in postharvest operations particularly stored products pest management.

The Food and Agriculture Organization of the United Nations through the Regional

Network on Postharvest Technology and Quality Control of Foodgrains (REGNET), in its bid to enhance technology transfer in postharvest has conceived a training course in Integrated Pest Management. The REGNET is composed of 13 Network Member Countries (NMC's) which include Bangladesh, Burma, Peoples Republic of China, Republic of Korea, India, Indonesia, Malaysia, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand and Vietnam. REGNET aims to establish Inter-Country Cooperation on grains postharvest technology in the Asian region through consolidating institutional linkages in each of the NMC's. The REGNET is geared towards the improvement of the postharvest systems, thus enhancing food security in the region, through promoting a permanent dialogue and the exchange of information, expertise and technology.

The course is designed for trainors involved in pest control programmes and agricultural extension services related to pest control practices on stored grains.

II. Objectives

The training course is envisaged to strengthen the training capabilities of the NMC's and to enhance the transfer of existing technologies in IPM among national institutions in the region.

Learning Objectives.

The participants should be able to:

1. Understand the state of the grain postharvest industry in Asia, specifically the grain storage pest situation in the context of the technical, socioeconomic and cultural conditions in the region, the researches undertaken, relevant results and technologies generated.

2. Know the physico-chemical properties of grain as these relate to stored grain pest management; process of grain deterioration, dry matter loss and grain fissuring.

3. Acquire knowledge and skills on the management and control of pests in storage.

4. Familiarize themselves on the critical role of storage methods and systems as these relate to grain pest infestation and control.

5. Know the concepts, principles and practices of postharvest technology extension with emphasis on training design, planning and implementation, and skills teaching.

III. Methodology

The course was focused on a systems viewpoint addressing the major components of Integrated Pest Management. As such the training course was designed to incorporate five working modules namely; state-of-the-art of the Asian grain postharvest industry, grain

properties, pest infestation in storage, storage methods and systems and training and extension. These components were integrated into a wide range of training methodologies such as lectures, open forum, laboratories and field simulation exercises and country reports. It utilized small and big group sessions and buzz sessions whenever needed. A training facilitator was in charge to oversee the overall direction of the course. An inhouse bulletin called the IPM Communique was produced by the Training Management to account and monitor highlights of the training course.

The course was organized by the Training and Extension Department of NAPHIRE in cooperation with REGNET Regional Coordinator Robert L. Semple. It was conducted at the National Postharvest Institute for Research and Extension in Munoz, Nueva Ecija, Philippines on June 6-18, 1988.

IV. Profile of Course Participants

The participants to the course were categorized into official participants and observers.

Participants included pest control officials operating or managing pest and quality control at either government or cooperative level storage, or extension workers involved in agricultural extension services related to pest control practices. There were 12 participants and 17 observers to the course.

One hundred percent (12) of the official participants came from government institutions. Fifty eight percent (7) are pest and quality control officers while 25 percent (3) are research and extension workers. Seventeen percent (2) belong to top management of government institutions. Forty two percent (5) have Bachelor of Science courses while the other 42 percent (5) have finished their Master of Science courses.

For the observers, 61 percent (10) work in government agencies like the National Food Authority and Department of Agriculture. Thirty three percent (6) are pest and quality control officers while sixty seven percent (13) are extension workers, researhers and instructors. Eighty-two percent (14) finished their B.S. while 30 percent 18 percent finished their M.S. Seventy five percent (13) have major in plant protection, agriculture and chemistry.

V. Resource Persons Profile

Fifty nine percent or (13) of the speakers came from the University of the Philippines at Los Banos, the National Food Authority, the Central Luzon State University, IDRC/SEARCA while 41 percent were inhouse speakers. Forty three percent of (9) of the speakers are Ph.D. holders while 24 percent have finished M.S. Fifty five percent of the Ph.D. holders major in Pathology and Entomology while the rest in allied disciplines.

Assessment of the general evaluation of the training course revealed that the strongest

point of the course was the pool of competent and credible interdisciplinary lecturers.

V. Administrative Details

A. Accommodation and Registration

1. The foreign participants were first billeted at the Metropolitan Apartelle in Quezon City. They were transported to Munoz, Nueva Ecija after the brief tour around Metro Manila. The participants were then billeted at the guest house and in of the Central Luzon State University and afterwards were transferred to the executive suites of the NAPHIRE Training Dormitory where they stayed throughout the entire duration of the course. The other participants were accommodated in the Training Dormitory.

2. A package of training materials which include a bag, pad papers training brochure, pamphlets, l-shirt and posters were provided to the participants (observers included)

B. Meals and Snacks

1. Meals were served at the Executive lounge, while snacks were served at the Session hall.

2. The participants were asked about their food preferences, which served as guide for the caterer for food preparation.

3. Participants were encouraged to see the food caterer if they have complaints or special food arrangements.

C. Laundry Services

1. Cost of laundry sevices were charged against the individual participants. Laundry services were coordinated by the dormitory matron.

D. Transportation Services

Transport services were provided by the Institute throughout the duration of the training course. Stand by vehicles were provided to respond to the immediate needs of the participants.

Evaluation Procedure

A. Benchmark Evaluation

To have a logical basis for measuring the possible learning of the participants, a benchmark evaluation was made to test the participants initial knowledge on the subject

matter and its degree of relevance to their work.

Before the training course, the participant's average perceived level of knowledge as revealed by the pre-test is 66.36 percent. On the other hand, 60 percent of the participants were slightly aware of the objectives of the training program thus slightly aware of the relevance of the training course to their work.

Another activity that was done to lay down the grounds for better mechanics of the training course was the expectation surfacing. The expectations of the participants vary from general to specific, these are the following:

1. **Increase in knowledge in modern pest management strategies and new developments in storage IPM**
2. **Improved skills in handling pest control activities in storage**
3. **Increase in knowledge on extension of pest management technologies and training of personnel in storage management.**
4. **Practical application of theories on IPM**
5. **General knowledge on biological control measures.**

B. Post-training Evaluation

After the training course, its effectiveness was evaluated vis-a-vis the learning objectives

and was determined in terms of measuring knowledge gained, participants performance and participation, relevance to work and resource speaker's competence.

Knowledge gained

The level of knowledge after the training increased from 67 percent to 84 percent, while new knowledge gained was quantified at 78 percent.

Participants performance

The achievement of the participants was measured through a written essay type of examination covering the topics discussed in the course.

Based on the result of the examination, the average (mean) score was 78 (which could be taken as the passing score). The number of participants who attained grade above the passing score was 56 percent. Two participants got perfect scores. While the rest got scores below the mean score.

Sixty four percent scores above the mean average score of 84 percent during the post-test.

Participant's participation

Seventy two percent of the participants rated their relationship with other participants

very satisfactory while 74 percent has very satisfactory relationship with the training management staff. One hundred percent of the participants rated very satisfactory the relationship with the resource speakers.

Resource Speakers Competence

Eighty six percent of the participants rated the resource speaker's competence to be from very good to excellent.

Fifty percent rated the subject knowledge of the resource speakers excellent while 41 percent agreed that the speakers have very good subject knowledge. Eighty seven percent graded the resource speakers presentation to range from very good to excellent.

Expectations met

Ninety two percent of the participants noted that their expectations from the training course were well met. On the other hand, 90 percent said that in general the objectives of the training were met and 88 percent rated that the objectives were fully met.

Relevance to work

Seventy eight percent of the participants said that the knowledge and skills gained in the training are very useful to them and in their work. Fifty percent of the participants noted

that socioeconomic aspects of IPM should be given more emphasis. Generally the participants underscored the importance of more practical and laboratory activities like simulation exercises and field trips to village and farm level storage.

Hand outs

Ninety-four percent agreed that the hand-outs help them much in the acquisition of knowledge from the different topics.

Fifty eight percent prefered the hand-outs to be in manual form while 70 percent want the hand-outs distributed either before or after the lecture.

Course Administration

The course administration was generally rated very good. Sixty percent rated the accommodations to be from very good to excellent. Eighty four percent rated the training facilities to be from very good to excellent while 92 percent rated the training management was from very good to excellent.

IV. LIST OF PARTICIPANTS

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1. Francisco L. Tua Executive Director

2. Jose B. Santos Deputy Executive Director

3. Engr. Billy T. Belonio Research Assistant, Systems Analysis & Dev't. Dept.

4. Engr. Nicasio M. Quindoza Research Assistant, Facilities Processes Design and Development Department

5. Engr. Ruben E. Manalabe Manager, Facilities/Processes Design & Devt. Dept.

6. Ms. Miriam A. Acda Research Assistant, Food Protection Dept.

7. Mr. Rolando L. Tiongson Research Associate, Food Protection Dept.

8. Mr. Josue S. Falla Senior Training Officer, Training & Extension Dept.

9. Engr. Rodolfo P. Estigoy Technical Writer, Training and Extension Dept.

B. Guest Faculty

1. Dr. Romeo Rejesus (Ph.D. In Entomology) Entomologist, Department of Entomology UPLB, College, Laguna Philippines

2. Dr. Melanda Hoque (Ph.D. In Entomology) Research Scientist, National Crop Protection Centre UPLB, College, Laguna Philippines

3. Prof. Leo Rimando (M.S. in Acarology) Professor, Department of Entomology UPLB, College, Laguna Philippines

4. Dr. Adelaida Quiniones (Ph.D. in Entomology) Director for Training, Research & Extension Central Luzon State University Munoz, Nueva Ecija Philippines

5. Dr. Rosalinda C. Garcia (Ph.D. in Postharvest Pathology) Researcher and Affiliate Professor National Crop Protection Centre & Institute of Biological Sciences UPLB, College, Laguna Philippines

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12. Ms. Rebecca Sampang (B.S. in Chemistry) Division Chief, Technology Resources Development Directorate National Food Authority quezon City, Philippines

13. Ms. Wenifreda C. Fajardo (B.S. in Chemistry) Section Chief, Bio-Physical & Culinary Testing Laboratory Technical Services Directorate National Food Authority Quezon City, Philippines

Recommendations

This report also lists the summary of recommendations made by the participants, among them:

