Storage Management

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MATCOM

training for the management of cooperatives

TRAINER'S MANUAL

STORAGE MANAGEMENT

material for management training in agricultural co-operatives

international labour office geneva

MATCOM

material and techniques for cooperative management training

The MATCOM Project was launched in 1978 by the International Labour Office, with the financial support of the Swedish International Development Authority (SIDA)

In collaboration with cooperative organisations and training institutes in all regions of the world, MATCOM designs and produces material for the training of managers of cooperatives and assists in the preparation of adapted versions for use in various countries. MATCOM also provides support for improving the methodology of cooperative training and for the training of trainers.

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Preface

This training package is one of a number of training packages designed by the ILO - MATCOM Project to assist people who plan or carry out training for the managerial staff of agricultural co-operatives in developing countries.

The training provided under this training package, as well as under the other packages in this series, is based on a thorough analysis of:

(i) the tasks and functions to be performed in agricultural co-operative societies in developing countries;

(ii) the common problems and constraints facing the effective performance of these tasks and functions.

The result of this analysis is reflected in the MATCOM "Curriculum Guide for Agricultural Co-operative Management Training". The Guide contains syllabuses for 24 management subjects and it is on these syllabuses that the training packages have been based.

The list of subjects and syllabuses is as follows:

1. Co-operative Knowledge
2. Co-operative Law
3. "Co-operative" Management
4. Farming
5. Collecting and Receiving Agricultural Produce
6. Transport Management
7. Storage Management
8. Marketing of Agricultural Produce
9. Supply Management
10. Rural Savings and Credit Schemes
11. Staff Management
12. Office Management and Communications
13. Book-keeping and Accounting
14. Financial Management
15. Cost Accounting
16. Risk Management
17. Statistics
18. Project Preparation and Appraisal
19. Work Planning
20. Rural Sociology
21. Economics
22. Development Economics
23. Export Marketing
24. Public Relations, Member Recruitment and Member Education

For more information on the above training material, please write to:

The MATCOM Project
c/o CO-OP Branch
International Labour Office
CH 1211 Geneva 22
Switzerland.

THE TRAINING PROGRAMME

1. Target Group

Target groups for this training programme on "Storage Management" are managers and assistant managers of agricultural co-operative societies with marketing functions.

Co-operative officers or extension staff supporting the above target groups could also benefit from the programme.

2. Aim

The aim of the programme is to train participants to organise and manage the storage of agricultural produce. In particular, the programme will enable trainees:

- to identify the fundamental reasons for storing produce;
- to compare the benefits and costs of storing produce, and to identify the critical importance of minimising costs;
- to estimate the amount of space that is needed to store particular quantities of specific crops;
- to select the most effective type of storage for the crops, economy and environment in which they operate, and to identify the information necessary for a decision of this sort;
- to decide whether their members' crop should be stored in sacks or in bulk;
- to identify the functions of stores records and controls as a basis for designing and operating effective control systems;
- to design and operate effective paperwork systems for the control of stores;
- to identify the interrelated effects of moisture and temperature on crop deterioration in storage;
- to select the most appropriate method in given circumstances for measuring temperature, relative humidity and produce moisture content in store;

- to select the most suitable instrument from a given range for measuring moisture content and temperature in stored grain;
- to identify the potential for damage caused by insects and rodents and to inspect storage premises in order to find out the level of infestation;
- to identify the various ways of preventing or reducing insect and rodent infestation, and to decide on the most appropriate type and method of application in given circumstances;
- to identify the role of storage in the marketing of perishables, and to evaluate the various ways in which the decline in value of perishable produce after harvest may be minimised;
- to identify situations where cold storage is and is not a worthwhile investment and to manage such facilities effectively;
- to apply what they have learned to improve their ability to make storage management decisions in general and to solve particular storage problems in their own societies.

The programme as described in this manual can be used for a special course on storage management, or it can be incorporated in the curriculum for a more comprehensive management training programme.

3. Duration

The complete programme, as described in this manual, consists of 17 learning sessions. Session times vary from 1 to 3 hours. The total programme will take approximately 35 to 40 hours, or between 6 and 7 days, depending on the qualifications and experience of the trainees. Time for study visits should be added and a timetable should be prepared accordingly.

4. Training Approach and Methods

The programme is based on the assumptions that training is expensive and that money for co-operative management training is scarce. Therefore, it looks upon training as an investment, and unless the training yields results, the return on the money invested in it will be nil.

On their return home from the training programme, the trainees should therefore be able to show concrete results of improved management. In order to prepare and equip the trainee to achieve this, the programme has adopted a highly active learning approach through the use of "participative" learning methods and a built-in action commitment.

Trainees will not learn about their duties in a general and passive way. Their day-to-day management problems have, as much as possible, been translated into realistic case-studies, role-plays and other problem solving exercises. Trainees (working mostly in groups) will learn by solving these problems as in real life with the necessary assistance and guidance from the trainer, who will act more as a "facilitator" of learning than as a lecturer.

The built-in action commitment at the end of the programme will give each trainee the opportunity of using the knowledge and expertise of his colleagues in the training programme to find a concrete and acceptable solution to a specific problem he is faced with - a solution to which the trainee will commit himself for implementation.

5. Structure

The programme is divided into seventeen topics.

1. Introduction
2. Why store?
3. The costs and benefits of storage
4. How much space is needed?
5. The choice of storage method
6. Bulk or bagged?
7. Stock records and controls
8. Paperwork and bin cards
9. Moisture and temperature
10. Measuring moisture and temperature
11. Measuring instruments
12. Insect and rodent damage
13. Controlling infestation
14. Perishable produce
15. Cold storage

16. When to sell
17. Action programme and commitment

Each topic above is covered by a session in this package. The following material is provided for each session:

- a session guide for the trainer (yellow pages), giving the objective of the session, an estimate of the time needed and a comprehensive "plan" for the session, including instructions on how to conduct the session;
- handouts (white pages) of all case-studies, role-play briefs, etc., to be reproduced for distribution to the trainees.

6. Adapting the Programme

Before "using" the programme in a real training situation, it may be necessary to adapt it.

Read through the programme and decide whether:

- the programme can be run as it is;
- only certain topics or session should be used;
- new topics and sessions should be added.

Your decision will depend on the training needs of your trainees and the means you have at your disposal.

Carefully read through the sessions you have decided to use. Check the subject matter in both the session guides and the handouts. Modify them where possible to include local currencies, names, crops and so on. Such adaptation will help trainees to identify themselves more easily with the people and the situations described in the handouts, and will considerably increase the impact and effectiveness of the training programme.

In the event of substantial adaptation, it is better to retype the page completely.

Minor adaptations (currency, one sentence or paragraph) can be corrected on the original supplied in this binder.

7. Preparing Yourself

Some trainers may feel that material of this sort means that they need only spend a few minutes preparing for each session. This is not the case.

You should carefully study each session guide and prepare a detailed lesson plan based on the content and sequence suggested in the guide, and on the adaptation which you may find necessary.

You should work through all calculations, so that you can explain them to the trainees.

You should obtain and study all necessary local forms, statistics or other material so that you can incorporate them in the session where they are suggested.

8. Preparing the Training Material

Handouts constitute an important part of the training material used in the programme. They can be reproduced from the original handouts supplied in the ringbinder, after the necessary adaptation has been made (see "Adapting the Programme"). Reproduction may be done using whatever method is available: stencil, offset printing, photocopy, or other.

The only item of training equipment which is absolutely essential is the chalkboard.

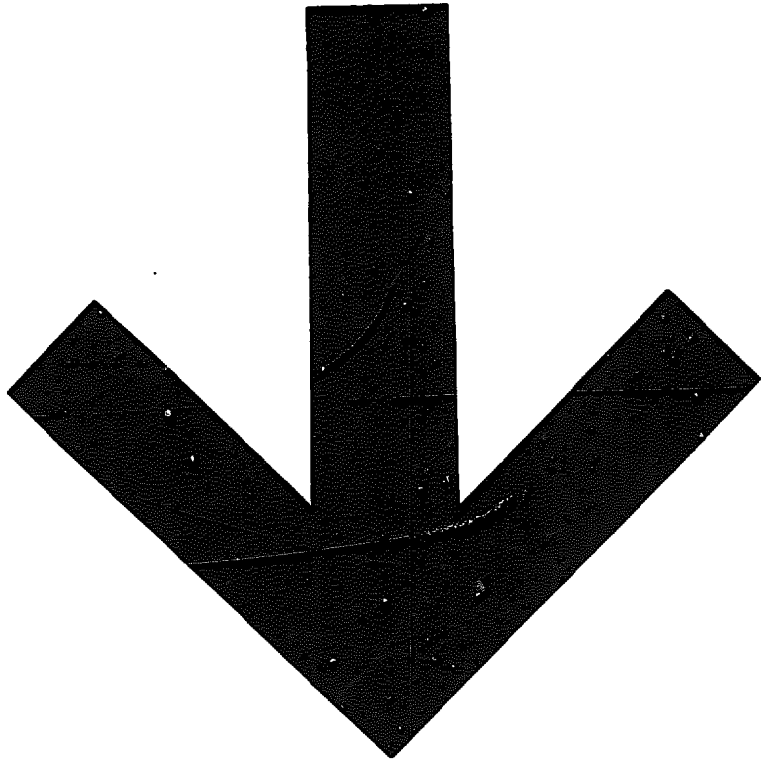
Trainees should be informed in advance to bring any documentation from their society pertaining to storage management such as:

- examples of stock control documents (bin cards, member's receipts, delivery notes, goods received notes, invoices, produce treatment records, etc.);
- calculations of storage costs;
- plans of godowns.

The Pre-Course Questionnaire should be sent to trainees in advance. Trainees should be asked to complete it and hand it in at the beginning of the training programme.

9. Follow-up and Evaluation

It is recommended that the instructor or other resource persons arrange to contact the trainees after six months in order to see how well they are doing with implementing their "action commitments". The course - not the trainees - should be evaluated by the success which trainees have had in the implementation of their commitments.



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topic

1

introduction

SESSION 1

INTRODUCTION

Objective: To demonstrate the importance of effective storage management, and to identify sources of storage expertise within the group.

Time: One to two hours.

Material: Completed pre-course questionnaire, timetable and list of participants.

Session Guide:

1) If a prominent visitor is to open the programme, he or she should be asked to give examples of problems or failures that have arisen through inadequate storage management and to stress that people in the trainees' position can make a major contribution in this area.

2) Ensure that any administrative problems are dealt with. Matters of accommodation, payment of expenses, transport, rooms for private study and any other points of information should be settled now.

3) Point out that a training course such as this is an investment. Attempt to estimate its total cost (including trainees' salaries while in training). Ask trainees to suggest how they might use this sum of money if it was available to them to improve the storage in their societies. They may mention investment in equipment, maintenance of buildings, or something else. Point out that unless the value of the benefit to the members from this course exceeds the cost of the course, the money would have been better spent as suggested. Trainees should therefore continually relate what they are learning to their own jobs. If it appears irrelevant, mistaken or they do not understand how to use it, they must say so and the course will be changed accordingly.

4) Go briefly through the timetable and stress that trainees will be required to contribute and not merely to listen: people learn not by sitting and listening but by participating and doing things themselves.

5) Ask each trainee to summarise his prior training and experience, and to state what he hopes to gain from attending this course. Refer to the pre-course questionnaire if necessary. Stress that everyone brings something to the course and that the total experience in the group as a whole is substantial. While trainers and the material will provide ideas and guidance about techniques and a structure to the course, a major input must come from the trainees.

   Attempt to classify trainees' objectives and experience on the board: identify the special expertise or experience that each trainee brings to the course, emphasizing the point that the group as a whole is an extremely powerful source of expertise and experience.

6) Tell trainees that at the end of the course everyone of them, individually, will be expected to produce and commit himself to an action plan which will include:

   - A statement of a storage problem in his society.
   - A brief description of the way in which he proposes to solve this problem.
   - Ideas on how he will "sell" this solution to his superior and/or subordinate staff, and to the committee and members if necessary.
   - A specific description of exactly what the trainee expects to have achieved by a certain specified date (within 6 months or 1 year from the end of the course).

   Tell the trainees that the instructors intend to contact them after this specified period to assess how successful they have been in implementing their plans; the course, rather than they themselves, will be evaluated by their success.

Pre-Course Questionnaire

Name: .....

Society: .....

Job Title: .....

Brief description of your responsibilities:

.....

.....

.....

What parts of your job do you enjoy the most?

.....

.....

.....

What parts of your job do you find the most difficult?

.....

.....

.....

Please complete the following sentence:

As a result of attending the course on Storage Management, I hope that I will be able to .....

.....

.....

... .

topic

2

why store?

SESSION 2

WHY STORE?

Objective: To enable trainees to identify the fundamental reasons for storing produce.

Time: One hour.

Session Guide:

1) Ask trainees what effect storage has on the physical condition of a crop. Is it better or worse after having been in storage?

   - In a few cases, such as tea or tobacco, storage is really part of the processing and improves the crop.
   - In most cases, the objective of storage is to preserve produce and to change the physical condition of the crop as little as possible.
   - Storage adds time value. Unless the crop is produced and consumed at the same time storage is needed to form a "buffer" between the two flows.

2) Ask trainees in what situations crops are harvested and consumed at more or less the same time. Answers should refer to "home consumption"; many vegetables and meat, for example, are produced and consumed in this way. Trainees should appreciate that little storage is required for these situations, but in today's developed and extended marketing situations most crops need a "buffer" between production and consumption.

3) Ask trainees to give reasons why it may be necessary and economically worthwhile to store produce. These may include:

   - Most crops are harvested seasonally and consumed continually.
   - Crops have to be accumulated from individual member's deliveries, until there is enough to warrant transport to a further customer.

- Crops are produced sporadically but processed on a continuous basis.
- Crops command low prices at harvest time. The cost of storage is less than the difference that can be obtained by selling them later.
- Crops for export must be accumulated until they make up a ship or aeroplane load for international transport.

4) Ask trainees what would happen if societies were to eliminate any form of storage, and to demand that customers bought their members' crop as and when members wished to sell them off the farm:

- The crops would be bought but for a lower price, since the purchaser would have to pay the stock holding costs instead.

or

- Members would have to store the crops themselves, and would bear the cost for this.

Why should a co-operative society be able to store members' crops any more effectively or economically than either members or ultimate customers? Why should a society not concentrate on credit, input supply, education and selling without incurring the expense and management burden of storage as well?

A primary co-operative society is <u>not</u> necessarily the most economical base for crops to be stored.

- Some crops, at some stages, may be more economically stored on the farm or by subsequent customers and processors.
- Unless crops can more economically and effectively be stored by a society, the society should allow its members or its customers to perform this function instead.

5) Ask trainees to write down as many different costs and risks as they can think of which make up the total cost of storage. Allow them up to fifteen minutes for this. Ask each trainee in turn for one item and continue until all suggestions have been listed on the chalkboard/OHP. Trainees may include items such as the following; ensure that the basic categories of physical facilities, risk or loss, deterioration and cost of money are all covered.

- The cost of storage buildings.
- The cost of packaging required only for storage.
- The cost of land on which buildings are built.
- The cost of equipment for moving the crops into and out of storage.
- The cost of racks or any other storage appliances.
- The cost of crop loss to unavoidable fungus, rodent attack and so on.
- The cost of decline in value because the crop is less fresh.
- The cost of insurance.
- The cost of labour for storing and putting into and withdrawing from storage.
- The cost of interest or whatever else might have been earned with the money if the crop had been sold earlier (opportunity costs).
- The risk of theft.
- The risk of fire.
- The risk of decline in value.
- The risk of other disasters such as flood and wind damage.

Stress that costs must include <u>certain</u> cost items as well as risks. Even if none of the possible disasters happen, the society would not even run the risk of them happening if the crop had been sold at once, and risks are therefore a form of expense.

6) Trainees may not all be familiar with the concept of opportunity costs, or of the costs of incurring risks. Ensure that both are understood by asking and explaining the following questions:

- A friend borrows your bicycle on two separate occasions. The first time you were away and would not have used it, but the second time you wanted to use the bicycle to go to see a film but were generous enough to sacrifice this in order to oblige your friend. The borrower used the bicycle in exactly the same way on both occasions, and caused no damage or appreciable wear and tear. Was the "cost" to you of lending him the bicycle the same in both cases?

(The real cost of being deprived of anything is the value of what else you might have done with it.)

- You want to go to town and two taxis are available. One is fast and comfortable, but the driver is rather rash and is said to have had several near misses, although he has never had an actual accident. The other is slower and an old car, but the driver is cautious and extremely safe. Both cost the same, but some people choose the slow one; why?

  (To them, the risk of an accident, even though it is very small, "costs" more than the benefits of greater speed and comfort.)

7) Ask trainees to suggest why a society should be willing to incur all these different costs, merely in order to add "time value" to members' crops. How can time alone compensate for all these expenses?

   - Customers may pay higher prices for the crop.
   - The Society may incur lower transport or processing costs.

   Stress that crops should only be stored if the benefits exceed the costs. Co-operative management must appraise every storage decision on this basis, including decisions to continue storage as well as to start storing a crop. The purpose of this course is to enable trainees to <u>reduce</u> the cost of storage as much as possible and to <u>decide</u> when and whether to store crops at all.

topic

3

the costs and benefits of storage

SESSION 3

THE COSTS AND BENEFITS OF STORAGE

Objective: To enable trainees to compare the benefits and costs of storing produce, and to identify the critical importance of minimising costs.

Time: Two to three hours.

Material: Exercise "Storage Costs/Benefits".

Session Guide:

1) Ask trainees how they decide whether to store a commodity or to sell it at once. They may refer to "normal practice" but stress that all storage decisions must be based on a comparison of the costs and benefits. Ask trainees whether they would store a crop if the price was the same at harvest and after it had been stored. Would they store a crop for six months if the price was expected to increase from $100 to $101 a tonne during the period? Their answers should confirm that the decision to store or not, or to continue storing, is an economic one. Crops should never be stored as a matter of course.

2) Remind trainees of the costs of storage identified in the previous session. Ask how they would put a figure to each of the items identified at that time. Show that even apparently simple cost items are difficult to assess in given circumstances, but stress that some attempt must be made in spite of the difficulties.

Elicit a list of the costs, the calculation method and the problem of estimation as follows:

Cost Item	Method of Calculation	Problems
Buildings, Packing Materials and Handling Equipment	"Depreciation", or the cost of the item divided by its likely life. Rent paid.	Original cost of the item may be unknown. Inflation may make historical costs irrelevant. The items may be otherwise unused.
Land	Rent, or the interest that would have been earned during the storage period on the cost of the land.	The land may have been donated, its original cost may be irrelevant or it might otherwise not have been used.
Labour	The wages of people directly employed in storage, plus a proportion of supervision and management salaries.	The society may have a social obligation to employ poor people, labour may be provided gratis by members, management time cannot easily be apportioned, labour might otherwise be idle.
Decline in Value of Crop or Loss During Storage	Estimate of the percentage losses expected multiplied by the price expected.	Future losses and prices cannot easily be estimated.
Insurance	Actual price paid.	The Society may carry comprehensive insurance on all its affairs, so that the cost of covering a particular item cannot be determined.
Money Tied Up in Crop in Storage	Amount of interest that would have been paid on the money if the crop had been sold earlier.	Rates of interest vary, times of settlement cannot be determined.
Risk of Theft, Fire, Flood, etc.	The amount of the possible loss multiplied by the "odds" of its happening.	Chances of loss occurring are unknown.

3) Trainees may not be familiar with how to calculate the costs of risk, as suggested in the last item on the list. It is unnecessary to go into probability theory. Ask trainees which they would prefer of the following:

- $10 promised by someone who is always reliable.
- $15 promised by somebody who is said to keep his word two times out of three.
- $20 promised by somebody who is said only to keep his word half the time.

All of the money is promised to be handed over at the same time.

If they accept the estimates of the likelihood of the donors keeping their word, any preference will relate merely to the person's preference for certainty over risk taking. Most people unless they are gamblers, will choose the first option, but the three sums of money are in fact all "worth" $10, if the estimates of the likelihood of payment are to be believed.

Confirm trainees' understanding by asking whether they would be willing to pay $500 insurance against flood damage if it would cause $1,000 worth of loss and records show that floods occurred one year in ten. Trainees should realise that this would not be worth it. The "cost" of the risk, and the value of insuring against it, is no more than $100.

4) Trainees may suggest that a prudent co-operative manager should take out insurance against all such risks. Point out that insurance premiums are calculated on the basis of the likelihood of the loss occurring, plus the costs of administration and the profit of the insurance company. Ask trainees why they might not insure against such risks:

- Insurance premiums have to cover the average risks. If a given society is far less likely than average to suffer the particular accident, it may be less expensive not to insure against the risk.
- If it is more likely than average, that the accident will occur the society should insure against the risk, and if the accident would be disastrous for the society and might even force it into bankruptcy, the risk should be covered even if it is expensive.

5) Give a copy of the exercise to each trainee. Allow up to fifteen minutes for the first problem. Ask one trainee who is less likely than most to have a correct answer to give his conclusions.

Elicit the correct answer from this trainee and others, ensuring that all trainees understand each stage:

- Benefits of Storage:

Revenue from immediate sale	- 1,000 tons x $200	=	$ 200,000
Revenue from sale in six months (allowing for storage loss) x $230	- 950 tons	=	$ 218,500
Net Benefits from Storage		=	$ 18,500

- Costs of Storage:

Labour	$ 1,500
Rent	1,000
Insurance	2,000
Cost of Money - 10% x $200,000 x 0.5 year	10,000
Total Costs of Storage	$ 14,500

- The Society will be $4,000 better off if they store the produce for six months rather than sell it at once.

6) Stress that the margin is a small one, in relation to a total sale of over $200,000. It is less than 2½%. This is far less important than the 15% difference between $200 and $230 which is more obvious than the net benefit after storage costs.

Ask trainees which of the cost items is the most critical. Stress that even if labour, rent and insurance were all doubled, the advantage would only be very marginal with immediate sale ($14,500 + $4,500 = $19,000).

Ask trainees to calculate the effect of increasing the interest rate on money to 15%.

(An extra $5,000 "cost" would be incurred, making storage uneconomical.)

Ask trainees how many of their societies have to borrow money from the bank to finance payments to members if the crop is not sold at once. Ask what interest rate figure should be used as a "cost" of storage if such a loan is necessary. Is this significantly different from the interest rate paid on deposits which are made by the Society?

- Most banks, including co-operative banks, charge 4% or 5% more for loans than they give for deposits. The difference may mean that storage is no longer economical.

7) Ask trainees what other cost figure is even more important. Ask them to calculate the effect of an increase in the storage loss from 5% to 7½%.

(The net benefit would be reduced to $12,750, which is $1,750 less than the cost. Immediate sale at $200 would be more economical.)

Stress the vital importance of minimising losses in storage. Ask trainees what percentage of whatever crops they store is lost per month or per week, or what percentage decline in value it suffers because of declining quality. Trainees may deny that there is any loss, or admit that they do not know.

Stress that there will always be some losses in storage, and that in order to minimise them and to know what it is worth spending to reduce them, it is necessary to know:

- The amount of loss currently experienced.
- The cost of prevention measures.
- The reduction in the losses expected as a result of taking these prevention measures.

If the management of an agricultural co-operative does not have this information, they cannot market their members' crops in the optimum manner.

8) Allow trainees up to 30 minutes to complete the second exercise. After this period, ask a trainee to go through his calculations. Elicit the

following figures from various individuals as appropriate, ensuring that everyone understands every stage.

a) Sell Crop At Once and Repay Loan:

- Benefit:	Saving of interest at 10% on $50,000 for 0.5 year	$ 2,500
- Cost:		nil
- Net Benefit:		$ 2,500

b) Store Crop:

- Benefit:	¾ chance of selling 95 tons (i.e. crop net of storage loss) at $600		$ 42,750.00
	¼ chance of selling 95 tons at $750		17,812.50
	Total		60,562.50
	Less: Revenue if sell today		50,000.00
	Benefit		$ 10,562.50
- Cost:	Handling and Labour	$ 5,000	
	Insurance	2,000	
	Total		7,000.00
- Net Benefit:			$ 3,562.50

c) Sell Crop At Once and Buy Advance Supplies of Fertilizer:

- Benefit:	2,000 bags x $5 difference		$ 10,000
- Cost:	Handling and Labour	$ 5,000	
	Insurance	2,000	
	Total		7,000
- Net Benefit:			$ 3,000

The trainees may have chosen to treat the alternative of repaying the loan as zero, and may have added the $2,500 as an extra cost to the other two possibilities. This will produce the following figures:

- Repay Loan = zero
- Store Crop for six months, net benefit = $ 1,062.50
- Buy Fertilizer in Advance = $ 500

The result is the same and these are both equally "correct" solutions to the problem.

9) Some trainees can be expected to have made certain common errors:

- They may have double counted the interest charge, by counting the saving of $2,500 as a benefit for paying off the loan, and also adding interest costs as a cost of the other two alternatives. Ensure that they understand that it should only be counted once.
- Trainees may have failed properly to take account of the different price possibilities for the crop after six months. Explain the use of three-quarters and one-quarter as multiplying factors, by showing that their total is one. The object is to multiply each possibility by the chances out of one that it will happen.
- They may have made simple copying or arithmetical mistakes, possibly because of untidy layout. Stress the necessity for neatly organised layout of the problem and careful and double checked calculations in any type of quantitative assessment of this sort.

10) Ask trainees what they recommend the Manager should do. Stress that mathematical calculations are only an aid to judgement and not a substitute for it.

Their answers will depend on each Manager's believe as to the reliability of his estimates of:

- Future interest rates charged by the bank.
- The selling price of the crop after six months.
- The buying price and availability of the fertilizer after six months.
- The storage costs for fertilizer and the crop.
- The storage losses.

The figures alone suggest that the Beta Society should continue to borrow the money from the Bank and store their crop for a further six

months. The difference is so small, however, that risk factors such as those above can quite easily lead the Manager to choose one of the other alternatives.

Stress to trainees that this does not show that the calculations are a waste of time. Only when the size of the difference between the net benefit of two or more alternatives has been calculated can a manager decide whether his qualitative assessment of the situation requires him to over-ride the quantitative answer or not.

11) If time allows, ask trainees to calculate and to compare the effect of changes in interest rates, storage costs, prices and storage losses. Stress again the importance of curtailing losses, and the need for information in order to do this effectively.

Storage Costs/Benefits

1) The Manager of the Alpha Society was offered $200 a ton for his members' maize which had just been received into the Society's store. He knew that if he stored the maize for a further six months it would fetch $230 a ton. His members had produced 1,000 tons. He estimated the cost of storage as follows:

- Interest paid on deposits = 10% per year.
- Labour = $1,500 for the period of storage.
- Rent of buildings and equipment = $1,000 for the period of storage.
- Losses in storage = 5% during the period.
- Insurance = $2,000 for the period.

Should he accept the immediate offer or put the maize into storage for six months?

2) The Manager of the Beta Society was in a dilemma. How could he use the Society's scarce funds for the best advantage of its members?

