COMMERCIAL VEGETABLE PRODUCTION GUIDE

SWAZILAND 1996/7

The CAPM Project
United States Agency for International Development/Swaziland Ministry of Agriculture and Cooperatives

NOMCEED

Preface

This is the first edition of a commercial vegetable production guide for Swaziland. Information presented in this guide is based on research and/or years of experience in the field. The authors have also consulted with research personnel in South Africa and input suppliers in Swaziland.

The guide is intended for commercial vegetable growers who must make numerous and constant production decisions in managing their vegetable production. The information in the guide is intended to aid in the decision making. Particular conditions and experiences of the grower may warrant different choices than the suggested presented. When a new variety or other other production practice is to be used, it is sometimes wise to do so on only a portion of the production area, thus comparing to past methods.

The authors welcome constructive criticism and comments. It is hoped that this guide will be useful to all involved in the vegetable production industry and will help to eliminate much of the conflicting information that often surrounds recommendations given to farmers who produce vegetable crops.

Use of Pesticides

The chemical suggested in this guide for control of diseases and insects are often not the only materials that may provide control. Careful consideration has been given to safety, avoiding chemicals that are highly posionous to individuals or dangerous to the environment. Certainly only chemicals registered for the suggested uses were used. Careful thought by highly qualified specialists have gone into the selection of chemical, backed up by actual experience in fields in Swaziland. Users are urged to always follow label instructions for the chemicals and use safe practices. The minimum number of days between the last application of a chemical and harvest are listed for each chemical as the "days to withhold". This should always be adhered to.

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Where trade and brand names are used in this publication, no endorsement is intended by the authors, the CAPM project, the United States Agency for International Development, the Ministry of Agriculture and Cooperatives, or the University of Swaziland. Neither is any discrimination intended against other particular brand names or products not listed. In the Disease and Insect Control section for specific crops, trade names commonly available to farmer are used to make the guide more user friendly. If other trade names for the specific chemical listed are available, they may be just as effective as the one listed. Page 15 of this guide contains a cross reference for common names of chemical pesticides to trade names known to the authors. When purchasing chemicals, farmers should consult this list to determine if a particular brand name that may not be listed in the "Chemical Controls" sections has the same common name and active ingredient.

General Production Information

Planning for Production

The first step in planning to produce and market a vegetable crop is to determine how and where the crop will be marketed. This should be done before any planting inputs are purchased and field planting occurs. Information on average monthly price paid for different vegetables during the past few years can be found starting on page 24. Contact should be established with potential markets and firm sales arrangements made whenever possible. This should include how pricing will be determined, period of time when production is desired, how the crop will be delivered to markets.

It must then be established if the chances for successful production of the crop are likely at the desired time of year in your area. Tables 14, 15, and 16 (starting on page 16) provide guidelines for planting in the different regions. Consideration should also be given to what disease and insect problems may be expected during the time for proposed production.

Once the expected price is know, production and marketing costs must be considered to determine if it will be economically feasible to produce. Budgets showing average production and marketing costs for various crops are available and should be studied. Sample budgets are shown starting on page 19.

Recommended Varieties

The varieties listed under specific crops in this guide, except when otherwise noted, have been tried in Swaziland. Comments are listed for each variety to assist the grower in making a choice. It is very important to consider the demands and wishes of the markets to which the crop will be sold. Fruit size, firmness, flavour, and overall quality are characteristics that should be considered. Disease resistance or tolerance, indicated in the guide for each variety in (parenthesis), may be very important, especially when certain problems have been experienced in the past. The use of resistant varieties is sometimes the only feasible means for controlling a disease, for example viruses. Some varieties perform satisfactorily only during a certain season, while others are suitable for both summer and winter production. This Guide usually provides such information. Seed catalogues offer more detailed descriptions for varieties sold by a particular company and should be consulted for more information.

Fertilization

Low fertility and acid soils are two of the greatest limitations to crop production in Swaziland. Poor fertility is caused largely by cropping the same fields year after year without fertilizing, or with inadequate fertilization. Crops remove plant nutrients from the soil, as do animals. Therefore, farmers who do not replace the nutrients removed by crops are "mining" or "robbing" the soils.

Without adequate fertilization yields from successive crops will decrease each year until they are very low, which means that money spent on seeds and time invested will be mostly wasted. It is critical, however, that fertilizing be done correctly; otherwise money spent on fertilizer can be partly wasted.

The Major Nutrients

A list of important fertilizers, their nutrient contents, and their approximate costs are presented in Table 1. Single element fertilizers contain only one of the three major nutrients (N, P, or K). Fertilizer mixtures contain different proportions and concentrations of N, P, and K or sometimes only two of the these nutrients. This is indicated as a N:P:K ratio. For example, 2:3:2 contains 2 parts of N, 3 parts of P, and 2 parts of K. The concentration of all three nutrients (N, P, K) is indicated in parenthesis after the ratio, as a percentage. This means that 2:3:2(22) contains 22% N + P + K combined, while 2:3:4 (40) contains 40% N + P + K. It is also usual to indicate how much zinc (% Zn) is contained in fertilizer mixtures.

Nitrogen (N)

Nitrogen is important in promoting the development and growth of plant stems, leaves, and roots. Fertilization with nitrogen results in larger fruits and seeds, and increased succulence (water content) of crops such as lettuce and cabbage. Plants with insufficient nitrogen do not develop to normal size. The leaves turn yellow and tend to drop off early. Provided other soil conditions are adequate, nitrogen deficiency can be corrected very quickly by application of a nitrogen fertilizer.

Phosphorus (P)

Phosphorus is important because it influences flowering, fruiting, and seed formation. It also has an important effect on root growth and thus it is important to supply optimal amounts of P to newly transplanted crops. Phosphorous is especially important for production of legume crops like beans.

Potassium (K)

Potassium (also called potash) influences seed development and root growth. It has a strong effect on yields of root and tuber crops. Consequently, it is especially important in fertilization of potatoes and sweet potatoes.

Table 1. Amounts of actual nutrients supplied by different fertilizers, and the relative costs per unit of N, P, and K.

	Nutrient content (kg of N, P, K/100 kg)			
Fertilizer	N	P	K	E /kg N-P-K
2-3-2(22)	6.3	9.4	6.3	3.32
2-3-2(38)	10.9	16.2	10.9	3.18
2-3-4(30)	6.7	10.0	13.3	2.92
DAP	18.0	20.0	0	3.17
LAN 28%	28.0	0	0	2.04
Urea 46%	46.0	0	0	1.86
Super-phosphate	0	10.5	0	5.26
Potassium chloride	0	0	50.0	1.47
Potassium nitrate	13.0	0	38.0	2.81

Determining Nutrient Needs

Needs of various crops are expressed in terms of the amounts of actual nutrients; for example, how much nitrogen (N), phosphorus (P), and potassium (K). For this reason the suggested amounts listed for each particular crop in this guide is always given in kg of actual N, P, K to be applied. Since different fertilizer materials contain different amounts of the actual nutrients, we must know how many kg of each actual nutrient are in the fertilizer material. Table 1 lists the amount of actual N, P, and K in several fertilizers commonly used for vegetable crops.

The total nitrogen needs of the crop must be applied each year, since N leaches from the soil readily and is not held over from season to season. P and K are stored in the soil and the amount that should be applied can best be determined by soil analysis. If soil test results are not available the amount of P and K to be applied is generally about 1 1/2 to 2 times that of N. The amount of the mixed (or complete) fertilizer material to be applied is thus calculated on the basis of the requirement for N.

From the table we can then determine that if we have a 2-3-2(38) fertilizer, for example and the crop needs 80 kg of N/ha, we would have to apply 734 kg/ha (80/10.9 = 7.34). In addition to the N, this amount would supply 120 kg of P and 80 kg of K. If a 2-3-2(22) were used, the amount to be apply would be 1270 kg/ha. From Tables 2, 3, and 4 the amounts needed for three different fertilizers are listed for supplying different rates of N.

If a soil analysis reveals that the amount of these elements supplied by the complete fertilizer is not adequate, adjustments must be made by adding single element fertilizers to make up the additional needs or selecting a different ratio for the complete fertilizer. As and example, lets assume that soil test results indicate that we should apply 120 kg/ha of K. In our example above in which 80kg were supplied by the complete fertilizer, we would still need an additional 40 kg/ha of K (120-80 = 40). This could be provided by applying 80 kg/ha of potassium chloride, since from Table 1 we see that this material contains 50% actual K (80kg x .50 = 40kg).

Fertilizer Application

Farmers who apply fertilizer with a tractor drawn spreader should consult their farmer equipment dealer if they do not know how to calibrate the equipment to apply the correct rate. This is very important to make sure that money spent on fertilizer is not wasted by applying too much or too little, or by not applying it uniformly. Many farmers apply fertilizer by hand. With hand application it is impossible to fertilize correctly if a suitable method is not followed. Therefore, farmers who apply fertilizer by hand should carefully follow the procedure outlined below.

How to Use Tables 2 through 5

Tables 2 - 4 lists the distance that one cold drink can of fertilizer should cover to obtain different rates using three kinds of fertilizer materials. The fertilizer rates are listed as kg/ha of nitrogen, phosphorus, and potassium (N-P-K). Table 5 lists the same information for nitrogen topdress fertilizers.

To determine how many meters one 340ml cold drink can filled with fertilizer will cover, one needs to know the following information:

- Type of fertilizer to be used
- Row spacing
- The fertilizer rate per ha to be used.

Step 1 - in the appropriate table for the fertilizer to be used find the number in the left column that is nearest to the fertilizer rate desired. (Recommended rates for specific crops are given in the Specific Crop Information section, beginning on page 29)

Step 2 - move across the chart to the right and find the row spacing column appropriate to the farmer's situation. The number listed in these columns are the total meters that one 340ml cold drink can filled with the fertilizer should cover, for the fertilizer rate selected in the left-hand column.

In Tables 2, 3 and 4, the approximate number of metres covered by one cold drink can of 2-3-2(22), 2-3-2(30) and 2-3-2(38) is given for three different row spacings.

Table 2.

2-3-2(22)	Row spacing(m)		
N-P-K(kg/ha)	0.9	1.2	1.5
20-30-20	13	10	8
30-45-30	9	7	5
40-60-40	6.5	5	4
50-75-50	5	4	3
60-90-60	4.5	3.5	2.5
70-105-70	4	3	2
80-120-80	3	2.5	1.8
100-150-100	2.5	2	1.5
110-165-110	2.3	1.7	1.3
120-180-120	2.2	1.6	1.2
130-195-130	2	1.7	1

Table 3.

2-3-2(30)	Row spacing(m)		
N-P-K(kg/ha)	0.9	1.2	1.5
20-30-20	18	14.5	11
30-45-30	12	9.5	7
40-60-40	9	7.5	5.5
50-75-50	7	5.8	4.5
60-90-60	6	4.5	3.5
70-105-70	5	4	3
80-120-80	4.5	3.5	2.5
100-150-100	3.5	2.8	2.2
110-165-110	3.2	2.5	2
120-180-120	3	2.2	1.8
130-195-130	2.8	2	1.5

Table 4.

2-3-2(38)	Row spacing(m)		
N-P-K(kg/ha)	0.9	1.2	1.5
20-30-20	22	18	14
30-45-30	15	12	9
40-60-40	11	9	7
50-75-50	9	7	5.5
60-90-60	7.5	6	4.5
70-105-70	6.5	5	4
80-120-80	6	4.5	3.5
100-150-100	4.5	3.5	2.8
110-165-110	4.2	3	2.5
120-180-120	3.8	2.7	2.2
130-195-130	3	2.5	2

Table 5. Topdress for vegetables crops using Ammonium nitrate or LAN - meters covered by one cold drink can for three row spacings.

Actual N(kg/ha)	0.9	1.2	1.5
20	51	40	30
30	34	27	20
40	25	20	15
50	20	16	12

Lime

The soils of the Highveld and Middleveld are naturally acid, with pH values commonly well below that normally recommended for many vegetable and fruit crops. Generally, when pH values are below 6.0, production of these crops is not recommended because the acid conditions create nutrient availability problems. Lime and fertilizer work together to improve yields and crop quality. Lime is not a substitute for fertilizer and fertilizer does not substitute for lime. They must be used in combination. The amount of each that should be applied and the frequency of application must be determined by the crop to be grown,

The cost of lime in Swaziland, and the amount required per unit area makes liming expensive. Experience has also revealed that satisfactory results have been achieved with pH values as low as 5.5 to 6.0 in Swaziland. Therefore, for medium resource SNL farmers liming recommendations have been adjusted downward. Table 6 gives rates to apply if farmers are considering the use of lime. Applying the lime in a band over the row location will significantly reduce the total amount of lime required.

Table 6. Lime recommendations based on soil pH for vegetable and fruit crops for both broadcast and band applications.

pH ofSoil	Broadcast (t/ha)	Banded* (g/m of row)	Banded Cans/m**
4.0 to 4.5	12	900	1 3/4
4.5 to 5.0	10	750	1 1/2
5.0 to 5.5	8	600	1 1/4
5.5 to 6.0	5	375	3/4
6.0 to 6.5	2	150	1/3

* Assumes that lime will be applied in a 75cm wide band over the location where the crop row will be planted.

** Based on a 340ml cold drink can holding 490g of lime.

Manure

Animal manure, when used properly is valuable in vegetable production. Manure can provide a significant amount of the necessary plant nutrients. The actual content of the nutrients varies according to the type of manure, it's age, and how it was stored. Table 7 provides a general guideline for determining how much N, P, and K can be expected to be provided by a manure application. The amount of commercial fertilizer to be used should always be adjusted downward when manure is used. In addition to providing plant nutrients, manure also supplies organic matter to the soil.

Table 7. Approximate kg per ton of N, P, and K supplied by different manure.

Type of Manure	N	P	K
Cattle	5	4	4
Poultry	10	7	7
Pig	5	6	3.5
Horse	6	4	5

Foliar Feeding

Foliar application of plant nutrients to vegetable crops is generally not necessary. Maintaining an adequate supply of the essential plant nutrients in the soil is the most efficient and cost effective method. Studies have shown that foliar applications of nutrients under normal conditions are often mainly cosmetic, that is they promote good leaf colour but do not significantly increase yields. For these reasons the use of foliar feeding is only recommended when one or more nutrients become unavailable and must be added within a very short period of time, especially some of the micronutrients.

Soils

Soils that meet the needs of the crop and are well managed is a first step in successful vegetable production. Failure to follow good soil

management practices often leads to reduced yields for the current season crop and promotes long term problems. Some of the more important considerations are discussed.

Selection

Soils used for vegetable production should be well drained, fairly deep, relatively high in organic matter, and have good structure.

Soil texture describes the relative proportion of sand, silt, and clay particle in the soil. Soils that have a good balance of these particles will drain well and be reasonably fertile. While organic matter is not essential for plant growth it is important since it helps to hold the required nutrients and release these to the plant roots. Organic matter, as it decomposes, also helps to improve soil structure. Structure refers to how the soil particle form together into small aggregates. Structure can be improved or destroyed by production practices, such as tillage and cropping patterns.

Tillage

For most vegetable crops, the first tillage operation, often done by ploughing, should loosen the soil to a depth of about 20cm. This operation also is the time to incorporate organic matter or other materials, such as lime. Secondary tillage operations done after ploughing are necessary to prepare a smooth, level surface that is free of clods, stones, weeds and other debris. Various types of implements can be used to accomplish this. When soil conditions are appropriate, the use of a power rotovator may accomplish all of the required tillage in one operation.

Tilling at the correct soil moisture is important. Doing tillage operations when the soil is too wet can be very destructive to soil structure and can lead to long term problems. A simple test is to take soil and try to form a ball between your hands. If you can form a ball that does not readily crumble apart, the soil is too wet for tilling.

Large heavy tractors and implements also tend to compact the soil. It is best to use equipment that is a small as possible to accomplish the job. Excessive tillage will also destroy soil structure and should therefore be avoided.

Crop Rotation

Following a system for rotating crops to be grown on the land is important. Planting the same crop or crops that are closely related can lead to the development and build-up in the soil of disease. By rotating crops, a number of diseases (for example bacterial wilt) can often be prevented from becoming a problem. Once soil borne disease do become a problem certain crops may not be possible to grow for many years in the soil.

Rotation of crops is also a useful tool to manage soil fertility levels. The use of cover crops that return organic matter to the soil and allow the soil to rest are an important part of crop rotation.

Cover Crops

Planting some type of grass or grain crop once every three or four seasons is helpful to improve soil conditions. Cover crops can often be grown in periods of less favourable seasonal conditions or when market price are expected to be less favourable. An annual ryegrass is an example of a grass cover crop. It should be sown at a rate of 15kg/ha. Ryegrass can be sown between the rows of some vegetable crops (for example tomatoes) late in the season and left to grow for several weeks after harvest is completed. Broadcasting maize seeds over the area and allowing it to grow to about 1m in height before cutting and plouging under is often an inexpensive and fast way to add organic matter to the soil. A number of legumes can also be used as cover crops and have the added advantage of supplying nitrogen, when properly inoculated.

Regardless of what is grown as a cover crop, care must be taken to not allow the crop to grow to point at which it begins to deplete nutrients from the soil. Cover crops should also be cut down before weeds growing in them develop mature seeds, which may promote weed problems the following season.

Seeds and Seedlings

Starting with quality seeds or planting material is important for successful production. Seeds or plants should be purchased only from

reputable seed houses or nurseries. It is recommended that seeds not be collected and saved from previous crops by the farmer, since this practice often transmits diseases. In addition, many cultivars are hybrids, which will not grow true to type if grown from seeds from a previous crop.

Hybrids cultivars of many vegetable are available in Swaziland. These generally have increased vigor and are more uniform in growth and maturity than open pollinated cultivars. Hybrid seeds often are considerably more expensive than open pollinated cultivars, due to the increased labor required for their production. However, the increased yields possible with hybrids often will offset the greater costs.