1. **Socio-economic component must be an integral part of Integrated Pest Management research in storage.**
2. **Development of improved direct extension methods and strategies and communication media, for effective and efficient technology transfer in the region.**
3. **Regional training program on development of postharvest manpower should be in a continuing process. The leading countries that have well established infrastructure and manpower should be responsible for conducting the training program.**
4. **Postharvest extension specifically on IPM is basically poor in many of the developing countries. Program to develop the postharvest extension and technology transfer strategies should be made and a workshop in postharvest extension should be arranged.**
5. **Women's participation on postharvest activities has been well recognized, however there are no trained women extension workers, due attention should be given to this area.**
6. **The need to explore the use of natural controls, non-chemical methods and checks, and integrating these with the minimum use of chemicals vis-a-vis cost and socio-economic parameters.**

7. **Researchers on insect infestation during storage should be intensified.**
8. **Systems approach to IPM Research and Development.**
9. **Education of trainors in IPM through scholarship grants and study tours.**
10. **Integration of regional research findings and exchange of information for easy retrieval and efficient technology packaging and dissemination.**
11. **Awareness of policymakers on the problems of the postharvest industry.**
12. **Institutionalization of IPM, including the creation of a regional network for research, training and extension.**
13. **Integration of IPM courses in the curricula of agricultural colleges and universities.**
14. **Impact evaluation in all aspects of IPM training and extension should be done.**
15. **Provision of manuals and codes of practice for more efficient application of grain protectants and fumigants.**
16. **Harmonization of insecticide regulations/ acts in each of NMC on a regional basis.**
17. **Conduct of toxicological or residue analysis on regional basis using recognized procedures so results are accepted by international regulatory authority (i.e. CODEX). Results should be published in recognized abstracted journals for greater effectiveness.**
18. **Regional evaluation of botanical extracts and their suitability in grain storage systems in Asia (i.e. onfarm, cooperative or rural village level).**
19. **Cost effectiveness of a range of pest control strategy to enhance their adoption.**
20. **Implementation of incentives for grain quality grains through regional recognized**

grades and standards.

21. Introduction of a system of grain transfer from farm to procurement state as quickly as possible where adequate drying capacity is available.

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Annex: The role of naphire in coordinating national post harvest research extension and training in the Philippines

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HISTORICAL BACKGROUND:

The National Post Harvest Institute for Research and Extension (NAPHIRE) was established on May 24, 1978 by virtue of Presidential Decree No. 1380. The creation was prompted by the enormous losses being incurred in the post harvest handling of grain, which had been estimated to be within the vicinity of 10-37% from harvesting to consumption. Additionally, improved post harvest systems and facilities should be developed to sustain the gains achieved in food production.

NAPHIRE's actual operation started two years later and in the same year (May 1980), it was attached to the National Food Authority (NFA) through Letter of Implementation No. 123 for better program coordination and for financial and logistical support.

MISSION STATEMENT:

NAPHIRE is charged with the function of accelerating grains post harvest technology improvement through the generation and application and application of appropriate post harvest technology, to reduce losses and improve food and feed quality.

Hence, NAPHIRE undertakes research and extension on post-harvest primarily covering the areas of food and feed protection; post harvest facilities design and development, and; post harvest systems and analysis and development. NAPHIRE's efforts are directed to alleviate these priority problems in the grains post production industry: wet grain handling: pest infestation in storage; inefficient and expensive storage and handling systems; lack of socio-economic studies on the use and non-use of post production equipment and facilities; and the need for extension activities to facilitate the adoption of post harvest technologies.

Local and international seminars, workshops and other training programs have been conducted for various sectors in the post harvest industry. Such activities are significant in continuously developing awareness of the need for action on post harvest loss reduction

programs.

One of the most significant developments in NAPHIRE's effort to improve the country's grains post harvest industry is the establishment of the National Post Harvest Research and Training Center which now stands as the core of post harvest R & D programs in the country.

Therefore, NAPHIRE shall be to GRAINS post harvest technology what the National Rice Research Institute is to production.

ORGANIZATION:

The Institute is headed by an Executive Director who has overall responsibility for directly managing all the affairs of NAPHIRE.

NAPHIRE is governed by a Board of Trustees which provides direction and support to the Institute's programs and activities with the Administrator of the National Food Authority (NFA) as Chairman; and the following as members: the Secretary, Department of Science and Technology (DOST), the Chancellor, University of the Philippines at Los Banos (UPLB); the President, Central Luzon State University (CLSU); the President, Confederation of Filipino Rice and Corn Association, Inc. (CONFED); and the Executive Director of NAPHIRE.

NAPHIRE'S SPECIFIC OBJECTIVES:

1. To promote and establish scientific methods and techniques in grains handling storage and processing.

2. To initiate the development of low-cost post harvest facilities by tapping indigeneous resources.

3. To design and develop processing equipment/machineries necessary in promoting product/ byproduct utilization.

4. To conduct researches in the development of local capability in the area of support activities such as the manufacture/fabrication of graders, pest control equipment, testing instrument and the like.

5. To conduct basic and applied researches on all phases of grains post harvest distribution and utilization.

6. To establish definitive manpower training programs for effective post harvest operations.

7. To establish and disseminate research findings and recommend improvenents related to grain post production distribution and utilization.

HIGHLIGHTS OF PAST ACHIEVEMENTS:

From a program initially confined to research, NAPHIRE has expanded its activities. At present, its activities are classified into the following categories:

1. Research

2. Education and Training

3. Technology Dissemination and Utilization

4. Institutional Development and Technical Assistance (to alimited scale only)

To undertake all these activities, NAPHIRE has solicitied significant grants from international donors such as:

1. International Development Research Centre of Canada (IDRC)

2. The Royal Netherland Government (RNG)

3. Australian Centre for International Agricultural Research (ACIAR)

4. Asean-European Community Regional Collaborative Programme on Grain Post Harvest

Technology (AECRCP)

5. Europen Economic Community (EEC)

6. Asean-Australian Economic Cooperative Programme (AAECP)

7. Asean-Grains Post Harvest Programme (AGPP)

8. World Bank (WB)

9. Asian Productivity Organization (APO)

10. Overseas Development Administration through TDRI (Tropical Development Research Institute) of U.K. Government, now Natural Resources Institute (NRI).

Other sources of funds come from the National Government and the National Food Authority (NFA).

Two possible fund sources are:

1. Japanese International Cooperation Agency (JICA)

2. French Government

A. RESEARCH:

NAPHIRE's research program is aimed at providing better understanding of the nature, causes, and magnitude of post harvest losses and developing appropriate solutions to minimize these losses. Th research program has covered the following areas:

1. Food and Feed Protection (FPD)

2. Post Harvest Facilities Design and Development (PHFDD)

3. Post Harvest Systems Analysis and Development (PHSAD)

4. Training and Extension Department (TED)

B. EDUCATION AND TRAINING

In its ten years of existence, NAPHIRE has continued its commitment to the food postharvest the development goals of the industry. It has conducted and - evaluated training programs designed to upgrade the knowledge and skills of the various sectors in the food industry.

The training courses being offered are:

1. General training course on grains postharvest technology.

2. Specialized training course on grains postharvest technology.

3. Local and international workshops, seminars and technical symposia.

4. Individual coaching or apprenticeship

5. On-site training courses

6. Staff development programs

A national postharvest training center was established through the joint effort of the national government and the EEC and serves as the venue for the above training activities. It is equipped with training laboratories, furnished with modern postharvest laboratory equipment and a dormitory for training participants.

C. TECHNOLOGY DISSEMINATION AND UTILIZATION:

In order that results of research could reach the intended users and be utilized effectively, NAPHIRE is conducting the following activities:

1. Pilot extension of developed technologies

This is true for the developed corn sheller; the recommended pest management strategies; and the proposed warehouse stock inventory control.

2. Communication and publication program

- **Annual report**
- **NAPHIRE news**
- **Training manuals on grains postharvest technology**
- **Technical bulletin**
- **Slide set presentation**
- **Press releases, and;**
- **Symposia**

CONCLUSIONS

Considerable researh findings on rice and corn postproduction technology had been achieved by NAPHIRE. While the result of these researches have made some impact in terms of reducing postharvest losses, these available technologies have not been widely adopted by end-users, primarily the farmers and grain processors.

NAPHIRE fully recognizes this, hence, the Institute implements its research activities with a training and extension program which is equally significant.

These are primarily disseminated through intermediaries like the extension agents of related agencies which have direct linkage with farmers, and which have existing extension networks all over the country. Extension arms of these agencies serve as conduits of postharvest information.

The Institute conducts training courses which directly benefits end-users. It has for instance, conducted a series of seminars nationwide on efficient grain handling for NFA field personnel, grain postharvest technology for agricultural colleges and universities, special courses for MERALCOCORFARM personnel. Training courses shall also be packaged in the very near future for traders/millers. Information dissemination is likewise conveyed through mass media like newsletters, press releases, technical bulletins, slide sets and photo exhibits.

The message contained in these information materials are aimed at developing understanding and interest in the urgency of reducing postharvest losses.

Clearly, NAPHIRE's presence in the food industry lends strong support to the government and the private sector's sustained efforts in increasing food production.

Admittedly, we still have far to go, the need to arrest food wastage through proper and improved postharvest technology and facilities is NAPHIRE's pressing concern. Hopefully, however, we believe that the government, hand in hand with the private sector can work

together to minimize food wastage in the grains industry.

Summing all these, NAPHIRE's vital role in the development o the grain industry cannot be over emphasized.

PROJECT REVIEW:

1.a Grain Quality Deterioration in On-Farm Level of operation

A two-phased study was conducted to determine the nature, causes and extent of paddy quality deterioration at the farm level. In Phase I (the field study), three systems of post-harvest practices served as the treatments: System 1 simulated the existing flow of on-farm post-harvest practices; System II, the delay in threshing that employed different types of field stacking of freshly harvested paddy and System lll, the delay in drying where threshed, undried grains were stored in the farmer's storehouse.

In Phase II, field conditions were simulated in the laboratory to determine the effect on yellowing and other discolorations of paddy and milled rice, brought about by fungi identified in the field study. These fungi were Aspergillus flavus, Fusarium sp., Curvularia sp., Helminthosporium sp., Rhizopus sp., A. terreus and A. Ochaceus.