The Society had just been paid for last year's crop. After distributing the surplus and paying all necessary expenses there was $50,000 remaining. This could have been used to pay off the overdraft at the Co-operative Bank, but the Bank Manager was quite happy to allow the Society to continue to make use of this facility. The Bank charged an annual interest of 10% and he knew that the Beta Society was a well managed and secure operation.

The Manager was planning in a few days to sell the 100 tons remaining from members' second crop which has been in storage for about a month. He knew that he would be able to sell it for $500 a ton and the $50,000 which would be received would have to be remitted to members at once.

One of the Committee had pointed out that the Society should consider waiting six months before selling this crop. He had examined price movements over many years, and had calculated that about one season in four the price increased after six months to $750 a ton. In other years it rose to about $600. He argued that it was probably worth storing the crop for six months to get $100 a ton more, and would be a wonderful windfall if they could get $750. The members would have to be paid their $50,000 immediately, in any case, but he knew that there was a cash surplus from the earlier crop. He pressed the Manager to use it to pay the members so that they could store the second crop for a further six months and thus earn a high profit.

This decision was difficult enough, but the Manager had today had a letter from the National Fertilizer Corporation, offering 2,000 bags of fertilizer, which was Beta Society's normal annual requirement, at the special price of $25 a bag. The fertilizer would not be needed for six months, at which time it would cost $30 a bag, but in order to take advantage of this special price the Society would have to take the fertilizer into stock and pay for it now.

The space which was now being used for the members' second crop could easily be used for the fertilizer instead, but there was no other space available. The labour and equipment requirement would cost about $5,000 and insurance would cost a further $2,000 for the crop or the fertilizer. The Manager estimated that about 5% of the stock would be lost in storage, during the six months' period but he did not expect any deterioration or loss in the fertilizer.

The Manager realised that he could only do one of the three things. Which should he choose?

topic

4

how much space is needed?

SESSION 4

HOW MUCH SPACE IS NEEDED?

Objective: To enable trainees to estimate the amount of space that is needed to store particular quantities of specific crops.

Time: Two to three hours.

Material: Exercise "Space Calculations".

Session Guide:

1) Ask trainees to suggest what factors determine the amount of storage space needed by a co-operative society. They may think only of the amount of crop to be stored. Elicit further suggestions, and ensure that the following factors at least are listed on chalkboard/OHP:
   - The amount of crop to be stored.
   - The form of packing.
   - The height to which it is stored.
   - The density of the crop itself.
   - The width and frequency of access gangways.
   - The type of equipment, if any, used for handling the crop.
   - The number of different kinds of crop to be stored in the same place.
   - The frequency and speed with which access is to be required.

2) Ask trainees how they normally measure amounts of crops, and how they measure storage space or building size. How can tonnes of crop be converted into the linear or cubic measurements of storage buildings? Ensure that trainees appreciate that different crops occupy different amounts of space per tonne by asking them to compare the space required for a tonne of feathers and a tonne of lead. List the following crops on chalkboard/OHP and ask trainees individually to rank them in order of the cubic metres of space that they would expect one tonne of each crop

to occupy. Warn trainees that some of the crops may be approximately equal in the amount of space they occupy. Allow up to ten minutes for this exercise.

Crop	Order	Cubic Metres Per Tonne
Tealeaves in Chests	1	2.9
Bagged Maize	4	1.8
Dried Fish in Bales	2	2.3
Bagged Sugar	6 Equals	1.3
Bagged Coffee Beans	5 Equals	1.6
Bagged Maize Meal	3	2.1
Bagged Milled Rice	5 Equals	1.6
Bagged Beans	6 Equals	1.3
Bagged Whole Wheat	5 Equals	1.6

After trainees have completed their attempts, ask for their suggestions. Discuss the results, and compare them with the actual ranking given by each crop in the table above. These figures, and the figures for the actual cubic metres, should not of course be put on chalkboard/OHP until they have been discussed.

Demonstrate the size of a cubic metre, and ask trainees to suggest how many cubic metres of storage space would be occupied by a tonne of each of the crop. If trainees are more familiar with 90 kg. bags or some other measure, than with tonnes, ask them how much space would be occupied by eleven bags or whatever number of the local measure is equivalent to one tonne. Trainees may well underestimate, since a tonne of bagged produce looks far bigger than a cubic metre. Compare trainees' estimates with the actual figures which should only then be written down in the table as shown above.

3) Mark out in advance an area of approximately ten metres by five metres on the floor. This should not previously have been brought to trainees'

attention and they should not at this stage be told how big it is. Ask trainees to imagine that the area is the floor of a small storage building. Indicate the height of three metres on a wall, and ask trainees to estimate the cubic capacity of such a building, without having the opportunity to pace out or otherwise measure the space but relying merely on a visual estimate. The actual space, and the subsequent calculations, may be altered if the classroom is too small. Alternatively, it may be preferable to use the whole classroom as an example.

Write down their range of estimates on the chalkboard/OHP. Demonstrate by pacing or the use of a measurement tape that the dimensions are ten metres by five metres by three metres and the cubic capacity is therefore 150 cubic metres.

4) Refer back to the table given in "2" above. Ask trainees how many tonnes or bags of bagged maize meal and of bagged beans they would be able to store in a building of this size. This and all following examples should be worked in bags rather than tonnes if trainees are more familiar with this method.

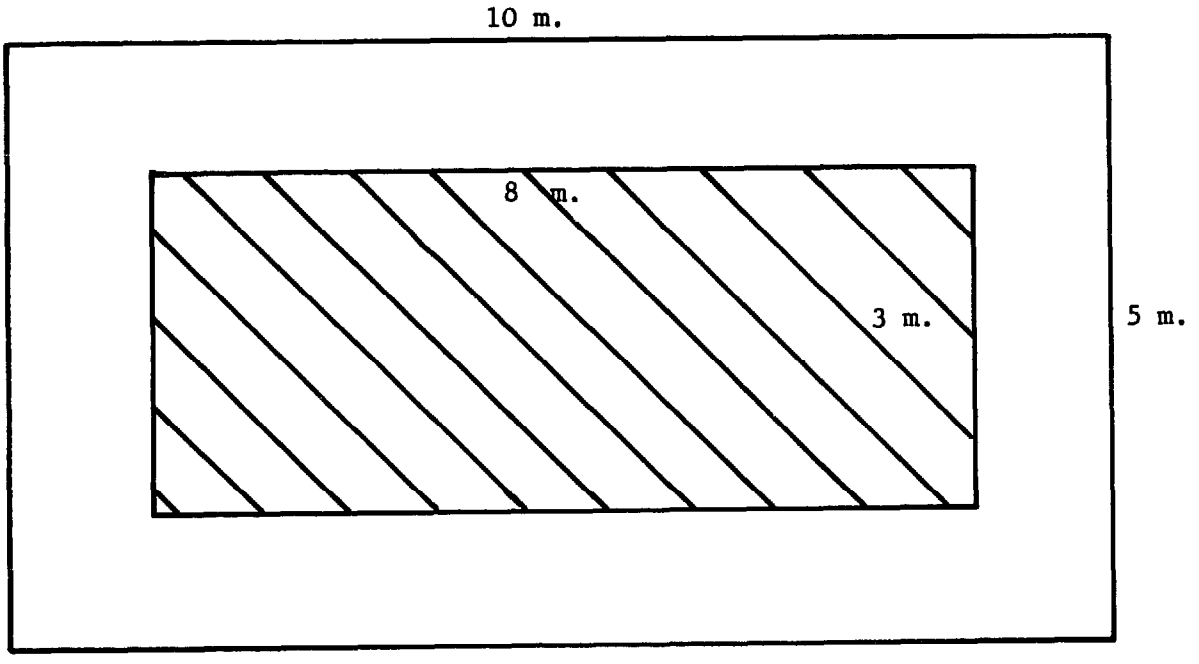
Allow trainees five minutes to calculate their answers. It is likely that some at least will divide 150 by 2.1 and 1.3 respectively to give the following answers:

Maize Meal = 71 tonnes approximately (or 788 90 kg. bags)
Beans = 115 tonnes approximately (or 1,277 90 kg. bags)

Ask other trainees to comment on these answers. If necessary, ask trainees what it would be like to open the door or to attempt to remove or inspect any crop if it was stored in this way.

Elicit the suggestion that space must be left for access and ventilation, and it must be practical to fill and empty the store. Refer to the measured area on the floor, or draw a plan on the chalkboard, and ask trainees how much empty space would have to be left. What proportion of the cubic capacity or such a warehouse could actually be used for storage?

5) Elicit the suggestion that at least one metre would have to be left all around the stack of maize or beans to allow access from all sides. Allow trainees up to ten minutes to estimate what proportion of the 150 cubic metres would be used by the clear area.



Storage Area =

Ask trainees for their answers. Show by reference to a plan such as the above that the total unoccupied area would be:

2 x 10 metres x 1 metre	=	20 square metres
2 x 3 metres x 1 metre	=	6 square metres
Total	=	26 square metres

The total cubic space unoccupied would be 26 x 3 cubic metres = 78 cubic metres.

This is 52% of the total space. 48% is thus the maximum proportion of a store of this size which could be usefully occupied.

Ask trainees how many tonnes of maize and beans could therefore be stored:

Maize 0.48 x 71 = 34 tonnes approximately (or 377 90 kg. bags)

Beans 0.48 x 115 = 55 tonnes approximately (or 611 90 kg. bags)

Stress the significance of the difference between these figures and original calculations which did not allow for gangways. Effective storage capacity must be correctly assessed in order to avoid losses due to poor storage conditions or inability to accept members' crops.

6) Ask trainees to suggest what factors limit the height to which crops can be stacked. Elicit the following:

- The height of the building. (Ensure that trainees appreciate the difference between the usable height to the eaves and the maximum height to the apex of a sloping roof. The triangle of space between is generally unusable.)
- The way in which the crop is put into and out of storage.
- The width of the access gangways which may or may not allow for ladders, elevators or other devices. (Stress that mechanical handling equipment not only displaces labour but reduces the usable space in a warehouse.)
- The strength of the sacks or other packaging which restricts the weight that can be put on the bottom layer.
- The crushing strength of the crop itself.
- The maximum load that can be placed on the floor of the building, particularly if it is not a ground floor.
- The availability of racks or staging which reduce the load on bottom layers and make handling easier but also use space in between the levels and around the vertical supports.

Stress that any assessment of building storage capacity must take all these factors into account.

7) Ask trainees to compare the storage facilities which are familiar to them with the simple small rectangular space which has been discussed

so far. What proportion of the space available in a larger building can be usefully occupied for storage? Should crop be stored in the same way as in a smaller space?

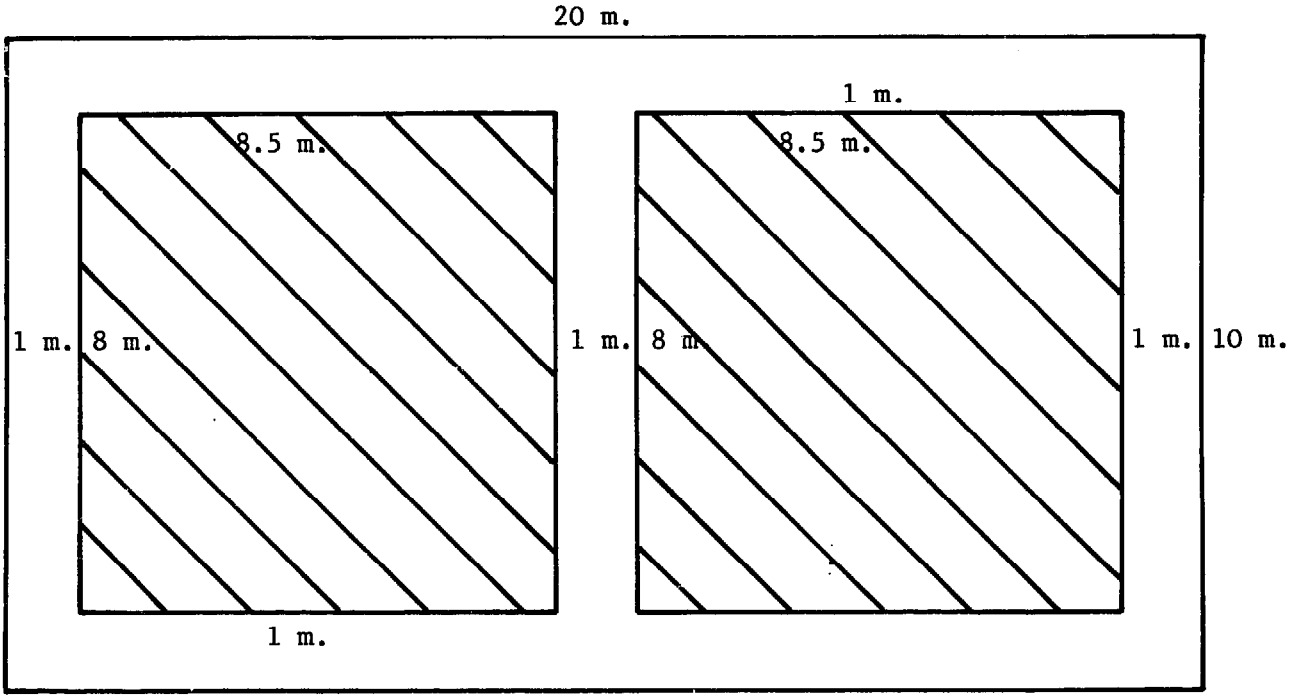
- Access space around the walls need be no wider. The proportion of space so used will therefore be less.
- The crop will have to be stored in more than one stack, to provide access and ventilation. Gangways between stacks will absorb more space.
- Any mechanical handling equipment such as roller conveyers or fork-trucks will require wider gangways and thus use more space.

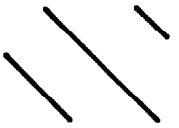
8) Pace out a space twenty metres by ten metres and show trainees how high four metres would be, if possible within he classroom but otherwise by reference to a previously measured object in full view outside. Alternatively use the whole classroo as an example. The following figures should then of course be amended accordingly. Ask trainees how much total cubic capacity this space would provide.

Record trainees suggestions as before. Point out that the cubic capacity is 800 metres and stress that very large increases in cubic capacity are obtainable with apparently modest increases in length, width or height.

Allow trainees up to ten minutes to calculate how much space would be taken up by a one metre wide gangway around the outside, as before, and a one metre wide alley between sacks packed in two stacks.

Ask trainees for their answers. Illustrate the method of calculation by a simple plan as below



Storage Area = 

Unoccupied Area: 2 x 20 metres x 1 metre = 40 square metres
3 x 8 metres x 1 metre = 24 square metres
Total 64 square metres

Cubic Capacity: 64 x 4 = 256 cubic metres.

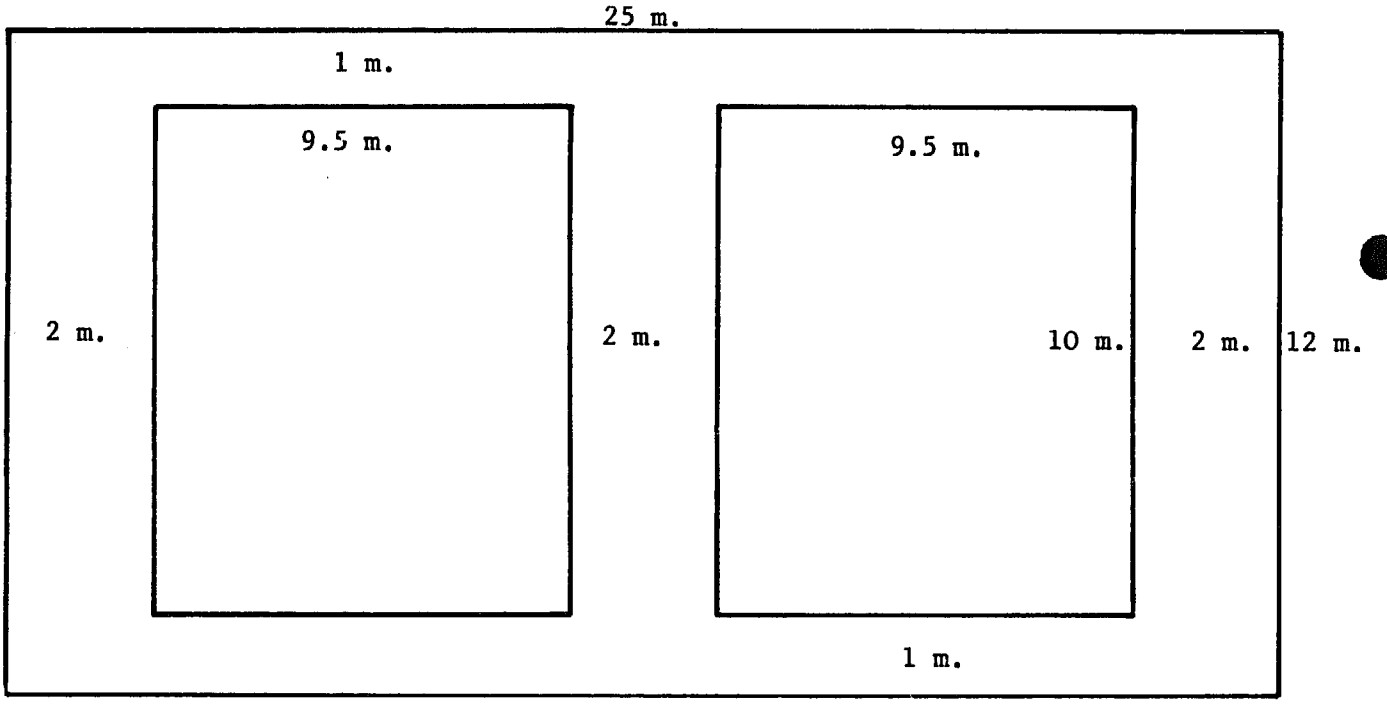
This is 32% of the total space. 68% can thus be used for storage.

9) Distribute the size calculation exercises, and allow trainees up to 30 minutes to complete them. Trainees may use calculators if they are generally available to them. Ensure that they can refer to the table of cubic metres occupied per tonne of various crops which was completed in "2" above.

After 15 minutes, ask trainees for their answers and ask those who have calculated correctly to go through the calculations to demonstrate how they should be done.

Use simple plans on the chalkboard as follows to demonstrate how the occupied spaces can be assessed and calculated:

The Theta Wheat Growers



Occupied Area: 9.5 metres x 10 metres x 2 = 190 square metres

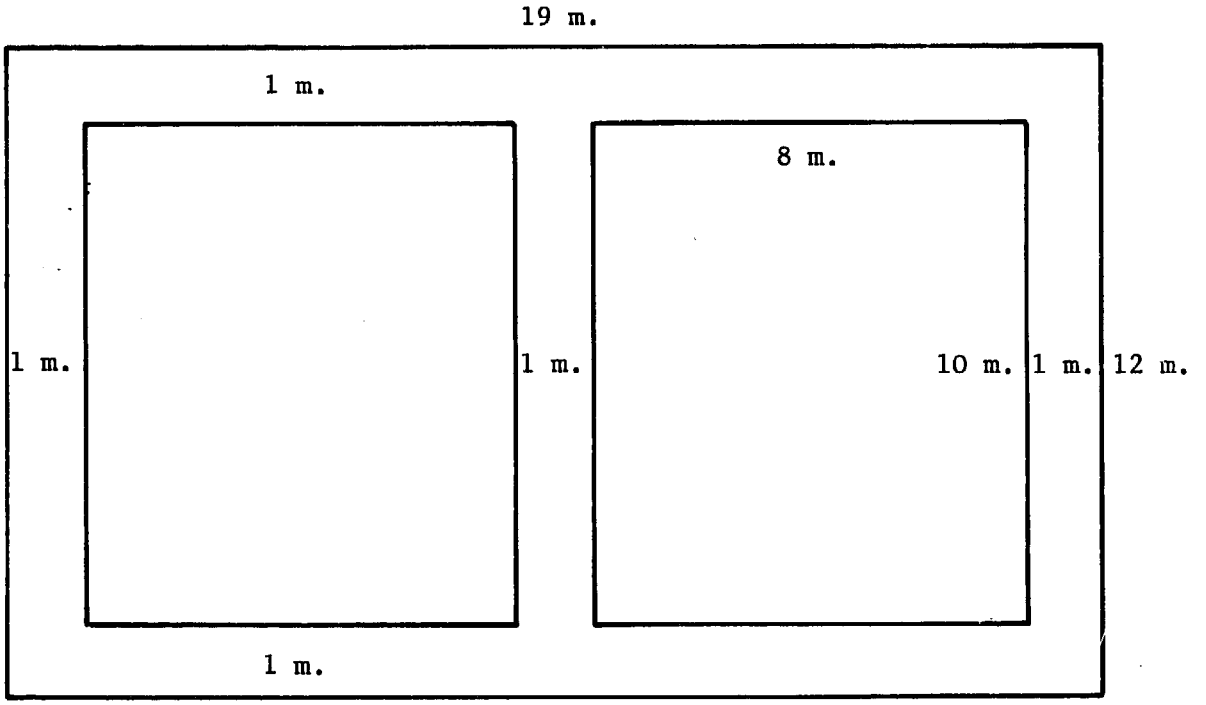
Cubic Capacity: 190 x 3 = 570 cubic metres.

Wheat occupies 1.6 cubic metres per tonne and the store will therefore hold approximately 356 tonnes or 3,955 bags. The Secretary should therefore arrange for 44 tonnes or 489 90 kg. bags to be stored in the Union godown.

10) Ask trainees for their answers to the Resurgent Rice Growers' problem. Go through the calculations as follows if necessary:

- Total amount of rice to be stored = 300 tonnes.
- One tonne of bagged milled rice occupies 1.6 cubic metres.
- Total cubic metres required = 480 cubic metres
- Height of building = 3 metres.

- Storage area required = 160 square metres.
- Area required per stack = 80 square metres.
- A convenient layout might be planned as follows (trainees may suggest alternatives which are acceptable but should minimise the length of outside walls):



Area of Space not used for Storage:

2 x 19 metres x 1 metre	=	38 square metres
3 x 10 metres x 1 metre	=	30 square metres
Total		68 square metres
Area Required for Storage:		160 square metres
Total		228 square metres

Cost at $150 per square metre = $34,200

11) Trainees may have made mistakes for the following reasons:

- Errors in transposing the figures.
- Simple mathematical mistakes.
- Double counting or ommission of area figures.

Stress that clear layout and effective simple diagrams can eliminate most mistakes. Errors of this kind have in fact led co-operative societies to spend or lose large sums of money quite unnecessarily.

12) Trainees may claim that their own society's storage space is antiquated and/or inadequate and irregular in shape. They cannot afford to waste space on external gangways or limited stack sizes, and it would be impossible to calculate capacity of old irregularly shaped buildings.

Stress that they must assess the capacity of the space, however difficult it may be, in order to measure its inadequacy and to have a proper case for construction of more space. Adequate gangways may mean that less space is available for actual storage. It is however necessary for access and ventilation and the cost of extra time, labour and losses will exceed the benefits from marginally increasing the amount stored in a given space.

Space Calculation Exercises

1) The members of the Theta Wheat Growers' Society were, it was estimated, going to produce 400 tonnes (or 4,444 90kg. bags) of wheat this season. The Secretary was not sure whether it would be possible to store this amount in the Society's store.

The building was 25 metres long by 12 metres wide and was 3 metres high to the eaves. It was necessary to leave a one metre space along the sides of the store and a 2 metre space along the ends. The wheat would be in sacks and stored in 2 stacks with a 2 metres wide gangway between them.

The Secretary could reserve extra space in the Union's godown if it was necessary, but he had to notify the Union at once how much wheat he would want them to store.

2) The Resurgent Rice Growers' Co-operative wished to construct a store. They estimated that they would produce about 500 tonnes (or 5,555 90kg. bags) of milled rice each season. 200 tonnes will be sold at once and they would want to store the balance.

The rice would be stored in 90kg. bags. The standard design of co-operative stores had walls of 3 metres in height, and it was normal to leave one metre around the outside of any stacks for access and ventilation. A maximum of 200 tonnes (or 2,222 bags) could be stored in one stack. Any greater quantity would have to be stored in two or more separate stacks. Suitable buildings cost $150 per square metre to construct. The Secretary was asked how much money the Society should budget for the construction of a suitable store.

topic

5

the choice of storage method

SESSION 5

THE CHOICE OF STORAGE METHOD

Objective: To enable trainees to select the most effective type of storage for the crops, economy and environment in which they operate, and to identify the information necessary for a decision of this sort.

Time: One and a half to two hours.

Material: Case study "The Two Consultants" and Instructor's Data Sheet.

Session Guide:

1) Ask trainees to identify the major causes of loss in storage:
   - Moisture.
   - Attack by insects.
   - Heat.
   - Rodents.
   - Birds.
   - Theft by people.
   - Fire.

2) Ask trainees to describe an ideal method of storage which would more or less guarantee protection against all these "enemies", regardless of expense.

   Trainees' suggestions may differ, but an ideal store for grain might be as follows:

   - A double skinned insulated silo with refrigeration and air conditioning to control temperature and humidity, hermetically sealed against the outside atmosphere, and with partial vacuum or inert gas environment to inhibit growth of micro organisms, with secure locks at the unloading point and twenty-four hours a day security guards and automatic alarm systems.

3) Ask trainees why societies do not have facilities which can approach this level of protection:

- They are too expensive.
- The staff are not trained to operate them.
- The equipment or consumables and spares and services such as electricity might not be available at all.

What might be the opposite extreme? Ask trainees what would be the cheapest storage method of all, if losses were of no concern:

- Crops could be dumped on the ground without any form of covering or protection against the weather or insects, rodents or human depredations.

Why do societies and even individual farmers have something better than this, although they do not go to the other extreme?

- The cost of losses would be excessive.

4) Ask trainees to compare the storage methods used by members or other farmers on their farms with those used by co-operative societies. How do they differ in terms of size, cost per tonne stored, the use of labour in construction and operation and the degree of protection against loss?

- On-farm stores are smaller than society stores.
- On-farm stores are cheaper in total, and, usually, per tonne stored.
- On-farm stores generally offer far less protection against losses of all types. (Research in many countries shows that on-farm losses often amount to 40% of the crop per year, when losses in co-operative stores range between 5% and 10%.)
- On-farm stores generally require more labour both for construction and for loading and unloading.

Why do they differ in this way? Are farmers not at least as concerned as their societies to minimise losses in storage?

- Farmers have less money and more labour to spare than most co-operative societies.
- The amount of crops to be stored is far smaller.
- Farmers know less about available methods, and have less technical skills, than most societies.

5) Storage methods must thus be chosen in relation to a number of factors. There are no right or wrong ways to store crops of a particular type.

Divide trainees into groups of five members or less. Distribute the case study and tell them that if they need more information they are to request it in writing from you, without telling the other groups. They will then be given the information or told that it is unavailable.

6) Allow groups up to 45 minutes to reach a decision. Reconvene the class and ask each group in turn to state and briefly to justify their choice, without allowing discussion or comment at this stage.

