

Mechanisation Management

OBJECTIVES

- To explain the nature of the costs involved in owning and using farm equipment.
- To use practical examples to explain how the costs involved in owning and using farm equipment can be estimated.
- To investigate the reasons why farmers mechanise.
- To identify and elucidate the considerations that should apply when decisions are taken about the replacement of labour with farm machinery.
- To identify and elucidate what should be considered when deciding whether to buy or custom hire farm equipment.
- To analyse the pros and cons of buying used equipment and to show how a cost comparison can be made between owning new as opposed to used farm equipment.
- To identify and explain what should be considered when deciding on the size of farm equipment.
- To explain measures that could enhance equipment efficiency.
- To identify alternative financing methods for buying equipment and to show how the financing methods can be compared.

Mechanisation, if preceded by thorough planning, could hold substantial financial benefits for farmers. Unfortunately, it is also true that for some farmers in the RSA owning "the best, biggest and most expensive" farm equipment (machinery, implements, etc.), has become a status symbol and this is counter productive to farm profitability.

Like any other farming activity mechanisation calls for thorough planning in which all relevant aspects must be duly considered. Mechanisation planning and management as a whole are comprehensive and complex and as such the subject of many specialised publications. This chapter will only deal with a few of the more

business-orientated aspects of mechanisation management, without necessarily offering solutions to the problems. Finding solutions usually requires specialised knowledge and extension, such as that supplied by the Directorate of Agricultural Engineering and Water Supply of the Department of Agriculture and Water Supply.

THE NATURE OF MECHANISATION COSTS

Rational decision-making on mechanisation problems requires knowledge of the nature of mechanisation costs. The costs involved in owning and using farming equipment include the following:

- Fuel and lubricants
- Labour
- Interest on capital investment
- Cost of providing shelter
- Insurance premiums and licence fees
- Depreciation costs
- Repair and maintenance costs.

These costs are divided into three categories (see also the section on cost functions in Chapter 2), namely fixed costs, variable costs and semi-variable costs.

Fixed costs are those costs that remain the same whether the equipment is used a great deal or not at all. The fixed costs involved in owning and using farm equipment include the interest on capital investment, insurance premiums, licences and the cost involved in providing shelter.

The *variable costs* involved in owning and using farm equipment include expenditure on fuel, lubricants and labour. These costs increase in direct proportion with the use of the equipment.

Although the total fixed costs remain constant despite the extent and frequency of use, they naturally decrease *per unit* (e.g. per ha ploughed) the more the equipment is used. The opposite applies to the variable costs: they increase in total the more the equipment is used, but remain constant per unit.

Depreciation costs are partially variable and partially fixed. Virtually all farm implements decrease in value as they become older, whether they are used or not. This part of depreciation is therefore a fixed cost since it remains the same in total, regardless of the extent to which the equipment is used. Farm equipment also deteriorates through use and this part of the depreciation costs is therefore variable because it increases the more the equipment is used.

The nature of repair and maintenance costs is similar to that of depreciation. Even if a tractor is not used at all, certain repair and maintenance work will have to be

done (e.g. replace the battery) — therefore a fixed cost. On the other hand there are repairs that increase with use — therefore a variable cost.

For the above reasons depreciation and repair and maintenance costs do not increase in direct proportion with the use of the farm equipment and can therefore not be classified as purely variable costs. They do not, however, remain constant in total and can therefore also not be regarded as purely fixed costs. Such costs are therefore distinguished as *semi-variable* costs.

However, for practical reasons all depreciation costs are, for planning purposes, regarded as fixed costs, and all repair and maintenance costs as variable costs. This custom largely eliminates possible errors and the result is usually accurate enough to guide the farmer in his mechanisation decisions.

In practice the costs involved in owning and using farm equipment are divided into two categories, namely:

- Fixed costs (depreciation, interest, shelter, insurance and licences); and
- Variable costs (labour, fuel, lubricants, repair and maintenance costs).

Following the above explanation of the nature and costs involved in owning and using farm equipment, the following general statement can be made: *All farm equipment entailing high fixed costs (expensive equipment) should be used as intensively as possible so as to reduce unit cost of use. The unit cost of farm equipment with a low fixed cost does not, however, change markedly through more intensive use.*

Example A: Farm equipment with high fixed costs

Ha cultivated	Total fixed costs per year R	Variable costs/ha R	Total costs/ha R
1	1 000,00	2,00	1 002,00
100	1 000,00	2,00	12,00
1 000	1 000,00	2,00	3,00

Example B: Farm equipment with low fixed costs

Ha cultivated	Total fixed costs per year R	Variable costs/ha R	Total costs/ha R
1	10,00	2,00	12,00
100	10,00	2,00	2,10
1 000	10,00	2,00	2,01

ESTIMATING MECHANISATION COSTS

As will become clear later in this chapter, accurate estimates of the cost involved in owning and using farm equipment form the basis for rational decision-making on many mechanisation matters. It is therefore important that the farmer must be able to estimate mechanisation costs fairly accurately.

In the RSA the Directorate of Agricultural Production Economics of the Department of Agriculture and Water Supply periodically publishes a manual on mechanisation costs. The information in the manual covers a wide variety of farm equipment and can be fruitfully used by farmers who are considering the purchase of, especially, expensive farm equipment.

Table 11.1 illustrates a procedure that can be followed when estimating mechanisation costs. The procedure is elucidated with a practical example.

Table 11.1 Estimating the costs involved in owning and using a maize combine*

<i>Step 1: Obtain basic information</i>	
New 66-kw, 3-row, 1,5 m self-driven maize combine	
Cost price	R93 300
Salvage value (10% of cost price)	R9 330
Average value ($\frac{93\ 300 + 9\ 330}{2}$)	R51 315
Useful life	10 years (3 000 hours)
Estimated annual use ($\frac{3\ 000}{10}$)	300 hours
Opportunity cost of capital	12% p.a.
<i>Step 2: Estimate fixed costs</i>	
Depreciation (straight-line) = ($\frac{93\ 300 - 9\ 330}{10}$)	R8 397 p.a.
Interest = (R51 315 x 12%)	R6 158 p.a.
Insurance, third party and licences (actual cost on average value)	R936 p.a.
Total annual fixed costs	<u>R15 491</u>
Fixed costs per hour (R $\frac{15\ 491}{300}$)	R51,64
<i>Step 3: Estimate variable costs</i>	
Repair and maintenance costs (60% of purchase price)	R5 598
10	
Fuel (0,3 l/kw h @ 54,4c/l x 60% of engine power used)	R1 938
Labour (actual labour costs)**	<u>R500</u>
Total variable costs per year	R8 036

Variable costs per hour (R $\frac{8\ 036}{300}$)	R26,79
<i>Step 4: Calculate estimated total cost</i>	
Total costs per year (R15 491 + 8 036)	R23 527
Total costs per hour (R51,64 + 26,79)	R78,43

* The figures in the table are based on information contained in the Directorate of Agricultural Production Economics' (Department of Agriculture and Water Supply), Guide to machinery costs, May 1985.

** The labour costs will depend on the farmer's remuneration structure. Provision must also be made for time spent on maintenance work. The R500 in the example is a fictitious amount.

THE REASONS WHY FARMERS MECHANISE

Farmers mechanise for various reasons, the following being the most common:

Convenience and speed of work performance

Farm equipment is often acquired for the primary purpose of facilitating or expediting work performance or making it less monotonous. This sometimes leads to cost savings, but it is also not unusual if it leads to cost increases. Although capital investment in these cases therefore does not necessarily make a direct contribution to increased profitability, it may nevertheless hold considerable indirect benefits in that it makes for a happier labour force and may also enable labourers to work longer hours with greater concentration.

Increase in income

Income = Price per unit x yield in units.

Mechanisation could contribute to increased income in various ways. The following are the most important:

- Higher yields because larger areas can be cultivated.
- Increased yields as a result of more thorough cultivation. It has been scientifically proved that thorough seedbed preparation, efficient weed control, irrigation and harvesting machines could well lead to substantially higher yields.
- Higher yields through timely cultivation. Research results indicate that cultivation at the right time not only increases yields, but could also result in considerable cost saving.
- Higher prices as a result of a better-quality product. This applies especially to harvesting machines where, for example, poor potato lifters could have a

dramatic influence on the quantity of first-grade potatoes and the concomitant price. The same applies to grain combines.

- Higher prices through storage. Modern technology makes the irradiation or refrigeration of perishable products possible so that they can be stored for relatively longer periods. The extended marketing period could result in higher average prices than would have been the case if the products had to be sold immediately.

In all these instances of increased income as a result of mechanisation, the additional costs brought about by mechanisation must naturally be weighed against the increased income to determine whether the net result is favourable. There are several techniques for this and they will be illustrated later in the chapter.

Reduction in costs

The main economic reason for increased mechanisation is to reduce costs, especially labour costs, although mechanised processes could also have cost benefits in other respects.

The cost structure of a farming enterprise could be particularly reduced by the correct combination of the two inputs, labour and farm equipment.

It is impossible to use only labour or only machines in a farming enterprise. What does happen is that certain activities such as harvesting could be done mainly by labour or by machinery. If the decision to use mainly labour or to mechanise as far as possible is based on economic considerations, the cost structure could be reduced. This aspect will be discussed in more detail later.

Counteracting labour problems

For various reasons adequate labour as regards number, cost and quality may not be available, and farmers are left no choice but to mechanise. Problems which farmers sometimes experience with labour motivation and labour relations in general often "compel" them to mechanise. It is therefore clear that considerations other than purely economic ones could be valid when replacing labour with farm equipment.

Tax considerations

The tax situation in which the farmer finds himself could influence his decision to mechanise. This could be the main reason why farm equipment is bought or acquired within a specific year.

Unfortunately man's inherent reluctance to "give unto Caesar..." is often the main cause of over-investment in farm equipment and a constant dire shortage of cash.

Farmers mechanise to —

- expedite work performance and make things more convenient,
- bring about an increase in income,
- effect a reduction in costs,
- counteract labour problems, and
- alleviate tax.