Results showed that when freshly harvested paddy was immediately threshed and dried

as in System I, the percentage of yellow kernels was negligible. However, when threshing and drying of paddy were delayed as in System II and lll respectively, the percentage of yellow kernels significantly increased. The high moisture content (m.c.) of paddy at harvest, the high relative humidity and the type of field stacking used greatly contributed to the rate of yellowing. Yellowing was also found to more prevalent during the wet season.

Yellowing was observed as being caused by heating within the field stacks brought about by the combined respiration of paddy and micro-organisms. It starts right in the farm and is more pronounced when wet, unthreshed paddy is stacked in conical shapes or "mandalas" in field.

Results also showed that the growth and activity of fungi caused the following discoloration in paddy and milled rice: yellowing of milled rice from paddy incoculated with Fusarium sp. and Aspergillus flavus; yellowish brown color in milled rice from paddy inoculated with Rhizopus sp. and black color in milled rice from paddy inoculated with Curvularia sp., Aspergillus flavus and A. ochraceus.

1.b Paddy Deterioration from Procurement to Storage (Yellowing)

The study was conducted to determine the nature, causes and extent of paddy deterioration from procurement to storage, involving two systems. System I simulated a

delay in drying where newly procured high moisture paddy with 20-25% moisture content (m.c.) was stored for one month without drying. In System II, dried paddy with 14-18% m.c. was stored for one year and longer.

Yellow kernels increased when drying of wet paddy with 20-25% m.c. was delayed. The increase was higher and faster in paddy with 23-25% m.c. than in paddy with 20-22% m.c. The 2% NFA maximum yellowed kernels was reached after a one-week delay in drying for paddy with 23-25% m.c., and after a onemonth delay in drying for paddy with 20-23% m.c.

For System II, paddy with initial m.c. of 17-18% had more yellow kernels than paddy with 14% and 1516% m.c. The yellow kernels reached 2.3% during the 6th month of storage. No increase in yellow kemels was observed in paddy with 14% m.c. even after one year of storage. Furthermore, the number of damaged and chalky kernels in milled rice decreased as paddy was stored longer. The decrease is due to the reduced weight of the grains caused by breakage during milling.

Results indicate that yellowing is caused by the activities of microorganisms whose life is sustained by the high moisture content of paddy. Hence, the higher the moisture content, the faster is the yellowing process and the greater the number of yellow kernels.

Yellowing can be prevented by immediately drying the paddy to 14% m.c. before storage.

2. Maize Deterioration at On-Farm Level of Operation

The study aimed to determine and investigate the nature, causes and magnitude of maized deterioration on a time frame during farm level operations. It was conducted in South Cotabato and Isabela. In South Cotabato, the experiment was carried out by setting up four systems simulating the normal flow of operations in the area, shelling and drying delays and an ideal condition of handling maize after harvest. In Isabela, only the normal flow of operations was followed.

Results of the study showed that the existing farm practices in South Cotabato and Isabela greatly affect the quality of the grains produced in the two areas. The occurence of moldy and discolored grains and aflatoxin contamination was higher in South Cotabato while the mechanical damage grains was higher in Isabela.

Insect infestation was not much a problem at the farm as manifested by the minimal weight loss noted after two weeks.

The simulation experiment revealed varied quality and value losses. Drying delay yielded 5.69% and 6.56% moldy and discolored grains respectively, with a value loss of i, 0.36/kilo and aflatoxin contamination reaching the 20 ppb level on the second day of storage. Shelling delay, on the other hand, had 2.99% moldy grains, 3.8% discolored grains, a value loss of i, 0.19/kilo and the 20 ppb aflatoxin was reached 8 days after the harvest. With the

normal flow of operations in the area, moldy grains was 3.5%, discolored grains was 4.0% value loss was P 0.23/ kilo and 20 ppb aflatoxin was reached 6 days after harvest. Immediate shelling and drying maize after harvest gave the highest quality grains and least losses.

3. Maize Deterioration at Off-Farm Level of Operation

The causes and magnitude of losses in maize at the off-farm level of operation were investigated. Maize loss assessment study was conducted in two premiere maize producing areas and two corn processing centers. Maize samples were taken from local traderassemblers, wholesalers, millers and other maize processors.

The highest mean percentage of weight loss caused by insects was noted on samples taken from storage warehouses of wholesalers with an average of 1.5%, and a range of 0.01% to 21%. Yellow maize was found to be more susceptible to insect infestation in storage than the white variety. Yellow maize stored for six months incurred an estimated weight loss of 9.04% and 69.10% insect lost 5.01% in weight, and 47.86% of its kernels were damaged by insects. The Economic Threshold Level (ETL) for yellow and white Maize were reached at 1.64 and 1.57 months respectively. On the other hand, the Economic Injury Level (EIL) were attained at 1.87 months for yellow maize and 1.93 months for white maize.

Generally, all maize reaching the trade channels were positive for aflatoxin. Regional differences on aflatoxin contamination existed. Maize with nontolerable level of aflatoxin was more prevalent in samples originating from Southern Mindanao (74%) than in Cagayhan Valley (51%). An inverse relationship between the price of maize grits and aflatoxin contamination was noted.

In ability of farmers and traders to promptly dry the grains to a safe level of moisture content (13% to 14%) was identified to be the root cause in speedy maized deterioration. Recommendations are outlined directed towards the solution of the major problems identified.

4. Rodents Losses in Commercial Grain Storage

The field survey revealed that the average population and consumption of rodents and 111. individuals and 3.16 kilograms of grains, respectively. Likewise, stomach contents of rodents in government warehouses were found to have 99.5 per cent grain while those collected from private warehouses contained 90 per cent grains. The Norway rat, Rattus norvegicus Berkenhaut and the Philippine ricefield rat, Rattus rattus mindanensis Mearns were the prevalent rodent species found in storage.

Laboratory experiments showed that rodents consume an amount equivalent to 10% of their body weight per day and, while feeding, spill 7.5 times as much as the amount they

consume. it was also found that grains contaminated with rodent hairs, urine and faeces were infected with Aspergillus flavus and A ochraceus.

A -control program consisting of chronic poison baiting, in-warehouse reduced losses by 87%. A costbenefit ratio of 1.36 was achieved by implementing the control program for six months.

5. Bird Pests and their Control in Storage

The study aimed to determine the extent and nature of birds and develop a control strategy.

Results revealed that the most dominant bird species damaging grain in storage is the Phillippine weaver, Passer montanus. Warehouses visited were found to harbor 50 to 400 birds each, so daily losses range from 0.28 to 2.2 kg in each warehouse.

An integrated control program consisting of: a) providing physical barriers, to prevent easy access of the birds to the warehouses, b) maintenance of hygiene and sanitation inside and around the warehouse was developed.

6. Assessment of Paddy Loss in Storage

The study was conducted to determine the extent of grain quality deterioration due to the

biological factors in storage and to pilot test the proposed warehouse stock inventory control system.

Quality of paddy from procurement to ten months storage were evaluated through physical analysis, microbial analysis, fat acidity value (FAV), and alkali test. Existing warehouse operations were simulated to assess quantity losses.

Results showed that the storage of paddy with 14% and 15% moisture content resulted in only slight changes in the quality of rice. Yellowing of grains can be slowed down by providing aeration in the pile.

Losses due to respiration of the grains, insects, birds, rodents, poor handling, moisture loss associated with dry matter loss and changes in moisture content were accounted in the proposed system of inventory. Results revealed that this system could provide a more realistic estimate of losses provided that all warehouse documents are complete, true and correct.

7. Insect and Mite Pests and Their Control in Commercial Storages

The study was conducted to identify insect and mite species, associated with grains and grain products in storage determine the extent of losses in rough rice and maize at various lengths of storage period, establish the Economic Insury Level (EIL) and Economic

Threshold Level (ETL) in paddy and maize programming fumigation, and develop a control program to reduce losses in storage due to insect infestation.

A total of 31 species of insects and 13 species of mites were found in the survey. One species of insects and four species of mites are new records from the Philippines.

The lesser grain borer, Rhizopertha Dominica (F) has gained primary importance in the safe storage of rice. It has attained dominance over Sitophilus spp.. This new situation calls for the modification of present pest control strategies and relevant warehouse management practices.

Estimations of population density of insect pests inside the stacks can be obtained through direct sampling of stocks. Other monitoring techniques found to be a potential substitute to this method were visual inspection and the use of traps e.g. light traps, corrugated cardboard traps and Zoecon "pherecon" traps.

A direct association between the age of rough rice and maize stocks, and level of insect damaged kernels, and the age of stocks and percent weight loss were observed. The ETL and EIL for fumigating rough rice and corn were established based on the derived linear association between percent weight loss and number of insects. The ETL was determined at 2.02 months in rough rice and 0.35 months in maize. The EIL was attained after holding rough rice for 5.18 months in storage. In maize, the EIL was established at 0.9 months in

storage. The benefit from every peso invested from fumigating rough rice and maize are P 3.62 and P 1.17, respectively.

Quality assessment of rice revealed that the fat content (FAV) and gelatinization temperature (BEPT) of brown rice and milled rice increased significantly with time. In rough rice and opposite trend was observed. The gel consistency of all form of rice decreased significantly as the storage period was prolonged. The effect of insect damage on the FAV, BEPT and gel consistency however, was found to be insignificant.

Recommendations have been outlined to serve as guideposts in the modification of insect control strategies in the light of the present findings and observations.

8. Integrated Use of Pesticides In Grain Storage in the Humid Tropics

Pests continue to be the major cause of losses incurred in storage and it is suggested that pesticides will continue to be of much use in aiming to reduce these losses. The emergence of malathion resistant strains in our storage indicates the need to regularly revise insecticide treatments to counter the development of insecticide resistance. An effective system of pesticide usage therefore is necessary for safe storage of grains.

Grain mixture technology has been succesfully carried out in Australia and other parts of the world. In the Philippines such technology was tested with, modification so as to fit

NFA operations. Treatment of grains (corn and paddy) were done in the conveyor of bulk storages and was bagged for final storage. The most likely grain protectants previously screened by a series of laboratory tests were used. Tested were three synthetic pyrethroids (deltamethrin, permethrin and methacrifos) and one carbamate (carbaryl).