If any group has failed to request the necessary information, ask a representative of one which has done so to explain why it was necessary.

7) Ensure that groups' decisions are based on complete and correct calculations of the costs and benefits of each alternative. The less tangible qualitative or emotional arguments used in the two reports should only be taken into account after the quantitative results of each have been compared with one another.

The two suggestions may be quantitatively compared as follows:

Circular Silo Storage:

Annual cost of Elevator assuming 5 year life	$ 200
Annual cost of Silo assuming 20 year life	100
Labour costs per year	75
Running and Maintenance costs per year	500
Cost of Losses, 1% of 40 tonnes @ $300	120
Total Annual Cost	$ 995

Bagged Storage on the Ground:

Cost of Sacks per year	$ 160
Cost of Plastic Sheet per year assuming 2 year life	70
Labour costs per year	300
Cost of Losses, 4% of 40 tonnes @ $300	480
Total Annual Cost	$ 1,010

Stress that the calculations are very much oversimplified and that they ignore factors such as:

- The timing of costs and benefits.
- The interest payable on a bank loan.

More complete techniques are dealt with in the MATCOM cours on "Project Preparation and Appraisal".

8) Ask trainees whether the difference of $15 in the estimated annual costs is sufficiently large to be the basis of a decision. How accurate are the estimates on which the calculations are based likely to be? Elicit the following variables among others, which may change the result by far more than $15:

- Losses may be different from the estimates.
- The life of the equipment may be different from the estimates.
- The price of rice will almost certainly change in the future.
- The Society may not have enough rice to fill the 40 tonne capacity every season.
- Wage rates will change.
- The cost of sacks and plastic sheeting will change.

Stress that while it may be possible to assess the relative reliability of the different forecasts, and to modify the calculations accordingly, it is probably sufficient to accept that probable future changes are likely to affect both alternatives. The calculations merely show that both are more or less equal in quantitative terms, and the decision must turn on the other factors.

Stress that the calculations are necessary in order to show this. If the quantitative results are very different then this is sufficient basis for a decision.

9) Ask trainees to suggest factors other than the comparative calculations which favour the choice of a circular silo:

- Inflation is likely to increase prices. It is therefore wise to buy a long lasting asset at today's costs.
- The Society's members may be impressed and encouraged to support the Society more enthusiastically in future.
- The relative price of rice as opposed to labour and capital equipment may be expected to increase in the future.

What factors favour the plastic covered sacks stored on open ground?

- The method is flexible. The capacity can be increased or decreased according to the amount to be stored and there are no fixed costs from one year to the next.
- More people are employed, for longer, and thus employment is created.
- The method does not involve the Society in a major commitment or obligation.
- The method is likely to involve less expenditure of foreign exchange. This is good for the country and in future years spares may not be available.

10) If all groups are in favour of one alternative, stress the advantages of the other. If some favour each, encourage discussion. Stress the following points in conclusion:

- Crop losses are an expense like any other. They should be minimised, but only to the extent that the cost of reducing losses is exceeded by the value of what is saved.
- Good management is far more important than selection of the best method. The "wrong" method, well managed, is likely to be far more economical than the "right" method mismanaged.

The Two Consultants

The Manager of the Resurgent Rice Growers knew that the storage decision was a critical one for the Society which would affect its operations for many years. Because of the importance of the decision the Committee had authorised him to ask an adviser from the Co-operative Advisory Unit and an independent consultant to survey the situation and to make recommendations. Now that he had received their reports he was in a dilemma. Which conclusion should he recommend to the Committee for their approval?

The Society's existing storage was insufficient for members' crops now that they were nearly all growing high yielding varieties, and the Manager had asked each of the two consultants to say how 40 tonnes of milled rice should be stored for an average period of six months.

The rice could be sent over from the Society's mill in bulk trucks or in sacks whichever was most convenient for the subsequent method of storage. Some customers preferred sacks for their deliveries, but others would take delivery in bulk.

The Society did not have any cash to spare, but the Co-operative Bank was willing to provide interest free loans for any investment which was agreed to be necessary and in the interests of members. This only made the decision harder. The Manager looked yet again at the two summary reports and wondered what to do.

Assignment: Advise the Manager of the Society as to which recommendation he should follow. If you think that you need any additional information, you must request it specifically from the Instructor in writing. If it is available you will be given it.

FROM: I. Patel, Co-operative Advisory Unit.

TO: The Manager, Resurgent Rice Growers Society.

SUBJECT: Proposed Grain Storage Facility.

Thank you for the opportunity to investigate your Society's grain storage problems. My recommendations with supporting arguments are in summary as follows:

- The Society should purchase a circular metal silo of 40 tonnes capacity. The cost of this will be $1,500 for the silo itself and $500 for site preparation and erection labour. The silo will occupy approximately 25 square metres of ground and the Society currently has vacant land which can be used for this purpose.
- It will be necessary to purchase an elevator to load the silo and a suitable elevator with 10 tonne per hour capacity can be bought for a further $1,000.

The arguments in favour of this proposal are as follows:

- A round metal silo will keep losses to an absolute minimum. They should not exceed 1% of the rice stored for the six month period.
- The silo can be loaded or unloaded by one man. The total workload during the year should not exceed 15 days labour by this man, which is a negligible increase in the Society's costs. This includes the time taken to deliver rice from the silo either into sacks or into customer's vehicles.
- Circular metal silos are generally considered to be the best and most modern method of storage. Your Society will be maintaining its progressive leadership by making this investment.
- There has been much unfavourable publicity recently regarding co-operative societies' failure adequately to protect members' crops while in storage. By undertaking this investment, your Society will ensure that your members at any rate are satisfied and can take pride in their Society.

J. Singh,

Storage Adviser

The Manager,
Resurgent Rice Growers Society.

Dear Manager,

I have investigated your storage problem as requested, and in summary my recommendations are as follows:

- The Society should store its members' grain in hessian jute bags laid on plastic sheeting on level ground and covered by further sheeting. The cost of the bags will be 40 cents per hundred kilogram bag, or $4 per tonne stored, and the necessary plastic sheeting can be purchased for a further $140. It is assumed that the Society can find sufficient space for the storage area without any further expenditure.

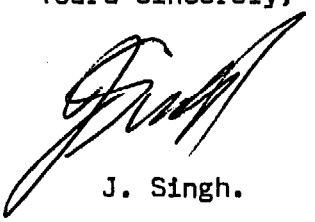
My reasons for proposing this solution are as follows:

- The capital cost is minimised.

- Losses should be controlled at about 4% of the crop stored, over the six month period.

- Three labourers will be required to stack and remove the bags for a total of approximately 20 days during the six month period.

Yours sincerely,



J. Singh.

Instructor's Data Sheet
Supplementary Information

- Expected life of sacks = 1 year.
- Expected life of plastic sheeting = 2 years.
- Expected life of silo = 20 years.
- Expected life of elevator = 5 years.
- Annual maintenance and running costs of elevator = $500.
- Average selling price of grain $300 per tonne.
- Wage rate = $5 per man-day.

topic

6

bulk or bagged?

SESSION 6

BULK OR BAGGED?

Objective: To enable trainees to decide whether their members' crop should be stored in sacks or in bulk.

Time: One to one and a half hours.

Material: Micro Cases "Bulk or Bagged?" Examples of jute, sisal, polythene, paper and cotton sacks or whatever is locally available.

Session Guide:

1) Ensure that trainees are aware of the various types of storage that are locally available. These need not necessarily be used by co-operatives, but may be in the future.

   Divide trainees into groups and distribute copies of the micro cases. Allow groups up to 30 minutes to decide which method of storage each Society should use.

2) Reconvene the class and ask each group to state its recommendations for each Society in turn. List on the chalkboard the number of groups choosing each option in each case, and ask groups briefly to state the reasons for their choice. These should be briefly summarised and listed beside the entry for each case study on the chalkboard. Trainees' conclusions as to which method should be chosen, and what factors influence their choice, should be summarised on the chalkboard in the following form:

Society	Choice	Reasons
Alpha	Bulk silos with automatic fumigation and loading facilities.	- Need for rapid loading of grain. - Large turnover, 20,000 tonnes. - Scarcity of land. - Customers' use of bulk transport.

Society	Choice	Reasons
Beta	Bagged, stored on tarpaulins in temporary thatched wooden structures to be built by local self-help groups	- Quantity to be stocked varies. - Little capital required. - Storage not confined to one location. - Different varieties and grades can easily be separated.
Gamma	Bagged, stored in buildings of local materials and local labour, or on well flattened earth platforms.	- Quantity calculations simple. - Need to create employment. - Need for loads that one man can handle. - Customers need small quantities. - Crops stored for a short period.
Delta	Bulk in silos with automatic fumigation equipment.	- Need to minimise spillage. - High and consistent quality to be maintained. - Grain to be stored for a long period. - Need for sophisticated and comprehensive treatment. - Need to protect against rodent attack.
Eta	Bagged in secure and spacious covered buildings with walls.	- Need to retain identification of grower of crop when it is in storage. - Minimise use of imported equipment or material. - Need to separate good from poor quality produce. - Need to avoid cross infection. - Damp conditions.

3) Groups may have made different choices to those listed above. Such a choice should not automatically be rejected as wrong but the group should be asked carefully to explain their choice in order to identify any assumptions they have made which support it. If necessary, misunderstanding of the respective advantages of bagged or bulk storage should be corrected.

4) Ask trainees to suggest a summary list of circumstances which will favour bagged or bulk storage respectively. Stress that neither is "better" than the other; the choice must depend on circumstances.

Elicit a summary approximately as follows, and ensure that trainees fully understand and remember it.

Bagged Storage:

- Flexible as to quantity and location.
- Requires less capital.
- Is simple to operate.
- Requires less ancillary equipment.
- Allows separation of varieties and grades.
- Simplifies measurement of quantities.
- Allows maximum use of labour.
- Helps to prevent cross infestation.
- Is suitable for short storage periods.
- Is more tolerant of high moisture.
- Is suitable for small-scale suppliers and customers.

Bulk Storage:

- Permits rapid loading and unloading.
- Uses little land.
- Minimises losses during storage.
- Is particularly suited for long periods.
- Facilitates fumigation and other treatment.
- Becomes more economic with larger quantities.
- Minimises the current costs of labour and materials.

5) Ask trainees what further decisions have to be made about the type of bags to be used if bagged storage is preferred. What alternatives are there and what are their advantages and disadvantages?

Trainees may not be familiar with different types of sacks, and the crops with which they are concerned may only be suitable for one particular type. Attempt to elicit whatever information and experience is available within

the group, and if at all possible illustrate unfamiliar sack types, and their functions, by handing round examples.

Material	Advantages	Disadvantages
Jute (Stress that jute is by far the commonest material)	- Low cost. - Fairly resistant to snagging and hooks. - Easy to handle. - Fairly strong. - Easily repaired. - Easily closed.	- Absorbs water. - Rots easily. - Strong smell. - Retains dirt. - Easily entered by insects or rodents. - Weakened by sunlight.
Sisal (Sisal or jute and sisal mixtures are used in countries which produce sisal)	- Great strength. - No smell. - Long lasting. - Does not retain dirt or taints.	- High cost. - Difficult to handle.
Cotton (Cotton sacks are used for flour, sugar and other processed crops)	- Fine produce cannot sift through. - High second-hand value. - Ease of marking.	- High cost. - Hooks or snagging tears fabric irreparably.
Polythene or other Plastics (Polythene or plastic sacks are often used for fertilizer)	- Water proof. - Does not rot. - Resale value for alternative uses. - Resists attack by insects. - Little smell. - Can be attractively marked. - Pilfering cannot be concealed.	- Contents cannot "breath". - One trip only. - Weakened seriously in sunlight. - Easily and permanently damaged. - Expensive. - Needs welding for effective closure. - Contents must be totally dry.
Polypropylene Fibre	- Does not rot. - Strong. - No smell.	- Slippery to handle. - High cost. - Imported material.

Material	Advantages	Disadvantages
Paper	- Cheap. - Easily marked. - Pilfering cannot be concealed. - Can carry instructions or other written messages. - Can be coated with other materials. - Protects against insects.	- Often have to be imported. - Easily torn. - Rapidly weakens when wet. - One trip only. - Needs sewing for closure. - Needs a filling machine.

6) Ask trainees how it might be possible to combine the virtues of more than one material such as the strength and handling characteristics of jute and the water and insect resistance of polythene:

- Polythene liners can be used in jute or other fabric outers, or with paper sacks. This increases the cost but is often worthwhile for processed crops which are ready for human consumption.

7) Most agricultural societies use jute sacks. Stress that these are an important expense for members and/or their society, particularly if they must often be replaced. How can expenditure on sacks be minimised?

- Members can be encouraged by well organised bag systems to take care of and return sacks when necessary.
- Sacks must be regularly inspected and small holes must be repaired at once.
- Empty sacks must be dried before storage and must be stored in a dry place.
- Full sacks must be stored on pallets, plastic sheets or other "dunnage" to protect them from ground moisture even in a store where rain cannot enter.
- Well made, preferably tubular woven sacks must be bought, and must be carefully inspected before purchase in order to reject any with faulty seams.

- Sacks must be properly closed, with jute or similar ties, and must be carefully opened to avoid damage.
- Sacks must not be over-filled.
- Staff must be instructed to handle sacks carefully, and to avoid dropping from over two metres.
- Any sharp corners or pointed obstructions must be eliminated in all vehicles and buildings where sacks are to be handled or stored.
- Inspection spears must be used with care.

Ask trainees how much money their societies, or their members, spend on sacks each year:

- If they do not know they should find out.
- If they know, how can the figure be reduced? Are all the above precautions observed?

8) Ask trainees with experience of bulk storage to describe the facilities which are familiar to them.

Distinguish between the two basic types:

- Floor storage, where loose grain or other produce is tipped out onto the ground. It may be in a building or outside, in which case the crop will be covered with plastic sheeting or other material.
- Bin or silo storage, where the produce is kept in a specially constructed square or circular container, constructed of metal, concrete or wood, which may stand inside a building or may be a building itself.

Ask trainees to suggest the various advantages of each type.

Floor Storage:

- Cheap.
- Flexible.
- Easy to load and unload without machinery.
- Can use existing buildings.

Silo or Bin Storage:

- Minimises losses.
- Can separate different varieties.
- Requires mechanical handling.
- Uses less space.
- Needs less labour.
- More secure.

Stress that the decision between the two methods of bulk storage is similar to that between bagged and bulk storage itself, as illustrated by the micro cases. Members' financial situation, the management and technical ability of the staff and the customers' needs must be carefully analysed. The final decision must be based on analysis of the costs and benefits of each method, which must be quantified whenever possible.

Bulk or Bagged?

The Alpha Society

The 50 members of the Alpha Maize Growers' Society marketed about 20,000 tonnes of maize every year through their Society. The depot was located on a small plot in the local industrial area, adjacent to the main railway which went to the capital city and the Society's customers usually collected their maize by freight wagon from the depot. These customers rented these wagons from the railway by the hour, and because of this and the tight train schedules the wagons had to be filled as quickly as possible. Customers were extremely demanding as to the quality of what they bought, but they paid good prices for top quality produce.

The Beta Society

The Beta Society had 500 members. They cultivated a number of different varieties of maize. Some of them were very progressive and consistently produced high grade produce, while others were less successful and grew maize of a low standard. They consumed most of their crops themselves, but in a good year an average member might market as much as 5 tonnes through the Society. In other years they had little or no supplies to sell at all. The weather in the area was very variable. Farmers on the hills produced more maize in some years, while the valley and plain farmers were luckier in other years. The Society, like its members, was very poor. They only had a very simple central office facility and it was convenient to move the crop reception and storage location to whatever area had produced the highest surplus in that particular year.

The Gamma Society

The Government had sponsored the Gamma Maize Growers' Society in an effort to help both the farmers and the large number of landless people in the area. The Society introduced new varieties of maize which required intensive weeding, so that members would be able not only fully to occupy their own families but would employ their less fortunate neighbours. The Society stored its members' surplus maize for only a few days or weeks, and it was purchased by large numbers of small traders whose requirements were very variable but were never

ry large. Many of these customers, and the Society staff, were illiterate, i it was important to simplify as much as possible the ways in which grain s measured and accounted for.

e Delta Society

e Delta Society marketed members' maize mainly for export. They only cepted the highest quality produce and it had to be subjected to stringent sts and carefully monitored fumigation and other treatments before being ssed as fit for shipment. Any traces of rodent damage or infestation, in rticular, would mean that the crop would be rejected outright by the presentative of the foreign buyer. The maize had often to be stored for veral months or even over a year, in order to take advantage of international ice movements. It was vital to minimise losses of any kind since the maize tched a high price and any significant losses might prevent the Society from nouring its contracts.

e Eta Society

e Secretary of the Eta Society wondered whether his task was impossible. mbers used to deliver all kinds of different qualities and quantities of maize, d because of the erratic weather, and their own ignorance, it was often damp. e maize was also in many cases infected with insect pests. The Society did s best to educate its members and to motivate them to produce better crops. was vital that every member's delivery should be kept separate from one another long as possible since infestation and other problems were not always evident en the crop was received and it was essential that members should be made aware deficiencies of this sort. The Society's problems were further complicated the high crime rate in the area, burglaries and thefts had been common tely. Another problem was the difficulty to find suitable building material d equipment; this was due to the fact that the country was desperately ort of foreign exchange.

signment: Each of the above societies must decide how to store its members' maize. How would you advise each Committee, and what factors lead to your choice in each case?

topic

7

stock records and controls

SESSION 7

STOCK RECORDS AND CONTROLS

Objective: To enable trainees to identify the functions of stores records and controls as a basis for designing and operating effective control systems.

Time: One and a half to two hours.

Material: Dialogue transcript "The Resurgent Rice Growers' Storage Problems".

Session Guide:

1) Record the dialogue with suitable actors and sound effects well before the session, or if a tape recorder is not available ask suitable trainees to enact the dialogue to the rest of the class, ensuring that they leave gaps as indicated.

   Warn trainees that they are about to hear a simulated discussion in a co-operative produce store. A large number of problems are encountered in a short time, but they are all real problems which have occurred in produce stores in various countries.

   Play or enact the discussion straight through without pausing. Then play it again with a pause after each "incident". Trainees should very quickly write down the basic origin of the problem.

2) Allow trainees up to a further twenty minutes to write down what they believe should have been done by the Society described, in order to prevent each problem. Trainees should not recommend a general improvement such as "maintain better stock control". They must write down specifically what the Manager, or whoever else they believe to be responsible, should in fact do to avoid recurrence of what happened.

3) Play the tape again or briefly summarise each problem. At each pause ask a different trainee to suggest a remedy. Summarise this on the chalkboard, and invite other trainees to suggest alternatives. Attempt to reach agreement on how the problem might be avoided in the future.

Stress that there is no reason why one solution should not prevent a number of different problems. Control procedures and formalities cost money and take time, and the objective should be to avoid duplication and to design a system which helps management to avoid these problems with the minimum number of forms and as little time as possible spent on record keeping and book entries.

4) Trainees' suggestions will vary according to their experience. A possible list of remedies for the problems revealed before each pause is as follows:

Pause 1: Up to date records of amounts in stock should be kept in the office.

Pause 2:
- Records of amounts in stock should be noted on bin cards actually on the stocks.
- Grades should be clearly marked on bags.

Pause 3: Different varieties and grades must be stacked in separate places, even if this leads to somewhat less economical usage of the warehouse space.

Pause 4: The store should be marked out in numbered sections, and each variety, grade or packing type should be kept separately and the store section number should be recorded in the office stock record.

Pause 5:
- As for Pause 3.
- Keep record of all treatments in the office and on bin cards.
- Poison treatments should never be used in the same building where food for human consumption is stored.
- If treated seed must be stored in the same premises as grain for consumption, it must be in totally different bags.

Pause 6: - Stacks should be of a standard height for every commodity.

- Bin card entries should record all movements in and out and should be signed by whoever was responsible.

Pause 7: - All produce should be weighed as well as counted when delivered and dispatched.

- Crops in storage should be checked regularly.

Pause 8: Sacks should be tagged to show their origin.

Pause 9: As for Pause 1.

Pause 10: As for Pause 5.

Pause 11: Records should be analysed and annotated to draw attention to any problems in need of attention.

Pause 12: Book stocks should be regularly checked against physical stocks.

Pause 13: Stocks should be rotated, using the firt in first out principle.

Pause 14: Test results should be recorded and entered on bin cards and in the central records, together with the signature of whoever carried out the test.

Pause 15: If produce is kept in the sacks in which it is delivered, the number of sacks as well as the weight should be recorded.

5) Ask trainees to describe the recording and control systems used in their own society's stores. Have they ever experienced any of the same sorts of problems in their own stores?

- Do they always know what is in stock and where it is?
- Do they always know what has been tested and treated, how, where and by whom?

If they cannot answer these questions totally and honestly in the affirmative, their control system or the way it is operated needs improvement, but not necessarily added complication.

Stress that the more documents that are required, the more mistakes are likely to be made and the more likely it is that the paperwork will be neglected. A system should be judged by its results and not by the number of forms which are used.

The next session will provide trainees with an opportunity to design a simple system and to compare it with those which are in use in their own societies.

The Resurgent Rice Growers' Storage Problems

Narrator: It was late in the morning. Johnson, the Warehouse Manager of the Resurgent Rice Growers, was going through his correspondence in his office beside the store. He turned to Jessica his Clerk:

Johnson: The City Merchants want 100 bags of best long grain rice delivered next week. Can we manage it?

Jessica: I don't know, I'll have to ask Andrew to see what we've got.

PAUSE 1

Johnson: Make sure you do that tomorrow morning. What's this now, the Traders Union is complaining that they received 5% brokens when they ordered top grade. They've knocked it off the invoice without asking to.

Jessica: Well, we certainly asked the store to load Grade 1, here's a copy of the entry. Ah, here's Andrew, he can help explain it.

Andrew: Good morning, why does the insurance company want to know our stocks, surely they only need to know what we lose?

Johnson: No, they need to know what we might lose if there is a fire or something, how many tonnes have we got anyway?

Andrew: Well, I took a quick look round and I think it comes to about 1,550 tonnes.

PAUSE 2

Johnson: Good, I'll put that down, and some sort of average value. But what have you got to say about this complaint from the Traders Union?

Andrew: Mmm, well, the bag marks often get knocked off, if they ever get put on, and it's almost impossible to read them when taking the sacks off the stack.

PAUSE 3

Johnson: Well we'll have to look more closely. We ought to be able to get some literate labourers these days. Now, have United Grain Exporters got their regular consignment yet?

Jessica: I've not seen the dispatch note.

Andrew: No, they want their rice packed in those special bags, you know, and nobody can remember where they're stacked. We'll have to have a good look around.

PAUSE 4

Johnson: Here's a note from the Co-operative Seed Society. They say we've not sent them their consignment of seed grain yet, that's the most profitable bit of business we ever get.

Jessica: We sent the note in a week ago.

Andrew: Yes, the trouble is, we sent the seed quality rice to the Rice Board instead of Grade 2, they never complained did they?

Johnson: Why should they, seed rice is worth twice as much as Grade 2. Uh, I hope we hadn't put the anti-pest poison on the seeds had we?

Andrew: No, at least I don't think so, I never forget all that business with protective clothing, we haven't done it for months.

PAUSE 5

Johnson: I hope not, I've no love for the Rice Board but we don't want to kill their customers. Let's go and have a look round the warehouse. Jessica, tell anyone who calls that I'll be back in a few minutes.

Jessica: Certainly. I'll start typing up these orders.

Andrew: What do you want to look at in particular?

Johnson: On nothing really. That's a neat bit of stacking. I've never seen a stack that high, of course it's in the middle of the building away from the walls so there is more space.

Andrew: I don't know who did that, it's higher than we normally do.

PAUSE 6

Johnson: These bags look a bit funny, look, I can pick this one up with one hand, wait a bit, it's all husk, what's going on?

Andrew: You're right, hey, Cassius, what's this?

Cassius: Nothing, sir. Oh, I see, well, the sacks looked alright when they came in.

PAUSE 7

Johnson: Where did they come from?

Cassius: Er, how should I know?

PAUSE 8

Johnson: Well get them out of here as soon as possible.

Andrew: Of course, see to it, Cassius.

Cassius: Yes sir, I'll see it's done tomorrow.

Johnson: What's all this Grade 2? I thought you said we'd run out last week, and we've not had any in since then.

Andrew: No . . . It's difficult, it all looks the same you see.

Johnson: We turned down orders for that, lost hundreds of dollars of business.

PAUSE 9

Johnson: What's this plastic sheet doing over this lot?

Andrew: It's being fumigated, we always put the sheets on.

Johnson: Yes, of course, but this sheet was here last week, surely its not been there all that while.

Andrew: Well I was away last week.

Johnson: You mean we are fumigating it again?

Andrew: I suppose we are.

PAUSE 10

Johnson: It's a waste of fumigation tablets, time and money, and it taints the grain too, don't let it happen again.

Andrew: Of course not, do you hear that, Cassius?

Cassius: I'll see to it sir.

Johnson: What's this damp stuff here by the wall, I remember we lost a dozen bags here through mildew last year, has the hole been fixed?

Andrew: I wasn't here as you know last year. Cassius what do you know about it?

Cassius: You're right as usual Mr. Johnson, I thought the leak was in the next bay, we had that repaired I know.

PAUSE 11

Jessica: *(Breathless)* Excuse me Mr. Johnson, you're wanted urgently.

Johnson: Alright Jessica, er, I'll come back to you in a moment Andrew. Er, Jessica, what is it?

Jessica: *(Whispering)* It's something awful about Mr. Andrew I think sir.

Johnson: *(Speaking on the telephone)* Hello. Yes, what, how many, oh no, but well we never really, no, we're very busy you see, no I'll not let him suspect a thing, thank you, good bye.

Jessica: What is it sir?

Johnson: Keep quiet about it, but they suspect Andrew has been involved in a gang which has been stealing hundreds of bags of rice from various stores. They asked if we've missed any, and said we mustn't let him know they suspect him.

Jessica: Oh I hope not, he's such a nice man.

Johnson: I don't know how they expect us to know whether a few bags have slipped out or not.

PAUSE 12

Jessica: There's another message too, sir, you're to ring the Rice Board right away.

Johnson: I'll be back in a moment, I'll just go and have a word with Andrew again. *(Goes back into the warehouse)*

Cassius: I'm sorry sir, Mr. Andrew said he had to go all of a sudden, he didn't say where he was going or when he would be back.

Johnson: Oh, I see, well, anyway, what's all this rubbish down here?

Cassius: Oh that's from last year, Mr. Andrew and the gentleman before him said never to take up the bottom layer, it always gets damp and dirty.

PAUSE 13

Johnson: I see, well what was the moisture reading last time we took it?

Cassius: Mr. Andrew or Silus do all the moisture checking sir. They make a note of it somewhere I suppose.

PAUSE 14

Johnson: I see, and where's Silus today?

Cassius: He had to go round the farms in the western area, finding out how many bags they sent in last week. They grow that hill variety you know, and we only know the weight they sent in.