THE REPLACEMENT OF LABOUR BY FARM EQUIPMENT

It has been shown that a reduction in costs is one of the main reasons for replacing labour with farm equipment. There are various techniques for determining the cost effect of such replacement. Although the use of these techniques reveals the cost advantage or disadvantage involved in replacement, there may be ripple effects that are not revealed.

Cost comparison techniques

Two cost comparison techniques can be used to assess the economic desirability of replacing labour by farm equipment, namely partial budgets and break-even budgets.

The discounted cash-flow technique dealt with in chapter 3 can also be used for most of the investment decisions on mechanical equipment and can indeed be recommended, because it usually produces more accurate results than other techniques. The accurate estimation of the annual net cash flow over the lifetime of the project is however difficult in practice. For this reason the other two techniques are rather used. The use of these two techniques for this purpose can be illustrated by means of an example.

Suppose N. Farmer plants 150 ha of cotton per year with an average yield of 3 000 kg/ha. Up to now he has had the cotton picked by hand by seasonal labourers at a cost of 11c/kg cotton picked. The costs include piece rates, rations and transport. N. Farmer intends to continue producing cotton in future and is now considering the purchase of a mechanical cotton picker to replace the seasonal labourers. A new cotton picker costs R60 000 and after a useful life of five years, he should be able to sell it for R20 000. The variable costs of the cotton picker are R15 /ha, but because cotton has to be picked twice by the cotton picker,

the costs effectively amount to R30/ ha. The mechanical picker also causes a yield and quality loss of R240/ha.

Is the replacement of labour by a mechanical cotton picker economically justifiable at the present scale of production? What is the minimum scale of production that will make the replacement economically justifiable?

Partial budget

● Cost of hand picking per ha = R(3 000 x 0,11)	= <u>R330,00</u>
● Cost of mechanical picker per hectare	= <u>R370,00</u>
— Fixed costs	
Depreciation = R $\frac{60\ 000 - 20\ 000}{5}$ = R $\frac{8\ 000}{150}$	= 53,33
Interest * = $(\frac{60\ 000 + 20\ 000}{2}) \times 10\% = R \frac{4\ 000}{150}$	= 26,67
Insurance and licences = R $\frac{3\ 000}{150}$	= 20,00
— Variable costs (including labour)	= 30,00
— Quality and yield losses	= 240,00

* The picker is financed with own capital with an opportunity cost of 10% per year.

Conclusion: It is not economically justifiable to buy a mechanical cotton picker to replace manual labourers at his present scale of 150 ha cotton per year. The cost of the mechanical picker is R40 per ha more than picking by hand.

Break-even budget

$$\begin{aligned} \text{Break-even point in hectares} &= \frac{\text{Total fixed costs}}{\text{Labour costs per ha} - \text{Variable costs per ha (mechanical picker)}} \\ &= \frac{8\ 000 + 4\ 000 + 3\ 000}{330 (30 + 240)} \\ &= \frac{15\ 000}{60} \\ &= 250 \text{ ha} \end{aligned}$$

Conclusion: If N.Farmer should cultivate more than 250 ha cotton, it would be economically justifiable to replace the manual labourers.

However, whether it is practically and economically justifiable to expand his cotton production when considering his enterprise as whole is another matter. It might require the replacement of other, more profitable, production branches, or there may be other limiting factors that do not allow for such expansion. Additional

partial budgets, or even a total budget, may be necessary to find the answer to this.

Additional considerations

If the decision to replace labour with farm equipment is based on cost comparisons as explained in the above example, it appears to be a relatively easy decision. There are, however, also other implications — not reflected in a cost comparison — involved in such a decision. The following highlight some of them:

- In the cost-comparison example the point of departure was that in the hand-picking process all picking was done by *seasonal labourers*. Farm equipment could, however, also reduce the need for *permanent labour*. By calculating only the time saving (hours) in permanent labour and multiplying this with the wage rate, the image will be distorted if the permanent labour force is not indeed reduced proportionally. It is, however, a well-known fact that mechanisation often does not lead to any reduction in the permanent labour force and therefore a reduction in the cost of permanent labourers. The saving in permanent labour hours therefore does not lead to any saving in labour costs.

On the other hand it could happen that mechanisation of a particular operation that has to be completed in a peak period leaves the permanent labour force free to carry out other urgent tasks that require attention during the same period. This could increase the net farm income of the enterprise as a whole via improved yield and quality as a result of the timeliness of activities and a reduction in the wages paid for overtime. In this way the "saving on labour costs" through mechanisation of a specific operation could be much higher than the amount obtained by simply multiplying labour time by the wage rate. The opportunity costs of the labour time saved could therefore indeed vary between nil and any higher amount.

- If labour had been a limiting factor in the planning of the combination and scale of the production branches included in the farming plan (see chapter 4), mechanisation of a specific activity or production process could eliminate this restriction and create the opportunity for a more profitable total farming plan. A cost comparison such as given in the above example, will not reveal this potential advantage.
- Mechanisation often demands additional capital investment in movable assets and, especially if a farmer experiences cash problems, he may be reluctant to mechanise and decide to rather be content with labourers even if it is less profitable. Where capital is a limiting factor a farmer may also decide to invest his limited capital in a different, potentially more profitable, alternative, even if the planned mechanisation indicates a satisfactory return

on capital. This problem can be dealt with in the cost comparison by adjusting the interest rate to allow for the opportunity cost of the capital which is to be invested in the intended mechanisation. It is, however, often impossible to determine the potential return on the alternative investment this accurately.

- Capital investment in fixed and movable assets increases risk. The demand for the product concerned — and therefore its price — may drop and make further production unprofitable, with the result that the equipment can no longer be used or sold economically. Provision for this risk can be made in the cost comparison by increasing the interest rate on the capital investment and/or reducing the expected useful life and/or the expected salvage value of the equipment. The problem is, however, to determine the probability and magnitude of such risk at the time when a decision on mechanisation has to be made.

The use of seasonal labourers allows for more flexibility because in such cases they are simply not re-employed.

- Finally, there is also the employment factor (unemployment). In South Africa, particularly, it is a political, social and moral duty of the farming sector to offer job opportunities to a vast unskilled labour force, even if they have to forfeit the financial advantages offered by mechanisation.

When deciding on the substitution of labour by farm equipment, the economics of the planned changes should be determined by means of cost comparisons. However, certain difficult and even unquantifiable considerations complicate the final decision.

PURCHASING OF FARM EQUIPMENT AS OPPOSED TO CUSTOM HIRING

The considerations that should apply in a choice of this nature correspond with those dealt with in decision-making on the replacement of labour by farm equipment. The same cost-comparison techniques should also be used to weigh the economics of the two alternatives (see also the example in chapter 4).

The following additional aspects are raised in this choice and/or deserve special emphasis:

- The opportunity cost of labour (driver and operators) required in the case of ownership and which will be saved by making use of a contractor, could differ considerably from the wage rate of such labourers (see the discussion on this on the previous page).

- Where the equipment under consideration is not self-driven but has to be supported by a tractor, the relevant fixed and variable costs involved in the use of the tractor (e.g. on an hourly basis) must also be taken into account in the cost comparison as costs of ownership. If the task for which the contractor is being considered does not, however, have to be carried out during a peak period for tractors, the use of the contractor will not affect the number of tractors on the farm — the farmer will probably have surplus tractor capacity — and it may therefore be argued that the fixed costs of the tractor must not, in such a case, be allocated to the cost of ownership in the cost comparison.

If the task for which the contractor is being considered falls within the peak period for tractors, it may, as the opposite extreme, happen that the farmer needs an additional tractor (and even driver) to support the equipment under consideration. Unless it is possible to hire an additional tractor and driver for the specific period only, it could be argued that the total annual fixed costs of the tractor and the cost of the driver should be regarded as costs of ownership in the cost comparison.

- There is the possibility that the use of a contractor could result in quality and/or yield losses because he will be less careful than the owner would be. On the other hand there is the possibility that the contractor has more specialised knowledge and equipment than the farmer and that this could indeed improve quality and/or yield. Such differences must also be included in the cost comparison.
- Closely associated with the above is the question of timeliness of operations. A delay in carrying out the operation — sometimes by as little as a day as in the case of insect or pest control — could result in substantial differences in yield and quality. On the one hand dependence on an operator — because he is engaged elsewhere — may cause delays and resultant losses in yield and quality. Because the contractor may have bigger and better equipment than the farmer he may, on the other hand, expedite performance of the operation, thereby preventing or reducing such losses. For these eventualities too, provision should be made in the cost comparison if it is at all possible to estimate the incidence and/or extent thereof in advance.
- Considerations concerning the elimination of limiting factors during peak times and the resultant potentially more profitable total farming plan, the reduction of the risk factor which accompanies large capital investment in fixed and movable assets and possibly more profitable alternative capital investment opportunities that were discussed previously, could also favour the use of a contractor.

When choosing between ownership of farm equipment as opposed to custom hiring, the general rule applies that a farmer should purchase equipment which

- is used intensively throughout the year because this leads to a low unit cost;
- has a relatively low purchase price; and
- is required for operations where timeliness has a critical influence on quality and/or yield.

THE BUYING OF NEW AS OPPOSED TO USED FARM EQUIPMENT

What are the pros and cons involved in owning used farm equipment as opposed to new farm equipment, and under what circumstances does used equipment fit in best?

- New equipment requires a larger capital investment than used equipment. However, used equipment does not necessarily lead to a saving in costs, but, especially where capital is a limiting factor, the capital saved by buying used equipment can be invested more profitably elsewhere.
- Used equipment usually fits in better on small farms. Such equipment is usually less reliable than new equipment and work with such implements is often slower as a result of interruptions for repairs. Farmers with small farms therefore run a smaller risk that their work will not be completed in time than is the case with farmers who have large farms. Used equipment could also cause lower quantitative and qualitative yields.
- In general the buying of used equipment leads to higher variable costs relative to fixed costs. Depreciation, interest on capital and insurance of new equipment will be higher, while the repair costs, fuel and labour of used equipment are higher.
- Because of the need for more repairs, the farmer's mechanical competence is an important consideration when buying used equipment.