Methacrifos and deltamethrin were applied as single treatments. The others were applied as combination treatments, one having a broad spectrum effect while the other in low concentration was to combat insect resistant strains. They were also synergized with piperonyl butoxide (PB). Thus, combination treatments used were: permethrin + chlorpyrifos-methyl + PB; fenitrothion + fenvalerate + PB and pirmiphosmethyl + carbaryl. The dosage applied is the amount that will provide protection against infestation for a period of 8 months for maize and 12 months for paddy.

Results showed that combination treatments were better than single treatments although biological response of test insects was dependent upon the kind of test species used. Although insects were present in treated piles at the end of storage period, losses were reduced to 60%. At the maize experimental piles, it was further observed that while the control pile was already infested with Trogoderma granarium (khapra beetle), the treated piles remained free from infestation. Its absence in all treated piles was highly noticeable.

Benefit-cost analysis showed that all treatments were economically viable. It is also disclosed that combination treatments were better than single treatments since it has the

effect of lowering residue contamination and reducing costs.

For maize, combination treatment of fenitrothion + fenvalerate + PB was the most effective with an incremental BCR of 14.07 while for padd, the best treatment was permethrin + chlorpyrifosmethyl + PB with an incremental BCR of 7.02.

9. Kinetics of Decay of Candidate Pesticides for Integrated Pest Control Program

The use of chemical pesticides is still the mainstay in large-scale control of most insects and other pests of economic and public health importance. Hence, demands and use of grain protectanis have increased significantly because these are are required to prevent subsequent infestation when mixed with the grain (Champ and Dyte, 1976). However, their extensive use has resulted in a number of serious problems including the development of insecticideresistant insects and presence of unwanted chemical residues which are toxic not only to target pests but also to humans.

The study aimed to understand the fate and distribution of insecticides during storage of tropical grains.

Incidentally, it compliments the previous project on the "Integrated Use of Pesticide" servicing its chemically oriented requirements.

Samples from the experimental stocks were assessed for residue level. Sampling was done during insecticide application (at five minutes interval) and at the start of storage and at a sixweek interval thereafter until the end of storage period which was eight months for maize and twelve months for paddy.

Significant losses of insecticides during application were measured after the assessment of residue level. The decline of residues from the initial sample was not due to rapid initial decay of pesticides as the interval between treatment and sampling was only five minutes, but is attributed to spraying where some of the aerosols drifted away from the grains being treated. Degradation of pesticide is also possible during transport of samples from treatment site to the laboratory.

The residues determined for both trials showed an exponential dependence of decay of pesticides with time of storage. The decline in concentration of insecticides was observed to be rapid at the start of the period followed by a relatively slow phase. This trend in degradation appears to follow first order kinetics, in which the rate of decay (rate of reaction) of pesticide at anytime is directly proportional to the concentration of the residue present which is expected.

Results for both trials also revealed that pyrethriods are more stable than the organophosphates. This is in agreement with published reports that organophosphates are generally unstable due to the high rate of volatization and susceptibility to photolytic

decomposition. Volatization is one of the most important pathways responsible for the decay of insecticides from grains. It is favored by high vapour pressure of insecticides, presence of moisture, increased air movement and high temperature. It is therefore appropriate to note that the humid tropical climate of the country mobilizes the insecticide, thus making them easily degraded.

Likewise, the kinetic study show that the calculated half-life, t, (the time for the pesticide to decay half to its initial 1/2 value) and the rate constant, k, for each protectant were relatively close to the predicted values (Desmarchelier and Bengston) especially for paddy. There are some variation in the values, and one possible reason is that it is harder to establish the kinetic behaviour of pesticides in field trials. For maize, the result was not as satisfactory as that of paddy because of the gap in the time of analysis. Analysis of maize samples was stopped for one year.

Another result obtained which is of particular interest and importance, is that the residues determined for maize and paddy were very much below the maximum tolerance level recommended by the Codex Alimentarius Commission of the Food and Agriculture Organization (FAO) on food commodities for safe animal and human consumption.

10. Long Term Storage of Grain Under Plastic Covers

Insect infestation is a serious problem commonly encountered in large government and

private trader warehouses, expecially when commodities are kept for a long time. Presently, the problem is alleviated by chemical control measures. However, the injudicious application of pesticides can lead to a rapid decline in their effectiveness, due to the development of insect resistance. Hence, other non-chemical control measures have to be explored.

NAPHIRE launched the project "Long Term Storage of Grain Under Plastic Covers" in collaboration with the Commonwealth Scientific and Industrial Research Organization (CSIRO), and the National Food Authority (NFA) with financial assistance from the Australian Center for International Agricultural Research (ACIAR). This project assessed the technical applicability and socio-economic feasibility of storing stacked, bagged rice and maize grains under sealed plastic enclosures, using carbon dioxide (CO2) to control insect infestations and preserve the grains quality under Philippine conditions.

Two trials with a duration of from 8-10 months and 14-15 months respectively, have been concluded. However, statistically tested information/ results are available only from the first trial. The analysis of samples gathered from the second trial is still in progress.

Among the significant observations are the following:

1. Per cent (%) weight loss is milled rice is significantly higher in the untreated or control piles (2.36%) compared to the treated pile (0.64%)

2. Per cent (%) insect damaged grain in paddy is slightly higher in the untreated piles (4-5%) compared to the treated piles (1.8-3.4%). Likewise, the % weight loss is higher in the untreated piles (0.62-2.26%) as against the treated piles (0.22-0.83%).

3. Per cent (%) insect damaged grain in maize is higher (5-9%) in the untreated piles and lower (4.3-6.0%) in the treated piles. However, the extent of weight lost did not significantly differ.

4. Comparison of the initial and final density of insects in the treated piles showed no significant increase. Moreover, the treated piles of milled rice and corn have significantly lower insect populations as against the control piles.

5. Significant reduction of microbial infection was observed in the treated piles of paddy and corn.

6. There was no significant difference observed in the milling recovery between the treated and control piles of paddy at the end of the experiment.

11. Effect of Controlled Atmospheres on Quality of Stored Grain

In the Philippines, rice and other food grains are commonly packed in bags and stored in stacks. This method predisposes the grains to insects and other agents of deferioration. As

a result huge losses are incurred in storage, particularly in large commercial ones.

The sealed storage technique has known advantages over the traditional method of storing bag stacks. However, the dearth of information on the effect of this technique on grain quality inhibits its more widespread use. Hence, the determination of reliablility of sealed storage technique in terms of protection from insects must be supported by the determination of the effect of this technique on grain quality.

This project aims to determine the influence of atmosphere in combination with moisture and temperature on grain quality.

The development of sealed storage technique in the Philippines has involved several trials: In the first trial, stacks of milled rice, paddy and maize were sealed in PVC-membrane enclosures and disinfested with carbon dioxide, the stacks of paddy, milled rice and maize were stored unopened for nine (9), eight (8) and eight (8) months, respectively. Grain samples taken at the time of opening were unchanged by the storage procedure, there being no obvious nor significant quality changes. Moreover, the cooking characteristics of stored samples did not change.

The same commodities and storage technique but longer storage periods (over a year) were used in the second field trial. The quality of grain samples taken from this trial is now being assessed.

12. Mould and Aflatoxin Build-up in Maize

The project aims to control aflatoxin contamination in maize through the development of appropriate post production practices and facilities at the on and offfarm level at the maize assembly points of traders and government procurement agencies. This is being conducted in the three main maize producing areas in South Cotabato.

The existing post harvest operations in three areas are being closely monitored for the wet and dry season to determine the effect of different stages of operations at the on and off-farm level on mould and aflatoxin formation. A study on the storability of grains at moisture content level is being carried out. Piling of 100 bags each of maize at four moisture content levels, and breaking of piles at one three and six months of storage has been accomplished. Control and treated piles were set up to determine the effect of insect infestation in storage on aflatoxin formation.

A grading and screening study at traders level was carried out in 1988 to determine the most suitable screening and grading procedures that will include aflatoxin as important parameters during grain procurement.

13. Groundnut Industry: Philippines.

The biological aspect of the project intends to control aflatoxin contamination in

groundnuts through the establishment of the required practices in the post production handling and primary processing phases. Field and storage experiments were conducted at the peanut farms and Madella Peanut Planters Cooperative Warehouse in Madella, Quirino, respectively.

In the field experiment, different treatments varying the types and duration of windrowing were established.

The storage study made use of 8 piles, 50 bags each, stored for 3 months. This determined the effect of the different moisture contents and unsound nuts combination on aflatoxin build up. The level of aflatoxin contamination and the mold infection was monitored from harvest to storage.

14. Aflatoxin Contamination in Peanuts at the Post Production Level of Operations

This study is part of the project on Groundnut Industry Economics; Phase 1. It determined the causes and extent of aflatoxin formation at each stage of the post production operation. It was carried out through a survey at the farmers, traders and processors level.

The results revealed that aflatoxin significantly increased from harvest to farm storage during the main cropping season. At harvest, peanuts contained, on the average, 3.16 ppb aflatoxin. The level continued to increase at the rate of 1.5 and 1.4 ppb per day during

windowing and farm storage, respectively. Aflatoxin contamination was significantly higher during the main cropping season.

At the traders level, samples from the middlemen contained 35.00 ppb aflatoxin. Samples from the wholesalers had 188 and 275 ppb aflatoin for the newly procured peanuts, and peanuts stored for 3 months, respectvely.

At the processors' level, raw materials for table peanuts (roasted and fried peanuts) contained 7.73 ppb aflatoxin; peanuts intended for peanut butter contained 17.13 ppb aflatoxin and rejected peanuts contained 120.6 ppb aflatoxin.

Results of the survey indicated that aflatoxin contamination commerced at harvest. Aflatoxin reached level significant amounts at the traders and processor level. The continued increase in aflatoxin was attributed to insufficient drying of peanuts after harvest.

POST HARVEST SYSTEMS ANALYSIS AND DEVELOPMENT

NAPHIRE has been closely investigating the inefficiencies in the post harvest systems in order to establish program priorities for practical and continuing improvement in the industry. Projects under this program thrust are being undertaken by the Post Harvest Systems Analysis and Development Department of the Institute.