Seeds lose their viability quickly, so fresh seeds should be used. If seeds are to be held for an extended period, they should be placed in an air-tight container (for example, a glass jar with a tight-fitting lid) and stored in a cool location. Table 8 lists selected information for seeds of different vegetables.

Table 8. Approximate seed counts, seed requirements per hectare and per 10 meters of row, and the planting depth for selected vegetables.

Kind	Approximate Count 1 gram	100 gram	Seed Required/ha Transplant	Direct	Seed/10m Row Direct	Planting Depth (mm)
Bean, bush	4	350		95kg	200g	40
Beet	55	5,600		15kg	9.3g	25
Broccoli	300	31,400	275g	2.2kg	2.3g	10-12
Cabbage	300	31,400	275g	2.2kg	2.3g	10-12
Cantaloupe	40	4,000	255g	2kg	4.5g	20-30
Carrot	80	81,000		3.4kg	4.6g	10
Cauliflower	300	31,400	275g	2.2kg	2.3g	10-12
Corn, Sweet	6	550		10.8kg	5.0g	30-40
Cucumber	35	3,500	4.6g	3.4kg	4.6g	20-30
Eggplant	230	23,000	275g	2.2kg	1.2g	12
Lettuce	900	88,500	70g	1.1kg	4.6	12
Marrow, etc.	9	900		4.5kg	4.6g	30-40
Onion	85	8,500	4.5-6kg	4.0kg	9.0g	12-20
Peas	4	400		100kg	150g	25-35
Pepper	155	15,500	275g	2.2kg	1.2g	8-12
Pumpkin	6	600		4.5kg	4.6g	30-40
Radish	75	7,500		10.8kg	9.3g	10-12
Tomato	350	35,500	140g	2.2kg	1.2g	8-12
Watermelon	10	1,000		3.4kg	9.3g	25-35

Seedbeds

The following vegetable crops are generally transplanted to the field using seedlings: broccoli, cabbage, cauliflower, eggplant, lettuce, onion, pepper, and tomato. Many can be sown directly to the field. These include: bean, beetroot, cantaloupe, carrot, cucumber, pea, potato, onion, pumpkin, radish, squash, sweet corn, Swiss chard (spinach), turnip, and watermelon.

For good results it is essential to begin with a stocky seedling that is free of diseases. Many problems that occur during the growth cycle of a crop begin in the seedbed. An outdoor seedbed can be used to grow healthy, vigorous seedlings, provided proper methods are followed. Recommended steps for preparing and maintaining a seedbed are as follows.

Preparing the Bed

1. Select a site with medium-textured soil that is well drained, exposed to sunlight for most of the day, and protected from animals or poultry that may destroy the seedlings. Preferably, this site should be near the homestead so that

it is easier to check the seedbed regularly for soil moisture levels, etc.
2. Measure out an area 1.2 m in width and long enough to hold the numbers of seedlings to be produced.
3. Dig the soil to a depth of about 20 cm.
4. Add well-rotted kraal manure or other compost material at the rate of 4 to 5 kg per sq m of bed (a layer about 3 to 4 cm in depth).
5. Add 2:3:2(22) fertilizer at the rate of 1 cold drink can (370 g) and 5 cold drink cans (1 kg) of ground limestone per 5 m of bed length.
6. Re-dig the bed, mixing well the compost material, fertilizer, and lime with the soil. While doing this, move the soil towards the center to form a raised bed. The bed should be 10 to 12 cm in height and 1 m wide at the top.
7. Remove clods of grass, stones, and lumps of soil; smooth and level the bed.

Disinfecting the Bed

1. Fumigate the bed to control nematodes, soil-borne diseases, and weeds. Basamid may be used as follows:
2. Apply 250 g/m of Basamid per 5 m of bed length evenly to the soil surface and rake in lightly. A cold drink can with holes punched in the bottom with a small nail can be used. One can will hold about 200 g of the material. Warning! Basamid must be handled with extreme care. Wear rubber or latex gloves to protect the hands and a face mask to prevent breathing the material while handling.
3. Firm the soil surface lightly using the backside of a spade.
4. Sprinkle the bed lightly until moist, to a depth of 6 to 8 cm.
5. Allow the bed to rest for 2 weeks.
6. Loosen the soil with a spading fork after 2 weeks and leave it to aerate for 2 days.
7. The bed is now ready for planting.

Sowing Seeds in the Bed

1. Make sure the soil is finely prepared.
2. Slope the bed gently from the center to the sides so that water will not stand on the bed. Only a small amount of slope is necessary, approximately 2 to 3 cm.
3. Make furrows across the width of the bed to place the seeds in. These should be spaced 8 to 10 cm apart and only 6 to 12 cm deep, depending on the size of seed to be sown. A small plank about 2 cm in thickness and long enough to reach across the bed works well for doing this. Make sure furrows are of uniform depth.
4. Sprinkle seeds uniformly across the furrows. As a rule of thumb, approximately 40 to 60 seeds of most vegetables should be placed in each furrow (1 m length).
5. Label the rows, especially if more than one cultivar or crop is sown. The seed packet with the seed name can be placed on a stake for this purpose. A rule of thumb is always to label from the left to the right.
6. Cover the seeds with fine soil and firm using a flat piece of thin plank.
7. Water the bed carefully using a sprinkling can or hosepipe with a pressure breaker to wet the soil to a depth of 12 cm. A thin layer of coarse grass helps reduce moisture loss from the soil and promotes early and uniform seedling emergence. Remove grass as soon as the seedlings begin to emerge.

Care of Seedlings

1. Provide shading, especially in summer. Shade cloth or grass can be placed at least 75 cm above the bed.
2. Check the beds 2 to 3 times daily for soil moisture levels. Allow the surface to dry slightly between waterings. Avoid watering late in the day whenever possible. Plant surfaces that are wet for prolonged periods favor diseases.
3. Thin seedlings after they have emerged and are growing well. In general, thinning should be done about 1 week after emergence, when seedlings are about 10 to 12 mm. Seedlings should be spaced 5 to 10 mm apart in the row, depending on the crop. Thinning seedlings is important because it helps prevent weak, spindly growth and promotes good air circulation, thus preventing disease development.
4. Observe seedlings regularly for insects or disease symptoms. It is a good idea to spray beds after each period of significant rainfall, especially in summer. See pest control suggestions under specific crops for controls in the section Specific Crop Information.
5. Plant seedlings to the field before they become too leggy or old. Time will vary from 4 to 9 weeks, depending on the crop and temperatures. Remove seedlings carefully to

avoid damaging the roots. A large knife or blade used to apply putty works well.

Tray Seedlings

Tray produced seedlings often give better results than seedbed-produced seedlings. Roots of tray-produced seedlings are less disturbed during the transplanting process. Tray seedlings can be purchased from different sources, but one should always make sure they are healthy and of the desired cultivar.

Irrigation

Management

Management of moisture levels in the crop root zone is the basic principal of irrigation, regardless of the type of system used. There are two basic questions that must asked in irrigation management:

- How frequently must irrigation be done?
- How much water should be applied each time?

Several factors influence the answers to these questions:

- Type of soil,
- Depth of root zone,
- Kind of crop plant and variety,
- Stage of growth,
- Climatic conditions, that is temperature, wind, humidity, and solar radiation.

To determine how much water should be applied during each irrigation cycle, we must first determine the water holding capacity of the particular soil in which the crop is growing. Soil types vary considerably in the amount of water they can hold. Sandy soils have much lower water holding capacity than do soils higher in clay content. Table 10 lists estimated amounts of soil water available to the crop plants for different soil types.

Field Capacity is a term used to describe the maximum amount of water a soil is able to hold. If a field were saturated by rainfall or irrigation and then allowed to drain for 24 hours, it would then be considered to be at Field Capacity. All free water would have drained from the root zone. The Permanent Wilting Point for a plant must also be considered. At this point the plant has removed from the soil all the water that is possible for it to take-up. Potential available water to the crop then is the amount of water that is in the soil when it is between Field Capacity and Permanent Wilting Point (PWP).

How Much Water to Apply

Soil water must be kept well above the PWP for good crop growth and response. As the available water in the soil decreases, the plants must use more energy to take-up water. For these reasons, we need to keep the available water level well above the PWP.

For every crop there is a growth stage at which a shortage of water will influence the productivity most severely. Table 11 shows an estimation of the allowable depletion and it's influence on soil water content at the most critical stages of development for some vegetable crops.

Multiplying the available water in the soil at field capacity by the percent allowable depletion determines the amount of water that can be applied in one irrigation. This answer is relevant for sprinkler and drip irrigation systems, where it is possible to closely control the amount of water applied.

However, with furrow irrigation this is less practical. The amount of water applied with furrow irrigation is based on rough estimation and experience of the irrigator, assuming that the infiltrated water is reaching the root depth.

Irrigation Frequency

When to irrigate? is the main question that needs to be answered. Irrigation interval, the number of days between irrigation cycles, depends on several factors:

- Weather conditions during the period,
- Type of crop and variety,
- Stage of growth
- Quantity of water given on one irrigation

High solar radiation, temperature, and winds increase the water uptake by the plants and the amount that is lost from the soil to evaporation. The amount of water used by the plant and lost to evaporation is estimated by a value called the evapotransparation rate (ET). A Class A

Evaporation Pan can be used to estimate the ET. Table 9 gives average daily ET values for Malkerns for each month of the year. These figures vary according to area.

Every mm of water lost through evapotranspiration is equal to10m^3 of water per hectare. However, we do not need to apply all of the water lost, since different crop plants and different stages of growth have varying water requirements. To assist in making the necessary adjustments, crop coefficients are used.

Table 9. Average potential daily evapotranspiration for each month.

Month	Ave. Daily ET (mm)
January	6.7
February	6.5
March	4.9
April	4.3
May	3.9
June	4.0
July	4.1
August	4.6
September	5.3
October	4.7
November	6.2
December	5.9

Data from Malkerns Research Station, average for the period 1991-1995.

Crop Coefficient

Plant coefficients were determined through years of research trials. They represent a percentage of the amount of the evapo-transpiration value that is required by a particular crop, at specific growth stages (see Table 12). These take into account the water required by the and the amount lost due to evaporation from the soil.

For example, if tomatoes are in the flowering stage the quantity of water required each day would be estimated to be 2.3mm. This is calculated by taking the average daily ET for the month of May (3.9mm) multiplied by the crop coefficient for tomato in the flower stage (0.5), that is 0.5 x3.9 = 2.3mm, which is equal to 23m^3/ha.

Drip Irrigation

Drip irrigation slowly applies small amounts of water directly to the root zone of the crop. Water can be applied frequently, daily if necessary, and thus the soil moisture conditions can be maintain at ideal levels. A major benefit of drip irrigation is that it uses considerably less water than sprinkler and furrow irrigation, often less than half. There are other important advantages that drip can offer, some are:

- low flow rates and operating pressures are required, lowering pumping costs;
- disease and insects problems are often lower, since the plant foliage is not wetted;
- weed growth between rows is reduced since this area is not wetted;
- leaching of fertilizers from the root zone may be reduced since close control of water application is possible;
- fertilizers and other chemicals can be applied through the system directly to the root zone; and
- labour for operating the irrigation is low.

The major drawback is the relatively high initial cost for the system. Higher levels of management are also usually required with drip irrigation. Moisture reserves in the soil are usually lower so careful management is necessary to prevent moisture stress to the crop. Moisture distribution is also sometimes limited. The equipment, especially the drip pipes, can easily be damaged by workers and animals.

Drip systems should be properly designed to match conditions. For most conditions with vegetable crops, emitters should be spaced about 30 to 35 cm apart and deliver from 1.8 to 2.3 l per hour of water.

It is important to have adequate filtration, matched to the quality of water available. There are different types of filters for this.

A general rule is to apply only about 6 mm of water per hour with drip irrigation, depending on soil type.

Table 10. Approximate water holding capacity in percent and quantity of available water at field capacity for different soil types.

Soil Structure	Water Holding Capacity (%)	Available water (m^3/ha) to depth of 30 cm
Coarse-fine sand	2 - 9	60 - 270
Loamy sand	6 - 12	180 - 360
Sandy loam	11 - 15	330 - 450
Loams-silt loam	17 - 23	510 - 690
Clay loam-silty clay loam	14 - 21	420 - 630
Silt clay-clay	13 - 18	390 - 540

Table 11. Allowable water depletion at critical growth stages for different crops in sandy loam soil.

Crop	Critical Stage	Allowable Depletion (%)	Available water (m^3/ha)	Amount to Apply (m^3/ha)
Beans	Pod development	40	200-270	132
Cabbage	Head development	40	200-270	132
Carrots	Root enlargement	40	200-270	132
Tomato	Fruit enlargement	35	215-293	115
Maize	Silking, tasseling	30	230-315	100

Table 12. Crop coefficients for selected vegetables at different stages of development.

Crop	Early Growth	Flowering	Fruit Set	Fruit Development	Maturation	Harvest
Maize	0-0.6	0.6-0.9	1.0	0.9-1.0	-	-
Melons	0-0.3	0.3-0.6	0.6	0.8-0.9	0.8-0.7	0.7
Tomato	0.3-0.5	0.5-0.7	0.6	0.8	0.9-0.8	0.8-0.7
Potato	0-0.8	0.8-1.0	1.0	1.0	1.0	-

Pollination

Vine crops (cucumber, melons, pumpkin, and squash) require pollination by bees, since they have two type of flowers. Pollen must be transferred from the one type to the other. Without proper pollination yields and fruit quality are seriously affected, fruits may be small and misshappen. Yields of some crops such as beans, eggfruit, peas, and pepper may also be improved when bees assist in the pollination process.

Wild bees are excellent pollinators but often are not present in adequate numbers when large areas of vine crops are grown. Growers should consider placing colonies of honey bees near fields of these crops to ensure adequate pollination.

Care should also be taken when spraying insecticides during the period when the crop is in blossom. Insecticides that are especially toxic to bees, e.g. carbaryl, should not be used during the period when bees are active. The application of insecticides when vine crops are in blossom should be avoided whenever possible.

Weed Control

Keeping the vegetable crop free of weeds is important in achieving a good yield. Weeds compete with the crop for plant nutrients, water, and light. In addition, weeds often serve as host plants for diseases or insects that may attack the crops.

Removing weeds from the crop early, before they become established and large, is

important. When weeds are removed by hand operations care must be exercised to prevent disturbing or damaging the roots of the crop. Hand weeding often requires considerable time and is expensive. The use of chemical herbicides reduce hand weeding requirements.

Herbicides must be used very carefully. Misuse can result in completed destruction of the crop or at the least no control of the problem weeds. Most herbicides are selective as to which plants they will effect and therefore can only be used with specific crops. Thus herbicides must be matched carefully to the crop. Information as to which crop(s) the herbicides can safely be applied can be obtained from the label on the container or from knowledgeable crop advisors.

The herbicide must be applied at very specific stages in the growth of the crop and the stage of development of the weeds. Some are applied before the crops is planted, others after seeding but before the seedlings emerge, and still others can safely be applied while the crop is growing.

The herbicide must also be applied at the correct rate to achieve adequate control of weeds and to prevent damaging the crop. This requires the use of the right application equipment and accurate calibration. The correct nozzle type must be used, one that sprays in a flat fan pattern and produces relative coarse droplets. If hand carried sprayers are used, walking speeds must be careful determined and maintained. Sprayers used for applying herbicides should never be the same ones used for applying chemicals to control diseases and insects. Care must be taken to accurately measure the herbicide material and mix with the correct amount of water. Some herbicides that are labeled for specific crops are listed, along with rates, in the Specific Crop Information section.

Special Methods

Mulches

The use of a mulch with certain vegetables often improves yields and the quality of the crop. Mulches create a more favourable environment for the roots of the crop by keeping soil temperatures more uniform. The also can provide other important advantages, some are listed below:

- reduce water loss from the soil due to evaporation,
- reduce weed growth in the row,
- reduce loss of plant nutrient due to excess leaching during periods of heavy rainfall, and
- keep the crop cleaner by preventing splashing of soil during heavy rains.

Vegetable crops which respond best to mulches include peppers, eggfruit, melons, squash and pumpkins. With some of these, crops yields may be increased by as much as 50% through the use of mulches. Mulches work very well in conjunction with drip irrigation, the drip line being placed underneath the mulch before it is put in place. Mulches can also be used effectively with sprinkler irrigation.

Thin sheets of polyethylene (plastic), about 1.2 to 1.5 m wide, are often used as a mulch. Black plastic is recommended for Swaziland conditions since this will prevent weeds from growing underneath the plastic. Plastic costs per hectare are in the range of E2000, which requires good management must to ensure that full benefits are obtained. When plastic is used it must be laid before the crop is planted and soil moisture should at optimum levels before laying. The plastic must be stretched tightly, with the edges and ends cover with soil to prevent the wind from blowing the off the plastic. At the end of the season the plastic must be remove and disposed of properly. This requires considerable time and effort but plastic should never be ploughed or disked into the soil. Special plastics are available which will biodegrade, but they must be specially formulated for the climatic conditions. Organic materials, such as dried grass or straw, can be used successfully. Advantages of this type of material includes lower costs, no need to remove the material at the end of the season, and addition of organic matter to the soil as the material decays. Care must be taken with these materials to avoid introducing weeds seeds to the field.

Pesticides

Safety

Chemicals used to control crop diseases and insects are dangerous when not used properly. Improper use and handling of the chemicals can results in injury or death to the persons applying the materials, other workers, and the people who consume the crops that will be marketed. Care must also be taken to prevent injury to animals, contamination of water supplies, and damage to the environment.