The following is one method of comparing the cost of new and used equipment: Suppose a farmer budgets as follows:

	New equipment	Used equipment
Cost price	R20 000	R12 000
Expected life	10 years	6 years
Annual depreciation	R2 000	R2 000
Repair costs p.a.	R1 200	R1 800
Insurance premiums	R180	R100
Total annual costs (interest excluded)	R3 380	R3 900

Assessed on this basis, the new equipment has a cost advantage over the used. But, *interest on the capital investment* still has to be taken into account. An additional R8 000 (cost price of new equipment minus cost price of used equipment) is invested in new equipment for a period of six years (the budgeted life of used equipment).

If this R8 000 could be invested elsewhere at an interest rate of more than 6,5% per year, or the interest rate on loan capital is higher than 6,5% per year, it would, under the given circumstances, and from a purely cost point of view, be more profitable to buy the used rather than the new equipment.

THE SIZE OF THE FARM EQUIPMENT TO BE PURCHASED

The following factors should be considered when deciding on the size of farm equipment to be bought:

- The difference in purchase price;
- The annual use that will be made of such equipment;
- The labour saving effected by the bigger equipment;
- Availability of labour and capital;
- Size of the existing equipment on the farm; and
- The urgency of the work that has to be done with the equipment.
- The difference in purchase price is important because it results in higher fixed costs in the form of depreciation, interest on capital and insurance premiums. If the difference in purchase price is negligible, this can be compensated for by the labour saving brought about by the larger equipment. If the difference is substantial, it is doubtful whether the labour saving will justify the purchase of the larger equipment.
- The annual use to be made of the equipment also helps to determine whether a larger or smaller item of equipment will be the most profitable. As the higher fixed costs involved in the purchase of larger equipment is spread over more units, the difference in fixed costs per unit between the larger and the smaller item becomes less, as is evident from the information in table 11.2.
- The larger equipment may stand up better to the wear and tear of constant use than the smaller items, and would therefore have a longer life. In such a case it might even be that the fixed costs per unit of the large equipment will be lower than that of the smaller equipment.
- The labour saving effected by larger equipment and the availability of labour and capital are key considerations. In general the statement holds true that farmers who have enough labour, experience a shortage of capital and do not intend to make extensive annual use of the equipment, should rather buy smaller items.

- Such farmers will probably be able to make better use of the capital saved in this way elsewhere in the enterprise than by buying large implements. On the other hand, larger equipment has a relative advantage on farms with a limited potential labour force, adequate capital and large use potential for the equipment.
- The size of the existing farm equipment could also affect the choice between large and small additional farm equipment. It would, for example, be quite foolish to buy a large trailer if the farmer already has a relatively small tractor, and vice versa.
- It must also be borne in mind that equipment with a high work capacity can complete tasks more quickly than in the opposite case. Where operations therefore have to be completed within a specific period to obtain satisfactory production results, larger equipment would be more advantageous than smaller equipment.

Table 11.2 The differences in the fixed costs per unit between a large and a small item of equipment at different rates of use

Number of units cultivated	Fixed costs per unit		Differences in fixed costs between a large and a small item of equipment
	Large	Small	
1	1 000,00	500,00	500,00
10	100,00	50,00	50,00
100	10,00	5,00	5,00
1 000	1,00	0,50	0,50
10 000	0,10	0,05	0,05

INCREASE OF EQUIPMENT EFFICIENCY

Equipment or mechanisation cost is one of the largest single cost items in most farming enterprises in the RSA which is why farm equipment must be used as efficiently as possible.

Steps that can be taken to increase the efficiency of farm equipment are divided into four main categories:

- The right choice of equipment
- Proper maintenance
- Proper utilisation
- Optimum time of replacement.

Choice of equipment

Choosing equipment involves the correct size and type of equipment for the specific task or tasks and for the type and the size of the farming enterprise. In the decision-making process aspects such as the purchase of used instead of new equipment and custom hiring instead of buying equipment also come to the fore. When a farmer has to choose equipment, he should endeavour to find answers to the following questions:

- Can the equipment under consideration carry out the task satisfactorily and will it lead to increased net farm income?
- Does the equipment have adequate capacity to complete the task in time so as to prevent quality and yield losses and is capacity available to accommodate expansions planned for the foreseeable future?
- What are the chances that the equipment concerned might become obsolete in the near future?
- Are contractors available to carry out the specific task and, if so, would using a contractor not perhaps be a better alternative than buying?
- Will used equipment have the capacity and be reliable enough to carry out the task satisfactorily?
- Can the capital investment saved by custom hiring or buying used equipment give larger returns elsewhere than an investment in an own or a new item of equipment?
- Can the labour saved by buying a larger item of equipment give a bigger return elsewhere in the enterprise than the cost difference between the bigger and the smaller item of equipment?
- Can the purchase of a larger item of equipment be justified on the grounds of improved timeliness of work performance?

As already explained in this chapter, there are quantifying techniques which, if used cautiously enough, could help a farmer to find satisfactory answers to these questions.

Maintenance

Repair costs represent a substantial percentage of the variable equipment costs on a farm, but this is a controllable cost item that can be kept within acceptable limits. Abnormally high repair costs can usually be attributed to

- exceeding equipment capacity;
- excessively high speed;

- poor maintenance practices; and/or
- misuse of the equipment.

Precision and properly trained operators could limit the incidence of these practices on a farm to the minimum. Repairs can also be controlled by keeping a proper record of repair and maintenance work, and for the more expensive equipment it should be done per individual item. Such records have the further advantage that they help to identify items of equipment with above-average repair costs. Such items could then be considered for early replacement. Repair costs can further be controlled by handling items of equipment strictly according to the manufacturers' directions.

Utilisation

In the previous paragraph reference was made to the proper use (in the sense that it must not be over-utilised) of an item of equipment as a way in which repair costs can be controlled. The correct technical use of an item also contributes to increased effective capacity utilisation.

A factor which often contributes to high mechanisation costs, is the *under-utilisation* of expensive, specialised machines because the fixed-cost component of such machines is high. Unless such machines are fully utilised, their unit costs (cost per hour or per ha) are very high.

Better utilisation can be achieved in two ways:

- Neighbours can buy and use machines jointly. Joint ownership of expensive equipment could hold great economic advantages, but a prerequisite is that neighbours must be able to co-operate and they must come to a prior agreement about practical matters such as the order of use and division of repair costs, operator's costs and insurance costs.
- By undertaking contract work for other farmers.

Replacement

One of the most difficult problems in mechanisation management is to determine the optimum stage at which an item of equipment should be replaced. Unfortunately there is no easy rule of deciding and an item may be replaced for any of the following reasons:

- As a result of age and repeated use, the existing item can no longer carry out the desired task.

- New technological developments or changes in cultivation practices have made the item no longer suitable for carrying out the desired task.
- Abnormal cost increases in the use of the present item of equipment could make it more profitable to acquire a new one. The cost items involved here are usually fuel and repair costs.
- The capacity of the equipment is no longer adequate as a result of an increase in area cultivated, or timeliness has become more critical and the present item cannot complete the work in time.
- The item has become unreliable and/or causes delays as a result of which quality and/or yield losses reach unacceptable levels.
- To benefit from tax concessions. This was also mentioned earlier as a reason for mechanisation.
- The owner's view concerning the relationship between the present and the future enterprise profitability. If he expects profitability to deteriorate in the future, the tendency is to replace immediately, and vice versa.
- To enjoy the prestige of owning the "newest and biggest" farm equipment. Although this may be an important consideration for some, it is not based on economic reasons and can therefore not be supported as a reason for replacement.

The validity of most of the above considerations in deciding on the replacement of a specific item of equipment can be tested objectively with the aid of partial budgets, provided all relevant factors are taken into account. Some of the other considerations are more subjective and the decision rests with the sound judgement of the manager.

FINANCING OF EQUIPMENT PURCHASES

When a farmer has decided to acquire a specific item of equipment, all that remains is the question of using the best method of financing. This may, but need not be, a complicated decision, depending on the different alternatives available to the farmer and the extent to which subjective likes and dislikes play a role.

In the RSA a farmer, depending on his particular circumstances, usually has the following financing alternatives when buying farm equipment:

- Own capital (cash)
- Loan capital in the form of —
 - Land Bank medium-term loans
 - medium-term financing through his cooperative
 - instalment-sales agreements
 - lease agreements.

For an economically sound choice the farmer must compare the differences in loan conditions (interest or financing costs, deposit required, term of loan and repayment conditions) and the various deductions allowed for income tax purposes.

However, the question arises: in what way can this be done? A method is explained by means of a practical numerical example. The general loan conditions used in the example (interest rates excluded) are those that normally apply for the various alternatives.

Say N. Farmer wants to buy a tractor under the following circumstances:

- Price of tractor after cash discount and GST = R20 000
- Expected annual taxable income over the next 5 years = R30 000.

After visiting all the different institutions that provide credit and getting quotations, N. Farmer considers the following financing alternatives:

The local agricultural cooperative

Conditions of loan

- Cash deposit = R5 000 (25% of cash price)
- Amount to be financed = R15 000 (20 000 - 5 000)
- Capital redemption = R3 750 p.a. (four equal annual payments payable at the end of each year = $R\frac{15\ 000}{4}$)
- Financing costs = R5 625 (15% per year on outstanding balance)
- Total costs = R25 625 (R20 000 + R5 625)

Repayment schedule

		R
● Beginning year 1:	Deposit	= 5 000,00
	Capital + interest	
● End year 1:	R3 750 + R2 250,00	= 6 000,00
● End year 2:	R3 750 + R1 678,50	= 5 437,50
● End year 3:	R3 750 + R1 125,00	= 4 875,00
● End year 4:	R3 750 + R562,50	= 4 312,50
● Total cost		<u>= R25 625,00</u>

Relevant income tax stipulations: The tax stipulations used in this paragraph are those applicable since 1978. In the year of purchase the cash price (purchase sum) plus the interest for that year is deductible, and thereafter the annual interest.