15. Socio-economic Study on the Utilization of Mechanical Dryers

The socio-economic constraints in the use and non-use of mechanical dryers at farm and mill levels, and how these could be overcome to enhance mechanical dryers utilization, were determined through survey case studies and feasibility studies.

Surveys showed that the major constraints by previous users of mechanical dryers at farm and mill levels were: 1) high fuel cost; 2) lack of understanding on the mechanical drying technology resulting in poor quality of dried paddy and difficulty in operation; 3) compatibility of drying capacity with the volume of paddy to be dried.

Among the non-users, limited volumes of procurement and low production volumes were the reported constraints by millers and individual farmers, respectively. The unavailability of mechanical dryers in the area also prohibited individual farmers to use dryers.

Conversely, continued users recognized the benefits and advantages of mechanical dryers, such as increase in volume of procurement during the wet season, maintenance of paddy quality and better price for good quality milled rice.

An in-depth analysis of operating dryers in the case studies revealed that the successful use of mechanical dryers required the following: large volume of paddy, dryer operation integrated as support to existing milling and marketing operations, compatible dryer

capacities with volume of paddy to be dried, and lastly, sufficient technical knowhow in operating of the dryer.

Feasibility studies of mechanical dryers also showed that profitbility of different types of dryers was dependent largely on the level of operations to which they were matched, and the proper integration of the drying operation in the overall operation of the system.

16. Socio-Economic Factors Affecting the Utilization of Post-Harvest Equipment in the Maize Industry

A survey was conducted in three major maize producing areas in the Philippiness: South Cotabato, Bukidnon and Isabela. The study determined the existing post harvest marketing flow of maize from production to consumption; identified the various socioeconomic and physical factors and the extent of their influence on the use and non-use of improved maize post harvest technologies and; determined the necessary requirements for the design development and sustained utilization of improved post harvest technologies for the maize industry.

Users and non-users of mechanical shellers and mechanical dryers were interviewed.

The study revealed that mechanical shellers were popularly used in South Cotabato and in Bukidnon, but not in Isabela. The farmers and millers in Isabela were still using manual

shelling because of the following constraints: the type of sheller introduced to them was producing poor quality grain, and produces broken cobs which they use for household fuel. In addition, the design of the equipment was very complicated and required frequent replacement of parts resulting in additional costs.

Two types of mechanical shellers were found in South Cotabato and Bukidnon: stationary and mobile types. The mobile type was common in Bukidnon, due to the fact that the average farm size in that area (Bukidnon) was bigger, (24.7 ha.) compared to South Cotabato, (6.61 ha.).

The stationary type sheller is bigger in capacity ranging from 40 to 200 cavans (2-10 tons) per hour while the mobile type had a capacity ranging from 30 to 60 cavans (1.5-3.0 tons) per hour.'

Users of mechanical dryers were found in the trading and processing centers of maize; such as Cagayan de Oro (4 units), Cebu (5 units), South Cotabato (3 units), and Bukidnon (9 units). However, out of the total users (21), 50% stopped using mechanical dryers. Reasons given for the non-usage of mechanical dryers were as follows: high operating cost, poor pricing scheme/lack of incentive for dried maize. For non-users, the following reasons were given: high investment cost, lack of incentive for dried maize mixing the wet and dried maize, availability of alternative drying such as corn drib, and unavailability of the dryer itself.

Contributing factors in poor marketing structure which discouraged the producers and even the traders to produce and maintain good quality grains were as follows: presence of market for wet and poor quality grain and ineffective pricing scheme/ineffective grading system.

17. Paddy Loss Assessment at the Farm Level of Operation

The reduction of paddy losses brought about by the introduction of newly developed post-harvest practices and facilities were assessed. Paddy losses incurred by the new technology, both quantitative and qualitative were compared to the traditional methods of post-harvest operations prevailing at Isabela and lloilo provinces, Philippines. The on-farm post-harvest operations considered were harvesting, piling, threshing and drying.

The costs and benefits derived from the application of both traditional and improved postharvest practices and facilities were evaluated in a systems study so that an appropriate combination of traditional and improved methods of an on-farm post harvest system, that which is socially and economically acceptable and entails a minimum loss, could be established and recommended.

The assessment of losses revealed significant reduction of about 3.08% quantiative grain losses in the threshing and drying operations. Better paddy quality resulted when the new facilities were used.

In the experiment, simulating in threshing delay and drying, the Grade I initial quality of paddy deteriorated to Grade II and Grade II to Grade lll classifications in just 2 to 4 days of delay, respectively.

Economic indicators showed profitability and high returns of investment for the new improved facilities. Payback periods, breakeven points and benefit-to cost ratios showed favourability in the adoption of the improved post-harvest practices and facilities at the farm cooperatives level or for the custom service investor.

Eight combinations of traditional and improved methods were identified to comprise the general alternative post-harvest systems. Economic justification in the selection of the most appropriate combination of an on-farm post-harvest system was made using the benefit-to-cost analysis for all systems. Guidelines to test the post-harvest systems' social acceptability and usefullness were recommended.

18. Pilot Testing of an Improved Mobile Maize Sheller

Pilot testing of the improved mobile maize sheller developed by NAPHIRE was instituted to investigate its economic viability and social acceptability; to establish the most viable system of utilizing the sheller and; develop the most appropriate extension strategy for its wider adoption.

Isabela and South Cotabato were chosen as pilot sites, located in the northern and southern Philippines, respectively. System I, a scenario depicting a sheller deficit area, and System II, a scenario exemplifying an area where several existing mechanical sheller in commercial operations were typified, in the respective provinces. A cooperator in each site was chosen to manage the sheller. Daily records of its operation were gathered and used in the economic analysis.

Regular interviews were conducted to obtain the social acceptability of the sheller. Users and observers alike at the pilot site were randomly interviewed in the study.

Result of the study revealed that the developed sheller was economically viable and socially acceptable economic indicators showed that the sheller obtained a 54.20% return on investment, a benefit cost ratio of 1.73 and payback period of 1.84 years, in System 1.

The adoption of the developed mobile sheller in areas where existing mobile shellers abound was slow. An increase in capacity for the developed sheller was recomnended for it to be viable. Sensitivity analysis showed that the developed sheller (at 40 cavans per hour capacity) would incur a negative return investment. A 70 cavan per hour capacity would make the sheller more economically viable.

The wider adoption of he developed sheller was recommended in areas typical to conditions exemplified by System I and a modification on the capacity for the sheller to be

competitive in areas typical to System II.

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19. Reduction of Milling Losses in Village Level Rice Milling

In the mid seventies, the country's rice production reached surplus levels enabling the country to export rice. Of the total rice stocks, the volume held at farm level is very significant. This is usually milled in small processing units called steel-huller mills which are claimed to deliver low milling recovery and poor quality milled rice. However, due to calamities the country has suffered in the last five years, the country shifted from a modest rice exporter to rice importer. Therefore, the need to upgrade the milling performance at village level rice milling of grains particularly the steel-huller mills was

deemed imperative.

NAPHIRE launched this project with the ultimate aime of reducing losses in village level milling of grains. Specifically, the project sought to evaluate the performance of steel huller mills in terms of different factors (machine, product, human) affecting milling yield and quality of milled rice. Also, it was geared towards the identification of socio-economic factors contributing to the widespread use of steel-huller mills and the development of policy recommendations for the improvement of milling performance of village ricemills.

The project was composed of two phases. Phase I is a performance evaluation of steel huller mills and Phase II is a socio-economic survey on the popularity of steel-huller mills.

Results showed no significant milling recovery differences among brands and input capacity (regardless of season and grain size).

The mode of payment had an effect on milling recovery. Payment in cash generated better milling recovery, as operator tends to maximize milled rice production, having milled rice output as the bais of payment. Payment in kind, in from of byproducts, generated lower milling recovery as operator maximize by-product production.

Results of the socio-economic survey showed that the widespread popularity of the steel huller mill is a compound effect of the existing socioeconomic and infrastructural

conditions in rural villages. At the miller's level, it was found to be popular because of its low initial cost and long per unit life span, relative ease in mill operation are served as an extension of family activity, complementing. At the client level the mill was found to be popular because of its relative accessibility, compatability of needs of the villagers, and the relationship/kinship existing between the miller and the client.

On the other hand, the poor milling performance of village mills was found to be largely associated with the poor paddy quality held at farm gate and the inherent characteristic of the village steel huller mill. It is expected that the improvement of either one of the two would help improve milling performance at village level operations.

20. A Study of a Farmer Based Enterprise (Philip. pines) (KAISA Case Study)

In the pursuit of rural development and to uplift the lives of small farmers in the countryside, an institutional approach in the form of Carmer's Associations or cooperatives could be employed. These institutions could serve as channels for the adoption of innovations and provide means by which development and structural transformation in rural communities could be affected.

The venture of farmer groups/associations in the country has a history characterized by constant failures. A case in point is the Kalipunan ng Irrigators Service Association (KAISA) in Calauan, Laguna. It is a federation, at the provincial level, of 5 smaller municipal

irrigators service associations. Organized by Farm Systems Development Corporation (FSDC), the farmer group was a beneficiary of a loan which was invested in postharvest facilities such as a warehouse, ricemill, mechanical dryer and trucks among others. The group formally began in 1980 and for some years was able to operate. The farmer-members would assemble their produce at the warehouse for drying, storage, milling and/or marketing. Yet, for some reasons which are not fully understood, KAISAS's operation slowly faltered and finally ceased in 1985.

This study aims to determine the necessary requirements that would enable farmers groups to be successful adoptors of postharvest technologies and active participants in the marketing system of paddy, with KAISA as the subject.

In depth analysis showed that the following factors contributed to the failure of KAISA: a) lack of commitment of the manager, b) undefined roles and functions of the employees and officers of the association, c) depleting working capital due to uncollected revenues and d) inefficient performance of mechanical dryers.

Problems identified by the farmers from the operations of the association were as follows: a) poor procurement services b) delayed payment of their produce c) lack of coordination between members and the management (association) d) inconveniences due to distance of the farms of members and the warehouse/facilities of the association.