PAUSE 15

Johnson: I see, we'll have to make a few changes, now I'd better go and telephone the Rice Board. *(Goes back to his office)*

Jessica: The Rice Board rang again sir, here they are.

Johnson: *(Speaking on the telephone)* Johnson here, what, oh no, who, where, which hospital did you say, how many, oh that's terrible.

Jessica: *(Hesitantly)* Um, was it the pest poisons on the seeds?

Johnson: I'm afraid so, ten in hospital so far.

topic

8

paperwork and bin cards

SESSION 8

PAPERWORK AND BIN CARDS

Objective: To enable trainees to design and operate effective paperwork systems for the control of stores.

Time: Two to three hours.

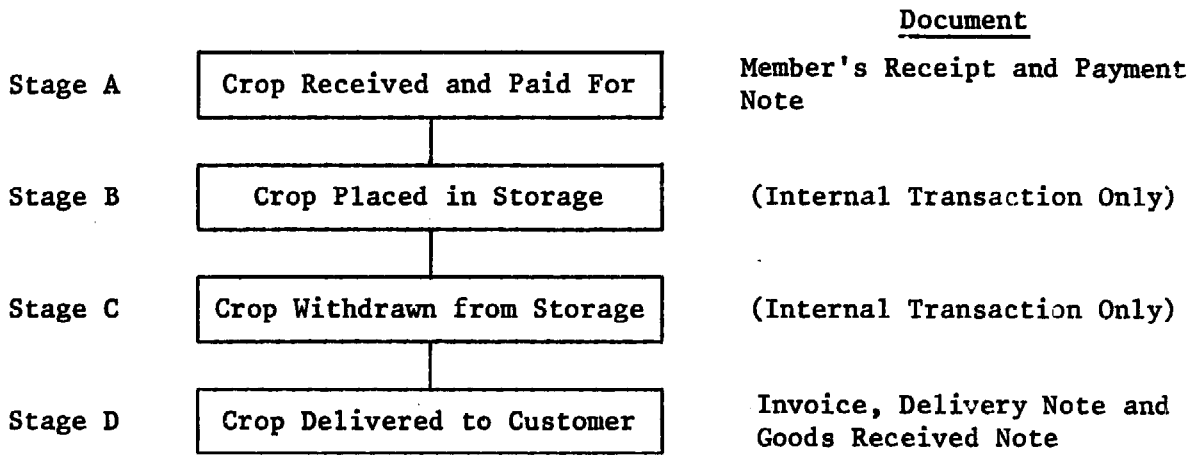
Material: Case study "The Resurgent Rice Growers".
Stores control documents from trainees' and other agricultural co-operative societies.

Session Guide:

1) Refer back to the previous session. Remind trainees of the need to keep records of produce received, in stock and dispatched, and of treatments and test results. Stress again the importance of simple control systems, which are themselves less expensive and are more likely to achieve their objectives than more complicated systems with large quantities of paperwork.

2) Allow trainees up to ten minutes to list the critical stages in the receipt and dispatch of produce, and to show at each stage any documents which are essential for suppliers and customers. Stress that they should not at this point concern themselves with purely internal paperwork.

3) Ask a trainee to read out his or her suggestions and summarise these on the chalkboard. Invite comments and modifications. The details will differ but the basic stages should be as follows:



Stage A:

The paperwork aspects of crop reception are covered in the MATCOM course on Collecting and Receiving Agricultural Produce.

Stage D:

Ensure that trainees are familiar with the documents required for crop deliveries to customers:

Invoice - this is usually sent separately from the goods, and is a request for payment. The customer normally checks it against the delivery note.

Delivery Note - this accompanies the produce, and serves as an instruction to the driver and is a check for the customer to be matched with the invoice.

Goods Received Note - this is a copy of the delivery note, which is signed by the customer and brought back by the driver as proof of delivery in case of dispute.

The purpose of this session is to examine the need for and design of internal documents, covering Stages B and C.

4) Refer back to the problems experienced by the Resurgent Rice Growers in the previous session. Could these have been prevented by the documents already identified?

There is clearly a need for certain internal paperwork to prevent these problems. Divide trainees into groups and distribute copies of the

Handout to them. Allow groups up to 45 minutes to complete the assignment. If time allows they should draw large-scale illustrations of the proposed documents on flip-chart sheets or OHP transparencies, for subsequent display to the rest of the class. Trainees may if they wish draw on the experience and documents used in their own societies, but should be sure that these would in fact solve the problems which were identified in the previous session.

5) Reconvene the class and ask each group in turn briefly to present their conclusions. Summarise these on the chalkboard, and discuss any marked differences. There is no single correct system, a possible approach is as follows:

Crop Entry Routine:

a) Grower's receipt in three copies;
one to grower,
one to Accounts Department to authorise payment and
one (without payment data) to accompany crops into storage.

b) Crops placed in storage in appropriate place, as shown on regularly maintained chart of variety/package type locations which can easily be referred to by all staff.

Crops entered on bin card which is kept in a holder on or immediately adjacent to the stack of produce.

The copy of grower's receipt is annotated with the location reference and with the responsible staff member's signature and sent to the Stores Office.

c) Information is transferred from the grower's receipt copy to the office copy of the bin card.

Crop Storage Maintenance Routine:

a) Every future test and treatment requirement is entered into a diary which is maintained in the office.

b) As each day's page is turned up, a note of the inspection or treatment required is issued, on the day previous to which it is to be undertaken, together with any necessary chemicals or equipment to the Stores Supervisor.

c) When the test or treatment has been completed, the information is entered on the bin card and the instruction note is returned to the office, together with any equipment or surplus chemicals, signed by the staff member who supervised the operation.

d) The appropriate item in the diary is ticked off, and the details from the returned instruction note are entered on the bin card copy maintained in the office.

e) Any entries in the diary which have not been ticked off after one week are followed up to ensure that the necessary test or treatment is in fact being carried out.

Crop Dispatch Routine:

a) Customer's order is received or noted in the Stores Office, and placed in a file according to the delivery schedule for that district.

b) On the day before dispatch date, orders for that area are withdrawn from the file and checked against stock as shown in the office copy of the bin card. Orders which cannot be delivered are placed in the next following delivery date.

c) Clerk prepares a three part set of the order which is to be delivered, consisting of a delivery note, a goods received note and an unpriced invoice. All three parts are noted with the stores location card and given to the stores staff as an instruction to withdraw produce.

d) Produce is withdrawn and prepared for dispatch, and withdrawal noted on the bin card in the stores. The delivery note and goods

received note are kept with the produce, the invoice copy is returned to the office signed by the responsible stores staff.

e) The withdrawal from stock is marked off on the office copy of the bin card and the invoice copy is then sent to the accounts department for pricing, extension and separate dispatch to customer.

6) Suggested layouts for the internal documents which are required might be as follows (ensure that trainees understand the ways in which carbon copy sets can be made up to exclude or conceal confidential information such as amounts payable to members, the use of smaller size sheets of carbon or by heavy overprinting of spaces where confidential data appears):

Bin Card (Front Side)

Grade/Variety: _____ Packing Type: _____

Location Code: _____

Date	Balance		Entered		Withdrawn		Balance		Signature
	Bags	kg	Bags	kg	Bags	kg	Bags	kg	

Bin Card (Reverse Side)

Date	Test	Result	Treatment	Signature

Treatment Instruction Slip

Date	Location Code	Test/Treatment Required	Result	Signature

7) Trainees should compare these and their own suggestions with systems actually used in their co-operative societies. They should test every system, and every document and entry within that system, by asking the following questions:

- What use is made of this document/entry?
- Is the cost in terms of staff time and administration more than covered by the benefits resulting from the document/entry?
- What would happen if this document/entry was eliminated?
- Can this document/entry be combined with something else to achieve the same effect?

8) Ask trainees for how long internal documents of this sort are filed in their societies. How accessible are they, and how often are they actually referred to after the transaction to which they refer has taken place? Filing costs are higher than they seem:

- Space is occupied.
- Expensive equipment is required.
- Staff time is occupied, and more time is needed to file or locate items if records are kept for many years.
- The necessary information can be lost if it is stored among large quantities of unnecessary information.

Trainees should on their return examine all filed documentation and press for the disposal of any whose costs of retention appear to exceed whatever use may be made of it.

9) Stress that paperwork systems are no substitute for good management. If they are not followed or used correctly they may even give a false impression of control which is more dangerous than no system at all.

The Resurgent Rice Growers

Johnson, the Manager of the Crop Store for the Resurgent Rice Growers' Society, was determined that the disasters of the last few weeks should never happen again.

The Foreman had absconded after it was found that he had been stealing large quantities of grain and many people had been hospitalized after eating rice which had been treated for use as seed that had in error been dispatched for human consumption. It was clear that complete re-organisation was needed and Johnson felt that he was lucky not to have been dismissed himself. The whole warehouse had been emptied in stages and treated with insecticide or repaired as needed, and the fifteen or twenty various types and package sizes had been neatly and separately restacked on suitable dunnage to prevent contact with the floor.

Johnson was sure that more was required however. There was no internal paper-work system worth mentioning, and the only documents which were regularly used were the notes given to members when delivering their crop and the delivery note, invoice and goods received note which went out when the goods were dispatched. Johnson knew that these documents would not in themselves solve his stores problems, and they had not prevented customers being sent the wrong produce.

Large quantities of rice of various types were received and dispatched every day during a large part of the year. Rice was brought in by members from the Society's mill, and it was delivered by the Society's own or hired transport according to a monthly rota of regular delivery routes. Johnson was not himself responsible for the invoicing and accounts function, but he had of course to ensure that the Accounts Department was notified of produce despatched so that they could send out the necessary invoices.

The Accounts Department used a standard grower's receipt. These were filled in by Mr. Johnson's staff when grain was delivered, and were then passed to the Accounts Department for pricing and payment. When the Accounts Department used to notify Mr. Johnson when grain was to be despatched from the store, Mr. Johnson's staff would in turn notify the Accounts Department when the grain had been dispatched, and in what quantity, by sending a note back to the Accounts

Department. They would then send an invoice to the customer. The grower's receipt and the invoice are shown below, and these forms would not be changed.

Grower's Receipt:

RESURGENT RICE GROWERS

Name: _____ Membership No: _____

Bags Delivered: _____ Date: _____

1	kg.	Total b/f	kg.
2	kg.	6	kg.
3	kg.	7	kg.
4	kg.	8	kg.
5	kg.	9	kg.
Total c/f	kg.	10	kg.

Grade: _____	Total Weight	kg.
	Net Weight	kg.
Signed:	Price Per Kg	$
_____	Total Due	$

Invoice Set:

RESURGENT RICE GROWERS

Date: _____ Invoice No: _____

Customer: _____ Order No: _____

Delivery Address: _____

_____

Produce	Bags	kg.
Total		
Less Allowance for Sack Weight		
Net Weight @ $ _____		
Total Amount Due		$
E&OE		

Invoice Set: The Delivery Note and Goods Received Note would be copied below this, with different wording written in such as "Received goods as below, in satisfactory condition" on the Goods Received Note and "Please receive the following produce" on the Delivery Note. The price information would be obscured by heavy overprinting at the appropriate section.

After the poisoning tragedy Ministry officials had visited the store and had laid down a regular programme of tests and treatments. Johnson had this pinned up in his office, but he knew that he must design an internal paperwork system to ensure that the schedule was properly maintained. He had no experience in designing paperwork systems, and he therefore asked the Co-operative Union's Organisation and Methods Department to send a consultant to design an internal system.

Assignment:

You are the Consultant for the Co-operative Union. Design an internal paperwork system for the Stores of the Resurgent Rice Growers' Society, showing in particular:

- Each stage in the system, indicating what entries on what documents are required and what happens to these documents.
- The ways in which the new system fits in with the existing receipt given to members and the invoice, delivery note and goods received note sent out to customers.
- The approximate layout of any preprinted forms or cards which you suggest.

topic

9

moisture and temperature

SESSION 9

MOISTURE AND TEMPERATURE

Objective: To enable trainees to identify the inter-related effects of moisture and temperature on crop deterioration in storage.

Time: Two to three hours.

Material: Test Data Sheet, Graph Paper. Case study "Too Cool or Too Dry?"

Session Guide:

1) Ask trainees why it is necessary to keep crops as cool and dry as possible. What damage is done by heat and moisture?

   - If stored crops are damp or hot, this encourages mould and insect attack, which reduces the salable quantity and the quality.

   Crops may be warm or cool, and dry or wet. Allow trainees up to ten minutes to identify all the possible combinations of these, and to rank them from the worst to the best environment for stored crops.

   Elicit the following sequence:

BEST	Cool Dry	Warm Dry	Cool Wet	Warm Wet	WORST

2) Ask trainees to suggest why stored crops may have a higher than desirable moisture content:
   - Crops harvested in the rainy season.
   - Crops wet by rain before being stored.
   - Damp floors to storage areas.
   - Damp packing material.
   - Rain entering the place of storage.

Why are crops hotter than they should be?

- Grain may be hot after artificial drying.
- Buildings are poorly insulated or unshaded.
- The process of decay itself generates heat.

3) Ask trainees how these factors can be reduced, so that crops are cooler and drier when put into storage, and remain so.

- Crops must be protected from rain during and after harvest.
- Storage buildings must be waterproof and well insulated.
- Dunnage must be used to protect damp rising from the floor.
- Building design and stacking must allow for space between crops and natural ventilation.
- Forced draught ventilation can be provided.
- Refrigeration can be provided.
- Storage bins can be hermetically sealed.
- Crops can be artificially dried before storage.

Stress that while effective management must play a part, nearly all these measures involve increased costs. It is therefore important to compare the damage caused by warmth and by moisture and to relate it to the cost of its reduction.

4) Point out that if time and the necessary facilities were available trainees could carry out experiments to measure the different effects of moisture and temperature on stored crops. Because this is not possible, they are to work from a set of data that was produced in such experiments, in order to see for themselves the relationship between the temperature and moisture content of a stored crop and its condition. The figures from which they will be working relate to rice. If trainees are not involved with rice storage, these figures should be replaced with similar data for whatever crop they do work with. If such information cannot be obtained the exercise is still a valid demonstration of the effects of moisture and temperature.

Distribute copies of the Data Sheet together with graph paper. Allow trainees individually up to 45 minutes to plot the curves according to the assignment. If necessary explain the basic principles of graphs to any trainees who are unfamiliar with this way of presenting data.

Point out that 90 days has been used as the storage period because this is a fairly typical period. If trainees are generally concerned with crops that are stored for far longer or far shorter, attempt to obtain similar information for these periods. If this cannot be obtained, the 90 day period is suitable for demonstration of the principles which apply to any period of storage.

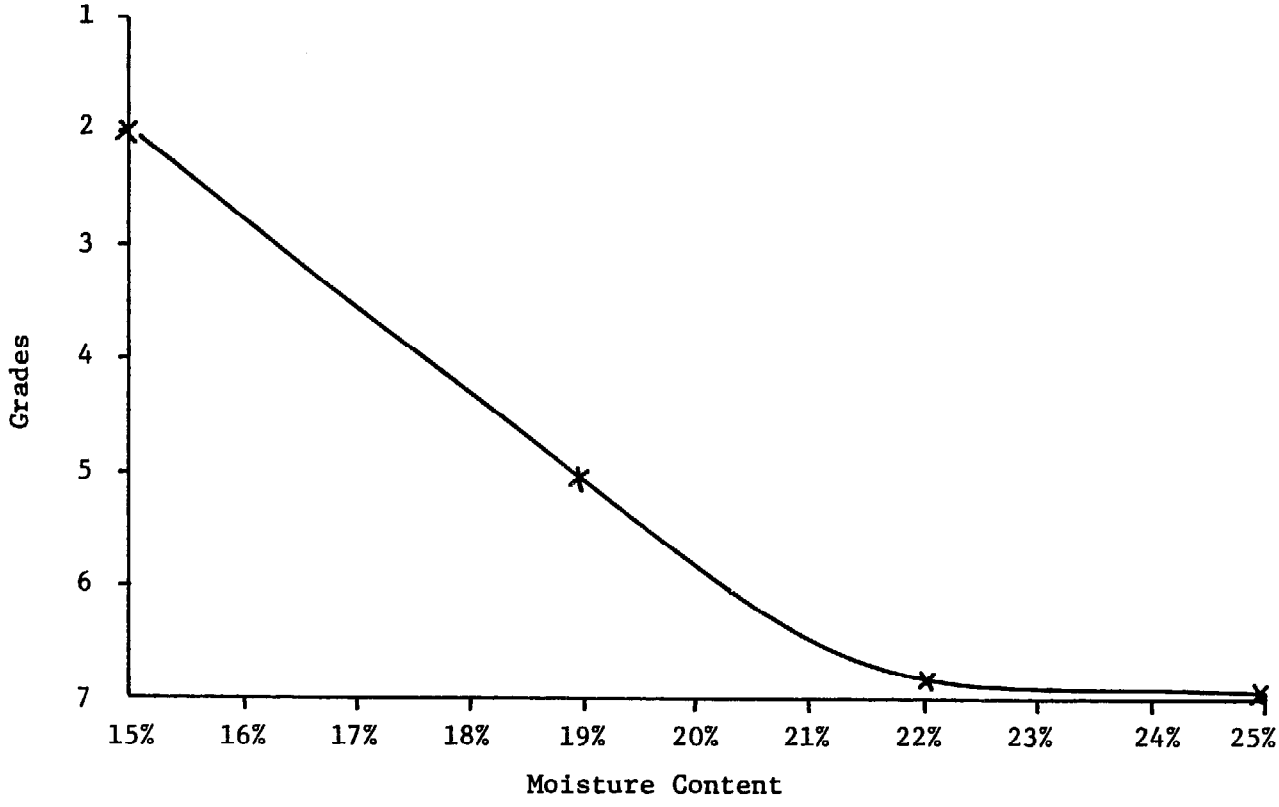
5) Circulate among the group to ensure that all trainees are drawing the graphs correctly. When they have finished, display a preprepared large-scale version on the chalkboard, flip-chart or OHP transparancy. Trainees' graphs should be approximately as follows, although the scale and choice of vertical and horizontal axes is clearly a matter for individual decision. Most trainees will start the temperature and moisture content axes from zero rather than the low points of the data. This is acceptable, although the result is less clear. Trainees should realise that data of this sort does not necessarily mean that the curves can be extended above and below the range of the data with any confidence.

Check trainees' understanding of the purpose of a graph by asking them to make simple readings such as:

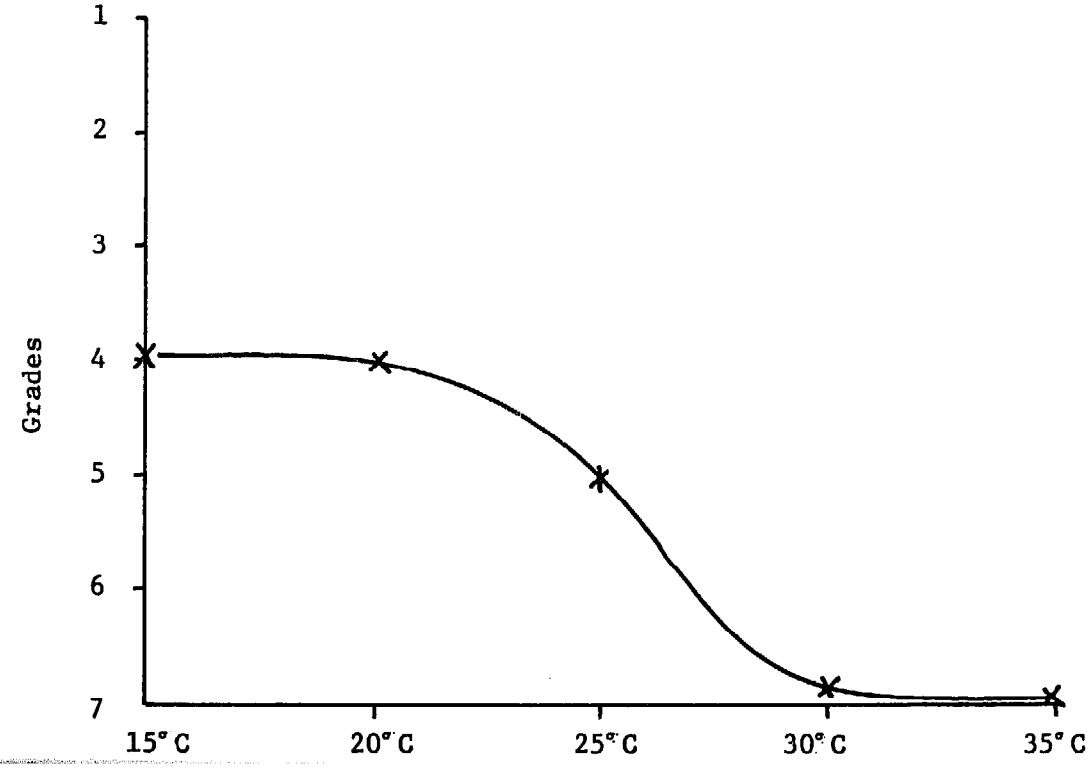
- What grade would be expected if rice stored at 25°C had a moisture content of 18%? *(Grade 4)*
- What grade could be expected if rice with 19% moisture content was stored at 27°C? *(Grade 6)*

Stress that even carefully controlled tests such as those from which these figures were taken cannot give completely consistent results. Crops are living organisms and so variations must be expected. The graph merely gives an indication of how temperature and moisture affect the value of stored crops.

Rice Stored at 25°C



Rice Stored at 19% Moisture Content



6) Distribute copies of the Case Study. Allow trainees up to 45 minutes to complete the assignment. Ensure that all trainees understand how they can use the graphs to help solve the problem.

7) Ask trainees individually to give their conclusions, without at this stage discussing their reasons. Summarise the number of recommendations for each alternative, or for both, neither or any other recommendation on the chalkboard.

Ask one or more trainees who have concluded that either the drying or the cooling proposal should be implemented to go through their calculations with the rest of the class. Encourage discussion, and elicit the following figures from a trainee who has concluded that neither proposal should be implemented.

Existing Revenue:

1,000 tonnes Grade 5 @ $242 per tonne	=	$ 242,000

Revenue with Drier:

1,000 tonnes Grade 2 @ $248 per tonne	=	$ 248,000

Revenue with Temperature Reduction:

1,000 tonnes Grade 4 @ $244 per tonne	=	$ 244,000

Increased Revenue with Drier	$ 6,000
Annual Cost of Drier	6,500
Reduced Net Income	$ 500

Increased Revenue with Ventilation	$ 2,000
Annual Cost of Ventilation Improvement	2,100
Reduced Net Income	$ 100

Trainees should therefore agree that neither proposal should be implemented because both increase costs more than revenues and would result in the Society being worse off than before.

8) Ask trainees how they might further advise the Society to improve its income. What possibilities might there be for improving these proposals? The necessary information is not available, but trainees may suggest:

- The high drying cost is a result of very small throughput. The Society should consider sharing the facility with other societies, or making use of a mobile drier.
- Improved ventilation might be possible by judicious use of existing windows and doors, and very simple home-made modifications to stacking and other arrangements. The same benefit might therefore be achieved at negligible cost.

Stress that improved management need cost nothing. If money must be spent, however, to reduce storage losses, the benefits must be carefully calculated and compared with the costs before investment is made.

The Resurgent Rice Growers
Temperature and Moisture Test Data Sheet

A series of laboratory experiments were carried out for the Resurgent Rice Growers in an attempt to measure the effect of temperature and moisture content on stored crops. Measured quantities of first grade rice were brought to certain levels of moisture content and were then stored for 90 days at various temperatures. Rice with a fixed moisture content was also stored at various temperatures.

The rice in both cases was then graded and the grades were recorded as follows:

Rice Stored at 25°C for 90 Days:

Moisture Content 25%	Grade after 90 days 7
" " 22%	" " " " 7
" " 19%	" " " " 5
" " 15%	" " " " 2

Rice Stored at 19% Moisture for 90 Days:

Temperature 35°C	Grade after 90 days 7
" 30°C	" " " " 7
" 25°C	" " " " 5
" 20°C	" " " " 4
" 15°C	" " " " 4

Assignment:

1) Draw a graph showing the effect of changes in moisture content on the grade of rice stored at 25°C for 90 days.

2) Draw a graph showing the effect of temperature change on the grade of rice at 19% moisture content stored for 90 days.

The Resurgent Rice Growers

To Cool or to Dry?

The Grain Drier Salesman and the Representative from the Storage Construction Engineers were equally persuasive. Both their proposals sounded very attractive, but there was no doubt that the Resurgent Rice Growers could only afford one. The problem was which?

Johnson, the Storage Manager, kept regular records of the temperature and moisture content of the 1,000 tonnes of members' rice which was regularly stored for three months in the Society's store. When the rice was put into storage it was always of Grade 1 quality and the Society was continually fighting against deterioration of the produce by trying to reduce moisture and storage temperature throughout the storage period in order to keep the highest possible grade and thus achieve the best possible financial results. The figure 19% moisture and 25^{o}C temperature were a great improvement over the previous performance, and representatives from a number of neighbouring societies had visited the Resurgent Rice Growers in order to see how they achieved these results.

The Committee and the Manager were however determined to do even better. They knew that members were growing better crops every year, and they felt a moral as well as a financial responsibility to store their rice in such a way that it best maintained its value.

Johnson studied the current price schedule for rice because the Society's income depended on the grades they obtained.

Rice Price Schedule	
Grade 1	$ 250 per tonne
Grade 2	$ 248 per tonne
Grade 3	$ 246 per tonne
Grade 4	$ 244 per tonne
Grade 5	$ 242 per tonne
Grade 6	$ 240 per tonne
Grade 7	$ 230 per tonne

The Grain Drier Manufacturer proposed to install a drier which was guaranteed to reduce the moisture content from the present level of 19% down to 16%. The Accountant had calculated that the cost of this proposal, including depreciation, interest charges, fuel and other necessary costs would be $6,500 per year.

The Storage Construction Engineers had proposed to install a system of ventilation ducts, improved insulation and other changes to the store which were guaranteed to reduce the average temperature of the stored rice from 25°C to 20°C The Accountant had similarly calculated that the effective annual cost of this investment was $2,100 per year.

The Storage Manager now had to decide which proposal to recommend to the Committee since only one of them could be undertaken.

Assignment: Advise the Storage Manager.

topic

10

measuring moisture and temperature

SESSION 10

MEASURING MOISTURE AND TEMPERATURE

Objective: To enable trainees to select the most appropriate method in given circumstances for measuring temperature, relative humidity and produce moisture content in store.

Time: One and a half to two and a half hours.

Material: As many actual examples as possible of temperature, relative humidity and crop moisture content measuring equipment. Alternatively leaflets illustrating and describing such equipment as is locally available.

Session Guide:

1) Ask trainees what the staff who are responsible for monitoring storage conditions in their societies do with any data on the temperature and moisture which they collect. Is it recorded and filed away, or does somebody do something, which he would not have done otherwise had the information not been available?