Some general guidelines for the safe use of crop chemicals are listed below (refer to Chapter 6 of the Farmer's Handbook for a more complete discussion of pesticide safety and handling):

- use only chemicals labeled for the crop and pest to be controlled
- avoid use of highly poisonous chemicals whenever possible
- read the label and follow all directions
- use the correct rate
- measure the chemical and water accurately
- mix correctly
- calibrate the sprayer
- do not apply when windy or when people are in the area
- wear protective clothing (respirator, rubber gloves, long pants, boots, etc.)
- wash with soap and water after applying, remove clothing and wash them
- do not eat, smoke or drink while handling pesticides
- clean the sprayer carefully
- store chemicals away from children and living quarters
- keep chemicals only in original containers, never put them in food or drink containers
- do not transport or store chemicals in cars with people, or with food for humans or animals
- rinse chemicals containers after they are empty, pouring rinse water into sprayer
- never wash chemical containers or sprayers in rivers or ponds
- dispose of containers by burning paper (avoid the smoke) or bury glass or tin containers, crush them first

Application

Effective control can only be obtained by applying the correct chemicals. The proper amount of chemical must be mixed with the correct amount of water according the calibration of the sprayer.

After this is done, the spray mixture must reach the target plants. Care must be taken to avoid spray drifting from the target areas. In addition, the crop plants must be uniformly wetted with the spray, including the undersides of leaves. Usually with boom type sprayers or hand units the plants are wetted until they just begin to drip. This must be taken into to account when the sprayer is calibrated.

The correct nozzle is important for proper coverage. A nozzle that provides a cone shape pattern is generally best for disease and insect control. These nozzles provide a fine droplet size. Information on calibrating sprayers can be obtained from extension workers or in the case of larger tractor drawn units from the manual that comes with the sprayer.

Selection of Chemicals

The first rule in selecting chemicals is to follow label directions. Chemicals should only be applied to crops that are listed on the label and applied at the rates and timing as indicated.

Later in this production guide suggested chemical controls are listed for particular disease and insect problems under specific crops. These suggestions were made by specialists and based on years of experience. In making the suggestions consideration was given to the effectiveness of the chemical and also the relative toxicity of the material. Chemicals that are highly toxic to use or dangerous to the environment were avoided as

much as possible. The grower should always use the least dangerous chemical possible that is labeled for the crop and pest to be controlled, and that will provide satisfactory results.

Chemicals suggested in the guide are listed by the common trade names used in Swaziland, to make the guide as easy to understand as possible. No endorsement of a particular trade name or company is intended by the use of the trade name. Chemicals with the same active ingredient may be available under different names, and will likely be just as effective as the trade name listed. Table 13 (page 16) can help to determine other trade names that may exist for the same active ingredient.

Post Harvest Handling

Vegetables that are fresh and have good flavour often bring higher prices and lead to repeat sales. How vegetables are handled during and after harvest directly affects quality. The grower can do much to ensure high initial quality and maintain it for a longer period. Proper handling methods include:

1. Handle produce gently during harvesting, sorting, and moving to market. Prevent bruising, cuts, and abrasions. Do not squeeze, drop, or throw produce.
2. Do not heap produce in containers. Heaping promotes bruising of produce, especially that on the bottom of the container. Use acceptable containers that are not too large and do not have sharp edges.
3. Harvest produce at the correct time for peak quality demands of markets. Produce with high quality at harvest has longer shelf life.
4. Harvest during the coolest part of the day, beginning early in the morning and deliver to packshed or market as early in the day as possible.
5. Move harvested produce from the field to shade as soon as possible. Do not allow produce to sit in the sun.
6. Sort produce, removing damaged, diseased or otherwise poor quality produce before delivering to packshed. Trim and clean as necessary. Produce that is to be delivered directly to markets should be carefully sorted and graded to market standards. This should be done in a shaded area.

Post Harvest Aging

Fruits and vegetables are living systems (even after harvest) that are subject to change and deterioration through the aging process. The time required for aging changes to occur, however, may be extended by controlling the major factors which are known to accelerate ripening, disease, and deterioration of produce.

The factors which influence post harvest changes in fruits and vegetables are: 1) environmental temperatures and field heat, 2) ethylene gas respiration and vital heat, 3) water loss, 4) mechanical injury, 5) physiological disorders, and 6) disease. An understanding of the effects of each of these factors on the aging of horticulture crops has resulted in the development of sound procedures to maintain produce in a fresh condition for market and optimize returns. Table 26 on page 28 contains information on optimal storage conditions for selected vegetables.

Temperature and Field Heat

Increased temperatures will accelerate the ripening and aging process and result in negative changes in the quality of many harvested fruits and vegetables. The extent of the temperature effect depends upon the exact temperature and the nature or the plant materials. Nevertheless, high temperatures are very DESTRUCTIVE to harvested fruits and vegetables! High temperatures decrease the shelf life of various commodities.

The temperature of crops at the time of harvest is know as the FIELD HEAT. If the field heat is high, it must be reduced as soon after harvest as possible. The most common modern techniques of reducing the field heat of crops (known as precooling) may include hydrocooling (placement of fruits and vegetables in cold, running water) or cooling by fan-driven air movement over fruits and vegetables. Facilities for precooling may not be available, however, field heat should be reduced as much as possible. Harvesting early in the morning and keeping the harvested vegetables in a cool, shaded will help dramatically.

Ethylene Gas Production

Ethylene is a plant hormone (phytohormone) that is produced in relatively high amounts in many plant parts under normal circumstances of growth an development. This gas influences a number of processes in plants. For examples, ethylene stimulates ripening and aging of fruits and vegetables. It also accelerate leaf senescence (yellowing and deterioration), leaf abscission, sprouting of potatoes and the development of bitter tasting chemicals on carrots.

High temperatures and mechanical injury of harvested fruits and vegetables stimulates the production of ethylene, particularly in fleshy fruits. It is for these reasons that careful handling practices of fruits and vegetables should be employed.

Because the production of ethylene by post-harvest fruits and vegetables during transportation, marketing and holding is a major problem, many post-harvested handling procedures are directed to the removal of ethylene. Modern technology for the removal of ethylene from containers, bins and storage rooms consists of appropriate filters for circulation and exhaust fan systems, refrigeration, and controlled atmosphere facilities where low oxygen and high carbon dioxide may be maintained. Ideally, refrigeration or cool shelters should be employed to handle and hold produce packed in crates or perforated plastic bags.

In general, produce should not be mixed in storage. For example, fleshy fruits and vegetables will produce high amounts of ethylene which will promote aging of leafy vegetables that do not normally produce ethylene. During transportation, storage and marketing, produce should be contained in crates, boxes or other suitable packing materials which allow for the circulation of air around the produce so that the ethylene concentration will be reduced.

Water Loss

A major characteristic of many horticultural product is that they contain 70 to 95% water. It is the water content of fruits and vegetables that provides the crispness, texture and appearance that appeals to the consumer. Loss of water results in decreased weight with losses in texture and nutritional value. Often vitamins, particularly vitamin C, are lost during desiccation and wilting.

Water loss is especially high in fruits and vegetables after harvest. Unprotected produce will lose water from the internal tissues to the surface and into the atmosphere. The drier the surrounding air, the more water that is lost.

Temperature plays an important role in water loss from harvested plants parts. Even if the relative humidity is high around produce, increased temperatures will accelerate the loss of water. The reduction of field heat and the continuance of low temperatures during post-harvest handling is, therefore, very important.

Current procedures for protection harvested fruits and vegetables from excessive water loss are based on the reduction of field heat and the maintenance of high relative humidity. Thus, the packing of some fruits and vegetables in perforated plastic bags allow for gas exchange (ethylene, oxygen and carbon dioxide), but maintains relatively high humidity and decreased water loss.

MECHANICAL INJURY

The effects of physical damage (bruises, cuts and pest damage) produce high losses of fresh produce. Surface cuts and bruises provide sites of infection by disease organisms, loss of water and increased rates of ethylene production and respiration. This problem can be resolved dramatically by gentle handling of fruits and vegetables both during and after harvest.

Personnel involved in handling produce should be instructed to avoid squeezing, dropping and piling produce. Also, the common practices of dropping and piling tomatoes and other fleshy vegetables into open trucks should be avoided. Produce should be placed into crates or boxes with proper aeration and protection during shipping.

Production Costs and Market Information

Tables 17 through 21 are crop budgets for selected vegetables. They are presented only as examples of costs involved in production and marketing, and the returns that may be expected

under average conditions. The costs are based on the actual costs for inputs to follow the suggested practices that are given in the Specific Crop Suggestions section, using 1996 prices. Actual costs encountered by a farmer will vary according to conditions and practices followed.

The net returns shown for each crop are calculated using average yields that can be expected for specific crops and average market prices for the selected commodity at the Encabeni market over the past several years, for the period of the year when prices were the most favourable to the farmer. Actual yields obtained will depend on the management of the farmer, weather conditions, and other factors. Yields may be much higher than those shown or much lower. The critical figures to consider in this regard are the yield of marketable quality and the actual prices received when the crop is marketed.

Market prices may also vary considerably. Tables 22 through 25 show the average monthly prices at the Encabeni Market for the past year.

It is important that the farmer recognize that the information in the tables is presented only as a guide and that the actual returns received for a given crop may be much different than shown.

Table 13. The name of the active ingredient for chemicals used in the Guide is given in the first column, followed by the trade names the chemical is often sold under, the poison group to which the chemical belongs, and the relative toxicity of each chemical represented by the LD_{50}.

Common Name	Trade Name(s)	Poison Group[a]	LD_{50} Value Oral[b]	LD_{50} Value Dermal[b]
abamectin	Agrimec	I	10	>330
acephate	Orthene	III	866-945	>2000
alphamethrin	Fastac	II	66-94	>500
aldicarb	Temik	I	0.5-1	2.5-5
benomyl	Benlate	IV	>9590	>10000
bifenthrin	Talstar	II	53-55	>2000
bitertanol	Baycor, Bacsea	IV	>5000	>5000
carbaryl	Sevin, Sevkol	II	400-850	>4000
carbofuran	Curaterr, Furdan	I	8-14	>500
captab	Orthocide	IV	9000-15000	>22600
chlorothalonil	Bravo	IV	>10000	>10000
cypermethrin	Ripcord, Cymbush	II	203-295	>1600
cymoxanil-propineb	Milraz	III	1425	>3000
copper oxychloride	Blitox, Cupravit,	III	700-1000	-
deltamethrin	Decis	II	128-138	>2000
diazinon	Kyazinon	II	108-600	4000
dimethoate	Rogor	II	200-300	400-600
dichlorvos	Devipan, Dedevap	II	80	75-107
dicofol	Kelthane	III	575-1100	1000-1200
endosulfan	Thiodan, Thioflo	I	35-110	74-680
fosetyl-Al/mancozeb	Rhodax	IV	5400	>3200
fenthion	Lebaycid	II	200-310	330-650
fenvalerate	Agrithrin	II	300-630	1000-3200
gama BHC	Bexadust, Lindane	II	88-184	900-1000
Iprodione	Rovral	III	3500	>2500
lambda-cyhalothrin	Karate	II	183-320	>2000
mancozeb	Dithane M45	IV	>8000	-
mercaptothion	Malathion, Malasol	III	1375-2500	>4100
maneb	Trimangol	IV	6750	-
mevinphos	Phosdrin	I	3-7	16-34
metalaxyl	Ridomil	III	515-868	>3100
permethrin	Ambush, Alpha	III	>4000	4000
pirimicarb	Pirimor	II	147	>500
profenofos	Curacron	II	358	3300
profenofos, premium	Selecron	II	358	3300
propamocarb	Previcur	IV	2000-8550	>3000
propiconazole	Tilt	IV	8500	>1000
sulphur	Wettable Sulphur	IV	Relatively non-toxic	-
trichlorfon	Dipterex	III	450-650	2000-2800
triadimefon	Bayleton	II	363-568	>1000

See notes at top of next page.

a - The poison group to which a chemical is assigned indicates the relative toxicity. Those in Group I are the most poisonous, those in Group IV the least.
b - LD^{50} is a measure of the amount of chemical per body weight (mg/kg) required to kill half the population of test animals. Oral refers to the chemical ingested through the mouth and Dermal to the chemical absorbed through the skin. The lower the number the less chemical required, thus the lower the LD^{50} value the more dangerous the chemical.

CROP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gr. bean	-	-	++	++	++	+	++	++	+	+	-	-
Beetroot	-	-	++	++	+	+	+	++	+	+	-	-
Broccoli	-	-	+	+	+	+	-	-	-	-	-	-
Cabbage	-	-	+	+	++	++	+	+	-	-	-	-
Carrot	-	-	+	+	++	++	+	+	-	-	-	-
Cauliflower	-	-	+	+	+	-	-	-	-	-	-	-
Cucumber	-	+	++	++	+	+	+	++	+	+	-	-
Eggplant	-	++	++	+	+	-	+	+	+	-	-	-
Garlic	-	-	++	++	+	-	-	-	-	-	-	-
Leek	-	-	+	++	+	+	+	-	-	-	-	-
Lettuce	-	-	+	+	++	++	+	+	+	-	-	-
Melons	-	+	++	++	++	+	+	++	+	+	-	-
Onion, winter	-	+	++	++	+	+	-	-	-	-	-	-
Onion, summer	-	-	-	-	-	-	-	++	+	+	-	-
Peas	-	-	-	+	++	+	+	-	-	-	-	-
Pepper	+	+	+	++	+	+	+	++	+	+	+	+
Potato	-	-	+	++	++	++	+	-	-	-	-	-
Pumpkin	-	-	+	++	++	+	+	-	-	-	-	-
Radish	-	-	+	++	++	+	+	-	-	-	-	-
Squash	-	-	+	++	++	+	+	+	-	-	-	-
Sweet corn	+	+	+	+	+	+	++	+	+	+	-	-
Swisschard	-	-	++	++	+	+	+	++	++	+	+	+
Tomato	-	-	+	++	++	+	+	++	++	+	-	-
Strawberry	-	++	++	+	+	+	+	+	-	-	-	-

Table 14. Best times, suitable times, and unsuitable times for field planting selected vegetable crops in the low veld.

Key:
++ best time for planting
+ suitable time for planting
- not recommended for planting

CROP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gr. bean	+	+	++	+	-	-	+	+	++	++	+	+
Beetroot	+	+	++	++	++	+	+	++	+	+	+	+
Broccoli	+	+	++	++	+	+	+	++	++	+	+	+
Cabbage	+	+	++	++	++	+	+	++	++	++	+	+
Carrot	+	+	++	++	+	+	+	++	++	++	+	+
Cauliflower	+	+	++	++	+	+	+	++	++	+	+	+
Cucumber	+	++	+	+	+	-	-	+	++	++	+	+
Eggplant	+	+	++	+	+	-	-	++	++	++	+	+
Garlic	-	+	++	++	+	-	-	-	-	-	-	-
Leek	+	+	+	+	+	+	+	+	+	+	++	+
Lettuce	+	++	++	++	++	+	+	++	++	++	+	+
Melons	+	++	++	+	+	-	+	++	++	+	+	+
Onion, winter	+	++	++	+	-	-	-	-	+	+	+	-
Onion, summer	-	-	-	-	-	-	-	++	+	+	-	-
Peas	-	-	+	++	+	+	++	++	+	-	-	-
Pepper	+	++	++	+	-	-	-	++	++	+	+	+
Potato	+	++	++	+	+	+	++	++	+	+	+	+
Pumpkin	+	++	++	+	+	-	+	++	++	++	+	+
Radishe	+	++	++	+	+	+	+	++	++	+	+	+
Squash	+	++	++	+	+	-	+	++	++	+	+	+
Sweet corn	+	+	+	+	+	-	-	++	++	++	++	+
Swisschard	+	+	++	++	++	+	+	++	++	+	+	+
Tomato	+	++	++	+	-	-	+	++	++	++	+	+
Strawberry	-	++	++	+	-	-	-	-	+	+	-	-

Table 15. Best times, suitable times, and unsuitable times for field planting selected vegetable crops in the middle veld.

Key:
++ best time for planting
+ suitable time for planting
- not recommended for planting

CROP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beans, green	+	++	++	-	-	-	-	+	++	++	+	+
Beetroot	+	++	++	++	+	+	+	++	++	+	+	+
Broccoli	+	++	++	+	-	-	+	++	++	+	+	+
Cabbage	+	++	++	++	+	+	+	++	++	++	+	+
Carrot	+	++	++	+	+	+	+	++	++	++	+	+
Cauliflower	+	++	++	+	+	-	+	++	++	++	+	+
Cucumber	+	++	+	+	-	-	-	+	++	++	+	+
Eggplant	+	++	+	-	-	-	-	++	++	++	+	+
Garlic	+	+	++	++	-	-	-	-	-	-	-	-
Leek	+	+	+	+	+	-	-	+	+	+	++	+
Lettuce	+	++	++	++	+	-	+	++	++	++	+	+
Melons	++	++	-	-	-	-	-	++	++	+	+	+
Onion, winter	+	++	++	+	-	-	-	-	-	-	-	-
Onion, summer	-	-	-	-	-	-	+	++	+	-	-	-
Pea	-	-	+	++	+	-	++	++	+	-	-	-
Pepper	+	+	-	-	-	-	-	++	++	+	+	+
Potato	+	++	-	-	-	-	++	++	++	+	+	+
Pumpkin	++	+	-	-	-	-	-	++	++	++	+	+
Radish	+	++	++	+	+	-	-	++	++	+	+	+
Squash	++	+	-	-	-	-	-	++	++	++	+	+
Sweet corn	+	+	-	-	-	-	-	++	++	++	++	+
Swisschard	+	++	++	++	+	+	+	++	++	+	+	+
Tomato	++	+	+	-	-	-	-	+	++	++	+	+
Strawberry	-	++	++	+	-	-	-	-	+	+	-	-

Table 16. Best times, suitable times, and unsuitable times for field planting selected vegetable crops in the high veld.