Factors which influenced the farmers to market their produce outside the association were as follows: a) prevailing commercial high price, b) availability of local buyers c) extension of credit d) convenience since the stocks were picked up from the farm e) traditional buyer and f) presence of market for wet paddy.

Expressed needs/services of the farmers from the association were as follows: a) production loan, b) good price for their produce, c) transport and drying facilities.

The technical evaluation of the existing facilities of the association suggested to replace the batch type dryers instead of repairing it because it would only entail additional cost yet the total capacity will still be incompatible with the total drying requirements of the association.

Analysis of two others KAISA's, San Fernando KAISA in La Union and the Tacloban KAISA in Leyte, showed that the common factor which contributed to their success is the strong management capability of the person in charge of the operation. Even without much support from the members if the manager has the skill to manage a business enterprise, it will successfully operate. The presence of strong management capability with person who handle the business was also observed with the Free Farmer Cooperative, Incorporated (FFCI) in Tagum, Davao del Norte.

The study revealed that the following requirements should be met in order to make

farmer groups active participants in the post harvest operation: a) strong management capability, b) enough working capital c) compatible post harvest facilities and d) provide service to the needs of the members.

Feasibility study of rehabilitating the Calauan KAISA required an additional capital of P 1.5 million for trading, operating expenses and for the acquisition of a continuous flow mechanical dryer. Using these facilities plus the additional capital would generate an average income of P 2.0 million per annum. The additional capital of P 1.52 million and the previous loan amounting to P 1.43 million could be paid back after 4.65 years. The Net Present Value of investment (NPV) after ten years would be P 4.42 million at a 12% discount rate, while the computed IRR would be 29%.

21. Development of a Viable Drying Scheme for Mill Level of Operations.

Significant grain losses and quality deterioration occurs due to inability of farmers and traders alike to reduce the high moisture content of freshly harvested grain at a rate fast enough to arrest spoilage. The difficulty becomes severe particularly during-the main season crop which is harvested during the rainy months of the year where sundrying cannot be relied upon. Despite the availability of several mechanical drying technologies and obvious need for such facilities by the industry, the private sector has been quite reluctant to use mechanical dryers.

The gap between generation and application of the drying technology is indeed wide. There is a need then to examine more closely why this has been so, through a system approach, that will consider the totality of the grain post harvest system will drying as the focus of the analysis.

The project therefore, presents a study on the development of a viable scheme by providing a dryerrice mill combination into the post harvest system particularly at trader/miller level. It is traders/millers Involved can there easily relate the effects of proper drying to improved milled rice quality and increased business income. An appropriate drying scheme matching the requirements of the existing post harvest system for a typical trader/miller was developed.

The viable scheme is currently being pilot tested in Cagayan Valley, Philippines, one of the highest palay producing regions in the country, and whereby paddy drying is a major problem due to the occurence of high precipitatin level; determine if integration of the mechanical dryer in the cooperator's rice milling business will be viable or profitable. Internal Rate of Return (IRR) and Pay Back Period (PBP) were the measures

Drying

Sundrying is the usual practice in the area. Farmers make use of acorrugated drying pavement with alternating parallel ridges and grooves designed especially for the rainy

season. When a sudden change in weather condition occurs at the time the grains are on the pavement dryer, they gather the maize at the ridge then cover it with canvass to prevent it from getting wet. The grooves serve as a passageway for the rainwater dropping from the maize plastic cover.

When all drying pavements are occupied, farmers also utilize their barangay plaza and basketball courts in drying maize wherein mats are spread and used as underlays.

Most of the Tampakan farmers have their own corrugated drying pavement. Drying a batch of maize can be finished in one day depending on the heat intensity of the sun. In some instances, delays from shelling to drying occur ranging from 1 to 7 days. Cost of renting a drying pavement including laborers ranges from P 0.50 to P 2/00/ sack.

Marketing

A farmer sells from 40 to 70 cavans shelled maize per hectare per season to local traders. The maize is disposed either wetshelled or dry shelled depending on the availability of dryer in the area and the agreement between farmers and traders. These traders are usually financiers of he farmers. Tampakan and Marbel farmers sell their produce dryshelled while the majority of Banga farmers sell it wetshelled.

At times, temporary storage from 1 to 15 days exists because the buyers pick up the maize

at the farm level all at the same time.

Local traders deliver the grains to the wholesalers using 6-wheeler trucks carrying around 100 sacks per trip. For ten wheeler trucks, it can carry around 400 sacks per trip. The wholesalers in turn sell it to the processors located in Cebu and Manila.

Storage

Storage of corn intended for sale is rarely practiced by farmers because of immediate need of cash for the next planting season. Only a small amount is left at home unshelled and set aside for feeds and seeds. Seeds are stored and use for the next planting season.

At the trader level, storing of maize is done for a period of 1 to 14 days. Maize stored and kept in sacks are either wet, semi-dry or dry. Wet and semi dry marize are further dried or mixed with other maize stocks befor selling it to other local traders and wholesablers in the locality.

Storage at the wholesalers level lasts for one month or at most two months. They store the maize in bags.

23. Design and Development of a Low Cost Shelled Maize Dryer

Farmers usually harvest maize with an initial moisture content exceeding 30%, which is

too high for storage. This condition also favors the growth of microorganisms, germination and discoloration of the grains.

It is estimated that about 70% of the total maize produced in Mindanao has an aflatoxin level more than 20 ppb. Such a high build-up of aflatoxin was traced to the delay in drying practiced by maize farmers.

Farmers experience delays in drying their maize stocks due to the prevailing inclement weather in the area during harvest season and lack/absence of mechanical dryers. Most farmers do not rely on mechanical dryers due to its high investment and operating cost. The capacity of existing dryers are not compatible with the volume of their produce. Hence, there is a need to develop a mechanical dryer appropriate to their needs.

Project Highlights:

A survey conducted in South Cotabato revealed that only farms engaged in the production of hybrid corn own a mechanical dryer and it is mainly used in drying their seeds. The main reason for the nonutilization of mechanical dryers by most farmers is due to the high acquisition and operating cost. Farmers/traders commonly rely on the sundrying method due to the low cost involve in drying their produce. However, quantity and quality losses are usually high especially during the rainy season due to delays in drying. A significant quantity of the stored wet corn grains deteriorated in storage. Deteriorated grains are

normally mixed with good grains at a 1:20 ratio and are sold to wholesalers at a discounted price ranging of 25%-30% of the prevailing price.

The dryer developed by NARHIRE use bagged maize grains as the retaining walls and can be installed on the floors of existing warehouses. It has a capacity of 2.5 tons. Grain with initial moisture content ranging from 25% to 30% (w.b.) could be effectively dried from 7 to 9 hours at a temperature of 60C and an airflow rate ranging of profitability, used in the feasibility study. Integrating a mechanical dryer into a rice milling business with a 100,000 cavan level of procurement would have incremental IRR of 31.92% and a PBP of 4.6 years. If the level of procurement increase up to 130,000 cavans with the dryer, and the wet paddy to 18% moisture content using the mechanical dryer rather than sundried it down to 14% moisture content, then its incremental IRR goes up to 32.22% with PBP of 4.76 years. If there would be an inclement weather condition, the 130,000 cavans will then be dried to 18% (1st stage) then to 14% moisture content (second stage) using the mechanical dryer, this will result to an incremental IRR of 31.19% and a PBP of 4.97 years. The assumptions used in the feasibility study will be pilot tested for one dry season and two wet seasons trials. Another pilot mill located in Isabela, also one of the high paddy producing province in Cagayan Valley was selected to replicate the first pilot mill.

If the drying scheme is proven viable economically, technically and socially, a program for nationwide campaign for the adoption of mechanical dryers at the trader/miller level will be recommended.

22. Control of Aflatoxin in Maize

Study 2: Maize Production and Post-Production System

South Cotablato is one of the major corn producing areas in the country wherein eighty four percent (84%) of its total land area are planted with maize. It has 14 municipalities contributing to the growth of the industry.

Three of its municipalities with high production of maize are Tampakan, Marbel and Banga. They have sandy loam type of soil suitable for maize production. General Santos City is the main trading center where all the maize produced in the province are channelled. It is 60 kms away from Marbel, the town capital.

Most of the local traders/assemblers are situated in Marbel where every barangay is 4 to 15 kms. away from the town proper. Seventy percent (70%) of corn produced are yellow while 30% are white.

Tampakan is around 22 kms. away by rough road from Marbel. More than 10 barangays cover the municipality but only 7 barangays are producing maize. It has 6,300 land area devoted to maize, producing about 4,100 tons per cropping season. Three active Samahang Nayons (SN) are operating with pavement dryers of their own available for rent but catering primarily for their members.

Banga is a 15 kms. travel to Marbel. It has the largest corn area with 20 barangays all of which produces corn. A total of 12,350 ha. is cultivated producing 6,000 tons per cropping season. Three active SN are also operating in the area helping its members dispose their produce to the local traders and wholesalers.

Pre-harvest/harvesting practices

Seventy four percent (74%) of the farmers at the pilot site plant maize twice a year. Varieties planted are the yellow or high yielding varieties (HYV) and the "Cebu White" or "Tinigib". HYV's popularly used (61 %) by farmers mature at 105-110 days after planting while Tinigib have 90-100 days to maturity. Farmers usually harvest on time but delays or advances in harvesting also happen from 15 days due mainly to bad weather conditions.

Harvesting is done through manual ear picking method. Dehusking is performed in the field before sacking and transporting the maize to the farmer's house. Hauling is also done the same day to prevent the maize from being stolen at the farm area. Laborers ranging from 15 to 20 persons can finish harvesting a hectare of mize in one day producing around 100 to 160 sacks (in cobs) or 60-90 cavans wetshelled, including dehusking and hauling. In harvesting, sharing arrangements are followed in which the owner pays the harvesters 10% of their total harvest.

Shelling

Shelling of maize follows after harvest. No predrying prior to shelling is done by farmers to reduce the high MC of maize. If predrying will be practiced, it would entail additional cost for the farmers. Mechanical shellers are popularly used in the survey area with a capacity of between 60 to 80 cavans per hour and a shelling recovery of about 65%-75%. Mobile shellers are more frequently used than stationary models as it can be transported from one farm to another where it is needed. Enough shellers are existing in the site but in spite of this, harvested maize is not shelled immediately. Delays in shelling happen from 1 day to 14 days. Maize held in sacks after harvest still remain in the bags until the time it is ready for shelling.