The Land Bank

Conditions of loan

- Cash deposit = Nil
- Amount to be financed = R20 000
- Capital repayment = R5 000 p.a. (four equal instalments, payable at the end of each year = $R\frac{20\ 000}{4}$)
- Financing costs = R6 000 (12% p.a. on outstanding balance)
- Total costs = R26 000 ($R20\ 000 + R6\ 000$)

Repayment schedule

	Capital + interest	R
• End year 1:R5 000 + R2 400	=	7 400
• End year 2:R5 000 + R1 800	=	6 800
• End year 3:R5 000 + R1 200	=	6 200
• End year 4:R5 000 + R600	=	5 600
• Total cost	=	<u>R26 000</u>

Applicable income tax stipulations: The same as in the previous instance.

Instalment-sales agreement

Conditions of loan

- Cash deposit = R2 000 (10% of cash price)
- Amount to be financed = R18 000 ($R20\ 000 - R2\ 000$)
- Financing costs = R13 428 (approximately 22% p.a. on outstanding balance. Both the amount and the interest rate are provided by the loan institution. See also the explanation in chapter 6.)
- Total cost = R33 428 ($R20\ 000 + 13\ 428$)
- Debt repayment = R6 285,60 p.a. (purchase price plus financing costs in five equal annual instalments payable at the end of each year = $R\frac{33\ 428}{5}$)

Repayment schedule

	R
• Beginning year 1	= 2 000
• End year 1 to end year 5: ($5 \times R6\ 285,60$)	= <u>31 428</u>
• Total cost	= <u>R33 428</u>

Applicable income tax stipulations: The total cost are deductible in the year of purchase.

Leasing agreement

Conditions of loan

- Cash deposit = Nil
- Amount to be financed = R20 000
- Financing costs = R8 620 (approximately 22% p.a. on outstanding balance. See also remarks with the instalment-sales agreement.)
- Total costs = R28 620 ($R20\ 000 + R8\ 620$)
- Debt repayment = R5 724 p.a. (purchase price plus financing costs in five equal annual instalments payable at the *beginning* of each year =
$$R \frac{28\ 620}{5}$$
)

Repayment schedule

	R
• Beginning year 1	<u>5 274</u>
• End year 1 to end year 4: (4 x R5 724).	$= \underline{\hspace{2cm} 22\ 896}$
(For all practical purposes the end of one year can be regarded as the beginning of the next year.)	
• Total cost	$= \underline{\hspace{2cm} R28\ 620}$

Applicable income tax stipulations: The annual instalment is deductible.

Cash purchase

The total cash price (R20 000) is payable at the time of purchase and this amount is deductible from income tax in the year of purchase.

Preliminary conclusion

Should N. Farmer have to make a decision purely on cost considerations at this stage, the following order of priority would apply:

Cash (R20 000); agricultural cooperative (R25 625); Land Bank (R26 000); leasing (R28 620); instalment-sales (R33 428).

As already indicated, different income tax stipulations and conditions of repayment apply to the different financing methods, and this should also be taken into account when making the final decision.

Income tax implications

The income tax implications must be calculated annually for each financing method over the full period so that meaningful comparisons can be made.

The procedure for each method is as follows:

- Calculate the annual taxable amount by deducting the relevant tax concession valid for the particular financing method from the estimated annual taxable income (R30 000).
- Calculate the annual tax by applying the tax rate for the annual taxable amount. The tax rates used in this example are the 1984/85 scales for a married person under the age of 60 years.

Financing through the agricultural cooperative serves as illustration:

Year	Taxable income	Amount deductible for tax purposes	Taxable amount	Tax payable
1	30 000	20 000 + 2 250	7 750,00	790,00
2	30 000	1 687,50	28 312,50	6 831,25
3	30 000	1 125,00	28 875,00	7 067,50
4	30 000	562,50	29 437,50	7 303,75
5	30 000	—	30 000,00	7 540,00
Total	—	—	—	R29 532,50

If this procedure is applied to each financing method, the net result and the order of priority at this stage are as follows:

	Cost price + Financing costs	+	tax	=	Total capital outflow
				R	
Cash purchase	20 000	+	31 280	=	51 280
Lease	28 620	+	26 224	=	54 844
Agricultural cooperative	25 625	+	29 533	=	55 158
Land Bank	26 000	+	29 420	=	55 420
Instalment-sales	33 428	+	28 749	=	62 177

The time value of money

Since the annual outflow of money varies for the different financing methods, the time value of money must also be taken into account in the comparison. This is done by discounting the annual capital outflow that applies to each financing method.

A major problem in this respect is to determine the discounting rate (see also the section dealing with capital budgets in chapter 3). Where own capital (cash) is involved in the comparison, it seems logical to use the after-tax opportunity cost of own capital as discounting rate. If it is assumed that the own capital would otherwise be used in the production process of the enterprise, the discounting rate is the rate of return on own capital less the average tax rate ($\frac{\text{tax}}{\text{taxable amount}}$) as percentage of the rate of return on own capital. If N. Farmer therefore estimates his rate of return on own capital before tax at 10% per year, the discounting rate that must be used in the example is about 8% per year.

Discounting rate

$$\begin{aligned} &= \text{Rate of return on own capital less (tax rate} \times \text{rate of return on} \\ &\quad \text{own capital)} \\ &= 0,10 - (\pm 0,20 \times 0,10) \\ &= 0,10 - 0,02 \\ &= 0,08 \end{aligned}$$

To illustrate the method, financing by the agricultural cooperative will again be used:

Year	Net capital outflow (deposit + annual interest and capital repayment + annual tax)	Discounting factor* $i = 0,08$	Present value of capital outflow
Beginning 1	R 5 000 (deposit)	—	R 5 000
End 1	6 790	0,9259	6 287
End 2	12 269	0,8573	10 518
End 3	11 943	0,7938	9 480
End 4	11 616	0,7350	8 538
End 5	7 540	0,6806	5 132
Total	R55 158	—	R44 955

*See table 2.2 in the annexure.

The financing decision

Once the influence of financing costs, income tax and the time value of money on each of the financing methods has been taken into account, N. Farmer is able to make a decision on the most advantageous (in the economic sense) financing method. Under the given circumstances in the example, the order of priority of the different financing methods will be as follows:

Cash (R44 160); Land Bank (R44 323); agricultural cooperative (R44 955); leasing (R45 623); instalment-sales (R49 009).

It must, however, be pointed out that this order of priority only applies under the given circumstances. Other loan conditions, taxable income, tax rates and discounting rates could drastically change the order of priority. Apart from the considerations taken into account in the example, there are also other non-quantifiable factors that might influence a farmer's final choice. For example, a farmer may decide — even though cash purchases are the most advantageous — to rather choose a different method of financing and to keep his cash available for unforeseen eventualities. Similarly a farmer might decide — even if cash purchases are not the most advantageous — to pay cash in any case because he does not like the bother of regular instalments.

Implications of leasing agreements

A few implications of leasing agreements need to be mentioned:

- When a lease agreement expires, a farmer has the choice of
 - returning the item of equipment to the financial institution, in which case the institution repays the current market value (trade-in value) as "rent recovered" to him. This amount then becomes taxable as would have been the case if the farmer should sell or trade in the item under any of the other financing methods.
 - retaining the item of equipment in which case he pays GST on the then current market value. If the farmer is already aware of this intention when evaluating the financing methods, he should make an estimate of the market value of the item on the date of expiry of the leasing agreement and include the calculated amount of GST as a part of the financing costs in the last year. This GST is, however, deductible for tax purposes and should be dealt with as such in the evaluation.
- The conditions of payment in leasing agreements are flexible and therefore negotiable. This makes it possible to arrange for small initial instalments and

bigger payments later in the leasing period, or vice versa, instead of equal payments. Under certain circumstances this may hold advantages for the farmer.

SUMMARY

This chapter dealt with various aspects of mechanisation management. There are several techniques that a farmer may use as aids in his decision-making on mechanisation matters. The practical use of these techniques is, however, fairly complicated at times, but in view of the size of most farmers' capital investment in farm equipment and the resultant fixed costs and risk attached, mechanisation is not a matter to be treated lightly.

END NOTE

$$1 \quad \frac{(3\ 900 - 3\ 380)}{8\ 000} \times \frac{100}{1} = \frac{520}{8\ 000} \times \frac{100}{1}$$

$$= 6,5\% \text{ per year}$$

12

Risk and Uncertainty in Farming

OBJECTIVES

- To explain the differences between risk and uncertainty.
- To give an overview of the nature, types and sources of risk and uncertainty in agriculture.
- To explain how future expectations can be used in decision-making.
- To illustrate different decision-making criteria in the farming enterprise (pessimistic, optimistic and other).
- To formulate strategies and actions through which farmers can counteract or reduce risks and uncertainties in agriculture.

Decisions on future actions are made more difficult by inadequate knowledge. Someone once rightly remarked that the only sure thing about the future is that it is unpredictable. Managers therefore often find that their good decisions, based on scientific projections of the future, do not produce such good results as were expected. The reason for this can usually be found in changes that occurred between the time that the decision was made and its ultimate outcome.

Agriculture is no exception in this regard. Many of the decisions taken in the farming enterprise have results that only manifest months or even years later. Good examples of these are the choice of a specific breed of cattle, the decision to plant a certain grape cultivar or the choice between different cultivation methods.

Apart from the normal business risks to which farmers are subject, dependence on weather conditions and climatic changes increases their risks and uncertainties. Farmers must, however, accept this fact — they function in an industry with a higher than normal risk factor. If there had been no risks and uncertainties, everyone could have been equally successful businessmen, managers or farmers. It is the fact that some farmers are better able than others to handle risks and uncertainties which often makes the difference between good and poor farmers. Briefly, the farmer must first know that he functions in an industry that is subject

to large-scale risks and uncertainties, *secondly* he must be able to handle these risks and uncertainties and *thirdly* he must be able to adapt to changing circumstances quickly and effectively.

DEFINITION OF RISK AND UNCERTAINTY

So far the concepts *risk* and *uncertainty* have been used rather loosely. There are, however, differences of degree between the two, and it is necessary to consider this.

Risk indicates a situation where there is adequate information about the possible result so that expectations can be based on statistical probabilities.

Uncertainty indicates imperfect or inadequate knowledge about the result of a certain action.