Key:
++ best time for planting
+ suitable time for planting
- not recommended for planting

Table 17. Crop Budget for Butternut

BUTTERNUT SQUASH

SEASON:	Summer	AREA:	1 ha
CULTIVAR (Name):	Early Butternut		Buy
WATER(Elec, Diel, or None):	None	IRRIGATION(Furrow or Drip):	Furrow
SYSTEM:		WEED CONTROL ("Hand" or,'Chemical'):	Hand
YIELD POT. (Hi, Ave):	Ave	MARKET COMMISSION %(eg. 5, 10):	8
		FARMER PACKED (Yes, No):	No

INPUTS/ha	UNIT	AMT.	E/UNIT		E/MONTH 1	2	3	4
Tractor hire (land prep.)	hrs	5.6	0.00	0.00	0.00			
Seed cost	1000	2.0	370	740.00	740.00			
Fertiliser								
2-3-2(22)	kg	796	0.94	748.24	748.24			
LAN	kg	71	0.96	68.16		68.16		
Labour	p-da	3		0.00				
Planting (labour)	p-da	8		0.00				
Weed control								
Hand	p-da	28		0.00				
-		0 0		0.00	0.00			
Disease and Insect Control								
fenthion 50ec - 6X	lt	7.2	7.20	51.84	10.37	15.55	15.55	10.37
Malathion 25wp - 2X	lt	6	19.56	117.36	23.47	35.21	35.21	23.47
Bravo 500sc - 10X	lt	20	37.15	743.00		222.90	260.05	260.05
Kelthane 18.5wp - 2X	kg	4	20.60	82.40	20.60	20.60	20.60	20.60
Labour	p-da	22		0.00				
Irrigation				0.00	0.00			
Water/pumping	hrs	72	0	0.00	0.00	0.00	0.00	0.00
Labour	p-da	15			0.00			
Harvesting (labour)	p-da	26		0.00				
Total labour	p-da	102	6.00	614	154	135	154	172
TOTAL PRODUCTION COSTS				3165	*1696*	*498*	*485*	*487*
Packaging	ea	0	0.80	0		0		
Transport	t km	100	0.10	120			36	84
Commission (12.5%)	%		0.08	825.6			284	662
MARKETING COSTS				946	0	0	320	746
TOTAL COSTS				4111	1696	498	805	1232
Yield/gross returns	tonne	12	860.00	10320			3612	6708
NET RETURNS/ha				6209	-1696	-2194	613	6089

Table 18. Crop Budget for Cabbage

CABBAGE (PER HECTARE)

SEASON: Summer
CULTIVAR (Name): Hercules
WATER(Elec, Diel, or None): None
SYSTEM ():
YIELD POT. (Hi, Ave): Hi

AREA: 1 ha
SEEDLING SOURCE ("Buy" or "Seedbed"): Buy
IRRIGATION(Furrow or Drip): Furrow
WEED CONTROL (Hand or if Chem-'Sencor' or 'Lasso'): Hand

INPUTS/ha	UNIT	AMT.	E/UNIT	TOTAL (E)	E/MONTH 1	2	3
Tractor hire (land prep.)	hrs	5.6	65.00	364.00	364.00		
Seedlings	1000	33.3	40.00	1332.00	1332.00		
(Seed)	kg	0.3	140.00				
Fertiliser							
2-3-2(22)	kg	1112	0.94	1045.28	1045.28		
LAN	kg	105	0.96	100.80		100.80	
Labour	p-da	3		0.00			
Planting (labour)	p-da	15		0.00			
Weed control							
Hand	p-da	28		0.00			
		0 0		0.00	0.00		
Disease and Insect Control							
Bravo (2)	lt	0	37.15	0.00	0.00	0.00	0.00
Dithane M45 (4)	kg	12	21.53	258.36	64.59	116.26	77.51
copper oxychloride (5)	kg	20	9.98	199.60	49.90	89.82	59.88
mercaptothion 25 wp(2.5)	kg	0	19.56	0.00	0.00	0.00	0.00
Ripcord (5)	lt	1.5	110.00	165.00	82.50	82.50	
Curacron	lt	2	62.60	125.20		62.60	62.60
Labour	p-da	18		0.00			
Irrigation				0.00	0.00		
Water/pumping	hrs	72	2.40	172.80	51.84	60.48	60.48
Labour	p-da	14			0.00		
Optional							
			0.80	0.00		0.00	
			60.00	0.00		0.00	
Harvesting (labour)	p-da	10		0.00			
Total labour	p-da	88	6.00	528.00	211.20	132.00	184.80
Total Production Costs				4291.04	*3201.31*	*644.46*	*445.27*
Packaging		4375		0.00			
Transport	t km	100	0.10	350.00			350.00
Commission (12.5%)				1312.50			1312.50
Total Market Costs				1662.50			
TOTAL COSTS				5953.54	*3201.31*	*644.46*	*2107.77*
Yield/gross returns	tonne	35	300.00	10500.00			10500.00
NET RETURNS/ha				4546.46	-3201.31	-3845.77	4546.46

Table 19. Crop Budget for Onions

GREEN BEAN (PER HECTARE)

SEASON: Summer AREA: 1 ha

CULTIVAR (Name): Masi

WATER(Elec, Diel, or None): None — Furrow

SYSTEM (Double or Single): Double — WEED CONTROL (Hand or Chemical): Chemical

YIELD POT. (Hi, Ave): Hi — No

INPUTS/ha	UNIT	AMT.	E/UNIT		E/MONTH 1	2	3	4
Tractor hire (land prep.)	hrs	5.6	65.00	364	364			
Seed	kg	40	21.00	840	840			
Fertiliser								
2-3-2(22)	kg	796	0.94	748	748			
LAN	kg	105	0.96	101		101		
Labour	p-da	3		0				
Planting (labour)	p-da	15		0				
Weed control								
Chemical	p-da	6		0				
Lasso		5	50	250	250			
Disease and Insect Control								
Bravo (2)	l	4	37.15	149	37	74	37	
copper oxychloride (5)	kg	10	9.98	100	50	50		
mercaptothion 50 ec(750)	kg	3	19.56	59	29	29		
Kelthane 18.5wp (2)	kg	2	20.6	41	21	21		
Carbaryl 85wp (1.2)	kg	1.2	39.07	47		23.442	23.442	
	kg	0		0	0			
Labour	p-da	12		0				
Irrigation				0	0			
Water/pumping	hrs	72	2	173	35	60	52	26
Labour	p-da	15			0			
Optional								
				0		0		
				0		0		
Harvesting (labour)	p-da	380		0				
Total labour	p-da	431	6.00	2586	647	905	1164	
Total Production Costs				**5457**	*3020*	*1264*	*1276*	*26*
Packaging		5000	0.15	750		187.5	562.5	
Transport	kg	5000	0.25	1250		312.5	937.5	
Commission (12.5%)								
Marketing Costs				**7457**	*0*	*500*	*1500*	*0*
TOTAL COSTS				12914	3020	1764	2776	
Yield/gross returns	tonne	5	2500	12500		3125	9375	
NET RETURNS/ha				**5043**	**-3020**	**-1659**	**4940**	

Table 20. Crop Budget for Green Pepper

BELL PEPPER (PER HECTARE)

SEASON: Summer
CULTIVAR (Hybrid or OP): OP — SEEDLING SOURCE ("Buy" or "Seedbed"): Buy
WATER(Elec, Diel or None): None — IRRIGATION(Furrow or Drip): Furrow
Bare — WEED CONTROL (Hand or if Chem-'Sencor' or 'Lasso'): Hand
YIELD POT. (Hi, Ave): Ave

					E/MONTH			
INPUTS/ha	**UNIT**	**AMT.**	**E/UNIT**	**TOTAL (E)**	1	2	3	4
Tractor hire (land prep.)	hrs	5.6	65.00	364.00	364.00			
(Seed)	kg	0.25	220.00	55.00	55.00			
Seedlings	1000	13.4	43.00	576.20	576.20			
Fertiliser								
2-3-2(22)	kg	1115	0.94	1048.10	1048.10			
LAN	kg	143	0.96	137.28		137.28		
Labour	p-da	3	6.00	18.00	18.00			
Planting (labour)	p-da	15	6.00	90.00	90.00			
Weed control								
Hand	p-da	28	6.00	168.00	42.00	42.00	42.00	42.00
Disease and Insect Control								
Ridomil MZ (1)	kg	12	109.59	1315.08	263.02	394.52	394.52	263.02
copper oxychloride (5)	kg	15	9.98	149.70	149.70	44.91	44.91	44.91
mercaptothion 25 wp(2.5)	kg	7.5	19.56	146.70	36.68	36.68	36.68	36.68
Kelthane 18.5wp (3)	kg	9	20.60	185.40	61.18	61.18	61.18	
Dithane M45	kg	3	21.53	64.59	16.15	16.15	16.15	16.15
Benlate (7)	kg	6	125.00	750.00	187.50	187.50	187.50	187.50
Labour	p-da	12	6.00	72.00	18.00	18.00	18.00	18.00
Irrigation								
Water/pumping	hrs	72	2.40	172.80	34.56	60.48	51.84	25.92
Labour	p-da		6.00	0.00	0.00	0.00	0.00	0.00
Optional								
Plastic mulch	m	8333	0.00	0.00	0.00			
- Labour	p-da							
Harvesting (labour)	p-da	21	6.00	126.00				126.00
Total labour	p-da	79	6.00	474.00	168.00	60.00	60.00	186.00
Total Prod. Costs				**5912.85**	*3128.08*	*1058.70*	*912.78*	*946.17*
Packaging		2000		0.00				
Transport	t km	100		0.00			0.00	0.00
Commission (12.5%)			0.10	2160.00			1296.00	864.00
Marketing Costs				**2160.00**				
Yield/gross returns	tonne	12	1800.00	21600.00			12960.00	8640.00
NET RETURNS/ha				**13527.15**				

Table 21. Crop Budget for Tomato

TOMATO (PER HECTARE)

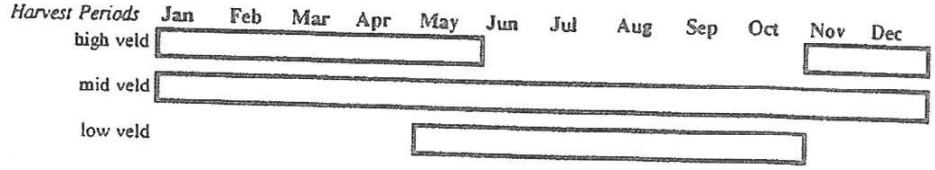
SEASON: Winter
CULTIVAR (Name): Maximillion
WATER(Elec, Diel, or None): None
SYSTEM (Trellis or Ground): Trellis
YIELD POT. (Hi, Ave): HI

AREA: 1 ha
SEEDLING SOURCE ("Buy" or "Seedbed"): Buy
IRRIGATION(Furrow or Drip): Furrow
WEED CONTROL ("Hand" or,'Sencor' or 'Lasso'): Hand
MARKET COMMISSION %(eg. 5, 10): 8
FARMER PACKED (Yes, No): No

INPUTS/ha	UNIT	AMT.	E/UNIT	TOTAL (E)	E/MONTH 1	2	3	4
Tractor hire (land prep.)	hrs	5.6	65.00	364.00	364.00			
Seedlings	1000	13.4	43.00	576.20	576.20			
(Seed cost)	1000	14.7	28.00	412.72	412.72			
Fertiliser								
2-3-2(22)	kg	955	0.94	897.70	897.70			
LAN	kg	200	0.96	192.00		192.00		
Labour	p-da	3		0.00				
Planting (labour)	p-da	15		0.00				
Weed control								
Hand	p-da	28		0.00				
-		0 0		0.00	0.00			
Disease and Insect Control								
Bravo (6)	lt	16	37.15	594.40	118.88	178.32	178.32	118.88
Dithane M45 (6)	kg	24	21.53	516.72	103.34	155.02	155.02	103.34
copper oxychloride (5)	kg	25	9.98	249.50		74.85	87.33	87.33
Patron (0.5)	kg	1.0	609.00	609.00	152.25	152.25	152.25	152.25
Curacron (1.5)	lt	6	62.60	375.60		187.80	187.80	
Talstar (.4)	lt	0.8	295.32	236.26	47.25	94.50	94.50	
Labour	p-da	12		0.00				
Irrigation				0.00	0.00			
Water/pumping	hrs	180	2.40	432.00	86.40	151.20	129.60	64.80
Labour	p-da	15			0.00			
Optional								
Trellis poles	ea	2084	0.80	1667.20		1667.20		
Trellis string	roll	10	60.00	600.00		600.00		
Trellis labour	p-da	12				0.00		
Harvesting (labour)	p-da	78		0.00				
Total labour	p-da	163.4	6.00	980.40	245.10	215.69	245.10	274.51
TOTAL PRODUCTION COSTS				8703.70	*3003.85*	*3668.83*	*1229.91*	*801.11*
Packaging	ea	0	0.80	0.00		0.00		
Transport	t km	100	0.10	280.00			84.00	196.00
Commission (12.5%)	%		0.08	1792.00			621.60	1450.40
MARKETING COSTS				2072.00	0.00	0.00	705.60	1646.40
TOTAL COSTS				10775.70	3003.85	3668.83	1935.51	2447.51
Yield/gross returns	tonne	28	800.00	22400.00			7840.00	14560.00
NET RETURNS/ha				11624.30	-3003.85	-6672.67	-768.19	11344.30

Table 22. Market Facts for Butternut

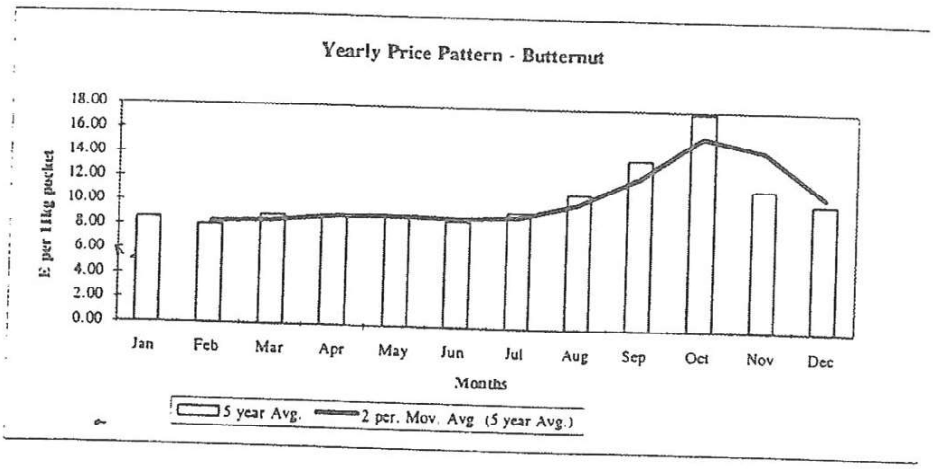
Seasonality:



Market Price Pattern (Encabeni):

E per 11kg

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	7.67	7.48	8.53	8.53	9.51	9.18	8.77	10.19	12.31	20.10	7.17	7.18
1992	9.20	8.96	9.28	8.96	9.97	10.37	10.66	13.06	17.45	19.31	13.56	10.61
1991	9.47	8.76	9.57	10.60	10.36	10.84	11.46	12.30	14.75	18.51	11.84	9.34
1990	10.86	9.92	11.19	9.01	8.74	6.46	7.36	9.91	14.99	17.42	14.02	10.34
1989	5.82	5.25	6.13	7.54	7.00	6.63	9.06	9.82	10.16	13.81	11.28	14.76
5 year Avg.	8.60	8.07	8.94	8.93	9.12	8.70	9.46	11.06	13.93	17.83	11.57	10.45



Sales (Encabeni):

11 kg pocket

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	1273	909	909	818	1091	636.4	1364	1091	364	545	1727	3091
of which Swazi:	1273	545		91	455	182					182	545

Yearly Average 1152 pockets (11kg) per month
Low period Sep to Oct 455 pockets (11kg) per month
High period Nov to Dec 2409 pockets (11kg) per month

Market Price Expectation:

Best Months: *September to November* E11 per pocket *peak in October* E 16
Worst Months: *January to July* E 8 per pocket
Price difference: (between best and worst months) 38 percent

1 The figures used in this compilation come from NAMBOARD, MAU, and CAPM (Seasonality).

2 Market Price expectation was developed based on an analysis of 5-year historical average monthly prices in Encabeni, and are based on the grade and packaging requirements of the Encabeni market.

3 For farmers selling at Encabeni, in addition to the cost of packaging, transportation costs, market fees (5%), and agent's commission (5 to 7.5%) must be deducted from the selling price.