Stress that increases in temperature are more important than the absolute level. What action might a storage manager take if the temperature of stored produce was found to be increasing unexpectedly?

- Ventilation could be improved.
- Produce could be inspected for heat generating infestation and treated accordingly.
- Produce could be restacked.
- Produce could be sold sooner than planned, even at a lower than anticipated price, to avoid more costly deterioration in quality.

2) Ask trainees at what stage it is valuable to measure the moisture content of grain and to explain what specific actions the results of such inspection may lead to:

- Moisture content of grain can be measured in the field before harvest to decide whether it is ready for harvest or should be left standing for a longer period.
- Moisture content may be measured before grain is milled or otherwise processed, to decide whether or not it is ready to be processed, or to determine the settings to be used in processing.
- Moisture may be measured when produce is being put into storage, to determine whether or not it should be accepted at all, whether it should be dried artificially or in sunlight, how long it should be kept in storage and under what conditions.
- Moisture content may be measured when produce is being sold since prices may vary according to how much water the customer is buying along with his crop, and its suitability for storage or further processing.
- Moisture content may be measured as part of routine daily or weekly inspection procedures, for the same reasons as storage temperature and relative humidity of the atmosphere.

3) Ask trainees to explain the following statement to someone who does not know what it means:

"The moisture content of this maize is 20%."

Trainees must distinguish carefully between the following two explanations:

- "20% of the total weight is water." (Wet basis)
- "This maize contains 20% of its own dry weight in water." (Dry basis)

Illustrate the difference by a diagram as follows:

- MMMMMMMM WW - 2 parts out of the total of 10 parts are water.
- MMMMMMMMM WW - 2 parts of water are present to every 10 parts of maize.

It is vital to be clear whether moisture content figures are on a wet or a dry basis. Confusion can lead to large errors, with serious effects on grade and price.

Confirm trainees' understanding by asking them to assume that the first statement is on a wet basis and to convert it to a dry basis:

- If x is the total weight, 0.2 x is the weight of water and 0.8 x is the weight of the grain alone.
- 0.2 as a % of 0.8 is 25%.
- The moisture content is therefore 25% on a dry basis.

Ask them to convert the following statement of moisture content on a dry basis to a wet basis:

"The moisture content of this maize is 18%."

- If x is the weight of the dry maize alone, 0.18 x is the weight of water and 1.18 x is the weight of water plus maize.
- 0.18 as a % of 1.18 is 15.25%.
- The moisture content is therefore 15.25% on a dry basis.

4) Ask trainees what determines the moisture content of produce in storage:
   - The amount of moisture in the produce when it is put into storage.
   - The amount of moisture in the air or water in the store itself.

Even if crops are properly dried before being put into store, moist air or water can increase the moisture content when they are stored. It is therefore important to know not only the moisture content of produce itself, and to keep the store physically dry, but also to measure the moisture content in the atmosphere in which crops are stored.

Ask trainees to explain the following statement to someone who does not know what it means:

"The relative humidity of this atmosphere is 85%."

Stress that it does <u>not</u> mean that 85% of the atmosphere by weight, volume or anything else is water.

Ask a trainee who does understand relative humidity to explain:

- 100% relative humidity means that the water content of the atmosphere has reached saturation. The air cannot absorb any more water. "85% relative humidity" means that the water content is 85% of the maximum level.

Trainees will probably be familiar with the "sweat" that forms on beer or soft drink bottles when taken out of a refrigerator. Ask trainees why water condenses out of the atmosphere into droplets on cool surfaces or mist in cooler air.

Warm air can contain more water than cool air. Air at 85% relative humidity contains more water if it is warmer than if it is cool.

Ask trainees why this factor is important for anyone controlling the conditions in a produce store:

- High temperature is not only encouraging infestation and decay, it increases the water carrying capacity of the air, which in turn makes the produce wetter.

Temperatures must therefore be reduced as much as possible.

Ask trainees how a society may suffer if they do not control moisture content and temperature:

- They may accept produce which is substandard and will damage other produce with which it is stored.
- Their produce will deteriorate without them knowing it.
- They may receive lower prices than their quality deserves because they cannot check the buyer's assessment.

Tests must be frequent and accurate. Allow trainees up to ten minutes to write down the ideal specifications for the kind of equipment to be used to measure temperature, relative humidity and produce moisture content. Trainees who already use such equipment should ignore it and

write down an ideal list of specifications from their own point of view, regardless of the advantages and disadvantages of equipment with which they are actually familiar.

6) After trainees have finished their lists ask them to read out one item at a time. List their specifications on the chalkboard/OHP. The list should include the following items at least:

- It should be inexpensive to buy.
- It should not need expensive consumables or spares.
- Any consumables or spares should be easy to obtain.
- It should be simple to operate.
- It should be robust.
- It should be quick to operate.
- It should be portable.
- It should not depend on outside power supply.
- It should be easily understood by members, customers and others who may be affected by its results.
- It must not require any lengthy calculations in addition to the original measurement.
- It should be accurate.
- It should be applicable to all the types of produce the society is likely to store.
- It should be able to operate on its own and to provide a permanent record of results.
- (except for relative humidity) It should be able to measure the condition of crops which are in the interior of sacks or deeply stacked.

7) Draw up a chart on the chalkboard/OHP as a basis for the evaluation of the various methods of measuring temperature and moisture which are to be described. Ask trainees to copy this chart for themselves, allowing space for as many types of equipment as will be discussed.

8) Trainees should now have an opportunity to decide how well the various methods of measuring temperature, relative humidity and moisture content conform to the specifications they have produced.

Trainees should at least be familiar with the traditional mercury thermometer. Display an actual thermometer, or remind them of its appearance. Ask trainees to write glass thermometer opposite the top row of their chart and to place a tick or a cross against each feature which is listed in the specifications, according to whether or not the traditional thermometer qualifies.

The actual items to be evaluated will depend on what is locally available. The following paragraphs and table cover most types of equipment. This session should only cover those likely to be available to local societies.

Temperature Measurement

- Mercury Glass Thermometer: (This should be familiar to trainees) Explain that all mercury thermometers work because liquid mercury expands by a large proportion to its mass when its temperature is increased.
- Maximum/Minimum Thermometer: This is a mercury thermometer with the additional feature that it records the highest and lowest temperatures reached since the device was last reset.
- Steel Cased Mercury Thermometer with dial or moving pen readout: It should be apparent that this is a far more expensive piece of equipment than unprotected thermometers. The steel also slightly insulates the mercury from the surrounding air or produce so that it takes longer to obtain a reading.
- Bimetallic Strip Thermometer with dial or moving pen readout: Two different metals which expand at different rates when heated are attached together to provide a movement indicating temperature. This is more robust than a mercury thermometer and the sensing head can be mounted on a probe. It is slow and relatively inaccurate.

	Cheap	Spares etc. Available	Spares etc. Cheap	Simple	Robust	Portable	Quick	No Power	Easily Understood	No Calculations	Accurate	All Crops	Self-Recording	Deep Reach
Glass Thermometer	/	/	/	/	X	/	/	/	/	/	X	/	X	X
Maximum/ Minimum Thermometer	/	/	/	/	X	/	/	/	/	/	/	/	/	X
Steel Clad Thermometer	X	/	/	/	/	/	X	/	/	/	/	/	X	/
Bimetal Thermometer	X	X	X	X	/	/	X	/	/	/	/	/	/	/
Thermocouple	X	X	X	X	X	X	/	/	/	/	/	/	/	/
Thermistor	X	/	/	/	/	/	/	/	/	/	/	/	/	/
Moisture Measurement														
Capacitance	X	X	X	X	/	/	/	/	X	/	X	/	X	X
Resistance	/	X	X	/	/	/	/	/	X	/	/	/	X	X
Calcium Carbide	/	X	X	X	/	/	X	/	X	X	X	/	X	X
Relative Humidity														
Hair	/	/	/	/	X	X	X	/	/	X	X	-	-	-
Wet/Dry Bulb Thermometer	/	/	/	/	X	/	X	/	X	/	X	-	-	-

/ = Satisfies Condition

X = Fails to Satisfy

- = Not Applicable

- Thermocouple: This device measures the voltage difference caused by different temperatures at either end of a wire loop made of two different metals. It can provide very accurate and rapid readings, at a distance from what is being measured, but is very expensive and complicated to calibrate and to calculate from.

- Thermistors: These rely on a transistor-like sensory element whose electrical resistance changes by a factor of up to 100 to one when its temperature changes. This change can fairly easily and inexpensively be converted into a dial or moving pen record of temperature with robust solid state circuitry.

Moisture Content

Trainees may be familiar with laboratory methods such as weighing the sample before and after heating in an oven or with an infrared lamp, or distilling the water and weighing the resulting condensate. These are extremely accurate, and are used to calibrate field equipment such as is described later, but they are inappropriate for practical use in a co-operative produce store.

Commonly used field equipment includes the following:

- Capacitance Meters: These measure the electrical capacitance of the grain, by using a carefully weighed sample as the middle of a condenser the sides of which are formed by two metal plates. This method gives equally accurate results over a wide range of moisture contents. Readings must be corrected for temperature, and the sample must be of exactly the correct weight to obtain good results. They can work on whole or ground grain. Conversion scales are available for most common crops.

- Resistance Meters: These measure resistance of a sample to an electric current. Wet substances conduct electricity more readily than dry ones. These are only accurate over a rather narrow range of around fifteen percentage points, between about 8% and 22% moisture content. This however covers the range most likely to be encountered in practice. It is possible to use whole grain but better results are obtained with ground grain. Conversion scales are available for most crops.

- Calcium Carbide Measurement: When calcium carbide comes into contact with moisture acetylene gas is produced. This meter measures the pressure produced when a measured quantity of grain is placed in a sealed container with calcium carbide. This is not very accurate but is quite robust and portable. Calcium carbide may however be difficult to obtain and is dangerous and cannot therefore be sent through the mail. The user must himself convert the pressure figure given by the equipment into the equivalent moisture content figure.

- Simple Tests Without Equipment: Trainees may mention that they or other people often use simple techniques such as the following for estimating moisture content, or at least for deciding whether or not a particular batch is or is not too damp:
  - Biting the whole grain.
  - Tasting ground grain.
  - Visual inspection of whole or ground grain.
  - Squeezing ground grain to see if it sticks together.

  Stress that these methods can give useful results if equipment is unavailable and the tester is experienced. In the next session trainees who claim to be able to estimate moisture content in one or more of these ways will have an opportunity to compare their results with those obtained using sophisticated equipment.

Relative Humidity

- Hair Hygrometer: Hair and some other materials shrink or expand when they are wet. Material of this sort is kept under tension, and the movement can be used to determine relative humidity to an accuracy of plus or minus 5%. This equipment is fairly simple and is convenient for quickly determining whether relative humidity exceeds a certain maximum level. It is not particularly robust and it is not accurate enough for some crops where relative humidity is of critical importance.

- Wet and Dry Bulb Hygrometer: If a thermometer is kept wet and exposed to a current of air it will fall to the same level to which it would fall if the air was at 100% relative humidity. If another thermometer is dry and is exposed to the same current of the same air, it will come

to a higher level, depending on the relative humidity of the air. The difference between the two readings can be converted to a measure of relative humidity. The air current can be produced by a fan or a "Whirling Hygrometer", where both thermometers are mounted in a frame which is revolved by hand in the atmosphere. This method requires some simple calculations and is rather slow. The equipment is cheap and as robust as the mercury thermometer on which it is based.

9) It should be possible to obtain approximate prices for equipment that is locally available and these should also be used in the session.

Stress that there are no general rules for the selection of equipment of this sort. Every item should be selected according to local circumstances and the actual choice will depend particularly on the following factors:

- The competence of the staff by whom the equipment is to be used.
- The amount of money that is available.
- The degree of accuracy that is required.
- The actual crops whose storage is involved.
- The quality of service provided by the local manufacturer or distributor.

Ask trainees why local availability is important, apart from the convenience of being able to obtain the equipment and spares and service:

- The equipment is likely to be familiar to those to whom its results will be of importance.
- Customers will accept readings because they are familiar with the particular form of measurement.
- In case of dispute over calibration or accuracy of equipment, it will be possible to compare the Society's measuring instruments with those belonging to customers, suppliers or official testing authorities in order to avoid dispute.

In the following session, trainees will have an opportunity actually to evaluate a given range of methods and to select a particular one in the light of particular circumstances.

topic

11

measuring instruments

SESSION 11

MEASURING INSTRUMENTS

Objective: To enable trainees to select the most suitable instrument from a given range for measuring moisture content and temperature in stored grain.

Time: Two to three hours.

Material: Case study "The six societies".
Samples of measuring equipment with manufacturer's leaflets.
Grain samples.

Note: The assistance of Protimeter Limited, of Marlow, England, is gratefully acknowledged.

Session Guide:

1) Ensure that the case study is modified or if necessary totally re-written so that it only describes instruments which are actually available to trainees' societies if they wish to purchase them. Obtain descriptive leaflets, actual local prices and samples of the instruments together with supplies of grain for testing.

2) Remind trainees of the previous session. Stress that once a basic method of measurement has been selected, it is then necessary to choose a particular instrument. Distribute the case study and allow trainees, in groups, up to one hour to make the decision. Ensure that sample instruments can actually be tried out by trainees themselves, if necessary under the guidance of a qualified technician or a representative of the supplier of the equipment.

3) Reconvene the class and ask each group in turn to present and justify its decision. Opinions may differ, depending on the level of staff

sophistication in societies and trainees' views as to the relative importance of the very best method of measurement and the extra expense that may be required to achieve this.

The following suggestions are probably the most appropriate:

Situation	Equipment	Reasons	Total Cost
1	GrainMini	Reliable, rapid, maize reader rings available.	$ 288
2	GrainMini plus Electronic Thermometer	Calibration rings available for paddy and sorghum, temperature measurement essential.	$ 426 plus spears and extension rods as necessary.
3	GrainMini Automatic	Easy to use, very rapid, no grinding required.	$ 328
4	GrainMaster	Conversion chart can be prepared to convert temperature figures to moisture. Temperature measurement always useful.	$ 354 plus temperature spear plus rods.
5	GrainMini without case	Grain always dry when harvested, testing can therefore be done later. Temperature measurement will be required after grain has been stored for one year.	$ 232
6	2 GrainMini Automatics	Every lot must be sampled and tested on arrival and delays must not occur. Two instruments necessary to maximise throughput and to avoid total stoppage in case of breakdown.	$ 656

4) Ask trainees to compare the situations described in the case study with the delivery and storage conditions obtaining in their own societies:

- How do their societies control the moisture of incoming produce and monitor moisture and temperature while grain is stored?
- What instruments do they use for this purpose?
- If they do not use instruments of the type described in the case study, why not?

Ask trainees to describe occasions where their societies have lost money because of deterioration in quality, or loss of quantity, which might have been prevented through more effective measurement. Does the loss exceed the cost of effective measuring equipment? Should their societies purchase equipment of this sort?

5) It is important not to over-estimate the advantages of modern equipment, or to neglect the possibilities of far simpler methods. If any trainees claimed in the previous session that they could estimate moisture content without equipment, they should now be given an opportunity to compare their results with the equipment. If trainees do not have this experience, try to identify someone who does, or, if necessary, the instructor can himself through experiments quite quickly acquire the ability roughly to measure moisture content by rubbing ground grain between his fingers and seeing to what extent it sticks together.

Prepare samples of grain at various levels of moisture, such as under 10%, 12½%, 15%, 17½% and 20% (this can quite easily be done with a moisturometer by immersing grain in water for various periods).

Code the samples, and ask whoever professes to be able to measure moisture content without equipment to test the samples and estimate the moisture content. Compare the results with those obtained from the moisturometer, and demonstrate that even sophisticated equipment can give a range of readings for the same sample. "Manual" methods are better than nothing, and can at least be used to reject grain which is excessively damp.

The Six Societies

Six different marketing societies have decided that they must each purchase a moisture meter to control and monitor the moisture content of the grain to be stored in their new stores. They have come to this decision for the following reasons:

a) There will be serious losses during storage if some lots of grain with excessive moisture content are stored with other grain even for only a month in the hot climate in the area.

b) The societies have to pay the Government guaranteed price to members but this is conditional on grain having a certain maximum moisture content in order to protect them from members who may water their grain to increase its weight.

c) It may be possible to install small grain drying plants because many members find it difficult to reduce the moisture content in their grain down to a safe level in periods of poor weather. In this case the societies can accept grain with a moisture content higher than the Government maximum but would make a price reduction to cover the cost of drying and the weight loss. It would therefore be necessary to measure the moisture content exactly.

The grains produced by the societies include maize, sorghum and occasional lots of paddy. The grain will be delivered in small vehicles, in bulk, but some members will continue for the foreseeable future to deliver in sacks. Samples will be taken by sampling spears from bulk supplies or by sack "triers". Typical sampling spear samples will be about 200 grams but the triers will yield only about 50 grams. Sack samples will have to be tested individually because experience shows that there can be very large variations in moisture content between sacks.

It has been decided to select equipment from the range illustrated in the attached sheet, for the following reasons:

- All these instruments work on batteries rather than the mains. Mains electricity is not available in the Society's yard where most tests are done and the mains electricity is unreliable where it is connected.

- The battery required is small, cheap, can be obtained locally and will last for at least one year.
- All three models are said to be robust and easy to operate, and they only require a small sample.
- All models can be calibrated for maize, sorghum and paddy. They can also be calibrated for other crops which may be introduced in the future.
- The instruments are automatically compensated for temperature changes.
- The instruments can be used with whole grains or ground grain. The specially provided grinder can be attached directly to the instrument when in use.
- It is impossible to over-compress the samples.
- Calibrations are to International Standards Organisation (ISO) standards, which will be necessary if the Society ever decides to enter the export trade.

The prices of the three models illustrated are approximately as follows:

GrainMini	=	$ 288
GrainMini Automatic	=	$ 328
GrainMaster	=	$ 354

If a separate electronic thermometer is required this can be purchased for $ 138. It may also be necessary to purchase varying quantities of grain spears or extension rods for testing bulk stored grain.

All three models operate on the same basic system:

(i) A whole or ground sample of the grain required to be tested is placed in a cell on the instrument and a compressor is fitted over it.

(ii) The compressor knob is turned until it slips with a repeated clicking sound indicating that the proper pressure has been applied.

(iii) The results are presented.

The three models vary in the way in which the results are presented at this stage:

- GrainMini:

  A plastic ring is fitted over the knob and pointer for the type of grain being tested. Rings are available, for wheat, barley, maize, paddy, oilseed rape and sorghum. Other crops can be tested by reading from a 0 - 100 scale and converting this to moisture from a separate table which is provided. After the sample has been compressed a small button on the instrument is pressed and a light will show to indicate that the battery is not exhausted. The operator then turns the knob until the other light glows; a reading can be taken at this point.

- GrainMini Automatic:

  The procedure is the same as for the GrainMini except that it is only necessary to press the battery test button. The pointer then turns automatically to the correct reading and thus provides a quicker measurement.

- GrainMaster:

  (1) The left-hand toggle switch is moved to the right and the needle is brought to the "R" position by turning the central knob if necessary.

  (2) The left-hand toggle switch is moved to the left and the pointer then automatically indicates the moisture content of wheat or barley and a figure on a 0 - 100 scale. If the crop being tested is neither wheat, barley nor maize, the operator finds the moisture content of whatever crop he is testing by finding the appropriate figure in a conversion table which is provided with the instrument.

  (3) The GrainMaster also records temperature on the same dial and has a socket into which grain temperature measuring spears can be plugged. These spears can be left in stored grain and the instrument can be connected to each in turn and the temperature noted. This can be done as often as is required and very quickly.

If preferred, the GrainMini or GrainMini Automatic may be purchased and a separate electronic thermometer purchased for measuring temperature on its own.

The main features of the three instruments may be summarised as follows:

GrainMini	GrainMini Automatic	GrainMaster
Easy to use.	Very simple to use.	Easy to use for wheat, maize and barley but more difficult for other grains.
May be difficult to read in bright light.	More likely to go wrong.	A more delicate instrument.
No battery adjustment needed.	(As for GrainMini)	Instrument must be calibrated for battery strength.
Direct reading for wheat, barley, maize, rape, paddy, sorghum.	(As for GrainMini)	Direct reading for maize, wheat and barley only.
No temperature measurement facility.	(As for GrainMini)	Can measure grain temperature in conjunction with grain spears.
Large figures easily read.	(As for GrainMini)	Rather small figures.
Separate reader rings can be lost although special recesses provided in the instrument for storing them.	Reader rings can be lost and no storage place is provided.	No reader rings to be lost but readings depend on availability of conversion table.

Each Society must make its own decision and their circumstances differ. Recommend the appropriate instrument or instruments to be purchased by each of the following:

Society 1: Rapid throughput, no long term storage, only maize is grown.

Society 2: Only paddy and sorghum are grown and some grain will have to be stored for more than one year as a reserve for famine.

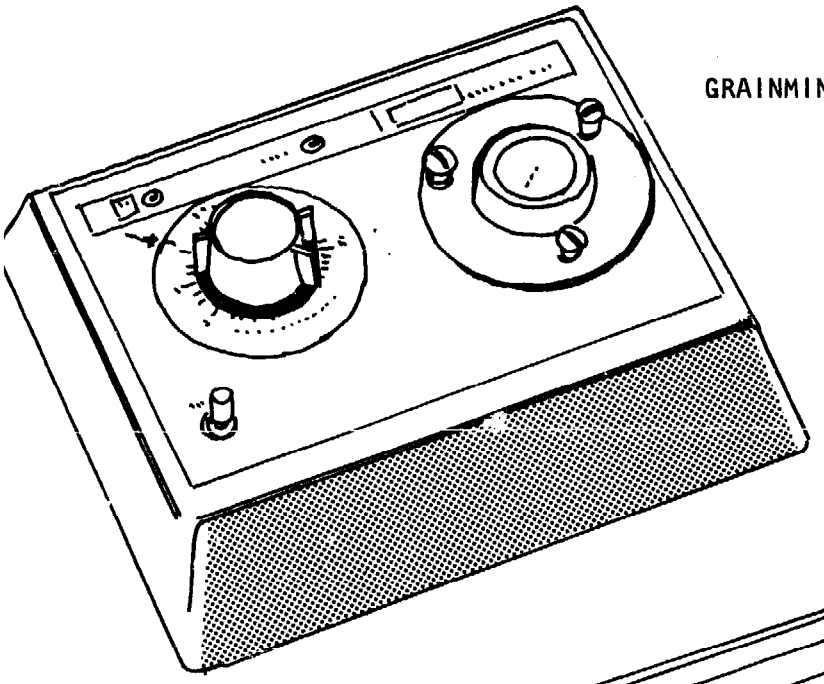
Society 3: All three types of grain will be grown and will have to be collected very rapidly in small lots. Measurements will be taken mainly in the open yard by very unskilled operators.

Society 4: A skilled and experienced manager or deputy will always be available and tests will normally be made on grain in the office rather than in the yard.

Society 5: Very little money is available for capital expenditure. Some grain is stored for long periods and the climatic conditions mean that all grain is dry at harvest time when members deliver it.

Society 6: Grain is frequently wet at harvest time and must be collected rapidly from a large number of small growers in small lots. The Society's location is in a remote area where no sophisticated servicing facilities are available.

GRAINMINI



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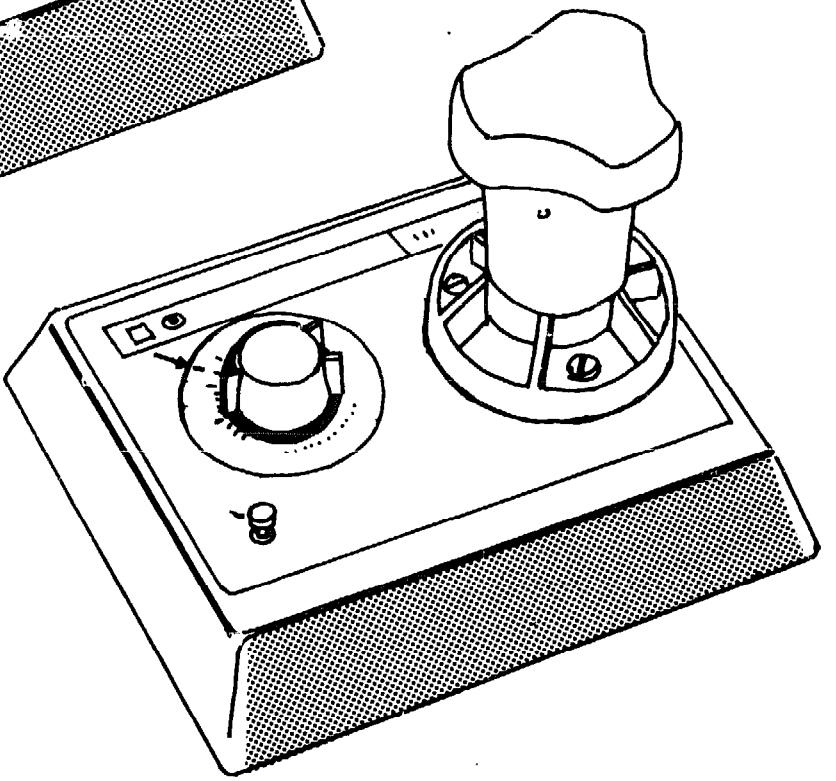
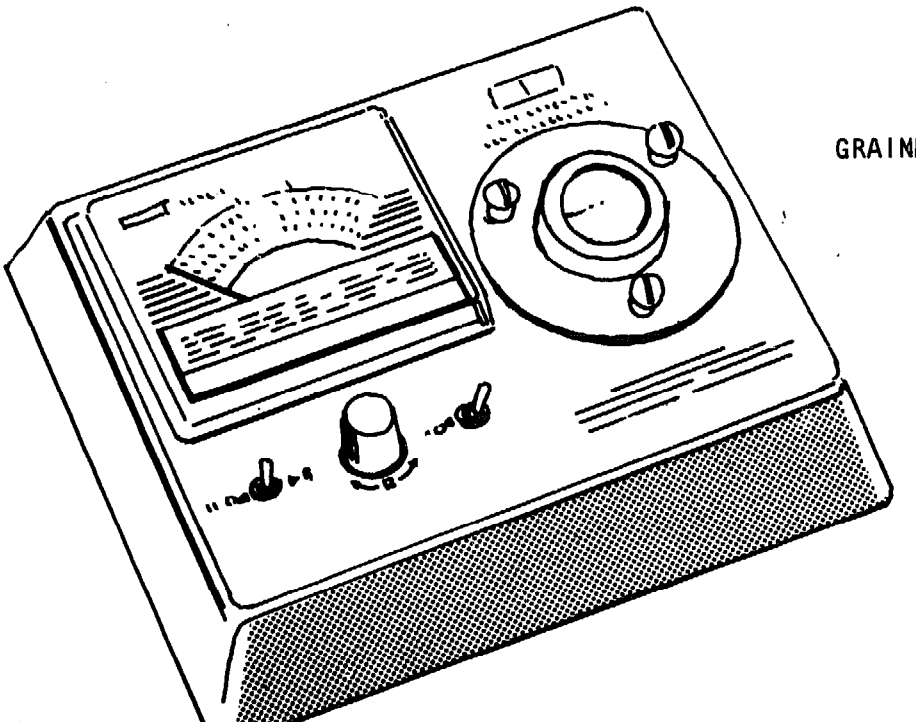
AUTOMATIC



GRAINMASTER



topic

12

insect and rodent damage

SESSION 12

INSECT AND RODENT DAMAGE

Objective: To enable trainees to identify the potential for damage caused by insects and rodents and to inspect storage premises in order to find out the level of infestation.