A risk situation can best be illustrated by means of a simple example. If a coin is tossed, the result could be heads or tails. The possibilities are therefore known and the expected result can be predicted statistically with some degree of certainty. The same applies to the mortality tables of life insurance companies according to which the life expectancy of certain categories of individuals is predicted and premiums are adjusted accordingly.

Uncertainty, however, indicates a situation where neither the result nor the statistical probability of the result can be predicted. This means that there are no valid grounds on which to base predictions of the outcome of future events.

In view of this distinction between risk and uncertainty, most situations in agriculture can be described as situations of uncertainty. However, to split hairs about which situations imply risk and which uncertainties, would serve no purpose. In the rest of the discussion the terms *risk* and *uncertainty* are therefore used interchangeably to indicate a situation in which the farmer has to make a decision based on inadequate or incomplete knowledge about the probability of the result itself.

SOURCES OF RISK AND UNCERTAINTY

There are various types and sources of risks and uncertainties which the farmer has to bear in mind. The following is a brief exposition of the most important ones.

Production risks

In most manufacturing enterprises the combination of certain inputs in a specific production process leads to a fixed (known) quality and quantity of a product. This does not hold true for agriculture and it often happens that the quality and yield vary from season to season without any change in the farmer's inputs or production processes. The main reason for this is variable weather conditions that can be neither controlled nor predicted. Other factors that could play a role in the variations in production are pests and plagues such as insects, diseases and weeds. The farmer can, however, control these to some extent and he can take precautions to reduce his production risk.

The fact that production risks are a common phenomenon in agriculture can be substantiated by numerous examples. Only one example — which refers to maize production — is given in table 12.1. Figure 12.1 sets out the average, highest and lowest maize yields of the Highveld, the North-Western Free State and the Western Transvaal for the period 1973/74 to 1983/84.

Table 12.1 Maize yields: White farms in the RSA, 1973/74 to 1983/84*

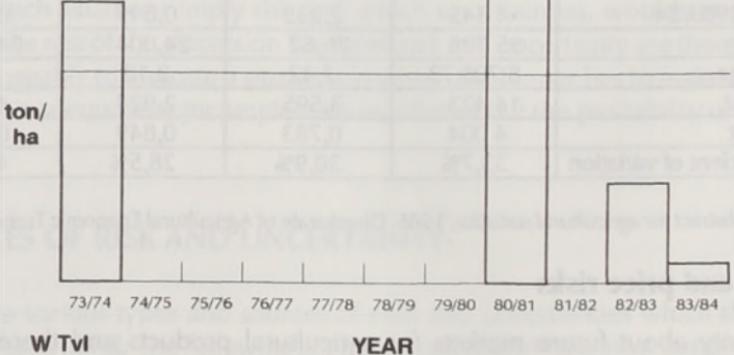
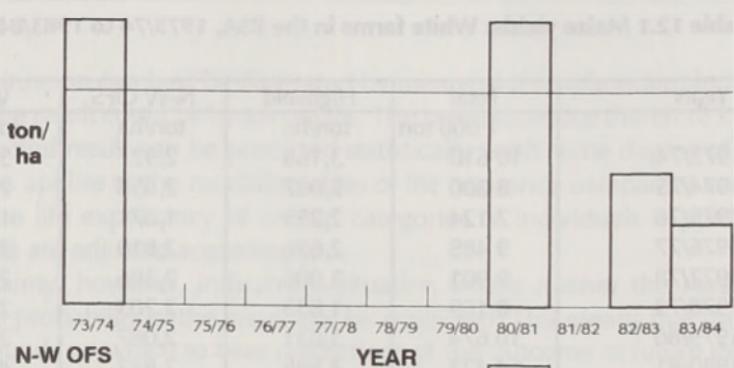
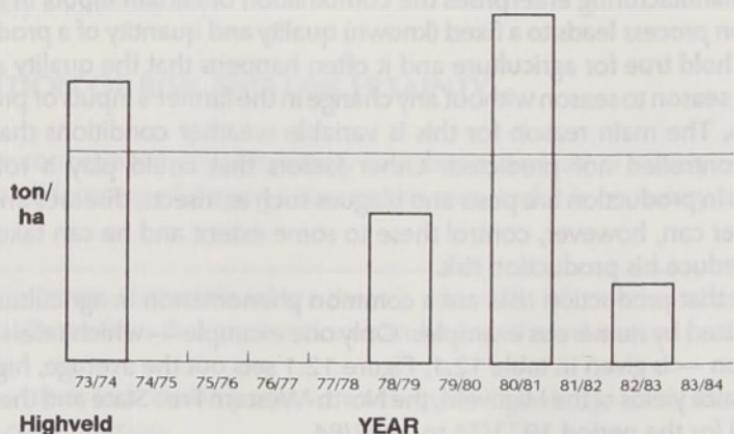
Years	Total	Highveld	N-W OFS	W.Tvl
1973/74	1 000 ton	ton/ha	ton/ha	ton/ha
1973/74	10 610	3,168	2,927	3,162
1974/75	8 800	2,007	2,658	2,526
1975/76	7 124	2,255	1,671	1,555
1976/77	9 485	2,696	2,810	2,644
1977/78	9 901	3,006	2,396	2,739
1978/79	8 169	1,839	2,203	2,197
1979/80	10 674	3,031	2,067	2,708
1980/81	14 423	3,595	2 832	4,335
1981/82	8 261	2,008	2,156	1,806
1982/83	4 004	0,783	1,435	0,852
1983/84	4 345	2,232	0,849	0,224
Total	95 796	26,62	24,004	24,748
Average	8 708,73	2,42	2,18	2,25
Highest	14 423	3,595	2,927	4,335
Lowest	4 004	0,783	0,849	0,224
Coefficient of variation	33,7%	30,9%	28,5%	47,6%

* Source: Abstract for agricultural statistics, 1985. Directorate of Agricultural Economic Trends, Pretoria.

Market and price risks

Uncertainty about future markets for agricultural products and therefore also agricultural product prices, is an important source of uncertainty in agricultural

**Figure 12.1 Average, two highest and two lowest maize yields for certain areas,
1973/74 to 1983/84**



production. Fluctuations in both the supply of and demand for agricultural products have often been responsible for considerable price fluctuations and accordingly led to fluctuations in farmers' income.

Several factors that influence market and price risks for farmers can be identified. Some of the most important are the *long-term nature of agricultural production*, a *large number of small producers* and *trends in international food policies*.

Because of the *long-term nature* of agricultural production, projections of market potential, consumer preferences and food substitutes must be made long before they become a reality. The farmer who intends establishing an apple orchard, must make a decision on future export possibilities, local apple prices and the manufacture of apple juice, 25 years into the future. The same applies to a cattle farmer who has to decide on a specific breed of cattle. Such a choice may affect more than one generation of farmers. Because of the immobility of production factors in agriculture, it is much more difficult for such farmers to make adjustments should circumstances change in the interim.

A further contributing factor to unstable markets and price fluctuations, is the *large number of small producers* who supply a specific market. As single individuals these producers have virtually no influence on the market forces to which they are exposed and they can therefore have little influence on the supply, demand and price of their products.

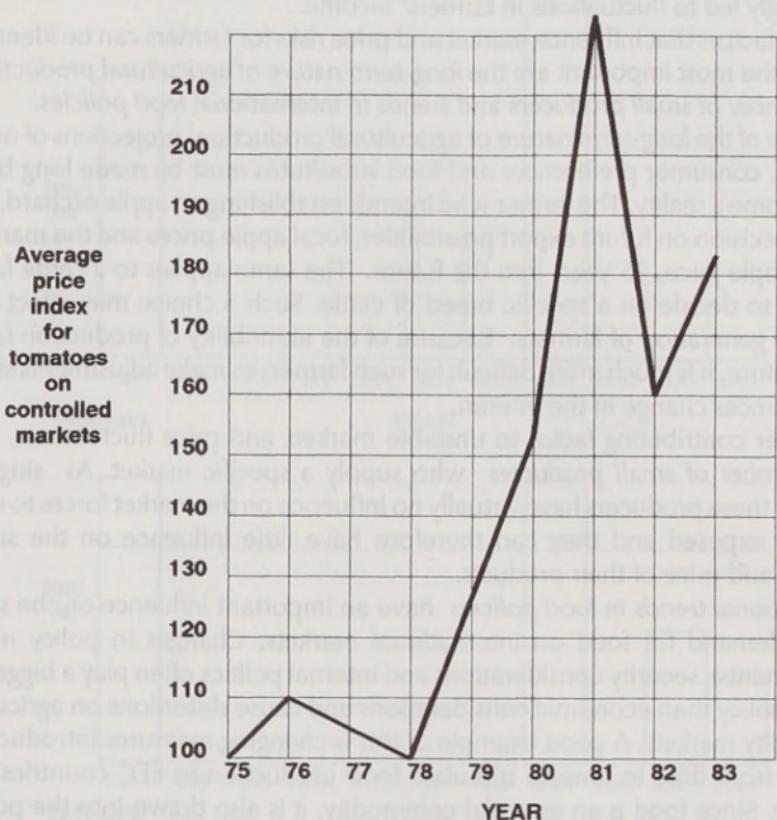
International trends in food policies have an important influence on the supply of and demand for food on international markets. Changes in policy makers (governments), security considerations and internal politics often play a bigger role in food policy than economic considerations and cause distortions on agricultural commodity markets. A good example of this is changing measures introduced by the EEC from time to time to stimulate food production in EEC countries or to restrict it. Since food is an essential commodity, it is also drawn into the political arena to a greater extent than other commodities.

The above factors naturally make it difficult for farmers to predict food markets and prices with any degree of accuracy, thereby increasing risk and uncertainty in agriculture.

Unstable product prices can be illustrated in three different ways. *Firstly*, absolute price situations can be taken as point of departure. The best example of this is probably product prices on fresh-fruit and vegetable markets. These price fluctuations are usually difficult to predict and they vary on a daily basis according to supply and demand. Although the average annual producers' price index ignores these daily fluctuations, it is evident from figure 12.2 that price fluctuations do occur from year to year.