Table 23. Market facts for Cabbage

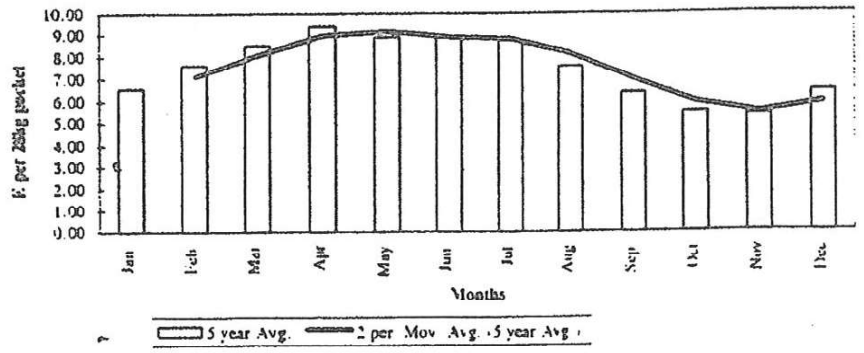
Seasonality:

Harvest Periods	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
high veld	■	■	■	■	■	■	■	■	■	■	■	■
mid veld	■	■	■	■	■	■	■	■	■	■	■	■
low veld							■	■	■	■		

Market Price Pattern (Encabeni):

E per 28 kg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	7.17	7.57	9.06	10.48	8.47	8.17	7.44	6.00	4.47	3.94	4.08	4.31
1992	5.77	7.60	10.08	11.68	11.48	12.84	14.26	12.68	10.65	8.47	7.98	7.84
1991	5.65	6.90	8.15	11.12	12.62	12.20	10.38	7.90	6.49	5.09	5.56	5.86
1990	9.65	10.91	9.79	8.25	7.19	6.48	6.42	5.92	5.43	4.84	4.63	5.52
1989	4.61	5.20	5.58	5.36	4.70	4.65	5.21	5.26	4.75	5.07	4.55	8.55
5 year Avg.	6.57	7.64	8.53	9.38	8.89	8.87	8.74	7.55	6.36	5.48	5.36	6.42

Yearly Price Pattern - Cabbage



Sales (Encabeni):

28 kg pocket

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	6643	7964	7107	11893	11286	9071	13393	6107	4607	4643	3250	3071
of which Swazi:	4964	2429	1893	3607	1000	6000	10036	5750	4607	4607	3214	3000

Yearly Average		7420	pockets (28kg) per month
Low period	Sep to Dec	3893	pockets (28kg) per month
High period	Jan to Aug	9183	pockets (28kg) per month

Market Price Expectation:

Best Months:	*February to July*	E 7 to 9 per pocket
Worst Months:	*September to December*	E 5 per pocket
Price difference:	(between best and worst months)	80 percent

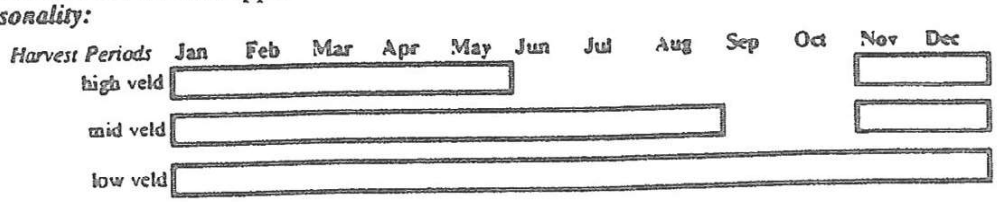
1 The figures used in this compilation come from NAMBOARD, MAU, and CAFM (Seasonality).

2 Market Price expectation was developed based on an analysis of 5-year historical average monthly prices in Encabeni, and are based on the grade and packaging requirements of the Encabeni market.

3 For farmers selling at Encabeni, in addition to the cost of packaging, transportation costs, market fees (5%), and agent's commission (5 to 7.5%) must be deducted from the selling price.

Table 24. Market facts for Green Pepper

Seasonality:

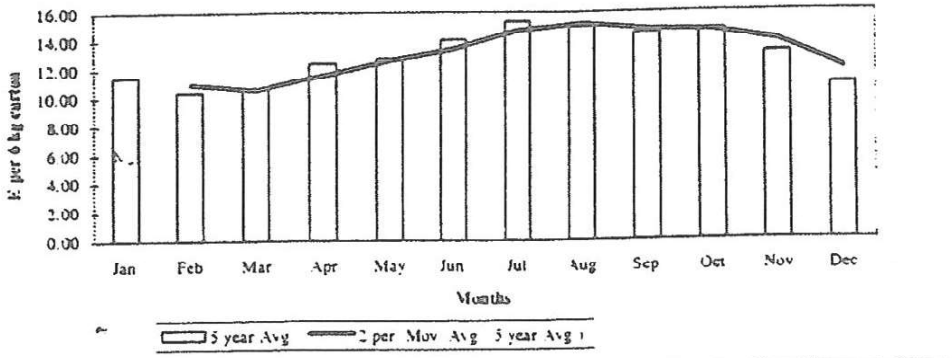


Market Price Pattern (Encabeni):

E per 6kg

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	12.43	11.67	11.49	10.04	11.70	15.09	17.98	11.33	11.21	13.15	6.92	6.55
1992	11.91			20.59	17.98	17.87	17.41	16.59	17.79	16.38	17.65	13.77
1991	9.68	8.51	9.00	11.13	11.48	12.37	14.25	15.24	14.07	12.74	13.30	9.90
1990	15.79	14.62	13.85	11.80	14.21	15.22	18.17	21.06	16.25	14.85	15.60	9.31
1989	7.40	6.68	8.34	8.68	8.39	9.68	9.03	10.67	13.17	16.60	11.89	14.73
5 year Avg.	11.44	10.37	10.67	12.45	12.75	14.05	15.37	14.98	14.50	14.74	13.07	10.85

Yearly Price Pattern - Green Peppers



Sales (Encabeni):

6 kg cartons

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	396	212	137	540	453	480	509	938	377	609	659	606

Yearly Average		493 cartons (6kg) per month
Low period	Jan to March	248 cartons (6kg) per month
High period	Aug. to Dec	638 cartons (6kg) per month

Market Price Expectation:

Best Months:	*July to October*	E 14 per 6kg carton
Worst Months:	*February to March*	E 10 per 6kg carton
Price difference:	(between best and worst months)	40 percent

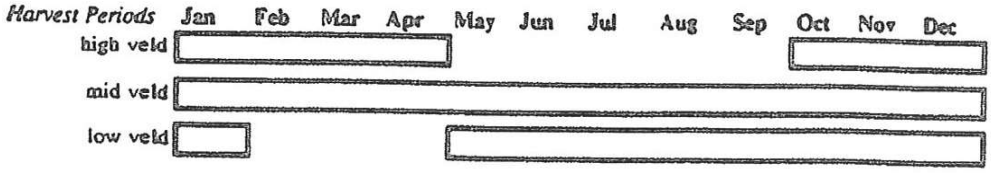
1 The figures used in this compilation come from NAMBOARD, MAU, and CAPM (Seasonality).

2 Market Price expectation was developed based on an analysis of 5-year historical average monthly prices in Encabeni, and are based on the grade and packaging requirements of the Encabeni market.

3 For farmers selling at Encabeni, in addition to the cost of packaging, transportation costs, market fees (5%), and agent's commissions (5 to 7.5%) must be deducted from the selling price.

Table 25. Market facts for Tomato

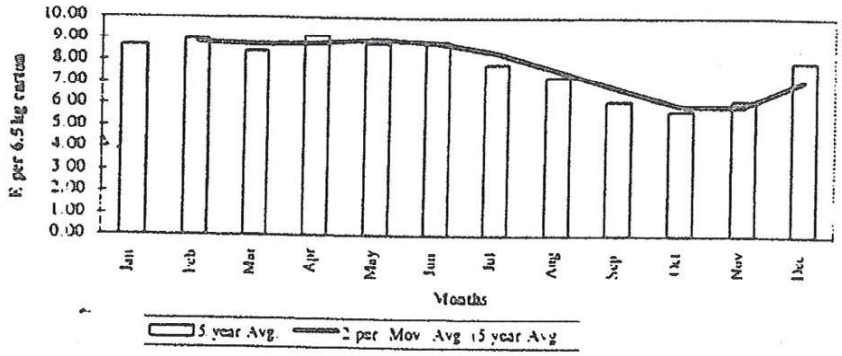
Seasonality:



Market Price Pattern (Encabeni):

E per 6.5kg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	12.02	9.73	7.34	7.55	8.58	8.67	6.04	6.72	4.16	3.28	3.70	6.28
1992	8.62	8.90	11.12	14.12	10.85	9.50	9.59	8.72	8.49	7.55	7.11	11.30
1991	8.84	9.65	9.46	11.07	9.70	9.14	8.55	6.91	6.50	6.06	7.89	7.85
1990	9.06	11.27	8.17	6.40	7.78	9.53	8.50	8.11	6.72	5.96	6.50	7.96
1989	4.73	5.33	5.88	6.45	6.84	7.41	6.55	5.92	4.92	5.69	5.71	6.46
5 year Avg.	8.65	8.98	8.39	9.12	8.75	8.85	7.85	7.28	6.16	5.71	6.18	7.97

Yearly Price Pattern - Tomatoes



Sales (Encabeni):

6.5 kg cartons

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	1077	2000	1385	1846	2308	2923	7692	6154	3538	3846	4000	4154
of which Swazi:	154	308	615	462	1692	1846	4769	4923	3385	3538	615	1538

Yearly Average	3410	cartons (6.5kg) per month
Low period Jan to May	1723	cartons (6.5kg) per month
High period July to Dec	4897	cartons (6.5kg) per month

Market Price Expectation:

Best Months:	*December to June*	E 9 per 6.5kg carton
Worst Months:	*September to November*	E 6 per 6.5kg carton
Price difference:	(between best and worst months)	50 percent

1 The figures used in this compilation come from NAMBOARD, MAU, and CAPM (Seasonality).

2 Market Price expectation was developed based on an analysis of 5-year historical average monthly prices in Encabeni, , and are based on the grade and packaging requirements of the Encabeni market.

3 For farmers selling at Encabeni, in addition to the cost of packaging, transportation costs, market fees (5%), and agent's commission (5 to 7.5%) must be deducted from the selling price.

Table 26. Recommended Storage and Transit Temperatures, Recommended Storage and Transit Relative Humidity, the Expected Life Under Ideal Storage Conditions, and the Sensitivity to Chilling for Selected Vegetables.

Crop	Storage/Transit Temperature	Storage/Transit Relative Humidity(%)	Expected Life Under Best Conditions	Sensitivity to Chilling
Asparagus	0 - 2	95	1-2 weeks	L
Beans, green	4-6	90-95	7-10 days	M
Beets	0	95	1-2 weeks	I
Broccoli	0	90-95	1-2 weeks	I
Brussels sprouts	0	90-95	3-5 weeks	I
Cabbage	0	90-95	3-6 weeks	I
Cabbage, Chinese	0	90-95	4-8 weeks	I
Carrots	0	90-95	1 month	I
Cauliflower	0	90-95	2-4 weeks	I
Cucumbers	10	90-95	1-2 weeks	H
Eggplant	10	90-95	1 week	H
Escarole	0	90-95	2-3 weeks	I
Lettuce, crisp head	0-2	95	2 weeks	I
Lettuce, bibb	0-2	95	1 week	I
Lettuce, romaine	0-2	95	1-2 weeks	I
Cantaloupe	3-7	85-90	1 weeks	M
Onion, green	0	95	1 week	I
Onion, dry	0	65-70	2-8 weeks	I
Peas	0	90-95	1-2 weeks	I
Peppers	8-10	90-95	2 weeks	M
Potato	6-7	90	1-2 months	L
Pumpkin	10-12	70-75	2-3 months	H
Radish	0	95	1 weeks	I
Squash, bush	10-12	90-95	1 week	H
Sweet potato	12-14	85-90	3-4 months	VH
Sweet corn	0	90-95	5 days	I
Tomato, green	15-20	85-90	1-3 weeks	H
Tomato, pink	14-18	85-90	5-10 days	M
Tomato, ripe	14-16	85-90	3-6 days	M
Watermelon	7-10	85-90	3-4 weeks	M

Sensitivity to Chilling Injury: L = insensitive; I = intermediate sensitivity; M = medium sensitivity; H = high sensitivity; VH = very high sensitive

Information in this table was adapted from 1996 (Pennsylvania) Commercial Vegetable Production Recommendations.

SPECIFIC CROP INFORMATION

BEETS AND SWISS CHARD

Soils and Rotations

Beets and Swiss chard grow best on loamy soils that are deep, loose, and well drained. Heavy soils high in clay and those which are compacted should be avoided. Soil pH should range between 5.5 and 7.0. If the pH is less than 5.5, lime should be applied (see Table 5, page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium); the remainder should be a calcitic lime.

Beets and Swiss chard should not follow one another in a crop rotation. Most other crops are acceptable to precede them in the planting sequence, especially leguminous crops.

Fertilization

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken every three years and sent to a reliable soil testing laboratory. However, in the absence of a soil test, the following can be used as a guide:

Rates of N-P-K (kg/ha) for Beets

Beets	Med. yields	High yields
Basal	60-90-60	80-120-80
Sidedress	0	0
Chard		
Basal	50-75-50	70-105-70
Sidedress	20-0-0	20-0-0

The sidedress application should be made about 4 to 5 weeks after field planting, using LAN, ammonium nitrate, or urea. If a crop of Swiss chard is to be held for additional harvests beyond 12 to 14 weeks, repeating the sidedress application at that time may be beneficial. Both basal and sidedress applications should be banded. In the case of basal treatments, the fertilizer should be worked into the soil before seeding the crop.

Tables 1 through 4 on pages 2 and 3 provide guidelines for making applications of different fertilizers using the cold drink can method.

Time of Planting

Both beets and Swiss chard grow best under cool, moist conditions. They can tolerate cool temperatures or light frosts. Both can withstand very warm temperatures, but chard leaf size is reduced under these conditions, and the overall quality of both crops suffers. They can be grown throughout the year in most areas, except for the summer months in the Lowveld. Summer production is not difficult in other regions, since few serious summer diseases affect either crop. Table 14 to 15 on pages 17 through 19 show recommended times to plant.

Field Spacing

Rows: single rows 45 cm apart (one row on each side of the irrigation furrow), or double rows 20 to 30 cm apart, with 90 cm between the centers of each double row.

In row: 8 to 10 cm between plants for beets
25 cm between plants for Swiss chard

Field Planting

Beets and Swiss chard should both be sown directly to the field in which they will be grown to maturity. The soil should be well prepared and free of stones, clods, and other debris. The seeds should be sown in rows so that the final stand of plants will be as indicated above. If sown more densely than the final spacing recommendations, excess seedlings should be thinned within 2 to 3 weeks after emergence. Seedlings that are removed can be used to fill gaps of missing plants.

Sow seeds in a moist soil to a depth of 15 to 20 mm. Cover seeds with soil free of large clods or clumps of sod. Firm the soil lightly over the seeds. Mechanical planters are

available which open a furrow, drop the seed, and cover seeds with soil.

Soil moisture must be maintained carefully during germination and establishment of the young seedlings. A light grass mulch placed over the row helps preventing drying and crusting of the soil. The grass should be pulled to the side of the seedlings or removed altogether after seedlings have emerged.

Irrigation

There are a couple of critical times during the growing season when it is most important that adequate water be available to the plant, for obtaining desired yields.

First, to develop strong and healthy seedlings, it is necessary to apply frequent light irrigations during the seed germination stage. After thinning it is most important that sufficient irrigation water be applied to wet the soil to a depth of about 30 cm. This will ensure a rapid, early-season plant growth, a good deep root development, and in turn high-quality produce. Subsequent irrigations throughout the remaining growing season until harvest, should be scheduled when 50% of the available water in the root zone has been depleted. Do not allow the soil to get overly dry at any time. Moisture stress may result in fibrous roots with cracks, poor color, and poor flavor in beets. Swiss chard needs sufficient water throughout the season so that the leaves develop properly and remain crisp. The available water in the soil should never be depleted below 50%. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer the irrigation section beginning on page 8.

Variety Information

The varieties listed below are suitable for both summer and winter production. The major seasonal effects are on growth rate and shape of the beet root. Cooler temperatures and shorter day length of winter adds approximately 25 days to the maturity period.

Beets grown in summer tend to have a rounded shape while those grown in winter are more topped-shaped. Colour also changes slightly with temperature, the best colour develops when temperatures are between 15 and 25° C. Information on varieties is presented in the following table.

CULTIVARS Beets	Source	Relative Days	Colour	Remarks
Crimson Globe	MF, P, SA	70	Crimson	D. mildew tolerance
Detroit Dark Red	MF, P, SA	75	Dark red	D. mildew tolerance
Early Wonder	MF, P, SA	65	Red	
Formonova	MF	70	Dark red	Cylindrical, low fibre
Red Cloud	P	70	dark red	

Swiss Chard (Spinach)	Source	Relative Days	Colour	Remarks
Fordhook Giant	MF, P, SA	60	dk. green with lt. midribs	heavily crinkled leaf
Lucullus	MF, P, SA	50	light green, cream midrib	wide midrib
Leda	P	50	light green, white midrib	lightly crinkled leaf, wide midrib
Redleg	P	60	red leaves	novelty type with red leaves

Source Key: MF = Mayford; P = Premier; SA = Starkes Ayres

Disease and Insect Control

Aphids

Damage: All stages of the insect feed in colonies by sucking plant juices from the tender growing parts, resulting in stunted, distorted growth.
Pest Description: Small, green, soft-bodied insects with or without transparent wings.
Cultural Control: Remove weeds surrounding the field.
Chemical Control: Apply insecticide when aphids are present and repeat as necessary.

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100ml	Rate Per ha	Days to Withhold
Rogor 400 ec	2.5	3.3	20ml	750ml	14
Malathion 25% wp	12.5	16.7	833g	2500g	7
Malathion 500 ec	4	5.3	200 ml	1200ml	7

Cercospora

Symptoms: Start as small round brown leaf spots with a purplish margin. The spot centers become light with time and may crack to produce a shot-hole appearance. Rotate to allow 2 years without beets, swish chard, and spinach.
Cultural Control:

- Destroy crop residues following harvest.
- Rotate crops on a three-year basis.
- Use good irrigation and fertilization practices, including the addition of sodium and boron.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100ml	Rate Per ha	Days to Withhold
captab wp	30	40	200-400g	1-2kg	3
Dusting with captab dp is an alternative to spraying					

Harvesting and Handling

Beets for fresh use are normally harvested when they are 5 to 8 cm in diameter. Those left until they reach a larger size often become fibrous and lose flavor. According to variety and season, the harvest stage will be reached within 12 to 15 weeks after sowing. Beets are lifted by hand, with care taken not to damage roots. The roots may be stored for a short period in the soil if markets are not available at the time.

Roots should be cleaned, and damaged ones removed before selling. They may be tied together in bunches with the tops attached for local markets. Beets lose moisture rapidly and must be sold shortly after harvesting. For distant markets, tops should be cut 4 to 5 cm above the bulb and then placed in mesh bags. They can be stored in cool, shaded areas with high humidity (90 to 95%) for several days.