Most of the existing shellers are owned by the local traders. Some farmers owning shellers are found only in Tampakan. A P3.00 rate is charged per sack including labor when renting a sheller from 36.87 to 45.29 cubic meter per minute per cubic meter of grain.

Project Impact

Adoption of the developed mechanical dryer will enable the farmers/traders to sell their produce to wholesalers at the prevailing market price without any price deduction. With the availability of this dryer, immediate drying by the farmers/ traders of their maize stock is possible, thus minimizing quantity and quality losses.

24. Utilization of Solar Energy for Grain Drying

A well-designed solar-heated grain dryer using a solar collector provides a better alternative to open-air sundrying in order to take advantage of the abundance of solar energy and to keep grain losses to the minimum.

This study therefore developed a solar grain drying system suitable for farm operations. It consisted of a solar heat collector, a flatbed dryer using rice hullfired furnace, and a rock heat storage.

Results indicated that the developed drying system is capable of drying 1.83 tonne of wet paddy from 24% moisture content (M.C.) to 13% M.C. within 8 hours. The drying air temperature obtained in the plenum ranged from 93.58F to 100.77F. The high airflow and insulation rates contributed to its high collector efficiency ranging from 46.35% to 64.03%.

Results also showed that drying cost using the system assuming an economic lifespan of five (5) years and a capacity of 400 tonnes/annum was P4.85 cavan.

25. Testing and Evaluation of Rice Hull-Fired Furnace for Grain Drying

Rice hulls have been widely used as a source of renewable energy, particularly for grain drying. However, more efficient methods of extracting maximum heat from rice hull should be developed. Present rice hull-fired furnaces being used for grain drying operate at very low thermal or furnace efficiency.

This project tested, evaluated and compared six locally manufactured rice hull fired furnaces used fro grain drying and came up with recommendation for modifications and improvement.

During the conduct of the study, the burning efficiency, furnace efficiency and operational characteristics, sensible heat utilization and drying system efficiency as well as the economic viability of the different furnaces was determined and evaluated.

The study revealed that horizontal grate and airsuspended types of furnace have the highest burning efficiencies of 99.12% and 98.61%, respectively. On the other hand, the combined vertical and inclined step grate furnace obtained the highest furnace efficiency of 71.39%, the lowest heat utilization of 2697 kilojoules per kg and the highest drying efficiency of 60.92%.

The flatbed dryer using the inclined step grate furnace is the most economically viable with a return on investment of 45.80%, payback period of 1.18 years and a break-even point of 154 tonnes.

Recommended for improvements were as follows:

1. **Storage construction materials to lengthen durability and minimize heat losses,**
2. **More efficient grate system design for butler fuel burning and disposal of ash**

residues.

26. Drying in Bulk Storage of High Moisture Grains in Tropical Climates

The In-Store drying technology, commonly called two-stage or combination drying is a technology, that originated in other countries and was verified by NAPHIRE for its possible suitability to local conditions. Specifically, this drying technology consists of a fast drying stage which could be achieved by the use of continuous flow driers, a batch dryer or a flash dryer. The grain would be dried rapidly to 18% M.C. This stage is followed by the final drying to be done in storage which is accomplished by moving ambient or supplementally heated air slowly through the grain bulk to bring the M.C. to 13.5-14%.

During field testing, a continuous flow dryer was used in the 1st stage drying and in the 2nd stage, existing NFA silos were modified and converted into instore dryers. These silos were equipped with rice hull fired-furnaces and perforated false floors to ensure uniform airflow.

About 123 tonnes of pre-dried paddy at 18% and 4.2 m grain depth was dried gently to about 12% in 13 days drying period without serious grain quality deterioration.

Combination drying has three advantages: a) flexibility in meeting drying requirement thus preventing backlogs during wet season harvest; b) lower energy cost required than

conventional heated air drying; c) high quality aried grain produced.

27. Design and Development of Corn Crib for the Humid Tropics

Corn cribs are a common practice of storing/ drying freshly harvested ear corn by farmers who resort to this practice to: 1) allow the high moisture content level to dry by natural air to a level favorable for shelling and 2) for price speculation. Significant losses due to deterioration of corn stored in this manner is incurred becaus of unfavorable weather conditions for natural air drying. Hence, modification of the traditional crib is expedient to prevent or minimize these postharvest losses.

Project Highlights

Deterioration due to mold damage and germination was identifid as the primary problem besetting the traditional system of corn cribs practiced by Bukidnon farmers. It was found out that maize damage was due to the inability of the ambient air to effectively dry the ear maize since the relative humidity in the project site was not conducive for natural air drying. Furthermore, the huge volume of stored ear maize (10 tons minimum) inhibited the movement of ambient air through the bulk leading to deterioration especially those at the central portion. Only ear maize located at the periphery of the traditional corn crib experienced minimal drying since these were fully exposed to the ambient air.

Results obtained from the storage/drying trials of the developed corn crib system showed that deterioration due to mold damage and germination was minimized at any given depth of maize stock, initial moisture content and prevailing wind condition. Findings revealed that for the particular vortex wind machine design combined with supplemental heating could enhance drying in storage using an optimum depth of 2 feet corresponding to 5 tons ear maize capacity. Storage/drying experiment using the mentioned depth showed that freshly harvested ear maize with an initial moisture content of 26.7% w.b. and 20.42% w.b. after 7 days storage/drying in the improved and traditional cribs, respectively. Maize deterioration was observed only in samples stored in the traditional crib. Damage was found to be 7.07% deteriorated shelled maize. The aflatoxin content of maize samples (initial-2.75 ppb) was found to be 3.06 ppb for ear maize stored in the improved crib and 12.72 ppb in the traditional crib after 7 days storage.

Project Impact

Results indicated that the use of the developed corn crib system significantly prevent or minimize corn deterioration while in storage. With the improved corn crib system, farmers will be able to save 353.5 kilograms of shelled corn with an equivalent amount of P1.237.25 ($88.38 AUS) using the optimum depth of 2 feet. This saving will be a substantial addition to the income of the farmers. Furthermore, the adoption of this improved corn crib system will enable the farmers to wait favorable corn prices with minimum postharvest losses.

28. Development of an Improved Mobile Corn Sheller

Problem Statement:

About 20% of Philippine population depend on corn as staple food. Corn serve as a raw material for consumer products and also as principal ingredient for livestock feeds.

Prior to final drying, shelling is an indespensible process which should be undertaken" to maximize space and promote the easy handling of grains. Maize shelling if done manually is one of the most labor consuming process done manually is one of the most labor consuming process in corn postharvest handling. The existing maize shellers are normally large and heavy, require high power input, operate and produces low product quality in terms of percent kernel breakage and purity. Damage kernels are susceptible to insect and molds thereby increasing the incidence of aflatoxin contamination.

Thus, there is a need to develop a locally manufactured corn sheller that is highly mobile, with higher efficiency, better product quality and powered with small engine.

Highlights of the study:

1) Problems and deficiencies identified on existing corn shellers;

- **Bulky design, less mobility on the field**

- **Dusty operation**
- **Significant spillage of grain during operation**
- **Low product quality due to higher damage relative and high impurities.**
- **Less efficient power transmission design**

2) Improvements in the Design of the Improved Corn Sheller;

- **Compact design**
- **With suction blower to separate light impurities from the grain and discharges it directly to the ground thereby maintaining a favorable working condition to the operators.**
- **Improved feeding method, oscillating sieve and discharge outlet to prevent spillage.**
- **Grain damage was reduced from 8.75% to 1.89% when shelling 25-30% m.c. The amount of impurities was also reduced from 2.15% to 0.27% maximum percent unshelled loss was reduced from 0.74% to 0.13%. These factors contributed to the improvement of the efficiency from 95.65% of the existing to 98.0% of the improved sheller.**
- **An efficient transmission system using Vbelt drives was used thus reducing the chassis.**

Techno-economic impact of the improved sheller:

1. An economic analysis using actual conditions of strategic corn producing viability of the sheller. It was found to be economically viable under Isabela and Mindanao situation. A sensitivity test was also prepared using decreased annual rate of utilization. Result showed promising return with an average payback period of 1.8 years.

2. Taking into consideration the decrease in the percent unshelled loss from 0.74% to 0.13%, an economic saving of around 3,200 tons with estimated value of P 9.6 M (US$0.48 M) annually of corn produced if the improved sheller would be substituted in use for the existing sheller.

3. The improvement in quality of the shelled grain and the reduction of kernel damage would reduce the level of aflatoxin

29. Study on the Physics of Bulk Storage of Paddy Rationale and Objectives:

This study therefore seeks to investigate the effect of the physical factors of storage on the quantity arid quality loss of paddy stored in bulk in order to establish the technical requirements and the operational management systems for the successful use of bulk storage facilities in the Philippines.

Status:

a. Completion of silo set-up. The silo set-up composed of two-90 ton capacity silos, bagging bin, and grain conveying equipment was completed. The electrical system that will operate the conveying equipment and aeration fan was installed. The conveying equipment and the aeration fan were test operated and found to be working satisfactorily.

b. Weather data analysis. Analysis of weather data for Munoz, Nueva Ecija, shows that the best time to conduct aeration is in the early morning or early evening of the day at the time when air water vapor content and enthalpy are at their lowest. A computer is being used to facilitate weather analysis.

c. Silo instrumentation. Temperatures, moisture condensation, and grain moisture sensors and meters are to be installed inside the silos. Installation of all these equipment will be made on the first quarter of 1988 upon the arrival of the grain moisture sensors and meters.

d. Paddy stocks. The 180 tons of experimental paddy stocks to be used shall be obtained from NFA. These will be treated with insecticide admixture during loading into the silos.

30. Drying of High Moisture Grains in the Humid Tropics

The general objective is to continue the development of techniques for drying paddy,

maize and groundnut adaptable for the humid tropics.