Time: Two to two and a half hours

Material: Handout - "Rattus Norwegicus, The Common Rat".
A sack of a familiar local grain, preferably with reasonably heavy insect infestation, a grain spear and any other items of inspection equipment which are available.

Note: If possible the session should be conducted in or near a store, so that trainees can see and try for themselves the various techniques that are discussed. If this is not possible, produce samples and equipment must be available in the classroom.

Session Guide:

1) Trainees should by this stage be aware of the need to control temperature and moisture. Produce can of course be cooked and destroyed by temperatures over 50^{o} and by actual contact with water. Why is it necessary to keep temperatures and relative humidity well below this level?

   - Warmth and moisture encourage insect and bacterial attack which in turn destroy the crops.

   Ask trainees how they would react if they discovered that thieves were regularly stealing 5% or 10% of their stored crops. Would their members have reason to be dissatisfied with the managers?

Clearly regular theft on this scale would be intolerable, and if it persisted members would rightly demand the resignation of management.

Ask trainees to suggest what proportion of stored crops is lost through insects, fungus and rodent attack in centralised society stores.

Figures vary from one country and one society to another, depending largely on the ability and efforts of the staff. The following figures for a sample of centralised stores, not farm granaries, may be of interest:

Sri Lanka	-	6.5% of rice is lost in storage.
Sudan	-	17% of rice is lost in storage.
Kenya	-	12% of maize is lost in storage.
India	-	8.5% of beans is lost in storage.
Pakistan	-	5% of wheat is lost in storage.

These losses take place on average over six months. Trainees should appreciate the need for trying to reduce losses due to pests in the same way that they would try to discover and prevent theft by human beings.

2) Ask trainees to suggest average shade temperature and humidity figures for the outside atmosphere during the months when crops are most commonly stored:

- Suggestions will vary according to locality, altitude and season, but $25^{o}c$ and 75% relative humidity are normal or below normal day time conditions in many tropical countries.

Ask trainees how conditions in a crop store are likely to differ from the outside figures, and why:

- Temperatures may be higher because of biological activity in the crop, even if this is minimised as much as possible.
- Relative humidity may be higher because moisture from the crop will evaporate into the air unless the moisture content of the crop is lower than that of the atmosphere. This is unlikely unless the crop has been artificially dried or has been harvested in very dry conditions.

3) Stress that the moisture content of stored crops and the moisture content, or relative humidity, of the air are closely inter-related and can effect one another.

Refer to moisture content standards with which trainees are familiar, or to The Philippines Standards for Rice which are reproduced in the MATCOM training material on Collecting and Receiving Crops. Remind trainees that 14% was the highest permissible moisture content for any marketable standard of rice in that case.

Draw the following table on chalkboard/OHP, and ask trainees to guess what would be the resulting moisture content figures for the three crops which are listed, if they were put into storage at 9% moisture content and stored for 3 months in air which is of the three figures for relative humidity. The correct figures are shown in the table. Trainees' guesses should be compared with these and they should appreciate the vital necessity of maintaining relative humidity below 80% if at all possible.

Relative Humidity	Maize Moisture Content	Wheat Moisture Content	Rice Moisture Content
40%	*9%*	*9%*	*10%*
60%	*12%*	*12%*	*13%*
80%	*16%*	*16%*	*17%*

4) Temperature and humidity affects the breeding rate of insect pests very significantly. Laboratory tests have been made to determine the minimum, ideal and maximum temperatures and relative humidity figures for a number of insects which commonly infest grains such as rice, maize and wheat.

Ask trainees to guess what might be the figures which were discovered; the minimum figures which insects could survive, the optimum figure which maximise their reproduction and the maximum figure which they could survive. Their guesses should be compared with the actual figures as follows:

	Temperature	Relative Humidity
Minimum	15°C	32%
Optimum	30°C	90%
Maximum	37°C	No species can survive if totally and permanently submerged in water

Stress that the optimum conditions for insects are not very distant from what might be expected in many stores. Every effort must be made to reduce temperature and humidity but this will not be enough. What else must be done in order to minimise insect loss?

5) Stress that stores must be inspected as a basis for attempting to reduce insect damage. Ask trainees what specifically might be done as a result of an inspection for insect infestation:

- Some grading systems include a measure of insect infestation, which affects the price.
- Previous control measures can be assessed and improved in future.
- Areas of intense insect infestation can be identified and treated locally.
- Badly infected crops can be separated from less affected crops to avoid cross infestation.
- Badly infected crops can be totally removed and sold for whatever they will fetch.

Ask trainees for how many months, on average, crops are stored in their societies.

Ask trainees to estimate what might be the number of insects of a typical species attacking grain after three months, if there were 50 adult individual insects at the beginning and the numbers were not controlled by insecticides or the lack of food, water or by natural enemies.

Ask trainees for their guesses and write them on the chalkboard/OHP. The theoretical figure is 6,250,000.

The formula for calculating the potential number of insects is as follows:

- The number after N months = the number at the beginning to the power of N plus 1.

Check trainees' understanding of this by asking them to work out the number of insects:

- After 2 months if there were 200 at the beginning. (8 million)
- After 5 months if there were 20 at the beginning. (64 million)
- After 1 month if there were 1,000 at the beginning. (one million)

Stress that although the theoretical reproduction rate is not achieved in practice, the starting numbers in these examples are artificially low. 500 insects per tonne is in fact a low rate of infestation.

Ask trainees whether inspection of insect infestation is most important at the beginning, the middle or the end of a storage period.

- Stored crops should be regularly inspected, but early inspection can enable corrective action to be taken in time to prevent the rapid expansion in numbers indicated by these figures.

6) Most insects that attack stored crops are small and unobtrusive. They are generally more active when it is cool and dark, and they generally bury themselves as deep as they can in whatever crevices or gaps between seeds are available. They only emerge if they are disturbed in order to find a more secure hiding place.

Ask trainees how an inspector can make use of these common insect habits in order to be able to find insects which naturally conceal their presence:

- Crops should be inspected at night when it is cool and dark.
- Bags or bulk storage should be shaken or otherwise disturbed to bring insects to the surface.

- The total contents of sample bags should be poured out in a line along a clean floor, to enable insects to be seen.
- Traps may be made from pieces of corrugated cardboard, or sticky material, to obtain evidence of insect presence.

7) Some infestation is almost inevitable. Regular checking can ensure that the numbers are static or declining, or can lead to corrective action if they are increasing. Ask trainees how inspection should be organised in order to obtain useful results:

- Samples should be taken at random from throughout the store, and from deep within sacks or bulk storage as well as from produce at the surface.
- Insect presence must be measured and recorded according to some standards, so that changes can be observed.

8) Stress that inspection must be easy and quick, since staff will otherwise be unable to inspect every part of the store often enough. Ask trainees how an inspector should sample grain from a sack:

- Opening a sack takes time, and it may not be properly closed after the sample has been removed.
- Even if the sack is opened, this only allows a sample to be taken from the top.
- If the whole sack is emptied, this takes far more time and will result in spillage which encourages rodent infestation.

Show trainees a grain spear. Demonstrate its use on a bag of grain, showing how the elasticity of the fabric automatically reseals the hole made by the spear. If time allows and trainees have not previously used grain spears, they should be given an opportunity to do so. Trainees may feel that it is wasteful to remove samples in this way. Stress that the amount taken by a probe is negligible, and sampled maize can in any case be collected in a bag for subsequent sale.

9) Ask trainees how they might quantify the degree of insect infestation, in order to provide a standard of comparison and to enable changes to be observed between one inspection and the next:

- A random sample must be taken from representative points within the store and the number of insects per kilogram must be physically counted.

Ask trainees how they would go about doing this. How can they ensure that a sample is random, and that the insects are properly counted without taking so much time that proper inspection becomes quite impracticable?

- Various devices exist for taking random samples from large amounts, without reducing or concentrating the amount of insects in the process.
- Sieves or other devices can be used to spread the sample out evenly or to separate material of different size or weight so that the insects can be counted without too much difficulty.

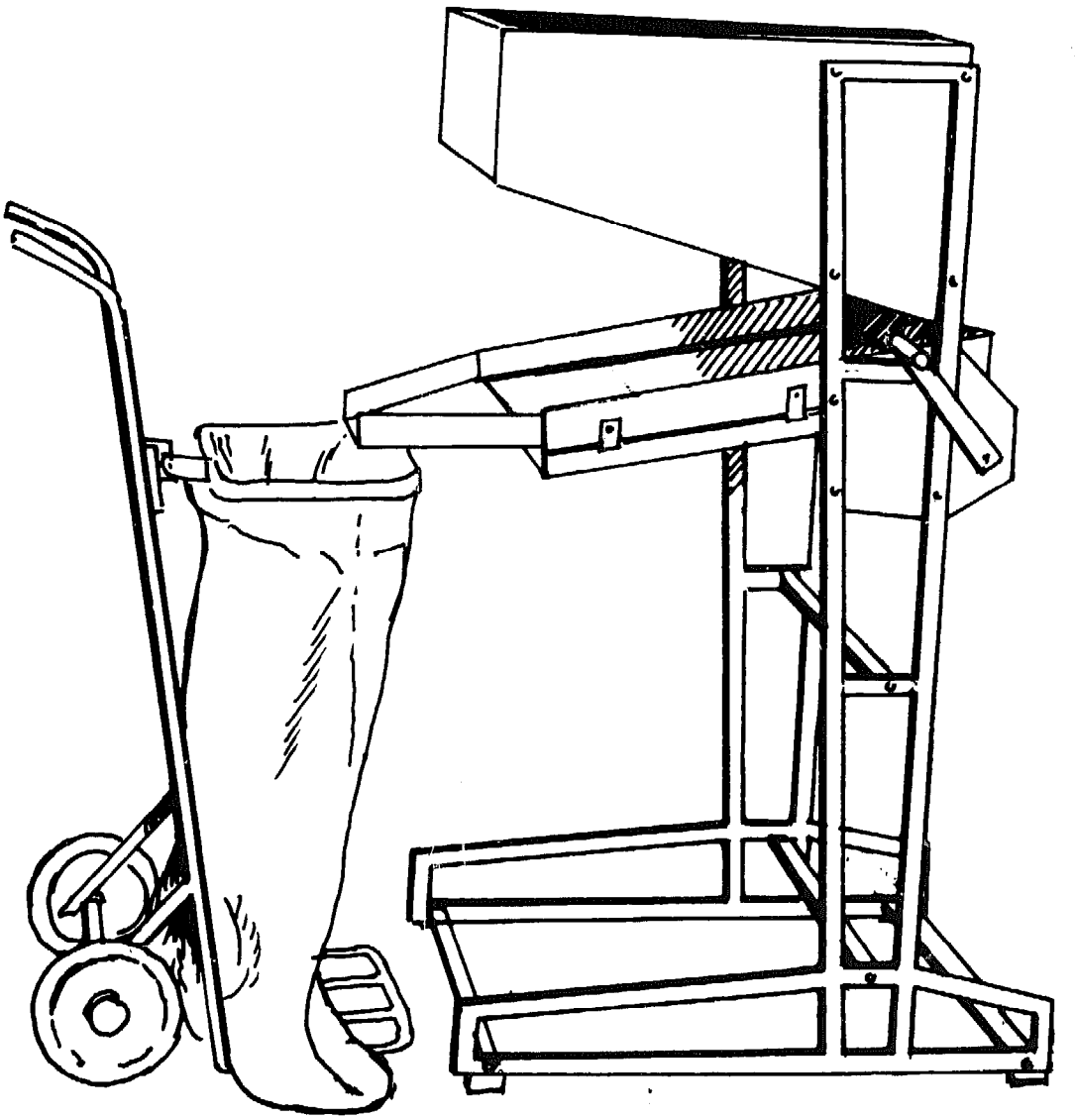
Any sampling or sieving equipment which is currently in use in co-operative stores should be described and if practicable demonstrated at this point. Stress that it is not necessary to purchase expensive equipment for this purpose. Pass round or display illustrations of the TPI inspection sieve and sack holder as below.

The device has the following features:

- Operating capacity 100 kg and throughput not less than 100 kg in four minutes.
- Total weight and overall dimensions are minimal and allow easy transport by Land Rover or estate car.
- Construction details are simple and robust to allow local manufacture and achieve maximum operating life at minimum cost.
- Oscillation of screen with minimum of effort via a simple mechanical drive from a hand operated crank.

The TPI Produce Inspection Sieve is designed to sample produce in bags. It eliminates within-sack variations of factors such as broken grain, insects and dust, which may often occur in patches, and provides the following information:

- A visual appreciation of the commodity in each sack sampled.
- A composite sample consisting of a large number of small samples may be taken by hand from all parts of the flow of commodity from each sack as it falls into the receiving sack.
- Dust and broken grains falling through the sieve may be weighed and sub-sampled for separate or combined analysis with the commodity sample. Dust weight is often correlated with damage unless pre-screening or winnowing has taken place.
- Insects falling through with the dust may be separated by re-circulation over a finer mesh sieve or removed if necessary after sub-sampling.



The Produce Inspection Sieve and Sack Holder

Equipment of this sort can easily and cheaply be made by local blacksmiths, using a proportion of scrap material. Further information about this particular item can be obtained from the Tropical Products Institute in "The Design and Development of the TPI Produce Inspection Sieve" published in London in 1975.

The following results can be achieved with equipment of this sort:

Inspection Rate	=	35 kilograms a minute.
Extraction of Insects	=	average 94% complete.

10) The number of insects per kilogram must be recorded. For convenience and consistency, and in order to conform to accepted grading standards, it is necessary to follow recognised methods of doing this.

Ask trainees how they would instruct someone to inspect grain in order to grade it according to the following system. How much actual grain will they have to inspect?

Over 15 insects per kilogram	=	VH (very heavy infestation)
Between 3 and 15 insects per kilogram	=	H (heavy infestation)
Between 0.5 and 2.9 insects per kilogram	=	M (moderate infestation)
Between 0.25 and 0.5 insects per kilogram	=	L (light infestation)
Less than 0.25 insects per kilogram	=	VL (very light infestation)
Zero insects per kilogram	=	Nil infestation

It is unlikely that one kilogram will be a large enough sample for any grade below H, but it is unnecessary to count all the insects in more than one kilogram if 15 or more are found in the first kilogram.

It is clearly necessary to count a larger sample if the insect content is at grade VL than if it is at M.

Trainees should be given up to fifteen minutes to design a procedure for inspecting grain according to this standard:

- The procedure must be easy to follow.
- The procedure must be rigid so that all inspections are made on the same basis.
- The procedure must avoid wasting time by unnecessary inspection of heavily infested samples.
- The procedure must ensure that sufficient produce is inspected to give reliable results even for the lower degrees of infestation.

11) Trainees' recommendations will vary, but they should all incorporate the principle of moving from a smaller to a larger sample as the observed number of insects decreases. A widely used procedure is as follows:

Stage One : Inspect One Kilogram.

- If more than 15 insects are found grade VH.
- If 10 to 15 insects are found grade H.
- If under 10 insects are found inspect 3 kilograms.
- If 9 or more insects are found in 3 kilograms grade H.
- If under 9 insects are found inspect 9 kilograms.
- If 5 or more insects are found in 9 kilograms grade M.
- If under 5 insects are found inspect 22 kilograms.
- If more than 5 insects are found in 22 kilograms grade L.
- If 1 to 5 insects are found in 22 kilograms grade VL.
- If zero insects are found in 22 kilograms grade Nil.

Remind trainees of their previous calculation of the reproduction rate of insects, which shows that millions of insects could develop in a very short time from small numbers. Stress that even the M, L and VL grades allow enough insects in a few kilograms, and far more than enough in several tonnes, for hundreds of millions to develop in a few months.

Inspection alone is not enough. Regular control measures must control the growth of insects which cannot usually be totally eliminated.

12) Remind trainees that rats, mice and birds are almost as serious a pest as insects, and they cannot so easily be observed or controlled.

Stress that infestation by rats has to be minimised for two fundamentally different reasons. Ask trainees to suggest what they are:

- They consume enormous quantities of produce.
- Their urine and droppings can cause plague and other diseases.

Distribute the Handout "Rattus Norwegicus, The Common Rat". Allow trainees up to 30 minutes to answer the questions and encourage them to use calculators if these are available.

Ask trainees for their answers and go through the calculations if there are any obvious errors. The exact answers are less important than the dramatic evidence of potential danger from rodents. The problems also provide a useful exercise in simple calculations.

Go through the calculations, which may be laid out in the following way:

Question 1:	Old Rats	New Rats	Total Rats
After 1 Month	8	32	40
After 2 Months	40	160	200
After 3 Months	200	800	1,000

Total Rats After 3 Months = 1,000 Rats

Question 2:	Old Rats	New Rats	Alive During Month
After 1 Month	2	8	2
After 2 Months	10	40	10
After 3 Months	50	200	50
After 4 Months	250	1,000	250
After 5 Months	1,250	5,000	1,250
After 6 Months	6,250	25,000	6,250
		Total "Rat Months" =	7,812

Food Per Month Per Rat = 20 g x 30 = 600 g = 0.6 kg

Total Food Consumed = 7,812 x 0.6 kg = 4,687 kg

Urine Per Month Per Rat = 0.5 l .Total Urine 7,812 x 0.5 l = 3,906 l

Droppings Per Month Per Rat = 2,000 x 0.05 g = 100 g = 0.1 kg

Total Droppings = 7,812 x 0.1 kg = 781.2 kg

Question 3:

Total "Rat Months" needed to consume 20,000 kg. =

20,000 ÷ (30 x 0.2) = 33,333.3 Rat Months

	Old Rats	New Rats	Alive During Month	Cumulative Total of "Rat Months"
After 1 Month	16	64	16	16
After 2 Months	80	320	80	96
After 3 Months	400	1,600	400	496
After 4 Months	2,000	8,000	2,000	2,496
After 5 Months	10,000	40,000	10,000	12,496
After 6 Months	50,000	200,000	50,000	62,496

The cumulative total of 33,333 "Rat Months" will be reached after about five and a half months.

Question 4:

Rat Months needed to produce 1 tonne of droppings =

1,000 kg ÷ 0.1 kg = 10,000 Rat Months

	Old Rats	New Rats	Alive During Month	Cumulative Total of "Rat Months"
After 1 Month	32	128	32	32
After 2 Months	160	640	160	192
After 3 Months	800	3,200	800	992
After 4 Months	4,000	16,000	4,000	4,992
After 5 Months	20,000	80,000	20,000	24,992

The cumulative total of 10,000 "Rat Months" will be reached after about four and a half months.

Trainees may suggest that the results will be effected by the numbers of either sex. Point out that one male rat can fertilize large numbers of females and fertilization can also take place between generations. Higher than calculated expansion rates if there are more than 50% females will compensate for the lower rates if there are more males.

13) Stress that disease and natural enemies reduce the theoretical rate of growth but that food stores can provide an ideal environment for rodents:

- They are protected from birds and animal predators of rats and mice.
- Food supplies are abundant.
- The temperature is conducive to rapid breeding.

The starting numbers given in the exercises are artificially low. The rate of increase is such that the objective should be to exclude rats altogether, or at least to control them so that the numbers never reach the critical levels calculated in the exercise.

14) Before taking any action to eradicate or control rodents, it is necessary to find out whether they are present, and in what part of the store. Ask trainees how they might observe the presence even of a small number of rats or mice:

- Inspection during hours of darkness.
- Careful observation of droppings.
- Inspection for tracks.
- Setting traps (which also help to control numbers).

It is very difficult totally to eliminate rats and other rodents from a store, and the cost of control measures is much lower than the costs of heavy infestation. Even if no infestation is found on inspection, control measures should be undertaken in order to prevent entry and growth of even the small numbers, which as the exercise showed, can so rapidly increase to overwhelming quantities.

The following session will focus on methods of controlling insects and rodent infestation.

"Rattus Norwegicus, The Common Rat"

The common rat eats 20 grams of food a day. It has an average of 8 young in each litter and has one litter a month. Rats can have young at one month of age. A rat produces approximately 0.5 litres of urine per month and 2,000 droppings a month weighing on average 0.05 grams each. Rats live for about one year.

Assignment: Answer the following questions, assuming that there are equal numbers of each sex, and that none of the females are pregnant at the start.

1) How many rats will there be in 3 months in a store which is initially infested by 8 mature rats?

2) How much food will be eaten by rats in six months in a store which is initially infested by one male and one female mature rat? How much urine and droppings will they produce?

3) About how long will it take for 20 tonnes of maize to be eaten by rats in a store which is initially infested by 16 mature rats?

4) About how long will it take before one tonne of rat droppings have been accumulated in a store where there are initially 32 mature rats, and no shortage of food?

topic

13

controlling infestation

SESSION 13

CONTROLLING INFESTATION

Objective: To enable trainees to identify the various ways of preventing or reducing insect and rodent infestation, and to decide on the most appropriate type and method of application in given circumstances.

Time: Two to three hours.

Material: Samples of locally available pesticides of various types and formulations.

Session Guide:

1) Ask trainees to suggest what is the best way of controlling damage to stored crops from insect or rodents.

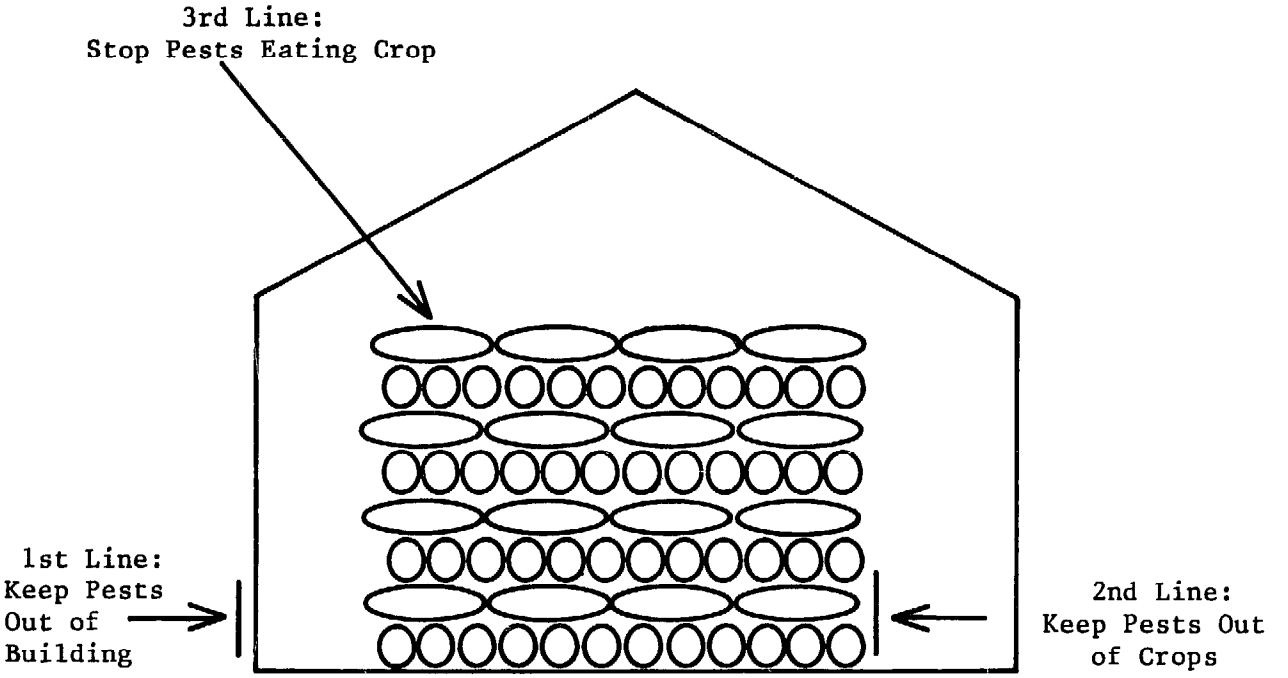
Trainees may mention chemical treatments. Stress that as with human health, prevention is better than cure. How can infestation be prevented?

a) By making it difficult or impossible for insects or rodents to enter the store.

b) By making it difficult for them to infest the crops if they do succeed in entering the store.

c) If insects overcome our efforts to achieve a and b, they must be discouraged from consuming the crop even if they are in it.

Stress that this session will deal with three stages of defence. Illustrate them with a diagram such as the following:



2) Ask trainees how pests can enter a crop storage building. How is it that storage staff actually help most insects, and some rodents, to enter a co-operative store?

- Some pests come into the building through roofs, doors, windows and so on.
- Most pests enter because they are already present in the crop when it is put into the store.

How can the second method of entry be minimised?

- Crops must be carefully inspected before acceptance, and must be rejected if they contain above a very minimal level of infestation.
- Crops can be artificially dried, fumigated or treated in other ways before being put into storage.
- Most crops are stored on the farm, even if for a very short period, before being delivered to co-operative stores. Members must therefore be trained, advised, assisted and encouraged in the construction and use of cheap and effective granaries, cribs and other methods of storage on the farm.

3) If trainees are ever likely to be involved in the construction of a new store ask them to imagine that they are briefing an architect for a new co-operative produce store. Write the following list of features on the chalkboard/OHP, and allow trainees up to 30 minutes to note down the points relevant to each feature which they would wish to bring to the architect's attention:

Location	Roof
Floor	Doors
Walls	Windows

If trainees are unlikely to be involved in the design of new stores, omit this section and continue with section 4.

When trainees have finished their lists, ask them to suggest individual items. Go round the class until every point has been listed. They should include at least the following:

Location:

- On high ground free from flooding.
- Site with a low water table.
- Site shaded by trees or other buildings if possible.
- Building positioned so as to minimise direct sunlight shining on to the roof.
- Hard standing free of vegetation to surround the building on all sides.

Floor:

- Dust free cement dressing.
- Built in waterproof membrane or other damp course to prevent ground damp rising.
- Joints in cement filled with soft expansion joint material.
- Floor must stand loads of around 5 tonnes per square metre.

Walls:

- Smooth surface to minimise adherence by insects.

- Non-porous and water proof.
- As thick as possible to improve insulation.
- Light coloured outside surface to reflect heat.

Roof:

- Leak proof.
- Light coloured to reflect sunlight.
- The gap between the eaves and the roof must be sealed.
- Generous overhanging eaves must shade walls.
- A false ceiling may be installed to improve insulation.

Doors:

- Tight fit to prevent pest entry.
- A fixed barrier at floor level to prevent pest entry when doors are open.
- Doors in line with prevailing wind to maximise through draft when they are open.

Windows:

- Omitted altogether if reliable artificial light and other ventilation is available.
- Screened against insects.
- Shaded against sunlight.
- Minimum size.
- High up in walls.