Swiss chard is of best quality as soon as leaves reach full size, or just before this stage. Leaves left longer become tough. Larger leaves on the outside of the plant are harvested first, while smaller inner leaves are left for later harvests. Harvesting in this manner can result in three or more harvests from one planting. Leaves should be cut about 3 to 4 cm above the soil surface, cleaned, and sold immediately. Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

BROCCOLI, BRUSSELS SPROUTS, AND CAULIFLOWER

Broccoli, Brussels sprouts, and cauliflower are crops that grow best under cool conditions. Some varieties, especially of broccoli are heat tolerant and can be grown in summer, however. All three crops can withstand light frost, Brussels sprouts and cauliflower will with survive temperatures several degrees below zero.

Soils and Rotations

The cole crops (Cruciferae), including broccoli, Brussels sprouts, cauliflower, and cabbage, grow best on soils that have a good organic matter content and are well drained. The soil pH should range between 5.5 and 7.0. If the pH is less than 5.5, lime should be applied (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium). The remainder should be a calcitic lime.

Broccoli, cauliflower, Brussels sprouts, and related crops cabbage and turnips should not be planted more than once every 2 to 3 years in the same field. Most other crops work well to precede these crops in a rotation, especially legumes, since they add nitrogen to the soil. These crops respond well to kraal manure applied before planting. When manure is applied synthetic fertilizer usage should be reduced.

Fertilization

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken (see FSG 85) and sent to a soil testing laboratory about once every 2 to 3 years. However, in the absence of a soil test, the information in the table on page 33 can be used as a guide.

The sidedress application should be made about 4 weeks after field planting using LAN, ammonium nitrate, or urea. For early-maturing cultivars of broccoli, a sidedress may not be necessary if growth is vigorous. Both basal and sidedress applications should be banded. In the case of basal treatments, the fertilizer should be worked into the soil before setting the seedlings. Tables 1 through 5 on pages 2 and 3 provide guidelines for applying different fertilizers using a cold drink can.

Time of Planting

Broccoli, Brussels sprouts, and cauliflower can be grown during most months of the year in the Middleveld and Highveld. Temperatures a few degrees below freezing generally will not adversely affect the crops. Broccoli is the most sensitive of the three to frost, and heads may be damaged if temperatures fall below -2° C. During very warm temperatures, the quality of all three may suffer. See Tables 14 through 16 beginning on page 17 for recommended times to plant.

Seedling Production

Starting with a good-quality seedling that is free from diseases is very important for obtaining good results. Seedlings grown in trays can be purchased ready for field planting. If purchased from a reliable source and handled properly, these are worth considering. Using good management practices as outlined below, good-quality seedlings can be grown either in trays or in seedbeds by the farmer.

Trays: High-quality seedlings may be grown using either plastic or styrofoam trays. The size of the individual cells in the trays should be about 3 sq cm or larger. A suitable disease-free medium should be used to fill the trays. Several peat-based mixes with the required fertilizer materials already added can be purchased for filling the trays.

Moisture levels in the trays must be carefully managed. The soil mixture in the cells must never be allowed to completely dry. On the other hand, the trays must not be kept too wet. Allow the soil surface to dry slightly before adding more water. Then add water until it comes out the bottom of the trays. Check trays regularly, two or three times daily on hot, sunny days. Keep trays elevated from the ground and protected from animals.

Seedbeds: Sow seeds in rows about 20 cm apart and cover with 5 to 8 mm of fine soil. Lightly firm the soil over the seeds using a wooden row marker or flat piece of wood. Sow seedlings to obtain a final density of about 40 to 60 seedlings per metre of row. Thin to this stand about 1 week after emergence if necessary. Keep beds moist, but allow the soil surface to dry slightly before watering. See the section Seeds and Seedlings beginning on page 5 for additional information.

Field Spacing

Crop	Between Rows	Between Plants
Broccoli	90cm	50cm
Brussels Sprouts	90cm	40cm
Cauliflower	90cm	60cm

Field Planting

Plants should be set to the field about 4 weeks after emergence (before they reach 10 cm tall). Seedlings left in the seedbed or seed tray too long become leggy and are less able to withstand transplanting. Remove plants carefully from the seedbed to avoid damaging roots. Plants should be kept in a bucket of water to prevent roots from drying during the transplant operation.

Cool, cloudy days are best for transplanting. On clear days it is best to plant in late afternoon. Apply sufficient water immediately after transplanting to thoroughly wet the soil to a depth slightly below the roots of the seedlings. If soil is extremely dry, a light irrigation one day before transplanting will be necessary.

Irrigation

There are several critical times during the growing season when it is most important that adequate water be available to the plant for obtaining desired yields. First, to develop strong and healthy seedlings grown in the bed, it is necessary to apply frequent light irrigations during the seed germination stage. When the seedlings are transplanted, it is important that sufficient irrigation water be applied to wet the soil to a depth of about 40 cm. This will ensure a rapid early-season plant growth and a good deep root development. The third critical time when the plant needs sufficient water is during flowering and early fruit development. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to the section on irrigation beginning on page 8.

Variety Information

Information concerning selected varieties that may be grown can be found in the table on page 34. Additional information about a particular variety can be found in seed catalogs or from seed suppliers.

Suggested Fertilizer Rates

Rates of N-P-K (kg/ha)

	Medium yields	High yields	Timing
Broccoli			
Basal	100-150-100	100-150-100	at planting
Sidedress	20-0-0	20-0-0	4 wks. after planing
		20-0-0	8 wks. after planting
Brussels Sprouts and Cauliflower			
Basal	80-120-80	100-150-100	at planting
Sidedress	20-0-0	20-0-0	6 wks. after planing

Variety Information

Broccoli Cultivar	Season**	Source	Relative Days	Colour	Head Shape	Disease Reaction
Arcadia*	W, F	MF	100	green-blue	deep dome	tol. DM
Atlantic	W, F	MF	75 to 90	green	short, compact	
Dandy Early*	S, W	MF	60	green	semi-dome	tol. BR, DM
Green Valiant*	W, F,Sp	MF, P	70	green-purple	deep dome	tol. BR, DM
Komacta*	F,W,Sp	SA	75	dark green	dome	tol. BR, DM
Pinacles*	Sp,S,W	SA	70	dark green	dome shaped	tol. DM
Shogun*	Sp,F	MF	100	green with slight purple	dome	tol. BR, DM
Star 2201*	F,W,Sp	SA	80 to 90	dark green	semi-dome	tol. BR, DM
Brussels Sprouts Cultivar			**Relative Days**	**Colour**	**Head Shape**	
Jade Cross E*	W	SA	110	uniform sprouts	medium sized	
Prince Marvel*	W	MF	110	uniform sprouts	medium sized	
Royal Marvel*	W	MF	130	round sprouts	medium sized	
Cauliflower Cultivars			**Relative Days**	**Colour**	**Head Protection**	
Candid Charm*	F,W,Sp	MF	75	white	excellent	
Glacier*	S,W	MF	90	white	excellent	
Snowball Y	F,W,Sp	P	90	white	good	
Spring Snow*	F,W	MF	90	white	good	
Star 4401*	F,W,Sp	SA	95	white	very good	
White Rock	W	SA	110	very white	very good	

* indicates a hybrid cultivar.
** F = fall, S = summer, Sp = spring, W = winter
Disease Reaction Key:
BR = Black Rot
DM = Downy Mildew
Source key:
MF = MayFord
H = Hygrotech
P = Premier
SA = Starke Ayres

Disease and Insect Control

See "Disease and Insect Control" under cabbage for descriptions and nonchemical controls.

Chemical Control

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
American bollworm: Apply when the bollworm is noticed. Repeat when needed.					
Fastac ec	1ml	1.4ml	7ml	-	4
Rogor 200 ec	0.1	0.1	10ml	30ml	4
Aphids (various species): Apply when aphids appear. Repeat when needed.					
diazinon 275 ec	1.2	1.6	120ml	360ml	14
Rogor 400 ec	0.8	1.0	75ml	225ml	14
Malathion 25% wp	7.5	10.0	500g	1500 g	7
Malathion 500 ec	2.5	3.3	250ml	750ml	7
Malathion 5% dp	dust	dust	dust	20-30kg	7

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Bacterial black rot: The most important bacterial disease is black rot which appears as yellow and dead V-shaped areas at leaf edges. Practice a 3-year rotation. Try not to work in plantings when they are wet. Destroy plantings when harvest is finished. When necessary, grow resistant varieties. Use pathogen-free seed. Use only disease-free transplants. Sprays can be applied every 7-14 days to slow black rot development; the sprays are more effective for downy mildew control than for black rot control.					
copper oxychloride 85% wp	5.8	7.8	400g	1.2kg	3
Dithane M45 wp	4.8	6.4	200g	600g	3
Diamond-back moth: This is the most important insect on cabbage but it may not occur early. Malathion also controls aphids and helps control thrips. Spray when the insect is noticed. Repeat as necessary.					
Selecron 500 ec	3.3	4.4	333ml	1L	7*
Malathion 25% wp	7.5	10.0	500g	1.5kg	7
Downy mildew: Typical leaf spots are first pale green and later yellowish-white with mold on under-surfaces of leaves. Apply fungicide every 7-14 days at seedling stage. These sprays will also help slow spread of black rot.					
copper oxychloride 85% wp	5.8	7.8	400g	1.2kg	3
Dithane 80% wp	4.8	6.4	200g	600g	3
Red spider mites: Apply sprays when mites are noticed.					
Kelthane 18.5% wp	30g	40g	200g	600g	7

* for Brussels sprouts 10 days withholding period is required

Harvesting and Handling

Broccoli

Heads should be harvested after individual flower buds are well developed but still remain tight and closed. Once any sign of yellow petals shows, the head is no longer marketable. Flower buds will develop very rapidly when temperatures are above 25° C. Under these conditions heads will remain at peak quality for only a very short time. During very warm periods harvesting should be done every 2 to 3 days to prevent heads from overmaturing. This may be extended to 4 to 5 days when temperatures are cool. Heads should be cut so that 15 to 20 cm of stem remains attached. After the central or apical head is removed, lateral or side shoots often develop. Under periods of rapid growth, even though size is considerably smaller, these are often worthy of harvesting.

Broccoli is very perishable and should be marketed as soon as possible after harvesting, within one day of cutting. Remove heads to a cool, shady location as soon as they are cut. Heads should be cleaned, trimmed to a uniform length, and sorted before selling.

Brussels Sprouts

Sprouts should be harvested when they reach a marketable size (usually 25 to 40 mm) and are firm. Hybrid cultivars usually mature uniformly and most sprouts on the plant can be removed at one time. Open-pollinated cultivars are less uniform in maturity and often must be harvested selectively over a period of 1 or 2 weeks. High-quality sprouts are bright green and firm. Those which are off-color, wilted, or soft should be discarded.

Sprouts are highly perishable and should be removed to a cool, shaded location after harvesting and sold the same day.

Cauliflower

Cauliflower heads should be cut when they have reached full size, usually about 15 to 25 cm across, and the curds are still tight with no yellow or greening. At this stage the leaves are still healthy and green. After cutting, remove all leaves that do not wrap around the head. High-quality heads have creamy white and smooth-textured curds. This can only be attained if the head, while developing, is protected from direct sunlight (blanched). To protect the head from sunlight, tie the large outer leaves over the head as soon as it begins to form. Secure the leaves using strips of cloth, string, gum bands, or similar material. Some cultivars, termed "self-blanching," grow with the leaves naturally folding inward over the head, reducing the need to tie them. It is helpful to use a different color or type of tying material each day. Thus, plants ready for harvest on approximately the same day will have the same color or type of tie, eliminating the need to open all plants to check for maturity. The morning, when heads are still cool, is the best time to harvest. Keep harvested heads in a cool, shady location and sell the same day of harvest.

Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

CABBAGE

Cabbage is generally considered a cool-season crop; however, cultivars have been developed that grow well under very warm conditions. Cabbage can be grown any time of the year in almost all areas of Swaziland. Temperatures a few degrees below freezing will not adversely affect the crop. Matching the proper cultivar to the season is essential in cabbage production. Market prices are best in summer, however, cultivars to be grown should be heat tolerant and have good tolerance to black rot.

Soils and Rotations

Cabbage grows best on soils that have good organic matter content and are well drained. The pH of the soil should range between 5.5 and 7.0. If the pH is less than 5.5, lime should be applied (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium). The remainder should be a calcitic lime.

Cabbage or related crops (broccoli, cauliflower, Brussels sprouts, and turnips) should not be planted more than once every 2 to 3 years in the same field. Most other crop can be grown before cabbage in a rotation, especially legumes, since they add nitrogen to the soil. Cabbage responds well to kraal manure applied before planting. When manure is used synthetic fertilizer usage should be reduced by about 25%.

Fertilization

Lime and fertilizer, except for nitrogen, requirements can best be determined by use of a soil test. It is suggested that a soil sample be taken (see FSG 85) about once every 2 to 3 years. In the case of nitrogen, the rule is to supply about 130 kg/ha of actual nitrogen to the crop during the entire growing season. The exception to this would be during period of exceptionally frequent or heavy rains, when excessive leaching of the nutrient may occur.

LAN is generally recommended for the sidedress applications, however ammonium nitrate, or urea may also be used. Both basal and sidedress applications should be banded. In the case of basal treatments, the fertilizer should be worked into the soil before setting the seedlings. Table 2 through 5, beginning on page 3, provide a guide for making applications using different fertilizers with the cold drink can method.

The table on page 37 provides a guide for nitrogen application, and in the absence of a soil test, for phosphorous and potassium.

Seedling Production

Starting with a good-quality seedling that is free from diseases is very important for obtaining good results. Seedlings grown in trays can be purchased ready for field planting. If purchased from a reliable source and handled properly, these are worth considering. Using good management practices as outlined below, good-quality seedlings can be grown either in trays or in seedbeds.

The use of good-quality seedlings free of diseases is very important for successful production of tomatoes. Seedlings grown in trays can be purchased ready for field planting. If purchased from a reliable source and handled properly, these are worth considering. When good management practices, as outlined below, good-quality seedlings can be grown by the farmer, either in trays or in seedbeds.

Trays, either plastic or styrofoam, with individual cells of 5 sq cm or larger size, can be used. A suitable disease-free medium should be used to fill the trays. Several peat-based mixes with the required fertilizer materials already added can be purchased for filling the trays.

Moisture levels in the trays must be carefully managed. The soil mixture in the cells must never be allowed to completely dry. On the other hand, the trays must not be kept too wet. Allow the soil surface to dry slightly before adding more water. Enough water should then be added to completely wet the medium in the cells. Check trays regularly, often two or three times daily on hot, sunny days. Keep trays elevated off the ground and protected from animals.

Seedbeds, should be prepared according to directions under "Seedbeds" on page 6. Space rows about 20 cm apart and cover with 5 to 8 mm of fine soil. Lightly firm the soil over the seeds using a wooden row marker or flat piece of wood. Sow seedlings to obtain a final density of about 40 to 60 seedlings per metre of row. Thin to this stand about 1 week after emergence if necessary. Keep beds moist, but allow the soil surface to dry slightly before watering.

Field Planting

Plants should be set to the field in about 4 weeks after emergence (before they reach 10 cm tall). Seedlings left in the seedbed or seedtray too long become leggy and are less able to withstand transplanting. Remove plants carefully from the seedbed so as not to severely damage roots. Plants should be kept in a bucket with water to prevent roots from drying during the transplant operation

Cool, cloudy days are best for transplanting. On clear days it is best to plant in late afternoon. Apply sufficient water immediately after transplanting to thoroughly wet the soil to a depth slightly below the roots of the seedlings. If soil is extremely dry, a light irrigation one day prior to transplanting is recommended.

Field Spacing

The spacing between plants controls to some degree the size of the mature head. If very large heads are desired, spacing should be increased slightly.

Single Row Prod. System		
Between Rows	Between Plants	
90 cm	25 to 40 cm	
Double Row Prod. System		
Between Beds	Between Rows on Bed	Between Plants
1.5m	30cm	35 - 45cm

Irrigation

There are several critical times during the cabbage growing season when it is most important that adequate water be available to the plant if desired yields are to be obtained. First, to develop strong and healthy seedlings grown in beds, it is necessary to apply frequent light irrigations during the seed germination stage. Then, when cabbage seedlings are transplanted, it is important that sufficient irrigation water be applied to fill the soil to a depth of about 50 cm. This will ensure rapid early-season plant growth and a good deep root development.

The third critical time that the cabbage plant needs optimal water is during the formation of the head and up to near harvest time. For more detailed information on determining when to irrigate and how much irrigation water to apply, please see page 8.

Variety Information

Selection of the right variety to be grown is an important step to success. Cabbage varieties differ considerably in their ability to withstand summer temperatures and their resistance to disease. Information on selected varieties can be found in the table on the next page.

Recommended Rates Of Nitrogen And Suggested Rates Of P And K To Use When A Soil Test Information Is Not Available

Rates of N-P-K (kg/ha)

	Medium yields	High yields	Timing
Basal	60-90-60	80-120-80	at planting
Sidedress	20-0-0	20-0-0	3 wks. after planting
	20-0-0	20-0-0	8 wks. after planting

Suggested Varieties

Cultivar	Source	Relative Days	Head Shape	Season	Holdability	Black Rot Rest./Remarks
Baby Ball*	P	60	ball	S &	3	3
Big Cropper*	MF	90	semi-ball	S & W	3	3
Cape Spitz	SA	80	conical	W	2	2
Conquest*	MF	80	ball	S & W	2	3
Conquistador*	MF	90	semi-ball	S & W	3	4
Green Star*	SA	80	ball	S & W	4	3
Green Crown*	P	90	semi-ball	W	3	2
Green Kid*	H, P	80	ball	S & W	3	4
Grand Slam*	H, MF	85	ball	S & W	5	3, also DM, Y
Green Coronet*	SA	100	ball	W	3	3
Hercules *	H, MF, P	85	semi-flat	S & W	3	4
Kingcab*	P	70	semi-flat	S & W	4	3, also DM
Perfection Cross*	SA	70	semi-ball	W	3	2
Star 3301	SA	80	ball	S & W	4	4
Tenacity*	MF	90	ball	S	4	5
Topmost*	MF	90	ball	W	4	4, also mosaic virus
Spitzo*	MF	80	conical	W	2	0

Specialty Types Cultivar	Source	Relative Maturity (days)	Head Shape	Season	Remarks
Scarlet O'Hara*	P	85	ball	S & W	Red leaves, excellent for baby cabbage
Ruby Ball*	SA	75	ball	W	Red leaves

Chinese Cabbage Cultivar	Source	Type	Head Shape	Season	Remarks
Blues*	SA	napa	barrel	S & W	smooth, tender leaves, tolerant to alternaria
Kinap*	P	napa	elongated barrel	Fall and Winter	smooth, tender leaves
Michihilli	H,	Chinese,	ball	S & W	leaves savoyed, pubescent

* indicates a hybrid cultivar

Source Key: MF = Mayford, H - Hygrotech, P = Premier, SA = Starke Ayres

Disease and Insect Control

American Bollworms

Damage: Larvae feed on plant leaves and flower heads.