A second method by which price fluctuations can be illustrated is to take the annual percentage change in producer prices as point of departure. If the percent-

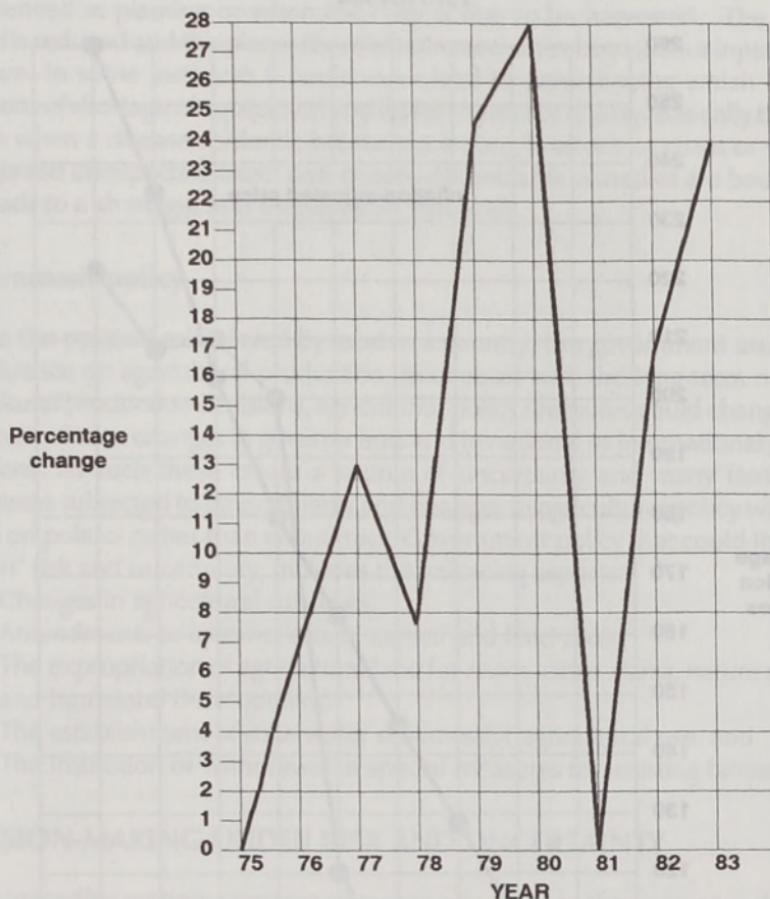
Figure 12.2 Fluctuations in average tomato prices on controlled markets, 1975 to 1983



age change between two successive years is 20% and the farmer bases his expectations for a following year on this, he will, in the case of a 5% price increase, be relatively worse off. The percentage change in the annual producer prices of summer grains for the years 1975 to 1983 (fig. 12.3) illustrates the unstable percentage changes in the price of agricultural products.

A third method to illustrate price fluctuations, is to compare the actual producer prices with the real price (adjusted for inflation). The assumption is that the producer price must keep pace with inflation. Such an assumption is naturally not always correct, but is nevertheless taken as point of departure for purposes of comparison. It emerges from figure 12.4 that the average on-the-hook auction prices for meat only exceeded the inflation adjusted price in 1981 and 1982. The adjustment for inflation was made according to the average inflation rate of 12,7% for the years 1975 to 1984.

Figure 12.3 Percentage change in the producer prices of summer grain, 1975 to 1983

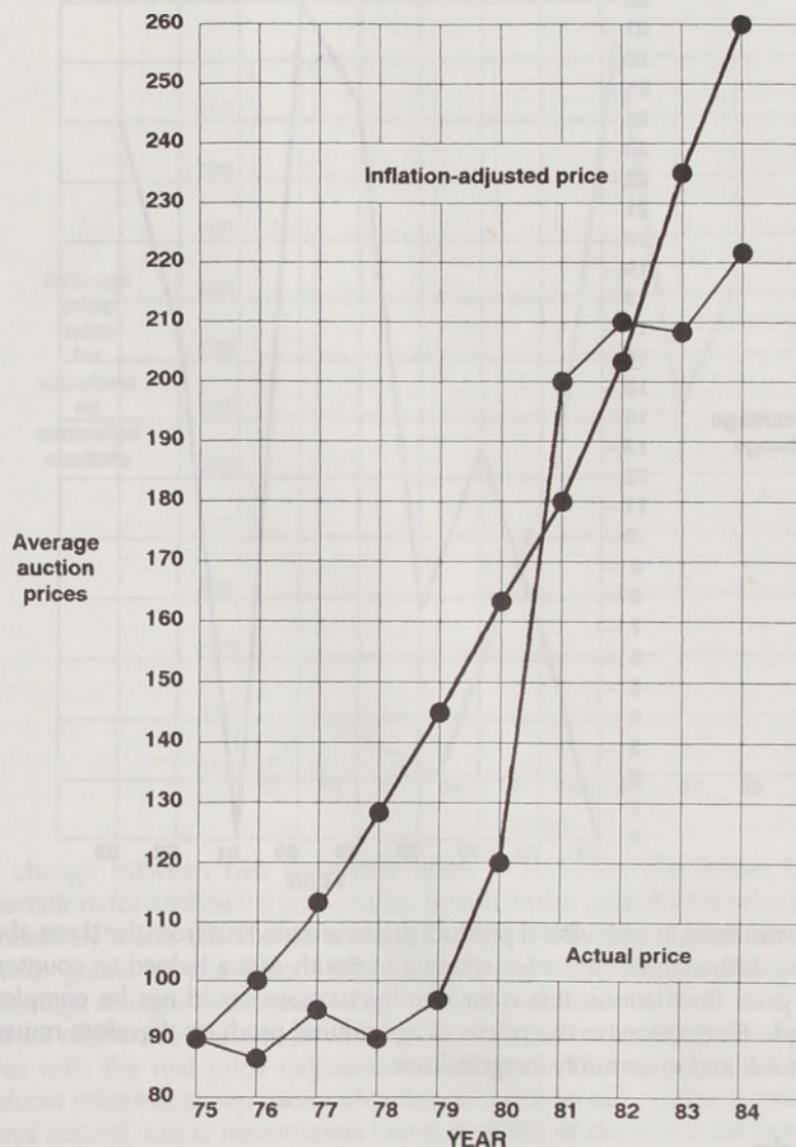


Price fluctuations in agricultural product prices are obvious from the three above examples. Although controlled marketing in South Africa helped to counteract extreme price fluctuations, it is clear that fluctuations could not be completely eliminated. Fluctuations in the prices of agricultural products therefore remain a source of risk and uncertainty in agriculture.

Input risks

The availability, quality and price of inputs can vary substantially because of climatic conditions. A good example of this is stockfeed which becomes scarce in times of drought, is usually of poorer quality and is also relatively expensive

Figure 12.4 Average auction price of meat compared with inflation adjusted prices, 1975 to 1984



compared with prices in normal years. During good rainy seasons the situation is reversed and good-quality stockfeed is freely available at reasonable prices.

Another example of an input risk is where excessive and untimely rains are experienced at planting or when the crop is due to be harvested. The harvest period is reduced and this places the available mechanical and labour inputs under pressure. In some instances it could even lead to panic buying which leads to situations of shortage of equipment and losses in yield or quality. Basically the same occurs when a disease epidemic breaks out among livestock or crops or where a widespread unexpected insect pest occurs. All available remedies are bought and this leads to a shortage, and therefore an input risk.

Government policy

Due to the political role played by food in a country, the government usually has an influence on agricultural production. In contrast with the long-term nature of agricultural production decisions, agricultural policy measures could change in the short term due to changes in governments and in national or international political situations. As such these create a source of uncertainty and many farmers are sometimes subjected to amendments and changes in agricultural policy which are based on politics rather than economics. Government policy that could influence farmers' risk and uncertainty, includes the following aspects:

- Changes in agricultural subsidies.
- Amendments to income, estate, capital and land taxes.
- The expropriation of agricultural land for roads, cities, dams, nature reserves and homeland development.
- The establishment of state water schemes for agricultural use, and
- The institution or withdrawal of special measures for assisting farmers.

DECISION-MAKING UNDER RISK AND UNCERTAINTY

In the preceding sections constant reference was made to the numerous decisions that farmers have to make without adequate knowledge about future weather conditions, prices, policy measures and inputs. This situation means that farmers' decisions are subject to risks and uncertainties which compel the farmer to make the best decisions within a framework of incomplete knowledge. To be able to do this, the farmer must form some expectation of the future result and rely on certain decision-making criteria.

Future expectations

Future expectations may be based merely on attunement or premonition, or on averages and probabilities. Farmers with many years of experience even develop a "feeling" about future events and although no fault can be found with this, it is

better to back such a feeling with a more scientific approach. In this regard averages, probabilities and the distribution of values around the averages can be identified as important aids for decision-making.

Averages as a method on which expectations can be based

A simple method on which future expectations can be based is to determine the average figure for the past and use this as point of departure for projections. The average can be calculated according to the *arithmetical* average or by using the *weighted average* method.

In the case of the *arithmetical average method* different values are not allocated to the data, while a *weighted average* is determined by allocating values to each given particular. In this way observations that do not go so far back into the past could have bigger values and therefore have a greater effect on the average. A self-explanatory example of the arithmetical and weighted average milk production in litres/week is given in table 12.2. From the table it is clear that the weighted average method gives a higher value than the arithmetical average and it probably reflects the value for the coming week better than the former.

Table 12.2 Expected value of milk production for a future week according to the arithmetical and the weighted average methods

Weeks	Average milk yield in litres	Weight	Weighted average
1 - 7 May	5 000	1	5 000
8 - 15 May	5 500	2	11 000
16 - 23 May	5 300	3	15 900
24 - 31 May	5 800	4	23 200
Total	21 600	10	55 100

Expected value for 1 - 7 June

Arithmetical average: $21\ 600 \div 4 = 5\ 400$ litres

Weighted average: $55\ 100 \div 10 = 5\ 510$ litres

Probabilities as a method on which expectations can be based

A second method on which future expectations can be based, is to take the value with the greatest probability as point of departure. As first condition for the application of this method, the probability for each possible result must be known or it must be possible to estimate it with reasonable accuracy. A second condition is that the result must be measurable and it must vary between certain limits. It is therefore not possible to use this method where the result is completely unknown or where it can assume any possible value.