4) Ask how many trainees have actually been involved in the construction of a new purpose-built produce store. How many of their societies have new stores of this type?

It is more frequent for societies to have to use old buildings, which may not have been designed for storage, or are even parts of private houses. Not many societies have enough money to build stores incorporating all the necessary features.

Ask trainees to imagine that they have to decide how to improve their existing store, or to take over an existing building, such as a disused workshop or other structure not originally designed for storage. They have a small budget for improvement and should work from the same list of features as used previously and note all the points which they will investigate and attempt to remedy.

Allow 30 minutes for this purpose. List trainees' suggestions against the respective headings as before. They should include at least the following:

Location:

- Improve drainage, ensure that roof water is carried away in effective soakaways.
- Apply herbicide and maintain vegetation free one metre wide zone all around outside walls.

Floor:

- Test for rising damp by laying down a sheet of impervious material over night and inspecting for damp in the morning.
- If damp is found lay a waterproof surface coating on the floor.
- If the floor itself cannot be waterproofed use waterproof dunnage on which all crops should be stored, such as wooden pallets or plastic sheeting.

Walls:

- Repair and seal holes.
- Whitewash to improve reflection of heat.
- Cover all drains and ventilation holes with insect and rodent proof mesh.

Roof:

- Repair any leaks.
- Fill gaps between eaves and walls.

- Cover with bitumen and light coloured gravel or other waterproof and reflecting surface.
- Install under-roof insulation or a false ceiling.

Doors:

- Improve seals.
- Install floor level barrier.

Windows:

- Screen and shade windows.
- Possibly fill in window openings altogether.

Stress that something can be done with any building, however limited funds are. Protection against pests is more a matter of management than money.

5) Remind trainees that the second stage of pest control is to discourage access to crops by pests which have succeeded in entering the store.

Ask trainees how this can be done:

- By spraying insecticide on the inside walls of the store.
- By spraying the interior of storage bins with insecticide.
- By placing a barrier of insecticide around heaps of bags or loose produce to discourage access by non-flying pests.
- By ensuring that there are no accumulations of rubbish, old sacks or other places where insects or rodents can be hidden.

Ask trainees to suggest what characteristics an insecticide needs to perform these functions:

- It must be able to be sprayed on flat surfaces and adhere to them.
- It must be long lasting so that one treatment will last as long as the produce is stored.
- It must kill on contact to avoid the insect going into the crop and dying there, and must repel as well as kill.

Summarise these applications and required characteristics on the chalkboard for reference later in the session.

6) Remind trainees that many insect pests can fly. How can a barrier be set up to limit their access to stored crops, once they have succeeded in entering the store?

- The atmosphere must be made poisonous to them.

Ask trainees what characteristics an insecticide must have for this application:

- It must be able to be sprayed in a fine mist that will hang in the air.
- It must be non-toxic to human beings.

Note this application and desired characteristics as before on the chalkboard.

7) Ask trainees to identify the next "line of defence". How can they discourage insects from further infesting stored produce even if they have obtained access to it?

- Insecticide can be mixed with the crop as it is put into store.
- Stored produce can be regularly treated when it is in storage.

Ask trainees what characteristics an insecticide would need for this type of application:

- The insecticide must be non-toxic for human beings.
- The insecticide must be able to be spread evenly through the crop and if it is to be applied when the crop is already in storage there must be some way in diffusing it through heaps of loose produce or stacks of sacks.
- It must not be spread through water which will increase the moisture content of crops.

Summarise these characteristics on the chalkboard as before.

8) Point out that insecticides differ from one another in a number of different ways. The user must be familiar with each of them, and must select the correct combination for each application:

- They kill insects in different ways.
- They are applied in different ways.
- They are based on different chemicals.

These should now be described in as much detail as the time, scientific background and instructor's expertise permit.

Reference should only be made to specific varieties which are locally available, and they should be illustrated by leaflets and actual containers to familiarise trainees with the main brands.

It may be appropriate to invite one or more representatives of companies distributing pesticides to contribute at this stage, as long as they can be persuaded to be brief, non-technical and objective.

The summary should be in the following form, in order to enable trainees to select appropriate ways of carrying out the various functions they identified earlier in the session. Before describing the various forms of insecticide, warn trainees that they will be asked at the end of this section to decide which types are most applicable for the various applications they identified earlier.

Methods of Killing:

- Contact which kills on touch.
- Ingested which kill when eaten.
- Atmospheric which kill when inhaled.

Application Methods:

- Dust, applied by shaking or pumping in the dry form.
- Wettable powder which is mixed with water and applied in a spray in order to adhere to surfaces which it touches.
- Liquid concentrate, mixed with thin oil or water soluble base, for atmospheric spraying or diffusion by aerosol techniques.

- Tablets which diffuse insecticide slowly when in contact with air or moisture.
- Pyrotechnic formulations which are mixed with a smoking or gassing agent so that the insecticide is diffused in the form of a gas.

Chemical Base:

- Pyrethroids; naturally based on pyrethrum (which itself is the main crop of many co-operative societies in tropical countries).
  - Non-toxic to human beings, short life, useful against most insects and immediate action.
  - Repellant as well as lethal.
- Chlorine Based, such as DDT, lindane, dieldrin.
  - Highly toxic, long lasting, slow acting on insects.
- Phosphorous Based, such as malathion.
  - Non-toxic to human beings, rapid killing, wide application.

9) Refer trainees back to items 5, 6 and 7; ask what method of application, formulation and variety should be suitable for each of the three applications identified earlier in the session:

- Preventing pests in the store from reaching the crops: Chlorine based contact killing insecticides in wettable powder for mixing with water and spraying on to walls etc.
- Spraying in the air to kill flying insects: pyrethrum based, contact or ingested or inhaled, in liquid formulation for aerosol type diffusion in the atmosphere.
- Mixing with crops as they are put into storage: pyrethroid or phosphoric based contact or ingested insecticides, applied in dust form to the crop as it is put into storage.
- Treatment after crops are in storage: pyrethrum or phosphorous based insecticide, diffused through stored crops by gasification, tablet or pyrotechnic formulations.

10) Stress that because rodents are more mobile and are stronger than insects they must actually eat the poison for it to be efficient. Rodent poisons are thus all of the ingested type.

There are two basic types of rodent poisons:

(i) Active poisons such as arsenic, which kills soon after being eaten.

- These are rapid, very dangerous to animals of all kinds and humans, and rodents may avoid them because they can clearly be associated with the death of their fellows which have eaten them.

(ii) Chronic poisons, such as warfarin, which have to be eaten in several doses to be efficient.

- They are usually safe for humans and animals, and rodents are less likely to avoid them. Rodents may develop resistance to some of the anti-coagulants of this type. They take some time to operate but the dead animals are usually dried up by the action of the poison so they are unlikely to effect the crops in which they die.

Point out that chronic poisons are easier to apply and generally more effective. When might it be necessary to use an acute poison nevertheless?

- Experience may show that rodents are resistant to chronic poisons.
- The infestation may be of epidemic proportions so that rapid action is necessary.
- It may be necessary to kill rodents very quickly in time for inspection or sale or before putting new crops into storage.

11) Stress that all pesticides and rodenticides are toxic chemicals. They have usually to be sold in highly concentrated forms for convenience and economy in handling, and this makes them even more dangerous.

Trainees should be aware of the following rules which improve both the economy of application as well as the safety:

- If bagged or bulk crops are to be fumigated with pyrethrum or similar diffusing tablets they should be securely covered with impervious sheeting to contain the gas where it is needed and avoid diffusion into the atmosphere for safety and economy.
- Great care must be taken to avoid using chemical treatments designed for seeds on produce designed for animal or human consumption. These are usually mercury based to prevent insect damage when planted, but are lethal to animals and humans.
- Mixing must be carefully calculated and supervised by trained literate staff. The proportion of active ingredients can vary from one formulation to another, and is a critical determinant of the amount of concentrate to be used. The percentage must be clearly marked on the container. Excessively weak mixtures will not function and excessively strong ones are dangerous and extravagant.
- All containers, sprayers, clothing, floor areas and staff themselves which come into contact with any type of insecticide or rodenticides must be scrupulously washed after any such contact.
- All staff must know the emergency procedures relating to each type of chemical in case it is inhaled, taken into the body through a cut or consumed. They must be trained in the proper precautions which must be simply summarised and displayed wherever insecticide is to be used. These instructions, and instructions for mixing and application, should be illustrated by drawings as well as in writing if any of the staff using them may be illiterate.
- Stocks of insecticides and rodenticides must be very carefully controlled. Only the necessary amounts must be issued and the balance must be put back into locked storage and only released to those who are qualified to use it.

topic

14

perishable produce

SESSION 14

PERISHABLE PRODUCE

Objective: To enable trainees to identify the role of storage in the marketing of perishables, and to evaluate the various ways in which the decline in value of perishable produce after harvest may be minimised.

Time: One and a half to two hours.

Material: Perishable Produce Evaluation Sheet, modified as necessary.

Session Guide:

1) Write the following list of produce on the chalkboard/OHP, and allow trainees up to five minutes to classify them into perishable and non-perishables:

Potatoes	Fresh Fish	Maize
Tomatoes	Flowers	Dried Cassava
Liquid Milk	Bananas	Wheat
Rice	Fresh Meat	Onions
Cabbage	Apples	Strawberries

Ask trainees to read out their lists. They will probably have classified them as follows:

Perishables		Non-Perishables
Potatoes	Fresh Fish	Maize
Tomatoes	Flowers	Dried Cassava
Liquid Milk	Bananas	Wheat
Fresh Meat	Onions	Rice
Cabbage	Apples	
Strawberries		

Point out that wheat which was found in the pyramids in Egypt and had been there for 5,000 years, sprouted and grew when planted. This is an extreme case, but crops can clearly be divided into the two categories. There may be some differences of opinion. In any case, ask trainees to state the basis on which they classified the various items.

2) Elicit through discussion the idea that perishable produce is produce which becomes less valuable, or totally valueless, within a few weeks, days or even hours of being harvested, even if it is kept in normally clean and dry conditions free from attack by vermin, such as would be considered ideal for long term storage of cereal crops.

3) Divide trainees into groups of up to four members in each and distribute a copy of the Perishable Produce Evaluation Sheet to each trainee. The sheets should be modified before the session, so that it includes one fruit, two vegetables and one type of fresh meat and of fresh frish which are likely to be familiar to trainees, even if not actually produced by their own societies. Elicit the fresh values for each item and ensure that each group starts from the same figures in the second column.

Allow trainees up to 30 minutes to complete the valuation sheet. Stress that the figures need only be approximate. What is needed is some idea of the magnitude of the costs involved in delay or spoilage.

4) Reconvene the class. Prepare in advance an enlarged version of the valuation sheet on the chalkboard, a large piece of paper or OHP, and ask each group in turn to give their valuation and percentage figures for one item of produce.

Their figures will of course vary according to the produce that has been chosen and the local market. It is unlikely that every group will have produced the same set of figures. Discuss any significant differences, but avoid wasting time on minor disagreements. Actual price figures should be obtained in advance if possible for at least some of the items, and these should be compared with trainees' estimates.

Typical figures might be as follows for selected items:

Item	Fresh		12 Hours		48 Hours		1 Week		1 Month	
Beef	$5	100%	$5	100%	$4.50	90%	$3	60%	valueless	nil
Tilapia (fish)	$4	100%	$3	75%	$2	50%	$0.50	12½%	valueless	nil
Cabbage	$1	100%	$1	100%	$0.95	95%	$0.70	70%	$0.30	30%
Potatoes	$0.25	100%	$0.25	100%	$0.25	100%	$0.25	100%	$0.20	80%
Mangoes	$0.50	100%	$0.50	100%	$0.45	90%	$0.35	70%	valueless	nil
Milk	$0.20	100%	$0.18	90%	$0.15	75%	valueless	nil	valueless	nil

5) Ask trainees what delays take place between the harvest and final sale of perishable crops with which they are familiar either as co-operative managers or as consumers. Ask trainees to estimate very roughly the total cost of each of the items which is likely to be produced by an average farmer in a year, and to calculate from the valuation sheet the amount of revenue the farmer loses because of the delay. Using the above figures, for example, a fisherman who catches 100 kilograms of Tilapia a month, and whose fish is generally not sold until twelve hours after it has been caught, is losing income of $100 a month, which is one quarter of his gross income.

Stress that the loss is more serious when compared with net earnings. If the fisherman has monthly expenses of $250 his monthly net income is affected as follows:

Sale of Fish if sold immediately	$ 400
Expenses	250
Net Income	$ 150
Sale of Fish sold after 12 hours	$ 300
Expenses	250
Net Income	$ 50

In this example, the fisherman's net income is cut by two-thirds because of the twelve hours' delay. Ask trainees how this sort of loss can be minimised. What can agricultural co-operatives do to minimise the decline in value of perishable crops produced by their members?

6) Because this course is focusing on storage, trainees may concentrate on ways in which improved storage can reduce the decline in quality, and thus maintain the value of crops for as long as possible after harvest. Their suggestions may include:

- Freezing for fish.
- Chilled storage for meat.
- Nitrogen enhanced atmosphere to reduce decay of fruit.
- Cooling for milk.

Stress that any form of storage to delay or prevent deterioration of perishables is likely to be very expensive. Its cost can easily exceed the increase in value it can achieve, particularly if only small amounts are to be stored. Ask trainees to suggest other ways in which farmers themselves, or their societies, can minimise the decline in value of perishable produce. It may be appropriate to select a particular item which is familiar to most trainees, and to elicit suggestions which apply to this. Examples might be as follows:

<u>Tilapia Fish</u>:

- Undertake shorter fishing trips to minimise storage time on the boat.
- Arrange for service boat to collect individual catches from fishing boats on the water and to bring them ashore while the fishermen remain at work.
- Improve storage on board the boats.
- Ensure that effective packaging is available as soon as possible.
- Arrange for transport, refrigerated or with ice, to be able to take all consignments straight to market as soon as they are landed.
- Arrange immediate sale at the market, direct to consumers or to traders with suitable facilities for cold storage or immediate sale.

- Contract to deliver surplus fish to fishmeal processors or other users to avoid total loss of unwanted fish.
- Organise drying, salting, freezing or other processing for fish that cannot be sold fresh.

Bananas:

- Harvest unripe fruit and allow it to ripen during transport and storage.
- Grow longer keeping varieties.
- Stagger harvesting time to avoid creating temporary surplus in the market which leads to delays.
- Prevent delays during transport to market.
- Remove decayed and substandard fruit before it infects the remainder.
- Arrange for cooled long term storage facilities if appropriate.
- Ensure that every selling intermediary in the chain is rapid and efficient.

7) Stress that while improved storage can play a part in these and most other perishable produce marketing systems, it is necessary to avoid concentrating solely on improving storage facilities for their own sake. The major objectives should be:

- To minimise the delay between harvest and marketing, to reduce the need for storage. Speedier marketing usually costs less than improved storage and may only require improved management.
- To ensure that every part of the marketing system, including harvest, packing, transport and storage at every stage, minimises delay and deterioration.
- To ensure that storage at every stage, including periods of transport, and not only when the crop is in the central co-operative store, is effective and efficient. An effective store is useless if it is part of an ineffective system.

Perishable Produce Evaluation Sheet

Perishable produce is produce whose value declines within a short period after harvest, even if it is stored in conditions which would be acceptable for non-perishables.

Fill in the first and second colums with the names of the items and their fresh prices, as agreed with the instructor. Fill in the columns for the value per kilogram (or other appropriate unit) for the meat, fruit, vegetable and milk products named, at the times specified after harvest, slaughter or milking, assuming that the produce is kept in clean conditions at ordinary outside temperatures. Calculate the corresponding percentage figures to show the proportional decline in value.

Item	Market Value per kilogram When Fresh		Value 12 Hours Later		Value 48 Hours Later		Value One Week Later		Value One Month Later	
Fresh Meat	$	100 %	$	%	$	%	$	%	$	%
Fresh Fish	$	100 %	$	%	$	%	$	%	$	%
Vegetables	$	100 %	$	%	$	%	$	%	$	%
	$	100 %	$	%	$	%	$	%	$	%
Fruit	$	100 %	$	%	$	%	$	%	$	%
Liquid Milk (per litre)	$	100 %	$	%	$	%	$	%	$	%

topic

15

cold storage

SESSION 15

COLD STORAGE

Objective: To enable trainees to identify situations where cold storage is and is not a worthwhile investment and to manage such facilities effectively.

Time: Two to two and a half hours plus field visit if possible.

Material: Exercise 1: To Store or Not to Store?
Exercise 2: Cold Storage Conditions.

Session Guide:

1) Ask trainees to restate the three main factors on which any storage decision must be based:
   - The value of the crop at harvest time.
   - The cost of storage.
   - The value of the crop after storage.

   Remind trainees of the previous session. Why is it even more important to make correct decisions about the storage of perishable crops?
   - If perishable crops are not preserved during storage they may not only decline in value; they will deteriorate very rapidly and may cease to have any value at all.
   - Perishable crops deteriorate in conditions which are ideal for storing durable crops. Effective storage can cost far more than the original value of the crop itself.

2) Distribute copies of the exercise sheet "To Store or Not To Store?" and allow trainees up to 45 minutes to answer each question, on their own.

When they have finished or after 45 minutes have elapsed, ask trainees to indicate by a show of hands how many decided for each alternative in each case. Display the results on the chalkboard/OHP in the form of a table:

Item	Store	Sell at Harvest	Other / Undecided
Apples			
Onions			
Strawberries			
Cabbage			

Ask a trainee who has the wrong answer in each case, or failing that one who is undecided, to go through his or her analysis. Elicit suggestions from other trainees and go through the correct calculations as follows:

Apples:

- Cost of Storage: $250 x 3 months = $750 per tonne = 75 cents a kilo.
- Benefits of Storage:

Price without storage		$ 0.10
Price with storage		1.00
Benefit	=	$ 0.90

- Net Benefit = 15 cents a kilo.
- The Society should therefore have the apples stored in the cold store.

Onions:

- Cost of Storage:

Capital Equivalent		$ 10,000 a year
Running Costs		2,000 a year
Total	=	$ 12,000

- Benefits of Storage:

Present Price	250 x 500 kilograms x 15 cents		$ 18,750
Stored Price	250 x 500 kilograms x 24 cents		30,000
Improvement		=	$ 11,250

- Net Cost (no profit) = $ 750.
- The Society should therefore not install the storage facility which is on offer.

Strawberries:

- Cost of Storage:

Capital		$ 2,500 per year
Running Costs		500 per year
Total	=	$ 3,000 per year

- Benefits of Storage:

Sales of strawberries now wasted =		
150 kg. x 3 days x 10 four day cycles x 80 cents		$ 3,600
Less cost of picking saved =		
150 kg. x 5 cents x 3 days x 10 cycles		225
Improvement in Revenue	=	$ 3,375

- Net Benefit = $ 375.
- The Society should therefore install a cold store.

Cabbages:

- Revenue from letting vacated area for 2 weeks:

Total crop	100 x 200 x 2 kilograms	40,000 kilograms
Sold at harvest	10,000 x 2 kilograms	20,000 kilograms
Stored balance		20,000 kilograms

- Revenue: 20 tonnes x 2 weeks x $10 = $ 400.
- Revenue from sale after 6 weeks storage: 20,000 x 30 cents $ 6,000
  Revenue from sale after 4 weeks storage: 20,000 x 28 cents 5,600
  Increased revenue from extra 2 weeks storage = $ 400
- It therefore does not matter whether the Society sells its cabbages after 6 weeks or 4 weeks. The extra revenue from storing the cabbages is the same as the revenue from renting out the storage space.

Ensure that all trainees understand the calculations and the logic behind them. Stress that errors are more likely to be made as a result of

simple mistakes in arithmetic than through ignorance of the technicalities of storage.

4) Ask trainees what other suggestions they might make to each Society, beyond the simple quantitative comparison of the two alternatives already calculated. Trainees may suggest that the margin in the cases of the apples and the strawberries is so small that the societies should reject the cold storage proposals. Elicit the following alternative suggestions:

Apple Growers:

- They should investigate the feasibility of building their own cold store.
- They should ensure that cold storage capacity will always be available as and when they need it.
- They should investigate the possibility of selling at harvest time to a trader who has a cold store. This might be more economical than the public facility, thus enabling the trader to offer a price which is more profitable to the Society.

Onion Growers:

- They should investigate other countries and other sources of supply and other makers of equipment. The foreign buyer may be trying to pay too little for onions and to charge too much for the equipment.
- They should ensure that the buyer is willing to hold or reduce his price for the onions, and for the equipment, independently of one another. The two transactions should be clearly separated.

Strawberry Growers:

- The Manager should try to persuade other marketers who can collect on the waste days to visit the area.
- They should attempt to grow varieties which can be left unpicked for three days without rotting.
- They should investigate the market for substandard strawberries for jam or other processing purposes.

Cabbage Growers:

- They should investigate the possibility and cost of expanding the cold store.
- They should possibly favour the other Society in the interests of co-operative fraternity or the future possibility of merging this Society with their own.

5) Stress that agricultural marketing societies should ensure that they are getting the best possible price, and that every aspect of their existing system is as well managed and organised as it should be, before deciding whether or not to install an expensive cold store.

Ask trainees what other questions must be answered before deciding whether or not to build a cold store:

- Is the electricity supply reliable or will the cost of a standby generator make the whole system uneconomic?
- Are members' normal crops of a sufficiently high quality to justify the higher prices payable after harvest?
- Can the Society's staff manage the cold store effectively?
- Are spare parts and maintenance available at short notice, to prevent spoilage in the case of breakdown?
- Will cold produce be ruined in transit from the cold store to the market, thus wasting the cost of cold storage?
- Is supply and demand of the crop likely to be maintained or improved for the likely life of the storage equipment?

6) Ask trainees to write down a rough guess of the cost of constructing each of the following three facilities:

a) A high standard non-refrigerated store for durable produce, 10 metres x 20 metres x 5 metres. (1,000 cubic metres.)

b) A cold store for perishable produce allowing temperatures down to $0^{o}C$, 10 metres x 20 metres x 5 metres. (1,000 cubic metres.)

c) A cold store as above, but 30 metres x 20 metres x 5 metres. (3,000 cubic metres.)

Ask trainees to state their guesses. Summarise them on the chalkboard/OHP. Trainees' estimates will obviously differ from one another and actual costs will vary according to the country concerned. Approximate figures for a typical country in 1981 are as follows:

a) $ 200,000

b) $ 400,000

c) $ 600,000

Trainees should notice:

- Cold storage facilities double the cost of an equivalent size store without such facilities.
- Cold storage costs drop rapidly as capacity increases. The cost per cubic metre of a 1,000 cubic metre store is twice that of a 3,000 cubic metre store.

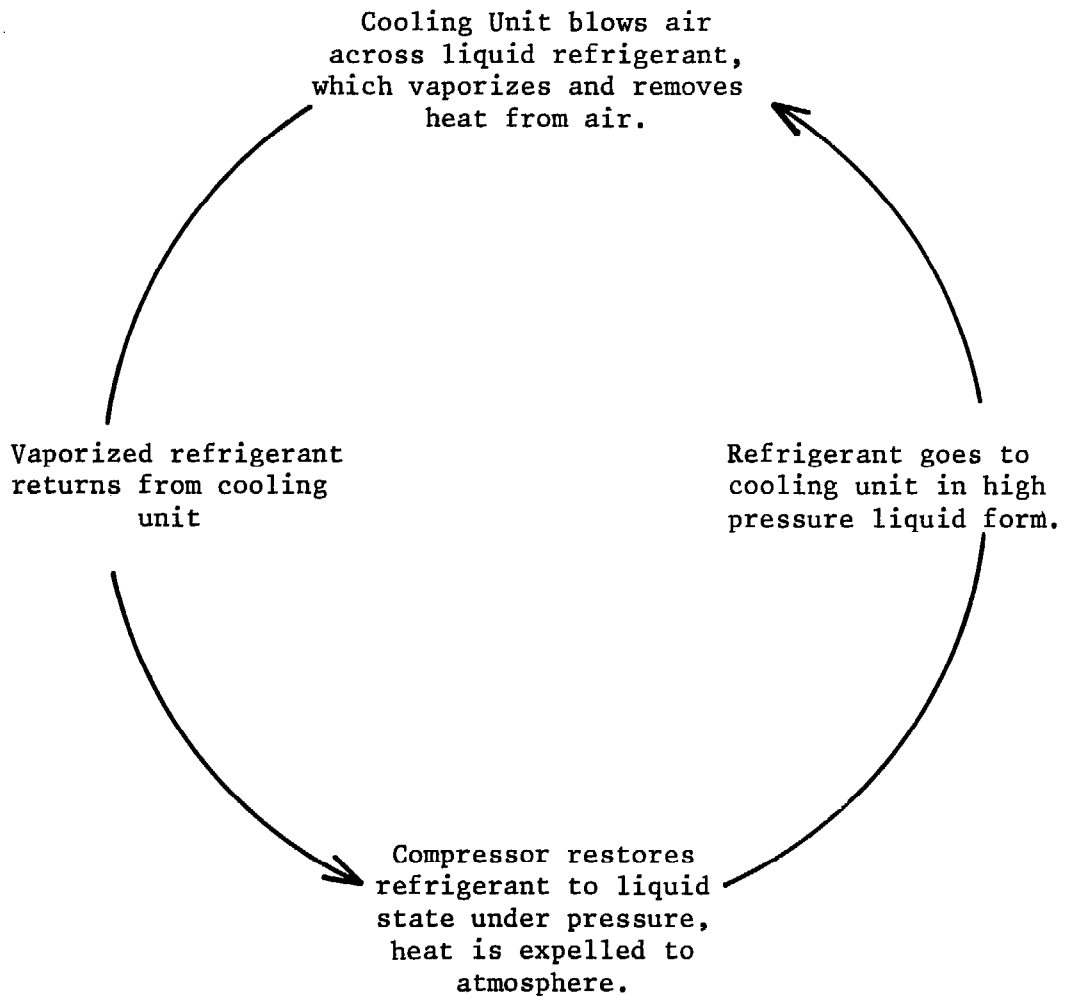
The figures do not include running costs which will depend on local costs of labour, power and maintenance and the temperature to be maintained.

Running costs are likely to be more than double equivalent costs for durable goods stores, because of high fuel costs, and the need for skilled labour and regular maintenance.

7) Ensure that all trainees understand the basic principles of refrigeration. Ask a trainee with a knowledge of physics to explain the principles of a compressor with a volatile refrigerant such as freon. Illustrate this by a simple diagram, such as the following:

Stress that this requires:

- Sophisticated equipment.
- Regular maintenance.
- High power consumption to drive the compressor and a fan to bring warm air from the storage area and to recirculate the cooled air once again.
- High quality produce, since the selling price of anything but the best produce will not justify the high costs of cold storage.



Cold storage involves reducing the temperature of the produce. Ask trainees what will be the results if the temperature is too low:

- The water in the produce will freeze and on thawing the produce may break up.
- Unnecessarily high power costs will be incurred.