Pest Description: Full-grown larvae are about 40 mm in length. They vary from near black, brown, or green to pale yellow or pink, with a characteristic dark band along the back and light bands along each side.

Cultural Control: Hand pick larvae from crop.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when the bollworm is noticed. Repeat when needed.					
Decis 25 ec	0.25	0.33	20ml	-	3
Karate 50ec	1ml	1.4ml	8ml	-	2
Ripcord 200 ec	0.1	0.1	10ml	30ml	4

Aphids

Damage: Insects feed in groups or colonies and suck plant juices from the leaves, resulting in stunted, deformed growth.
Pest Description: Small, green, soft-bodied insects with or without transparent wings.
Cultural Control: Excessive nitrogen has been associated with high populations.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Aphids (various species): Apply when aphids appear. Repeat when needed.					
diazinon 275 ec	1.2	1.6	120ml	360ml	14
Malathion 25% wp	7.5	10.0	500g	1500 g	7
Malathion 500 ec	2.5	3.3	250ml	750ml	7
Rogor 400 ec	0.8	1.0	75ml	225ml	14

Bagrada Bugs

Damage: Insects feed by sucking plant juices, resulting in leaf death.
Pest Description: Small, black, shield bugs with orange and yellow spots and an orange cross on the back.
Cultural Control: None recommended.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Bexadust dp	dust plants			15 - 20kg	30
Lindane 200ec	3	4	300ml	-	30
Curaterr gran	200g per 100m of row before planting				77

Black Rot (Bacterial Spot)

Symptoms: The most important bacterial disease is black rot which appears as yellow and dead V-shaped areas at leaf edges. When cut, leaf veins are black inside plant stems, petioles and leaves. Some of the oldest leaves may wither and die.
Cultural Control:

- Use treated seed.
- Practice good seedbed sanitation and prepare seedbeds well.
- Practice a 3-year crop rotation. Avoid working in plantings when they are wet. Destroy plants after harvest. Use pathogen free seed, seed that has been treated is best. Use only disease-free seedlings.
- Use resistant varieties.

Chemical control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Sprays can be applied every 7-14 days to slow black rot development; the sprays are more effective for downy mildew control than for black rot control.					
copper oxychloride 85% wp	5.8	7.8	400g	1.2kg	3
Dithane M45 wp	4.8	6.4	200g	600g	3

Diamond Back Moth

Damage: Young larvae mine the leaves, later feeding on the exterior undersides of leaves and producing small holes.
Pest Description: Small, green caterpillars.
Cultural Control: None recommended.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Applied when pest is noticed. Be careful to spray underside of leaves.					
Decis 25 ec	0.25	0.33	20ml		3
Fastac 100ec	1ml	1.4ml	8ml	-	4
Malathion 50 ec	2.5	3.3	250ml	-	7
Selecron 500 ec	3.3	4.4	333ml	1L	7*

* for Brussels sprouts 10 days withholding period is required

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Downy Mildew

Symptoms: Typical leaf spots are first pale green and later yellowish-white with mold on under-surfaces of leaves. The disease often occurs in seedbeds.
Cultural Control:
- Do not overcrowd plants.
- Practice proper irrigation.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply fungicide every 7-14 days at seedling stage. These sprays will also help slow spread of black rot.					
copper oxychloride 85% wp	5.8	7.8	400g	1.2kg	3
Dithane M45 wp	4.8	6.4	200g	600g	3

Greater Cabbage Moths

Damage: Young caterpillars feed in clusters on the leaves.
Pest Description: Young caterpillars are green. As they mature their backs become lined with white and black spots. Feeding in groups they spin a thin web over the leaf.
Cultural Control: None recommended.
Chemical Control: Same controls as for Diamond Back Moth.

Red Spider Mites

Damage: Mites feed in colonies on the undersides of leaves, producing a yellowing or bronzing color.
Pest Description: Very small spider-like mite with reddish, oval body and four pairs of legs.

Cultural Control: None recommended.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply sprays when mites are noticed.					
Kelthane 18.5% wp	30g	40g	200g	600g	7

WEED CONTROL

Control of weeds is very important throughout the season if good yields of quality product are to be obtained. With some crops such as cabbage, chemical herbicides may be safely used to aid in weed control. However, herbicides must be used with care to obtain control and prevent damage to the crop or environment. Only chemicals labeled for the particular crop must be used and directions on the label need to be followed. Care must be taken to prevent the herbicide drifting to other crops during application and the sprayer used should never used to apply chemicals for disease or insect control. Page 10 contains additional information regarding the use of herbicides.

Suggested Chemical Controls

Dacthal (chlorothal) 75 wp.
Rate: 9 to 14 kg per hectare.
Time: Apply at time transplanting or direct seeding to the field. May be applied preplant incorporated.
Control: Annual grasses and some broadleaf weeds.
Remarks: Rates vary according to soil type.
Crop Rotation: Replanting crops other than those that are listed on the label within 8 months of application may result in crop injury.

Nabu (sethoxydim) 186 ec.
Rate: 1 to 3 litres per hectare.
Time: Apply postemergence, when grasses have reached the 2 leaf stafe. May be applied preplant incorporated.
Control: Grasses. If grasses become to old by tiime of application control will be reduced.
Remarks: Rates vary according to the type of grass to control. Avoid applying within 2 to 3 days of other pesticides to prevent crop injury. Observe a 30 day interval befor harvest.
Crop Rotation: see label.

Goal 240 ec (oxyfluofenl)
Rate: 3 litres per hectare.
Time: Apply preemergence to a well prepared soil surface. Transplant the crop and irrigate immediately.
Control: Some annual grasses and many broadleaf weeds.
Remarks: Rates vary according to soil type. More than one treatment may be applied, up to within 45 days of harvest.

Harvesting and Handling

It is generally best to cut heads so that only three or four wrapper leaves remain. After harvesting, keep heads out of direct sunlight. Remove all loose wrapper leaves and those which are diseased or are soiled before putting in shipping bags or storing for extended periods. Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

An acceptable yield should exceed 30,000 kg/ha; very good yields can exceed 80,000 kg/ha.

CARROTS

Soils and Rotations

Carrots grow best on sandy or sandy loam soils that are deep, loose, and well drained. Avoid heavy soils high in clay and those which are compacted, since they often produce misshapen roots. Soils infested with root-knot nematodes should be avoided since these pests cause roots to be short and poorly shaped. Soil pH should range between 5.5 and 7.0. If the pH is less than 5.5, lime should be applied (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium). The remainder should be a calcitic lime.

Crops should be rotated so that carrots are not planted on the same land area more than once in 3 years. Carrots respond well when planted after cabbage or leafy vegetables in a rotation.

Fertilization

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken once every 2 to 3 years (see FSG 85) and sent to a reliable soil testing laboratory. However, in the absence of a soil test, the following can be used as a guide:

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
40-60-40	60-90-60	at planting
Topdress		
Medium yields	High yields	Timing
20-0-0	20-0-0	4 wks. after planing

The sidedress application should be made about 5 weeks from field planting using LAN, ammonium nitrate, or urea. Both basal and sidedress applications should be banded. In the case of basal treatments, the fertilizer should be worked into the soil before sowing the seeds. Tables 1 through 5, beginning on page 2 provide a guide for making applications of different fertilizers using a cold drink can.

Time of Planting

Carrots are a cool season crop that are not damaged by cool temperatures or light frosts. They can be grown throughout the year in most areas, except for the summer months in the Lowveld. Summer production is not difficult in other regions, since there are few serious summer diseases affecting carrots. See Tables 14 through 16 for suggested times to plant.

Field Spacing

Rows: single rows - 45 cm apart
double rows 15 to 20 cm apart
spaced on 90-cm centres.
In row: 2 to 3 cm between plants

Field Planting

Carrots should be sown directly to the field in which they will be grown to maturity. The soil should be well prepared, free of stones, clods, and other debris. The seeds should be sown in rows so that the final stand of plants will be about 2 to 3 cm apart. If sown more densely than this, excess seedlings should be thinned within 2 to 3 weeks after emergence.

Seeds should be sown in a moist soil to a depth of about 8 to 12 mm. Cover seeds with soil free of large clods or clumps of sod. Firm the soil lightly over the seeds. Mechanical planters are available that open a furrow, drop the seed, and cover seeds with soil.

Soil moisture must be maintained carefully during germination and establishment of the young seedlings. A light grass mulch placed over the row helps prevent the soil from drying and crusting. The grass should be pulled to the side of the seedlings or removed altogether after seedlings have emerged.

Irrigation

Wide variations in soil moisture levels should be avoided to prevent splitting of the roots. There are a couple of critical times

during the carrot growing season when it is most important that adequate water be available to the plant if desired yields are to be obtained. First, to develop strong and healthy seedlings, it is necessary to apply frequent light irrigations during the seed germination stage. After thinning, it is most important that sufficient irrigation water be applied to fill the soil to a depth of about 60 cm. This will ensure rapid early-season plant growth, good deep root development, and, in turn, big carrots.

Subsequent irrigations throughout the remaining growing season until harvest should be scheduled when 50% of the available water in the root zone has been depleted. Prevent the soil from getting overly dry for this may result in carrots of non-uniform shape. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to the section on irrigation beginning on page 8.

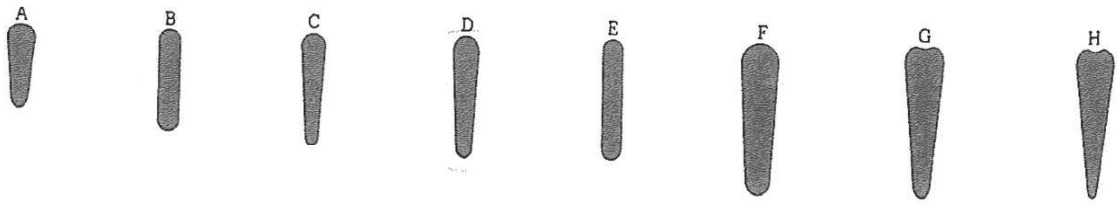
Variety Information

The varieties listed below are suitable for both summer and winter production. Roots of a given variety tend to be shorter and have a more blunt end when grown in summer as compared to winter. Colour also changes slightly with temperature, with the best colour developing when temperatures are between 15 and 25 °C. The following table provides information on selected varieties.

Variety Information

Cultivar	Relative Maturity	Root Shape	Alternaria Resistance	Features
Amsterdam	early	D	3	prepacks, baby
Brazilia	mid-early	D	4	fresh market
Cape Market	medium	G	2	fresh market
Clarion *	late	E	2	fresh market
Keystone Danvers	medium	H	4	fresh market
Kono Red Horn	late	H	4	fresh market
Kuroda	mid-late	G	4	fresh market
Kuronan	mid-late	B	4	prepacks
Minette		E	2	prepacks
Mokum *	medium	B	3	baby carrots
Nantes	early	B	2	fresh market
Parano *		E		fresh market
Red Core Chantenay	mid-late	A&G	2	fresh market
Topanova	medium	F	4	prepacks

* Indicates hybrid cultivar
Disease resistance key: 1 = low, 5 = high
Uniformity: 1 = poor, 5 = excellent
Shape:



Disease and Insect Control

Aphids

Damage: All stages of the insect feed in colonies by sucking plant juices from tender plant parts, resulting in stunted, distorted growth.

Pest Description: Small green, soft-bodied insects with or without transparent wings.

Cultural Control: Remove weeds surrounding the field.

Chemical Control:

Chemicals	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Begin sprays when aphids are present. Continue at 10-14 day intervals as needed.					
diazinon 275 ec	4	5.3	400ml	1200ml	3
Malathion 50 ec	1.5	2	153ml	460ml	7

Leaf Blight (Alternaria)

Symptoms: Small dark leaf spots occur and sometimes are associated with yellowing. Spots can expand rapidly and can result in shriveling of entire leaves. Some cultivars are tolerant to Alternaria leaf spot.

Cultural Control:

- Plant in well-drained soil.
- Rotate crops on a three-year basis.
- Use a resistant variety.

Chemical Control: When tolerant cultivars are used, fungicides may not be necessary.

Chemicals	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
No fungicides were labeled on carrots in South Africa in 1992. Both chlorothalonil (Bravo) and iprodione (Rovral) are labeled in the US as of 1995.					
Bravo 500 ec	2	2.5	173-211ml	518-633ml	0
Rovral 50% wp	9-18g	12-24g	61-121g	183-364g	0

Harvesting and Handling

Carrots should be harvested when they reach a size appropriate for the cultivar. For most fresh market carrots this is a shoulder diameter of 3 to 5 cm. According to variety and season, this will be within 12 to 15 weeks after sowing. Care must be taken when lifting so the roots are not damaged. The roots may be stored for a short period in the soil if markets are not available at the time.

Wash and sort roots, removing damaged, split, and short, stubby ones. Roots may be tied together in bunches with tops attached for local markets. Carrots lose moisture rapidly and must be sold shortly after harvesting. For distant markets tops should be removed from the roots. The carrots are often shipped in a mesh bag. In cool, shaded areas with high humidity (90 to 95%) they can be stored for several days. Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

An acceptable yield should be 20,000 kg/ha or greater.

CUCUMBERS

Soils and Rotations

Cucumbers grow best on sandy or sandy loam soils that are deep, loose, and well drained. Soil pH should range between 5.5 and 7.0. If the pH is less than 5.5, lime should be applied (see Table 6). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium). The remainder should be a calcitic lime.

Crops should be rotated so that cucumbers and related crops (melons, pumpkins, and squash) are not planted on the same land area more than once in 2 years. Cucumbers respond well to additions of organic matter and are a good crop on which to apply kraal manure (before planting). If manure is added, the amount of synthetic fertilizer applied should be reduced.

Fertilization

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken once every 2 to 3 years (see FSG 85) and sent to a reliable soil testing laboratory. However, in the absence of a soil test, the following can be used as a guide:

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
60-90-60	60-90-60	at planting
20-0-0	20-0-0	4 wks. after planing
Sidedress		
0	20-0-0	first flowering

A sidedress application should be when the plants begin to flower, using LAN, ammonium nitrate, or urea. Both basal and sidedress applications should be banded. In the case of basal treatments, the fertilizer should be worked into the soil before sowing the seeds.

Time of Planting

Cucumbers are a warm-season crop and are sensitive to cool temperatures or light frosts. They can be grown in most areas during summer and in regions that do not get frost in winter months. See Tables 14 through 17 for recommended times for planting.

Field Spacing

Rows: 1.2m apart
In row: 30cm between plants

Field Planting

Cucumbers should be sown directly to the field in which they will be grown to maturity. The soil should be well prepared, free of stones, clods, and other debris. The seeds should be sown in rows so that the final stand of plants will be about 25 to 30 cm apart. If sown more densely than this, excess seedlings should be thinned within 2 to 3 weeks after emergence.

Seeds should be sown in a moist soil to a depth of about 20 mm. Cover seeds with soil free of large clods or clumps of sod. Firm the soil lightly over the seeds. Mechanical planters are available that open a furrow, drop the seed, and cover seeds with soil.

Soil moisture must be maintained carefully during germination and establishment of the young seedlings. A light grass mulch placed over the row after seeding helps prevent the soil from drying and crusting. The grass should be pulled to the side of the seedlings after seedlings have emerged.

Cucumbers responds well to a mulch, such as black plastic or grass. These help to reduce weed growth and conserve soil moisture, often resulting in increased yields. Mulches can be readily used with a raised, flat-topped bed system (see page 10).

Irrigation

There are several critical times during the growing season when it is most important that adequate water be available to the plant for obtaining desired yields. First, to develop strong and healthy seedlings, it is necessary

to apply frequent light irrigations during the seed germination stage. After thinning it is most important that sufficient irrigation water be applied to fill the soil to a depth of about 80 cm. This will ensure a rapid early-season plant growth and a good deep root development. The third critical time when the plant needs sufficient water is from flowering until harvest time. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to the irrigation section beginning on page 8.

Variety Information

Selection of the right variety to be grown is an important step to success. Varieties differ in their ability to withstand summer temperatures and their resistance to diseases. Information on selected varieties can be found in the table below.