An example of the application of this method is illustrated in table 12.3. In this table a Free State wheat farmer's possible wheat yields are given as 1,5; 1,8; 2,6 and 3,3 t per ha in the first column of the table. Based on the historic data of yields in his area and the available soil moisture at planting date, the farmer expects that the probability of each yield possibility will be 0,2; 0,3; 0,4 and 0,1, as is shown in the second column. From this it appears that 2,6 t per ha has the greatest probability and this can therefore be taken as the expected yield for the season.

Table 12.3 Wheat yields based on different probabilities

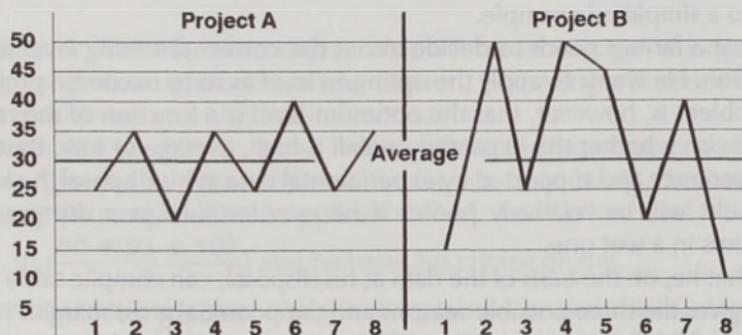
Possible wheat yield t/ha	Probabilities	Expected probability (yield x probability)
1,5	0,2	0,30
1,8	0,3	0,54
2,6	0,4	1,04
3,3	0,1	0,33
Total	1,0	2,21

A further method that can be applied to the data in table 12.3, is to determine an overall yield expectation. This is done by multiplying the possible yields in the first column with the probabilities in the second column. In this case it is found that the overall yield expectation is 2,21 t per ha. This is less than the 2,6 ton calculated in the previous case, because considerably smaller yields than 2,6 occur more often than is the case with bigger yields.

Distribution of values around the average

The farmer's choice between alternative possibilities is not only influenced by the averages of each, but also by the distribution of values around the expected

Figure 12.5 The influence of distribution on risk and uncertainty



average. This means that two projects could basically have the same average result and yet differ from one another in respect of risk. In fig 12.5 two projects, A and B, are compared with one another. Both have a duration of eight years and each yields an expected average result of 30 units.

The calculation of the projects' arithmetical averages is as follows:

Years	Project A	Project B
1	25	10
2	35	50
3	20	20
4	35	50
5	25	45
6	40	15
7	25	40
8	35	10
Total	240	240
Average	30	30

From figure 12.5 it appears that both projects have an average expected result of 30 units. As regards annual fluctuations, project A holds less risk than project B. A farmer who therefore does not have enough resistance would prefer project A to project B because his annual risk would be much lower. The above example proves that the farmer should not use averages as the only criteria in decision-making, but that he should also pay attention to the distribution of values around the average.

Decision-making criteria

The farmer can use the above information on the expectation and distribution of the result to create decision-making criteria. The criteria can best be explained according to a simplified example.

Assume that a farmer needs to decide about the correct fertilising level for the coming season. He wants to apply the optimum level as so to maximise profit per ha. The problem is, however, that the optimum level is a function of the rainfall and depends on whether the expected rainfall is high, average or low. Based on his own experience and supported by experimental data at his disposal, he knows that his results will be relatively poorer if he over-fertilises in a dry year and under-fertilises in a wet one.

Suppose that he, on the basis of the data at his disposal, can compile table 12.4.

This table gives the three possible seasons and the potential gross margins per ha for the different fertilisation levels. The right-hand column shows the probabilities

of a wet, dry or average season. These anticipated probabilities are based on rainfall statistics of the past 20 years, according to which there were six dry, ten average and four good seasons. A probability of one would indicate perfect certainty (20 out of 20 years), and a probability of nil, total uncertainty.

Table 12.4 Decision-making criteria based on different fertiliser application levels for different seasons

Seasons	Gross margin per ha for different application levels			Anticipated probability
	Low level	Medium level	High level	
Dry	80	75	62	0,3
Average	95	108	110	0,5
Wet	105	120	130	0,2
Decision-making criteria				
1 Pessimistic	80	75	62	
2 Optimistic	105	120	130	
3 Average	95	108	110	
4 Equal chance	93,3	101	100,7	
5 Maximum anticipated value	92,5	100,5	99,6	

According to the information in table 12.4 the farmer can follow one of five decision-making criteria.

Criterion 1: If the farmer has *pessimistic* expectations, namely that the season will be dry (ignore the right-hand column for the time being), he opts for a low level of fertilisation. This choice offers him the biggest gross margin of R80 that can be expected under pessimistic conditions.

Criterion 2: If the farmer has *optimistic* expectations, his decision-making criterion will be determined by the best result for the wet season. In this case he opts for a high level of fertilisation which leaves him a gross margin of R130 per ha.

Criterion 3: If the farmer accepts that it will be an *average season*, he chooses the highest gross margin for the average season. According to the table this is R100, which is achieved by a high level of fertilisation.

Criterion 4: If the farmer knows nothing about the expected probability of the seasons (ignore the right-hand column for the time being), he calculates the average gross margin for each application level. For the low level it is

$$R93,30 \left(\frac{80 + 95 + 105}{3} \right) \text{ and he bases his choice on this.}$$

According to this approach there is an *equal chance* that the season will be dry, average or wet, and he opts for the application level that will yield the highest gross

margin under even chances. In the example under discussion, this is R101, which will be obtained at a medium level of fertiliser application.

Criterion 5: If the farmer has some knowledge of the *anticipated probability* that the season will be wet, dry or average (right-hand column), he could base his choice on this. According to this he calculates that the expected gross margin for the low fertiliser level will be R92,5 ($80 \times 0,3 + 95 \times 0,5 + 105 \times 0,2$), that for the medium level R100,5 and for the high level R99,6. His choice will therefore be the medium level, which yields the highest potential gross margin of R100,5.

Conclusions

The following conclusions can be drawn from the above discussion:

- The choice of the decision-making criterion (pessimistic, optimistic, equal chance, etc.) that should be followed, depends on the farmer's personality and his specific physical and financial circumstances. (More will be said in a later section about farmers' approach to risk and uncertainty.) As regards the *physical circumstances*, the farmer must know the yield potentials of his specific soil types and take them into consideration. *Financial considerations* could compel a farmer who has inadequate capital at his disposal, to fertilise at a lower level purely because the high level requires more working capital — something which would increase his risk in case of crop failure accordingly.
- The difference between results within the same decision-making criterion would sometimes be very small. If this is the case, the farmer himself must decide what role his own judgement and feeling will play. As said before, the farmer with years of experience could develop sound judgement that could be invaluable in judging factual data. Long-term seasonal trends such as a dry or a wet cycle could also play a role here, because it might influence a farmer to reach a subjective decision.
- In South Africa with its erratic weather pattern, it seems as if farmers who follow a conservative approach (decision-making criteria for average seasons) have better achievements in the long term than vice versa. This observation is not, however, based on scientific facts and should be regarded as a practical conclusion.

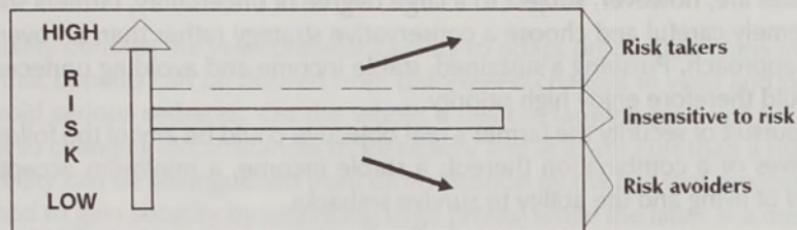
FARMERS' ATTITUDES TOWARDS RISK AND UNCERTAINTY

As mentioned before, people's approach to risk and uncertainty is influenced by their personalities and individual circumstances. The younger, progressive farmer, for example, has much to gain by tackling a high-risk enterprise. On the other hand, he has relatively little to lose in terms of own capital and he has a longer term ahead of him in which losses can be neutralised. In contrast, the older and

more established farmer has much to lose and relatively little, in relation to what he already possesses, to gain. He already has considerable accumulated assets which he could lose and his economically productive life in which losses can be neutralised, is relatively shorter. Such a farmer will therefore be more careful in his approach and rather endeavour to reduce risks and uncertainties.

If farmers are classified into groups according to their attitude towards risk and uncertainty, there appear to be three general groups. They are illustrated in figure 12.6.

Figure 12.6 Grouping of farmers according to their approach towards risk



The middle group (insensitive to risk) is generally indifferent to risks and accept them as a natural phenomenon of business enterprises within the capitalistic system. Risk avoiders endeavour to avoid risk as far as possible. They will carefully analyse the chances of success of any new undertaking and, if the probability of success is very high, the project will be accepted. Risk takers — also called risk seekers — thrive on risks. They are constantly launching new projects and it is often a case of the higher the risk the bigger the challenge and the greater the enthusiasm.

Which of the three groups has the most correct approach remains an open question. A starting point for every farmer is, however, to evaluate his own ability and willingness to take risks. In addition to this he must make a careful analysis of each farming decision in terms of the possible chances of success, profit or loss. By doing this it is possible to identify decisions to which great risk is attached.

This enables the farmer to —

- gather more information about such decisions and make more detailed analyses; and
- formulate strategies and actions to counteract the risks within the framework of his abilities and farming circumstances.

Some of the strategies and actions which the farmer can follow to counteract risk and uncertainties are dealt with in the next section.

MANAGEMENT STRATEGIES AND ACTIONS TO COUNTERACT OR REDUCE RISKS AND UNCERTAINTIES

As became evident in the previous paragraphs, risks and uncertainties form an integral part of farming activities aimed at maximising profit. Although farmers and other businessmen must be prepared to run risks, it is nevertheless understandable that they will make every effort to eliminate these risks or at least reduce them. Unfortunately this has cost implications that have to be weighed against the advantages of certainty and peace of mind.