It is vital to maintain temperature and humidity at the correct levels in order to obtain the optimum benefit from cold storage.

8) Clearly the correct temperature range depends on the particular type of produce. In order to check trainee's understanding of the purpose of cold storage, and the effect of temperature, distribute copies of the handout, "Cold Storage Conditions", and allow trainees up to 10

minutes to complete it on their own. Trainees should only complete the exercise for crops with which they are familiar, and it is unnecessary to make estimates for more than four or five items.

Stress that they cannot be expected to provide accurate figures. The exercise requires them to think about how temperature is likely to affect different sorts of produce, and to learn from any natural mistakes they will make.

9) After trainees have finished making their estimates, ask individuals for their suggestions for each crop. Indicate the range suggested on the chalkboard/OHP, and compare their figures with the correct figures as below:

Item	Temperature Range in ^{o}C	Storage Life
Apples	-1^{o} to $+4^{o}$	6 months
Cabbages	$+1^{o}$ to $+2^{o}$	3 months
Green Bananas	$+11^{o}$ to $+14^{o}$	2 weeks
Yellow Bananas	$+13^{o}$ to $+16^{o}$	1 week
Green Lemons	$+11^{o}$ to $+15^{o}$	3 months
Yellow Lemons	$+4^{o}$ to $+10^{o}$	1 month
Mangoes	$+7^{o}$ to $+10^{o}$	1 month
Oranges	-1^{o} to $+7^{o}$	6 weeks
Potatoes	$+2^{o}$ to $+3^{o}$	8 months
Green Pineapples	$+8^{o}$ to $+10^{o}$	6 weeks
Ripe Pineapples	$+4^{o}$ to $+10^{o}$	1 month
Tomatoes	$+2^{o}$ to $+3^{o}$	6 weeks
Fish	-1^{o} to -4^{o}	1 year
Milk	$+1^{o}$ to $+3^{o}$	2 weeks
Meat	$+1^{o}$ to $+2^{o}$	3 weeks

Ask trainees to suggest what this information implies for any society which wants to store cabbages, yellow bananas and green pineapples at the same time.

Unless they can afford two or more storage chambers, insulated from one another, the three items could not be stored together.

It is unlikely that one society would be concerned with a number of different crops demanding different storage temperatures. The viability of many cold stores depends, however, on renting out space to other producers. Any society considering constructing a cold store must be sure that their own crops, and those of any likely customers for space, fall into the same temperature range.

10) This session should if possible be supplemented by a visit to an actual cold store. Trainees should be guided to investigate the following aspects:

- The duration of storage.
- The variety of produce stored.
- The insulation required for the walls, roof, floor and doors.
- The scale and apparent complexity of the refrigeration equipment.
- The quality of what is stored.
- The safety arrangements to ensure that staff are not trapped in a store.
- The materials handling facilities.
- The form of packing used.
- The economics of the store.

To Store or Not to Store?

A : The Arcadian Apple Growers

The Arcadian Apple Growers' Society always sells all its members' apples, as they are harvested, for an average price of 10 cents a kilo. The picking season only lasts about a month, and it has been discovered that the same apples could be sold for $1 a kilo three months later. They would have to be kept at between $-1^{\circ}C$ and $+4^{\circ}C$ during the intervening period. The local public cold store quoted a price of $250 a tonne per month for storing the Society's apples at this temperature. Should the Arcadian Apple Growers put their apples into the cold store for three months?

B : The Organised Onion Growers

The 250 members of the Organised Onion Growers' Society each produced an average of 500 kg. of onions each year. They sold them on the local market for an average price of 15 cents a kilo. The Export Buyer from an international trading company visited the Society. He admired the quality of their onions and said that if the Society could offer vegetables of the same quality six months after harvest his company would guarantee a price of 24 cents a kilo. They would have to be kept in cold storage to maintain the quality. The international company had an agency for refrigeration equipment, and the Buyer said that the Organised Onion Growers could install a suitable facility for $50,000. His company would make a loan to the Society so that they could repay over ten years at $10,000 a year, including interest, and he said that it would cost about $2,000 a year to run the facility. Should the Society accept this offer?

C : The Sagacious Strawberry Growers' Society

During the picking season the Sagacious Strawberry Growers' Society sold about 250 kg. of fruit a day to passing tourists at $1.50 a kilo from its roadside stall. The fruit ripened so rapidly, however, that a further 150 kg. a day was usually wasted because there was a limit to the sales that could be made to passing tourists. A wholesaler came to the area every four days and

bought the surplus crop for that day. In the intervening three days, however, the strawberries rotted. The growers paid casual workers 5 cents a kilo to pick the strawberries, and since they knew roughly how many strawberries would be sold each day they only paid for picking the extra 150 kg. on the days when the wholesaler called. He would not agree to come on any other days during the 40 day harvest period, but he suggested that the Society should install a cold store, as others had done. If the strawberries could be stored at $0^{o}C$ they would keep for four days and he would be able to collect 600 kg. every time he called instead of 150 kg. He would pay 80 cents a kilo as he always did. He told the Secretary of the Society that a suitable refrigeration plant could be bought for about $10,000 and would cost about $500 a year to operate and maintain. The Secretary knew he could obtain the equipment on hire purchase at $2,500 per year. Should the Sagacious Strawberry Growers purchase a cold store?

D : The Cautious Cabbage Cultivators

The 100 members of the Cautious Cabbage Cultivators' Society harvested about 200 cabbages each every year, weighing on average 2 kilograms. The Society owned a cold store which was used for these and members' other fruit and vegetables, and they could easily fill any surplus storage capacity by renting it out to non-members, or other societies, at a standard rate of $10 per tonne per week. The present policy is to sell about 10,000 cabbages when they are picked, for an average price of 20 cents a kilogram, and to store the remainder for six weeks and then to sell them for an average price of 30 cents a kilogram. Another society had the same amount to store and they wanted to use the space occupied by the Cautious Cabbage Cultivators during the last two weeks of the six week period. One of the members noticed that cabbage sold for 28 cents a kilogram only four weeks after picking and he suggested that it would be more in the Society's interest if they sold the cabbage after four weeks and rented out the space to the other society. What should this Society do?

Cold Storage Conditions

Item	Temperature Range in ^{o}C	Storage Life
Apples		
Cabbages		
Green Bananas		
Yellow Bananas		
Green Lemons		
Yellow Lemons		
Mangoes		
Oranges		
Potatoes		
Green Pineapples		
Ripe Pineapples		
Tomatoes		
Fish		
Milk		
Meat		

Assignment: Estimate the temperature range in ^{o}C and the storage life for the above crops and write your estimates in the boxes provided above.

topic

16

when to sell

SESSION 16

WHEN TO SELL

Objective: To enable trainees to apply what they have learned to improve their ability to make storage management decisions.

Time: Three hours.

Material: Introductory Game Instructions.
Basic Information Sheet.
Society Progress Sheets (at least ten copies for each group).

Session Guide:

1) Before attempting to use the simulation game, it is vital that the Instructor should go through the details very carefully, and should preferably test the game with one or more colleagues. If the Instructor is not totally familiar with the way in which the game progresses, and any difficulties which trainees may have in making the necessary decisions and calculations, the session will not achieve its objective and the course, and the Instructor, will substantially lose credibility.

2) It may be useful to introduce trainees to the idea of the "trade-off" between storage costs and higher prices, and the calculations procedure, with a simple game played on an individual basis, rather than in groups. If time allows, and trainees need this preparation, distribute the hand-out, "Introductory Game" and go through it carefully to ensure they all understand what to do. Read out the first month's price; allow trainees to complete their decisions and show how this should be done on the chalk-board/OHP. Go through up to six months in total, using the following prices:

Month 1	$ 50	Month 4	$ 55
Month 2	$ 54	Month 5	$ 65
Month 3	$ 48	Month 6	$ 62

Ask trainees to read out their total figures for cash and the value of any unsold grain, ensuring that their calculations are correct, and congratulate the trainee(s) who has the highest total. Show that decisions of this sort are a risk. Storage managers must reduce the cost of storage, and, if they are responsible for selling decisions, they must attempt to forecast prices, using past data. The forthcoming group game will give trainees an opportunity to make these decisions, and calculate the results, in a rather more complex and realistic way than this introductory exercise.

3) Divide trainees into groups with a maximum of five people in each. There should not be less than three groups, and the management of the simulation will be very difficult if there are more than six.

Each group should sit around a separate table or be able in some other way to discuss their decisions and reach results without other groups overhearing them. All groups should if possible be in the same room so that the Instructor need only make the announcement once. It is more important however that groups' discussions should not be overheard by the others, and it may therefore be necessary to put them in separate rooms.

Each group should be given a name, and every attempt should be made to develop a spirit of rivalry and competition. It may be appropriate to offer a prize for the winners. The game must not devolve into nothing but a contest, but there is no reason why trainees should not enjoy themselves while they are learning.

Explain that each group is to represent the management of an agricultural marketing society which purchases, stocks and resells its members' crops of rice and wheat. Each group or "team" represents a different society. They will all start with the same resources and as the game progresses they will face the same market prices and other problems and opportunities as they arise each month.

The game will give trainees an opportunity to experience, in a highly compressed form, two years in the management of a co-operative store. They will have rapidly to make a number of decisions such as:

- Whether or not to sell produce that is in stock.
- Whether to apply certain treatments to the crop.

They will also have to keep a record of the financial and stock implications of their various decisions. At the end of the two years' period, after 24 months' decisions have been made, the winning society will be that which has made the largest surplus, measured in terms of the value of the crop at current prices plus cash in the bank. Any groups which make mathematical errors in their recording will be seriously penalised.

4) Distribute the "Basic Information Sheet". After trainees have had an opportunity to study it describe the procedure from the simulation which will be as follows:

a) The Instructor announces any special occurrences that have occurred during the month.

b) Groups calculate the effects of these occurrences on their stocks and cash.

c) Groups decide whether or not to carry out any fumigation or other treatments and if so calculate the costs and modify their cash balances accordingly.

d) The Instructor announces the selling prices for wheat and rice.

e) Groups decide whether and if so how much of either crop to sell, and calculate the effect of their decision on their stock and cash balances, and an interest paid or received.

The Instructor will then proceed to the next month when the procedure will be followed as above and so on.

Groups will be allowed a maximum of five minutes to complete their decisions and calculations each month. This is essential if the game is to be completed in the time allowed. Groups should be encouraged to use calculators if these are available.

The simulation can be reduced to cover only twelve months if absolutely necessary, but this will deprive trainees of the opportunity of learning from the first year's experience and thereby improving their performance.

5) Ask the groups to sit as they will do during the simulation and allow them up to fifteen minutes for initial discussions and to allocate their duties and method of working. Stress that while they may keep as many copies of their progress record as they wish, they must keep one master copy which is available for inspection when the Instructor comes to look at it, and by which their final position will be judged. The game is a lesson in small group organisation and decision making as well as in storage management. Stress that failure to come to any decision will in fact be a negative decision, that is to do nothing. This may be possible but will not always be in the best interests of the Society. It may be advisable to have one or two "trial" months before starting the game, in order to be sure that all teams understand the procedure.

6) Start the game by announcing the data for May. Continue announcing the monthly occurrences and prices as suggested in the list that follows. The prices and a summary of the occurrences should if possible be put on the chalkboard/OHP as they are announced, and not before. The complete record will then be on display at the end of the game.

After making each monthly announcement, circulate among the groups and ensure that they are making the correct calculations and filling in their master progress sheet correctly. Ensure that groups do not try to change the decisions that they had made in previous months in order to take advantage of later information. The decision and calculation time of five minutes per "month" may be increased if necessary at the beginning, while trainees are gaining familiarity with the procedure.

If possible the Instructor should maintain his own set of progress sheets for all the groups, or should ask a colleague to do this, in order to check on their accuracy. He may also care to read out the cumulative results at particular stages, and particularly at the end of the first year, in order to encourage competition.

If staff are available, one or more extra instructors may assist by checking team calculations. They should avoid acting as advisors.

7) At the end of the game, announce the final results and give due credit to the winners. Ask a representative from each group in turn to attempt to explain their performance. Discussion should focus on the following points among others:

- The highest prices are usually obtainable at the most distant time from the harvest, but storage, spoilage and other costs also increase with time. A well managed society which is taking proper care of crops in storage can usually benefit by "hanging on" for a higher price, while poorer management leads to higher storage losses which makes earlier sale more necessary.
- Fumigations, treatments and so on are expensive and whilst they must not be neglected they must not be overdone. Like all investment decisions, they must be related to the likely benefits.
- Good decisions must also be made quickly, and simple calculations must be done rapidly and accurately. If a group is poorly organised it is less effective than a single individual. Only good organisations can make the best use of the combined ability of all group members.

8) The following schedule lists a set of monthly announcements. These may be varied at will, so long as they are consistent with the general outline and with the price limits given in the basic information handout. The schedule is followed by a sample copy of a completed progress sheet based on its contents. This sheet should obviously not be given to trainees before the simulation, and represents only one possible set of decisions. It is given merely as an example of how the sheet should be completed.

<u>May</u>:

- Cost of labour $2,000.
- Price of wheat $160 per tonne.
- Societies may if they wish insure all stored crops against theft or damage, but not against damp or infestation, for one year for $5,000. The policy may be extended for a further 12 months next

May at the same cost. Insurance cannot be taken out at any other time.

June:

- Cost of labour $1,000.
- Storage loss if crop not fumigated the previous month 2%.
- Price of wheat $180 per tonne.

July:

- Cost of labour $1,000.
- Storage loss if crops not yet fumigated at all 5%.
- Storage loss if crops fumigated only in May 2%.
- Price of wheat $210 per tonne.
- Famine levy. Government demands that any societies with over 980 tonnes of wheat in stock "donate" 10 tonnes.

August:

- Cost of labour $1,000.
- Storage loss if crops not yet fumigated 3%.
- Price of wheat $200 per tonne.

September:

- Cost of labour $2,000.
- Theft of produce. Uninsured societies lose 10% of stock.
- Price of wheat $230 per tonne.
- Labour problems. No more than 100 tonnes of wheat can be sold.

October:

- Cost of labour $4,000.
- Rice harvest, bumper crop, members deliver 400 tonnes at $250 per tonne.
- Any wheat unfumigated for two months or more loses 10% of volume.
- Price of rice $250 per tonne.
- Price of wheat $260 per tonne.

November:

- Cost of labour $2,000.
- Any wheat unfumigated for two months loses a further 5% of volume.

- Price of rice $210 per tonne.
- Price of wheat $250 per tonne.

December:

- Cost of labour $1,000.
- Rice not yet fumigated loses 2% of volume.
- Price of rice $210 per tonne.
- Price of wheat $250 per tonne, but up to 100 tonnes may be sold for a special United Nations famine relief contract at $350 per tonne.

January:

- Cost of labour $1,000.
- Any wheat in stock, regardless of fumigation, loses 5% of volume.
- Transport shortage. No more than 100 tonnes can be sold.
- Price of rice $240.
- Price of wheat $260.

February:

- Cost of labour $1,000.
- Flood damage, uninsured societies lose 50% of crop by volume and pay $10,000 for repairs.
- Bridge destroyed, no sales can be made this month.
- Price of rice $250 per tonne.
- Price of wheat $250 per tonne.

March:

- Cost of labour $2,000.
- Any crops in stock lose 10% in volume unless fumigated last month.
- Price of wheat $220 per tonne.
- Price of rice $280 per tonne.

April:

- Cost of labour $2,000.
- Wheat harvest. Members deliver 800 tonnes for which they are paid $150 per tonne.
- Price of wheat $150 per tonne.
- Price of rice $280 per tonne.

May:

- Cost of labour $2,000.
- Wheat unfumigated last month loses 5% of volume.
- Vehicles off road for lack of spares. No sales possible.
- Price of wheat $150.
- Price of rice $280.

June:

- Cost of labour $1,000.
- Rice unfumigated in the last three months loses 10% of volume.
- Price of wheat $160.
- Price of rice $280.

July:

- Cost of labour $1,000.
- Fraud discovered. Societies with rice in stock discover that 20 tonnes are missing.
- Wheat untreated since harvest loses 20% of volume.
- Price of rice $310.
- Price of wheat $160.

August:

- Cost of labour $1,000.
- Inspection reveals damp spot in stored rice. 10% of volume stored must be sold for $150 per tonne.
- Price of rice $320.
- Price of wheat $170.

September:

- Cost of labour $2,000.
- Any wheat in stock is attacked by mildew, 20% has to be sold off for animal fodder at $100 per tonne.
- Price of wheat $180.
- Price of rice $280.

October:

- Cost of labour $3,000.
- Rice harvest, drought restricts members' deliveries to 250 tonnes at $280 per tonne.

- Price of rice $280.
- Price of wheat $180.

November:

- Cost of labour $2,000.
- Any produce not fumigated last month loses 5% of volume.
- Price of wheat $170.
- Price of rice $240.

December:

- Cost of labour $1,000.
- Wind-storm removes roof. Societies which have not renewed insurance pay $10,000 for repairs.
- Price of rice $230.
- Price of wheat $190.

January:

- Cost of labour $1,000.
- Any rice in stock is attached by rats and 10% is lost.
- Price of rice $240.
- Price of wheat $200.

February:

- Cost of labour $1,000.
- The last delivery made by the society was wrongly graded. A penalty of 10% of its value has to be paid.
- Price of rice $300.
- Price of wheat $200.

March:

- Cost of labour $2,000.
- Any wheat in stock must be dried at a cost of $5 per tonne.
- Transport shortage. Sales this month cannot exceed 250 tonnes.
- Price of rice $300.
- Price of wheat $220.

April:

- Cost of labour $2,000.
- Any produce not fumigated since January loses 20% of volume.
- Price of rice $250.
- Price of wheat $200.

The two years are now completed. Groups should calculate and work out their crop balance, at the April price, and add the total to their cash balance. The "winner" is the society with the highest total figure.

SOCIETY PROGRESS SHEET

Year One	Rice			Fumigation Cost	Wheat			Fumigation Cost	Total of Labour, Treatment or Other Costs $	Cash			Interest Paid or Received $	Final Balance $ (100000)
	In Tonnes	Out Tonnes	Balance Tonnes		In Tonnes	Out Tonnes	Balance Tonnes			In $	Out $	Balance $		
May					1000		1000	2000	9000		9000	(109000)	(1090)	(110090)
June							1000		1000		1000	(111090)	(1111)	(112201)
July						20	980		1000		1000	(113201)	(1132)	(114333)
Aug.							980		1000		1000	(115333)	(1153)	(116486)
Sep.						100	880		2000	23000	2000	(95486)	(955)	(96441)
Oct.	400		400	2000		880 [1]			7400 [2]	205920	107400	2079	21	2100
Nov.			400						2000		2000	100	1	101
Dec.			400	2000					3000		3000	(2899)	(29)	(2928)
Jan.		100	300						1000	24000	1000	20072	201	20273
Feb.			300						1000		1000	19273	193	19466
Mar.		30	270	1350					3350		3350	16116	161	16277
Apr.		70	200		800		800	1600	3600	19600	123600	(87723)	(877)	(88600)

1) lost 88; sold 792.

2) labour 4000; fumigation 2000; overstorage 1400.

SOCIETY PROGRESS SHEET

Year Two	Rice			Fumigation Cost	Wheat			Fumigation Cost	Total of Labour, Treatment or Other Costs $	Cash			Interest Paid or Received $	Final Balance $
	In Tonnes	Out Tonnes	Balance Tonnes		In Tonnes	Out Tonnes	Balance Tonnes			In $	Out $	Balance $		c.f. (88600)
May			200				800		2000		2000	(90600)	(906)	(91506)
June		200					800		1000	56000	1000	(36506)	(365)	(36871)
July							800		2600		2600	(39471)	(395)	(39866)
Aug.							800		1000		1000	(40866)	(409)	(41275)
Sep.						160	640		2000	16000	2000	(27275)	(273)	(27548)
Oct.	250		250	1250			640		3000		74250	(101798)	(1018)	(102816)
Nov.			250			32	608	1216	3216		3216	(106032)	(1060)	(107092)
Dec.			250				608		11000		11000	(118092)	(1181)	(119273)
Jan.		25	225	1125		308	300		2125	61600	2125	(59798)	(598)	(60396)
Feb.		100	125				300		7160	30000	7160	(37556)	(376)	(37932)
Mar.		125					300		3500	37500	3500	(3932)	(393)	(4325)
Apr.						60	240		2000		2000	(6325)	(633)	(6958)

Value of Wheat 240 Tonnes @ $200	48000
Final Balance	41042

Introductory Game

You are the Manager of the Simulated Co-operative Society. You have just taken 100 tonnes of grain into stock, and you must during the next six months decide when and how much to sell. You must at the end of the sixth month sell out whatever remains, to make room for the next crop, but you can during the six month period sell whatever quantity you want, when you want. The price each month will be announced by the Instructor. You know that prices tend to rise during the period, but they do not move steadily. You paid members $50 a tonne for the grain, and it costs $2 per tonne per month to store it.

Use the following table to record your sales and the inflow or outflow of money. Your objective is to have as much money as possible by the end of the sixth month, and you start with $100.

Month	Grain Tonnes			Cash $			
	Starting Balance	Sales	Closing Balance	Starting Balance	Sales Revenue	Storage Costs	Final Balance
1	100			100			
2							
3							
4							
5							
6							$

Storage Simulation - The Basic Information

You are a member of the storage management team of an agricultural marketing society. The Society has 1,000 active members, who farm on average 0.8 hectares each. They grow wheat during the cool season and rice during the monsoon. The wheat is planted in November and harvested in April-May. The rice is planted immediately after wheat harvest and is harvested in October.

The average yield is 1.5 tonnes per hectare of rice and 2 tonnes per hectare of wheat, but this varies a great deal from one season to the next. Members keep about half their rice and about a quarter of their wheat for their own consumption and they market their surplus through your Society.

The price paid by the Society for members' crops is announced by the Government each harvest time, and cannot be varied for that harvest. Your selling price is uncontrolled and you are free to sell or retain members' crops in storage as you think fit. Prices tend naturally to be at their lowest at harvest time and to rise from then onwards, but international prices and other factors affect prices so that you cannot be sure what they will be from one month to the next. In recent years the selling price of rice has ranged between $250 and $350 per tonne, and wheat from $150 to $250. It is unlikely but not impossible that these extremes will be exceeded in the future.

You must also decide what treatments to carry out while it is in storage. These cost money and you must decide whether the cost is justified by the benefits of reduced wastage. You can carry out such treatments at any month or less frequently. They cost $2 per tonne for wheat and $5 per tonne for rice.

In addition to deciding when and how much crop to sell, and what treatments to apply to whatever remains in storage, you must also keep a simple correct record of your stock of wheat and rice, of the treatments applied and the financial balance remaining to your Society. A progress sheet is provided for this purpose, and must be completed neatly and correctly every month.

Your objective is to accumulate as large as possible a surplus by the end of two years. This may be in terms of cash or of stored crops valued at the price obtaining on the final month.

SOCIETY PROGRESS SHEET

Year ____	Rice			Fumigation Cost	Wheat			Fumigation Cost	Total of Labour, Treatment or Other Costs $	Cash			Interest Paid or Received $	Final Balance $
	In Tonnes	Out Tonnes	Balance Tonnes		In Tonnes	Out Tonnes	Balance Tonnes			In $	Out $	Balance $		
May														
June														
July														
Aug.														
Sep.														
Oct.														
Nov.														
Dec.														
Jan.														
Feb.														
Mar.														
Apr.														

topic

17

action programme and commitment

SESSION 17

ACTION PROGRAMME AND COMMITMENT

Objective: To enable trainees to apply what they have learned to their own situation, to develop a solution to a specific problem with the assistance of the group and to commit themselves to its implementation by a given time.

Time: Up to one day.

Session Guide:

Trainees should have been warned at the beginning of this course that at the end they would be expected to describe a specific storage problem facing them at work, and to develop and present a solution to the problem that they will implement on their return home.

They should have been reminded of this constantly throughout the course, and of the need to identify at least one problem which the course will help them to solve. This final day gives them the opportunity to develop a solution to this problem, using what they have learned during the course and in consultation with a number of other trainees, and then to present the solution to the whole group for criticism and comment.

The problems and their solutions will of course be unique to each trainee and his organisation, but a typical example might be as follows:

- Problem: This has happened the last two seasons: The godown supervisor ensured that there were no rats in the stock of produce, he insisted that he maintained the building very well and that it was "rat-proof". But each year at the time of selling we have discovered enormous amounts of mice and rats and great damage to the crop.

- Solution: The following plan to be discussed with committee, godown supervisor and staff and their full support and collaboration ensured.

  1) Thorough inspection of the building in January, when all produce has been dispatched.

  2) Repair to the building in February, as necessary.

  3) Effective procedures for rodent control to be worked out and implemented regularly (weekly) by the supervisor and the manager.

  4) Application of rodent poison when necessary.

  5) Evaluation of the new procedures in July. Further improvements if necessary.

The time available should be divided into two periods - the consultancy period and the presentation period. During the consultancy period the trainees should be divided into groups of 3 to 4 people. The groups should not contain trainees of the same co-operative and ideally should include trainees from different backgrounds. In this period each trainee should be allowed about 30 minutes to present his problem and proposed solution to the other members of the group, who are expected to comment and help develop a solution to the problem, together with a timetable for its implementation.

During the presentation period each trainee should have at least ten minutes to present his problem and solution to the whole group, and to hear and react to at least a few of their comments. In this brief period the trainee must:

- Describe the problem.
- Describe the solution.
- Describe how the solution will be "sold" to whoever is involved.
- State a specific date by which the plan will be completed.

Trainees who are in a position of authority in a co-operative may feel that it is unnecessary to "sell" their idea to their subordinates. Such trainees should be warned that subordinate staff will contribute more efficiently to the work of the co-operative if they believe what they are doing is useful rather than if they do it out of fear or simple obedience.

The actual timing of the "consultancy" period and the presentation period will depend on the number of participants in the course. Ensure that each trainee has at least 30 minutes to discuss his problem with other trainees in his group and that at least ten minutes is devoted to a presentation to the full group of course members. In order to ensure that these minimum times are allowed to each trainee the normal session hours should be extended or some time should be allowed during the previous day. The session is important since it provides an effective "bridge" between the course material and the normal environment of the trainees. It also ensures that the trainees regard the completion of the course not as the end of training but at the beginning of personal improvement on the job.

Trainees should be encouraged to arrange to meet each other at work after the course for continued "group consultancies". The instructor should also undertake to visit or otherwise contact each trainee around the promised date of completion of the action plan, in order to ascertain whether or not it has been implemented. It must be stressed that this is not in order to evaluate the trainees, but the training course itself.

If possible a brief reunion should also be arranged, to take place after an appropriate interval. If this can be done, trainees should be asked to state in this session exactly what they plan to have achieved by the date chosen for the reunion, so that they can on that occasion compare progress with the stated intention. This is not only a useful evaluation device, but more importantly, the public commitment and knowledge of the forthcoming reunion will be a powerful incentive to actual implementation.