Specifically, the objectives are:

a. To investigate short term quality maintenance of wet paddy in the period between harvest and drying with particular reference to cooling in transit and after receival into handling complexes.

b. To study mill-level drying strategies for paddy based on rice hull conbustors.

c. To investigate first stage drying option in areas where a two-stage drying strategy is required.

d. To study the effect of the various aeration, coiling, and drying strategies on the quality of maize, peanuts and other grains and legumes.

Initial work is being done on the determination of physical properties for maize and peanut such as bulk density, equilibrium moisture content, drying rate, etc. Also, thin layer drying is also being done to establish drying parameters for maize and groundnut. Data to be gathered will be used in simulation studies to destablish drying strategies for these commodities.

31. Control of Aflatoxin in Maize Technology Performance Verification

The whole project aims to control aflatoxin contamination in maize through the development and application of appropriate post-production practices and facilities.

Initial results indicated that minimum damage in shelling is obtained at 17% M.C. of ear corn. Shelling above and below this MC level increases grain damage. Storing shelled corn above 24% also produces high percentage of discolored and moldy grain after 15 days of storage. Storing grain at 14% is safer with 1.8% discolored grain.

Furthermore, amount of discoloration can be minimized if aeration of the bagged grain is provided.

An inventory of postharvest equipment being used in the areas was also conducted as a requirement for further performance evaluation. The evaluation is necessary to establish capacities, efficiencies, etc., which will be used as basis for matching postharvest requirement of a given postharvest system. The project commenced in February 1987 and is sponsored by International Research Development Centre (IDRC).

32. Groundnut Industry: Engineering Aspects

The engineering aspect of the project covers the development of an indigeneous seed processing and storage technology that will meet the needs of small farmer.

Preliminary activities involved extensive literature search to gather groundnut baseline information. This is followed by laboratory work on equilibrium moisture content determination of two groundnut varieties, UPLPn2 and BPI-P9. The physical properties of these two varieties were likewise determined while thin layer drying experiment is in progress. These were done to gather data to be used for the actual design of the storage facilities. The project has a 3-year. duration. It started on October 1,1987 sponsored by IDRC.

TRAINING AND EXTENSION DEPARTMENT

Under this program, NAPHIRE is conducting the following activities:

1. Under the project '`University Training on Grain Post Harvest Technology" funded by EEC. NAPHIRE strengthens the role of agricultural schools and research institutions in meeting the manpower and facility needs of the industry. Post harvest equipment, training and consultancy services are provided to the project beneficiaries.

2. Coordinated in-country projects/programs planning of different institutions concerned with postharvest operations.

3. Offered consultancy services (to a limited extent) to the different sectors of the post harvest industry.

4. Establish linkages with other institutions here and abroad for better coordination of activities.

NEW PROJECTS

A. FOOD PROTECTION DEPARTMENT (FPD):

1. Development of an Integrated Pest Management (IPM) System for National Food Authority (NFA) and Private Mill Warehouses

Practical experiences and logic clearly indicates that more efficient control measures necessitates the integration of different control procedures by utilizing all available techniques into a single cohesive strategy aimed at controlling pest infestation.

Objective:

To evaluate and test a system of Integrated Pest Management Programme (IPM) for NFA and private mill-house operations with the end view or reducing losses due to insect infestation.

Specific:

1. To evaluate the effectiveness of different pest control strategies for the control of insect

pest in storage.

2. To develop an IPM which will focus on the prevention of pest infestation from procurement point to distribution.

3. To pilot test the suitability of developed IPM system in NFA warehouses and private mill warehouses.

2. Establishment of efficient Methods for the Prevention and Control of the Khapra Beetle, Trogoderma Granarium (Everts)

Relevance:

Trogoderma granarium (E) is a very serious pest of stored grains. Importing countries have imposed strict bans on any importations that are likely to be infested with T. granarium from countries where this species is endemic.

The biology and ecology of T. granarium has been exhaustively researched in other parts of the world where it is considered endemic, but information on an integrated cost-effective control strategy is lacking.

Objective:

To establish efficient methods for the prevention and control of the khapra beetle. T. granarium through improved quarantine procedures, policy implementation and effective treatments.

Specific:

1. To establish a nationwide profile of the occurence and distribution of T. granarium.

2. To identify strains that have developed resistance to currently used pesticides and fumigants.

3. To critically identify the constraints in implementing an effective quarantine campaign both in imported stocks and in transfer of stocks nationwide known to be infested in order to isolate and curtail its continued spread.

4. To identify/develop the most appropriate method of control.

5. To develop rapid and convenient detection methods for both early and hidden infestation.

3. Development of a Diagnostic Capability for the Control of Aflatoxin Contamination in Maize

Relevance:

Mycotoxin contamination of maize has long been recognized as a problem having far-reaching and detrimental effects on human and animal health and productivity, and with serious trade and economic repurcussions.

Plaque by such problem, the search for methods to remove or control aflatoxin in contaminated commodities has become imperative. However, monitoring labaratories to handle detection and analytical work have been lacking.

Objective:

1. To establish a centralized and regional laboratory facilities to monitor aflatoxin contamination.

2. To study methods of control once laboratory capability has been established.

4 Establishment of a Workable Grades and Standard of Aflatoxin for Maize

Relevance:

The existing grading practices for grains and related agricultural food and feed commodities both on farmers and traders level do not consider mycotoxin content as a quality factor. This nonexistence of established grades and standards of aflatoxin contamination have contributed to outright disregard by farmers/traders to consider preventive and control measures for mycotoxin contamination in their production and post production activities as no additional benefits are derived from their efforts.

The need to safeguard the health and safety of the public and the livestock as well, underscores the importance of pursuing the development and enforcement of grades and standards on aflatioxin for food and feeds.

Objective:

1. To develop grades and standards for maize on the permissible levels of aflatoxin contamination.

2. To develop a workable grading system for maize for field procurement.

3. To come up with a suitable pricing for the developed grades and standard.

5. Determination of Early and Hidden Insect Pest Infestation in Storage

Objectives:

1. To develop rapid and reliable means of detecting early and hidden insect infestation.

2. To use the early pest levels to predict future infestation and damage.

B. POSTHARVEST SYSTEM ANALYSIS AN D DEVELOPMENT DEPARTMENT

1. Pilot Testing of and Improved Maize Crib in the Humid Tropics

Relevance:

NAPHIRE has developed an improved Maize crib which has been technically proven to be more effective than the traditional corn crib. Equipped with a vortex wind machine and rice hull fired furnace, the improved Maize crib was able to dry 5-ton of freshly harvested ear maize from an initial m.c. of 26.7% to 16.64% m.c. after 7 days of storage/drying without so much sign of deterioration. Its economic viability and social acceptability was not yet verified through this proposed project.

Objectives:

General:

To determine the economic viability and social acceptability of the improved prototype maize crib in the humid tropics.

Specific:

1. To modify the improved maize into a low cost facility using indigeneous materials.

2. To compare the cost and benefits of using the improved maize crib against the existing maize crib.

3. To identify the various socio-economic factors that influence the utilization of the maize crib.

4. To identify the most viable system in using the improved maize crib under actual field condition.

2. Systems Study on the Socio-Economics of Paddy Bulk Handling for National Food Authority (NFA) Operations

Objective:

To develop a viable scheme for the adoption of paddy bulk handling system for NFA operation.

Specific:

1. To conduct a system study of the present handling and storage practices and management of the NFA operation.

2. To determine the economic feasibility of adopting bulk handling and storage techniques and management to the systems.

3. To develop policy recommendation for the eventual adoption of bulk handling techniques.

3. Adoption and Utilization of the NAPHIRE Improved Corn Sheller (NICS) in Selected Areas in the Philippines

Objective:

To promote a viable industry through an effective and efficient maize shelling operation.

Specific:

1. To enhance the awareness among maize farmers, producers and traders of the benefits from using the NAPHIRE Improved Corn Sheller.

2. To provide target-end-users with the necessary skills in operating the sheller.

3. To determine the rate of utilization of the sheller in the project area.

4. To determine the socio-economic impact of the adoption of the technology.

5. To identify the constraints and formulate possible solution to the adoption of the technology.

4. Establishment of Village Type Grain Processing Centers

Objective:

1. To determine the postharvest technologies which are technically feasible, economically viable and socially acceptable for farmer's cooperative at the rural village level.

2. To develop design consideration, standards and schemes in an integrated postharvest system at the on and off farm levels.

3. To evaluate the viability of a pilot farmers cooperative-based enterprise engaged in the processing and marketing of grains.

4. To evolve appropriate extension strategies and relevant policy guidelines as a basis for the wider implementation of the program.

C. FACILITIES PROCESSES DESIGN AND DEVELOPMENT DEPARTMENT

1. Design and Development of Mobile Farm Flash Dryers

Mechanical dryers are available but farmers cannot own a dryer even how inexpensive the unit is. They have other pressing priorities for any meager cash they have.

Past experience dictate that custom-drying using mechanical dryers, can be an area which farmers can explore in the same way as what happened with customthreshing and custom harvesting

Objectives:

The development of farm flash drying equipment and strategy to be made available to farmers by small entrepreneurs through custom drying services so they can increase their level of income.

D. TRAINING AND EXTENSION DEPARTMENT

In order that NAPHIRE's activities will meet the critical and specific needs of the grain industry, postharvest research and training is to interlock with production and marketing operations and on an integrated basis from harvesting, threshing, drying, storage, processing and handling/distribution. As such, aside from the regular research and training facilities and equipment required, it would be necessary to establish a pilot scale integrated grain processing plant with adequate structures to store both the material requirement of the plant and experimental stocks for research and training purposes. The pilot plant will ensure that technologies and recommendations are first validated under typical commercial conditions prior to extension.

Objective:

To develop and strengthen the research and training capabilities of NAPHIRE.

Specific:

1. To provide technical assistance in the preparation and formulation of specific plans/designs to upgrade the capabilities of NAPHIRE.

2. To train key NAPHIRE staff in the areas of project management and postharvest operations.

3. To construct research and training facilities and other related infrastructures to ensure the smooth conduct of the Institutes operations.

4. To supply the needed research and training equipment and capital outlay to enable the Institute to adequately respond to the needs of the grains postharvest industry.

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