Although farmers' approach to risk differs, all people try not to take unnecessary chances of which the success is uncertain or variable. Since most farming enterprises are, however, subject to a large degree of uncertainty, farmers should be extremely careful and choose a conservative strategy rather than an over-optimistic approach. Pursuing a sustained, stable income and avoiding unnecessary risk should therefore enjoy high priority.

In his pursuit of security the farmer's real objective could be any of the following alternatives or a combination thereof: a stable income, a minimum acceptable standard of living and the ability to survive setbacks.

Diversification

Diversification means that two or more production branches are included in the farming enterprise to avoid the price and yield uncertainty of a single product. The reason for this is that it is accepted that different products are subject to different price trends and production fluctuations. It is therefore assumed that a combination of different branches will contribute to a more stable income.

The purpose of diversification is therefore especially to produce a variety of products so that a setback in one branch does not mean ruin of the entire farming enterprise. However, the following aspects need to be considered when diversifying:

- It is not worthwhile incorporating a second production branch in the enterprise if its variability is influenced by the same economic and physical factors as the existing one. This would simply aggravate the situation.
- Perfect diversification could be achieved by choosing two products of which the prices (yields) are in an inverted relationship to one another — a negative correlation. When the price of one is at its maximum, the price of the other is at its minimum, with the same relationship between yields. In this way, and as regards yields, it would have been ideal to combine maize and wheat in areas where a poor year for maize goes hand in hand with a good year for wheat, and vice versa.

- Unless the production branches are supplementary (i.e. a second branch can be expanded without reducing the scale of the other) or complementary (i.e. by increasing the scale of the one the other can also be expanded) a second branch could have an adverse effect on profitability in the short term. This reduction must be regarded as similar to an insurance policy.
- When diversifying, the number of branches must be limited to a maximum of three or four. The reason for this guideline is that once a production branch contributes less than 25% of the gross production, the farmer tends to neglect and manage it inefficiently.

Flexibility

Flexibility denotes the entrepreneur's ability to adapt production plans in such a way that benefits can be derived from unforeseen changes in yield and prices or to avoid serious setbacks. On the whole a flexible farming plan will be able to adapt to changing circumstances more rapidly and at lower cost than a rigid plan. Flexibility can be distinguished from diversification by the fact that the former is a method to gain security by sacrificing large profits, while the latter is a method of gaining security through avoidance of substantial losses. Flexibility leaves scope for a change of plans over time as more information becomes available and the ability to make projections improves.

Flexibility receives a lot of attention in agricultural engineering. Building plans are drawn up in such a way that the building can serve more than one purpose. For example, a building can be constructed in such a way that it can be used for grain storage and to house implements, machinery and livestock. Farm machinery too, is now being designed in such a way to become multi-purpose simply by making a few adjustments.

Different production branches also differ in respect of flexibility. Many branches are less flexible because of the time factor involved before it generates an income (e.g. orchards and stud animals). Others have a shorter production period, making adjustments easier. Crops with a short growing season and which do not require special equipment, and dual-purpose cattle or sheep are examples of more flexible branches. If the price of milk should drop, the farmer could, in the case of dual-purpose breeds, easily switch to meat production. The same applies if the price of wool should decline if the farmer keeps dual-purpose sheep.

Production branches also differ in respect of the percentage of initial fixed and variable costs at the start of the production period. For example, if weaner lambs are bought for the specific purpose of finishing them for the market, the largest percentage of the cost — feed and labour — is variable. This branch can be compared with beef production where the calves are bred on the farm and a large percentage of the cost is fixed. Uncertainty attaches to both branches. However,

the "lamb enterprise" can be stopped early in the feeding programme so that losses can be restricted. If a large percentage of the capital investment is, however, in fixed form it is difficult to make adjustments in the short term.

From a risk point of view it would, in many instances, be better to custom hire expensive equipment instead of buying it because of a greater degree of cost flexibility.

The farmer can therefore bring about flexibility in respect of time, products and means of production (costs) in his enterprise and should always allow for this in his planning. Although flexibility has possible cost implications because income from the specialised branch or input is sacrificed, it could benefit the enterprise in the longer term.

Liquidity and management of the capital structure of the enterprise

Uncertainty in farming could have a considerable influence on the management of assets. In uncertain circumstances a greater percentage of the capital is kept in liquid assets. Such retention of liquid capital (internal capital rationing) implies that funds are not available for more profitable, but illiquid (cash-demanding) projects. Cash is needed for production and personal expenses and the amount of such cash in the capital structure of the enterprise is largely determined by the level of risk and uncertainty. A cash budget (see Chapter 4) is therefore necessary to determine the short, medium and long-term needs of the enterprise. From this can be inferred how much cash is required and how much must be available. Good cash management becomes increasingly important for survival under conditions of uncertainty.

Storage and building up reserves

To reduce the effect of uncertainty, it is often necessary to incur certain costs. For example, the building up and storing of reserve supplies (e.g. fodder) in good times will diminish the effect of droughts.

There are farmers who see and exploit times of prosperity not only to rehabilitate themselves financially, but also to build up reserves to supplement low incomes in less affluent times. They purposely attune their enterprises to a basis of average income and arrange their expenditure, even in prosperity, strictly accordingly. There are stockfarmers who farm in areas that are subject to severe droughts and who have not only attuned their farming systems to this, but who also concentrate on setting aside reserve funds in good years for the lean ones. Such farmers imply that providing for droughts in this way holds more benefits than building up fodder banks.

There are also farmers who regard less favourable conditions as opportunities in which they can discover and rectify the weak links in their enterprises. In such times the poorest portions of ploughed lands are identified and eliminated, the effects of poor pasture management are exposed and the worst production units are identified. Such farmers adapt Joseph's policy by exploiting times of prosperity to take precautions for the lean years ahead. They do this by following sound practices in respect of veld management, sparing of camps, veld recovery, establishment of pastures and the production and storage of fodder.

Adapted farming systems

Every agricultural region has a specific agricultural potential. To achieve optimum utilisation of the natural resources, farming systems and practices in specific areas must adapt to the limits and potential of the environment and harmonise with local conditions. Systems or practices that do not comply with these requirements have varying results and give rise to yields that fluctuate from year to year — mostly in proportion to the extent to which the production patterns deviate from the optimum.

Farming systems that are adapted to the natural environmental factors can therefore ensure that the risk of production is kept within limits. By incorporating dryland crop production in farming systems in regions where the natural environmental factors dictate extensive or semi-extensive farming systems, the farmer increases the income risk of his business which could result in the development of uneconomic farming units as a result of over-estimating the potential of such regions.

Sound farming practices (informal insurance)

By following sound farming practices (such as the immunisation and dipping of livestock and the spraying of crops) in the production process, instability in yield can be reduced. Prevention of problems through regular servicing of machinery and equipment, vaccination programmes for livestock, etc., can also limit high costs that could arise later. A further example of informal insurance is keeping an additional tractor over and above the minimum required. It serves as a safety margin should one of the tractors become defective. In the same way a bigger combine than would normally be justified, can be kept.

By entering into contracts for both inputs and products, a farmer could partially or totally reduce the uncertainty attached to a specific branch. In this way he could contract to deliver all yields from his vegetables, pigs, poultry, etc., at a certain price. This ensures the farmer of a market for his products at a fixed price. Problems

could, however, arise when there is a crop failure or diseases, and the products cannot be delivered.

As regards inputs, the farmer could, for example, enter into an agreement with the supplier of stockfeed or fertiliser in respect of a specific quantity of the input at a specific price over a certain period. He is then protected against price increases and can continue his planning at known prices. This makes more efficient resource use possible.

Forecasting with the aid of available information

By using the information available in his own records, from journals and publications, a farmer could try to build up his level of knowledge to where he can base forecasting on subjective probabilities. Although sophisticated mathematical forecasting models are available, they fall outside the scope of this book. (Nevertheless, have another look at the section dealing with decision-making criteria which discusses a fairly simple method of forecasting.)

Formal insurance

Insurance is protection against a definite, specified loss. When taking out insurance, preference is given to a combination of a small probability of a substantial loss and a large probability of no loss. Insurance is a method by means of which the risk of an adverse event for one party (the insured) can be reduced by transferring the risk to another party (the insurer). The insurer is in a position to offer the insured protection against the occurrence of possible economic losses by means of a protection fund that has been built up over time from the contributions (premiums) of individuals who were insured. It therefore amounts to spreading the risk over a large number of units, persons or properties at a cost (the premium).

The greater the probability of a loss with a given number of participants in the insurance scheme, the higher the premiums will be. On the other hand, the premiums will be lower the greater the number of participants in the scheme. The cost of an insurance scheme is therefore largely determined by the number of participants.

Insurance for the farmer can be classified as follows:

- Property insurance in respect of buildings, machinery and vehicles.
- Crop insurance where the choice is between comprehensive cover and hail damage.
- Accident insurance (workmen's compensation) is compulsory insurance for employees in South Africa. Its purpose is to compensate workers in case of accidents or injury while on duty.

- Life insurance.

Contracts

By drawing up contracts covering inputs as well as produce a farmer can, partially or even fully, reduce future uncertainty. In this manner the sale of yield from vegetables, pigs, chicken, etc., can be contracted at a certain price. However, should crop failure or stock diseases occur and the product cannot be delivered at all, this can create a problem.

As far as inputs are concerned, the farmer can come to an agreement with the supplier of fodder or fertiliser regarding a particular quantity of a certain input at a particular price over a certain period. Thus, the farmer is protected against price increases and planning can be done according to known prices. Consequently, more efficient utilisation of resources is possible.

SUMMARY

Risks and uncertainties are inherent in agriculture and are particularly the result of unpredictable and uncontrollable weather conditions. Contributing factors are pests and plagues and incomplete knowledge about future prices, inputs and government policy measures.

Due to these uncertainties, decisions in agriculture must be based on future expectations and the farmer must use certain decision-making criteria. In addition to these the farmer's own experience and sound judgement could be invaluable in making sound decisions.

Decisions that indicate great risk should be given more attention and be analysed in detail. In his efforts to reduce risk, the farmer could employ certain strategies such as diversification, flexibility and crop insurance.