Variety Information

Cultivar	Source	Maturity (days)	Shape	Flowering Habit	Use	Disease Resistance
Centurian*	SA	40	Straight, tapered	mostly female	Slicing	A, ALS, CMV, DM, PM
Comet A*	MF	60	Straight, tapered	mostly female	Slicing	A[1], ALS[1], CMV[1], S, DM[1], PM[1]
Dasher II	H	60	Straight, tapered	mostly female	Slicing	A, ALS, CMV, DM, PM, S
Delilah*	P	60	Straight, tapered	mostly female	Slicing	
Delight Green*	P	55	Straight, tapered	mixed	Slicing	CMV, DM, PM
Monarch*	MF	50	Straight, tapered	mixed	Slicing	A[1], ALS[1], CMV[1], S, DM[1], PM[1]
Sweet Crunch*	MF	60	Cylinder, blunt	mostly female	Pickling	DM[1], PM[1]
Special Rust Rest.	P	70	Straight, tapered	mixed	Slicing	A, ALS, DM, PM
Sweet Slice	H	55	Long, tapered	mixed	Slicing	CMV, DM, PM, WMV
Victory	H	60	Straight, round end	mostly female	Slicing	A, CMV, DM, PM, S
Score*	MF	50	Blocky	mixed	Pickling	A[1], ALS[1], CMV[1], S, DM[1],
Star 4001*	SA	45	Cylinder, blunt	mixed	Pickling	CMV, PM, S
Bella	SA	50	Slender, taper	all female flowers	Tunnel prod.	DM[1], PM

* Indicates hybrid cultivar
[1] = Indicates tolerance to disease as opposed to resistance

Disease Reaction Key:

A = Anthracnose	DM = Downy mildew
ALS = Angular leaf spot	PM = Powdery mildew
CMV = Cucumber mosaic virus	S = Scab

Source key:
MF = MayFord
H = Hygrotech
P = Premier
SA = Starke Ayres

Disease and Insect Control

Anthracnose

Symptoms: Symptoms appear as ragged spots on old leaves and circular sunken spots on fruit. Leaf spots may enlarge and tear, making the leaf appear scorched and torn.

Cultural Control : Disease is transmitted by seed; therefore, use only healthy or treated seed. Follow a 3-year rotation.

Chemical Control:

Chemicals	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Spray at 7-10 day intervals when disease is present. When disease pressure is high, a low rate of Benlate added to the Bravo or Dithane sprays has helped in the US.					
Bravo 75% wp	30-60g	40-80g	200-400g	up to 1500L	3
Bravo 500 sc	5-9	7-12	500-917ml	1.5-2.75L	3
Dithane M45 wp	4.8	6.4	200g	up to 1500L	3
Benlate 50% wp	0.9	1.2	30g	90g	3

Aphids

Damage: All stages of the insect feed in colonies by sucking plant sap from tender plant parts, resulting in stunted, distorted growth.

Pest Description: Small green, soft-bodied insects with or without transparent wings.

Cultural Control: Remove weeds surrounding the field.

Chemical Control:

Chemical(s	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply aphicide when aphids are present. Repeat as necessary.					
Rogor 400 ec	0.8	1	75ml	225ml	14
Malathion 25% wp	3.8	5	25g	750g	7
Malathion 5% dp	dust`	dust	dust	15-30kg	7

Downy Mildew

Symptoms: Symptoms start as yellowish leaf spots with gray mold on the bottom leaf surface under yellowish spots. In advanced stages, the leaf appears to dry up and dies, sometimes beginning at the margin.

Cultural Control:

- Use good irrigation practices.
- For susceptible crops, grow them in dry areas with well-drained soil.
- Follow crop rotation.
- Isolate new plantings from older plantings.

Chemical Control: Start spraying at first sign of disease. Continue weekly when weather is humid. In South Africa, the 400 gm/100 litres of spray mixture may be needed at a rate of up to 1500 litres of spray per ha. If necessary, fosetyl Al/Dithane (Mikel-M) and propamocarb (Previcur N) are two new fungicides with systemic properties, and should provide excellent control.

Chemical(s	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Bravo 75% wp	30-60g	40-80g	200-400g	0.6-1.2kg	3
Bravo 500 sc	5-9	7-12	0.5-0.9L	1.5-2.8L	3

Downy Mildew cont. Chemical(s	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold
copper oxychloride 85% wp	4.4	5.8	300g	90g	3
Dithane M45 wp	4.8	6.4	200g	600g	3
Mickel-M 44%/26%wp	37.5g	50g	50g	75 g	3

Powdery Mildew

Symptoms : A fungus disease first appearing white powdery growth on the undersides of leaves, and later forming on upper leaf surfaces and stems. Infected leaves shrivel and turn brown as they die.

Cultural Control: Grow tolerant varieties when possible.

Chemical Control: Powdery Mildew is prevalent when conditions are hot and dry. When sprays are needed, Benlate (Benlate) and Bayleton (triadimefon) are highly effective materials unless the fungus develops resistance to the fungicides. To slow or prevent development of resistance, alternate Benlate and Bayleton every 14 days, and apply Bravo each week when Benlate or Bayleton is not used.

Chemical(s	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Benlate 50% wp	1.5	1.9	50g	0.5kg in 1000	3
Bayleton 50% wp	2.3g	3g	15.2g	45.6g	0
Bravo 500 sc	5-9	7-12	0.5-0.9 L	1.5-2.8L	3

Pumpkin Flies

Damage: Adult flies lay eggs in young fruit, and maggots develop inside.

Pest Description: Adults are brown-colored flies with yellow bands or spots. Larvae are white, legless maggots found inside developing fruit.

Cultural Control: None recommended.

Chemical Control:

Chemical(s	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold

Fenthion (Lebaycid) should be applied as a full cover spray, and can be repeated at 1-2 week intervals. Malathion is applied as a bait to leaves; mix 3 gm of 25% wp, or 2 ml of 500 ec material with 80g of sugar and a small amount of water and apply as large droplets to leaves. Repeat weekly or after rain.

Lebaycid 500 ec	1.2	1.6	120 ml	360ml	10
Malathion 25% wp	bait	bait	See above	300g	10
Malathion 500 ec	bait	bait	See above	175ml	10

Red Spider Mites

Damage: Mites feed in colonies on the undersides of leaves, producing a yellowing or bronzing color.

Pest Description: Very small spider-like mite with a reddish oval body and four pairs of legs.

Cultural Control: None recommended.

Chemical Control:

Chemical	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when mites are noticed.					
Kelthane 18.5% wp	30g	40g	200g	600g	7

Scab

Symptoms: Symptoms always are most prevalent on the youngest plant parts. The symptoms include large ragged leaf spots (on the youngest leaves) surrounded by a yellow halo, spots and elongated streaks on young petioles and vine tips, dead areas on young leaves, and small dark depressed spots that later display a gray sooty growth on young fruit. Infection is promoted by wet and cool conditions.

Cultural Control: Scab is delayed by rotation and isolation from older plantings.

Chemical Control: Fungicides are needed before infection occurs and symptoms start to appear. Rates of Bravo that are labeled and effective in the US are lower than those in South Africa. If necessary, the following rates for 15 L, 20 L, and 100 L can be increased by 50% (e.g. from 5 scoops to 7.5 scoops). If necessary, it may be more helpful to increase the volume of spray material/ha than increasing the rate/ha applied in the same low volume.

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Bravo 500 sc	5	7	0.5 L	1.5-2.75 l	3
Bravo 75% wp	30g	40g	200g	0.6-1.2 kg	3

Thrips

Damage: Young plants are damaged by thrips, causing the plants to become deformed. Plant sap is removed by insects feeding on the lower leaf surfaces. Heavy feeding can kill young plants.

Pest Description: Very small elongated insects about 1 mm in length with four long, narrow, fringed wings. Thrips may be orange-yellow to black in colour and are very active.

Cultural Control: Destroy crop residue following harvest.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Thrips: Apply when thrips are noticed. Repeat after 10-14 days.					
Malathion 25% wp	3.7	5.0	250g	750g	7

Harvesting and Handling

Slicing cucumbers should be harvested when they are firm, have a dark green color, and are about 15 to 25 cm in length. Length is not the best determinant of when to harvest, since this will sometimes vary with the cultivar. Always harvest before the green color begins to fade and yellow or white begins to show at the ribs, as this is a sign of overmaturity. Pickling cucumbers are harvested at a much smaller size (often 15 to 70 mm). The size depends upon the market. Cucumbers develop rapidly and must be harvested several times per week.

Fresh-market cucumbers should be graded for appearance, size, and uniformity. Soiled fruit should be cleaned, and damaged or misshapen fruit discarded. Fruit should be kept in the shade after harvesting and sold within one or two days. An acceptable yield should be 8,000 kg/ha or greater.

EGGPLANT

Soils and Rotations

Eggplant grow best on soils that have a good organic matter content and are well drained. The soil pH should range between 5.5 and 7.0. If the pH is less than 5.5 lime should be applied (see Table 6 o page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium); the remainder should be a calcitic lime.

Crops should be rotated so that eggplant are not grown on the same land more than once in 3 years. Other crops that should not be grown for 2 or more years before eggplant include potatoes, tomatoes, peppers, groundnuts, tobacco, and cowpeas. Diseases that survive in the soil (bacterial, Fusarium, and Verticillium wilts) often develop when these crops are grown year after year on the same land. Once these diseases are present, it generally takes a 7-year period in which none of these crops are grown to eliminate the organisms from the soil.

Fertilization

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken about once every 2 to 3 years (see FSG 85) and sent to a reliable soil testing laboratory. However, in the absence of a soil test, the following can be used as a guide:

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
60-90-60	80-120-80	at planting
Sidedress		
20-0-0	20-0-0	4 wks. after planing
20-0-0	20-0-0	7 wks. after planing

In the case of basal treatments, the fertilizer should be worked into the soil before setting the seedlings.

Eggplant, if diseases and insects are effectively controlled, can be held for more than one crop cycle. If this is done, a additional sidedress of 20-40-20 should be made after about 3 months. Both basal and sidedress applications should be banded.

Time of Planting

Eggplant are warm-season perennials that are sensitive to low temperatures. They make their best growth when temperatures are between 18 to 30° C. When night temperatures drop below 15° C, growth is slowed and fruit set reduced. Given these limitations, eggplant can be grown in areas of the Middleveld and Highveld when minimum temperatures are generally above 12 to 15° C and in the Lowveld throughout the year. See Tables 14 through 17 beginning on page 16 for recommended times to plant.

Seedling Production

The use of good-quality seedlings free of diseases is very important for successful production of tomatoes. Seedlings grown in trays can be purchased ready for field planting. If purchased from a reliable source and handled properly, these are worth considering. With good management practices, as outlined below, good-quality seedlings can be grown by the farmer, either in trays or in seedbeds.

Trays, either plastic or styrofoam, with individual cells of 5 sq cm or larger size, can be used. A suitable disease-free medium should be used to fill the trays. Several peat-base mixes with the fertilizer materials already added can be purchased for filling the trays.
Moisture levels in the trays must be carefully managed. The soil mixture in the cells must never be allowed to completely dry. On the other hand, the trays must not be kept too wet. Allow the soil surface to dry slightly before adding more water. Enough water should then be added to completely wet the medium in the cells. Check trays regularly, often two or three times daily on hot, sunny days. Keep

trays elevated off the ground and protected from animals.

Seedbeds should be prepared according to directions on pages 6 to 8. Space rows about 20 cm apart and cover with 5 to 8 mm of fine soil. Lightly firm the soil over the seeds using a wooden row marker or flat piece of wood. Sow seedlings to obtain a final density of about 40 to 60 seedlings per metre of row. Thin to this stand about 1 week after emergence if necessary. Keep beds moist, but allow the soil surface to dry slightly before watering.

Field Spacing

Rows: 0.9m
In row: 50cm between plants

Field Planting

Eggplant respond very well to a mulch, such as black plastic or grass, often resulting in yield increases of 100 to 200%. Mulches can be readily used with the raised bed system as described for peppers. If the ridge and furrow system is used, plants should not be set in the lower section of the furrow.

Plants should be set to the field in about 7 to 8 weeks (when they reach 12-14 cm in height). Seedlings left in the seedbed or seed tray too long become excessively hardened and are less able to withstand transplant shock. Remove plants carefully from the seedbed to avoid damaging the roots. Seedlings from the seedbed should be kept in a bucket of water to prevent roots from drying during the transplant operation.

Cool, cloudy days are best for transplanting. On clear days it is best to plant in late afternoon. Apply sufficient water immediately after transplanting to thoroughly wet the soil to a depth slightly below the roots of the seedlings. If soil is extremely dry, a light irrigation one day before transplanting may be beneficial.

For transplanting on hot, dry days a spray application of an antitranspirant material (e.g., VaporGard) may help reduce water loss in the plant. Spray plants immediately after transplanting, covering the entire plant leaf surface, using a mixture of 1 part VaporGard to 100 parts water.

Irrigation

There are several critical times during the eggplant growing season when it is most important that adequate water be available to the plant for obtaining desired yields. First, to develop strong and healthy seedlings grown in beds, it is necessary to apply frequent light irrigations during the seed germination stage. When seedlings are being transplanted, it is important that sufficient irrigation water be applied to fill the soil to a depth of about 65 cm. This will ensure rapid early-season plant growth and a good deep root development. The third critical time when sufficient water is needed is during flowering and as the fruit is developing until near harvest time. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to the section on irrigation beginning on page 7.

Variety Information

Selection of the right variety to be grown is an important step to success. Varieties differ in their ability to withstand summer temperatures and their resistance to diseases. Information on selected varieties can be found in the table on the next page.

Variety Information

Cultivar	Source	Maturity (days)	Shape	Colour	Disease tolerance	Remarks
Black Beauty	MF, SA	80	Oval	Deep purple		
Blackbell*	H	70	Round - oval	Deep purple	TMV	
Black King	SA	80	Oval	Deep purple		Heat tolerance
Dusky*	H	65	Oval	Black	TMV	
Ebany*	P	65	Oval - tapered	Black	TMV, CMV	
Epic*	H	65	Oval	Deep purple	TMV	
Florida Market	MF, SA	85	Tapered	Deep purple		
Jet Set*	P	70	Oval	Deep Purple	Phompsis	Heat tolerant
Long Purple	MF, SA	75	Long taper	Med. purple		Space closer

* Indicates hybrid

Disease Reaction Key:

CMV = cucumber mosaic virus	TMV = tobacco mosaic virus

Source key:
MF = MayFord
H = Hygrotech
P = Premier
SA = Starke Ayres

Disease and Insect Control

Aphids

Damage: All stages of the insect feed in colonies by sucking plant juices from tender plant parts, resulting in stunted, distorted growth.
Pest Description: Small green, soft-bodied insects with or without transparent wings.
Cultural Control: Remove weeds surrounding the field.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Apply when aphids first are present. Repeat sprays as needed.					
Malathion 5% dp	dust	dust	dust	15-30kg	3
Malathion 25% wp	1.5	2	667g	2kg	3

Erinose Mites

Damage: Mites feed on buds and interior leaves, making leaf edges curl downward and inward. On older leaves, feeding area becomes swollen, with excessive growth of fine hairs.
Pest Description: Very small, torpedo-shaped mite with a cream-colored body.
Cultural Control: None recommended.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Begin spraying when mites first appear. Repeat application in 2-3 weeks.					
Kelthane 18.5% wp	6.5	8.5	667g	2kg	7
sulphur 80% wp	150g	200g	1kg	3kg	0

Powdery Mildew

Symptoms: A fungus disease primarily attacking the leaf blades, less frequently the petioles, stalks, flower parts, and fruit. Foliage symptoms include yellow spots on upper leaf surfaces, with a powdery covering on lower leaf surfaces.
Cultural Control: Plant varieties vary greatly in their susceptibility.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Benlate 50% wp	5	7	16g	50g	3
sulphur 50% wp	150g	200g	1kg	3kg	0

Red Spider Mites

Damage: Mites feed in colonies on the undersides of leaves, producing a yellowing or bronzing color.
Pest Description: Very small spider with reddish oval body and four pairs of legs.
Cultural Control: None recommended.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Red Spider Mites only.					
diazinon 275 ec	4	5.3	400ml	1.2L	14

Erinose, Rust Mites

Damage: Feeding on stems results in a loss of stem hairs and a purplish color. Leaves turn silver, then to brown, and eventually die. Fruit develops a coarse, rusty surface.
Pest Description: Very small, torpedo-shaped mites with a cream-colored to yellowish body.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Red Spider Mites only.					
Kelthane 18.5% wp	6.5	8.5	667g	2kg	7
sulphur 50% wp	1	200	1kg	3kg	0

Thrips

Damage : Adult and immature insects feed on plant juices from tender foliage, floral parts, and fruiting bodies.
Pest Description: Very small, yellow to dark brown, elongated insects 1-2 mm in length with four, long, narrow, fringed wings.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when thrips are noticed. Repeat after 10-14 days.					
Orthene 75% wsp	25g	33g	167g	500g	3
Malathion 25% wp	5	7	667g	2kg	7
Malathion 500 ec	4	5.3	400ml	1.2L	7
Malathion 5% dp	dust	dust	dust	5-25kg	7

Verticillium Wilt

Symptoms: A soil-borne fungus, affected plants display various degrees of leaf wilting (especially on sunny days), yellowing and death. When affected early, plants that survive are stunted. Cool conditions favor this disease.

Cultural Control :

- When possible, grow vigorous hybrids have resistance or tolerance.
- Use treated seed.
- Practice crop rotation; avoiding tomatoes, peppers and potatoes for a 4-year period.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Leaf spots and fruit rots: Leaf spots are not considered significant in SA. No fungicides are listed for leaf spots and fruit rot control in SA. Some maneb formulations (not Dithane) are labeled in the US for leaf spots and fruit rots. If necessary, begin spraying as fruit starts to ripen. Continue at 7-10 day intervals.					
Dithane M45 wp	7	9	91-121g	273-364g	5

Harvesting and Handling

Fruits should be harvested when the outside color has reached a glossy colour and the seed and the inside pulp is still white. If fruits are not harvested as soon as they reach this stage, the plant will produce fewer new sets of fruit. Dark-colored seeds and soft fruit are signs of overmaturity, and these fruits are of lower quality. Fruit should be cut from the plant leaving part of the stem attached. Handle the fruit carefully to avoid puncturing the skin.

Wipe fruit clean and remove those which are soft, overmature, diseased, or damaged. Keep harvested fruit out of sunlight. Under the best of conditions, fruit cannot be stored for more than 1 week. Therefore, they generally should be sold within 1 or 2 days of harvest. An acceptable yield should exceed 25,000 kg/ha.

Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

GREEN BEANS

Beans are a tender, warm-season crop which are sensitive to cold temperatures and frosts. Many modern green beans are bush types. These do not develop runners but grow on compact plant. A few are runner types that can be grown on poles or left vine around on the soil surface. Green beans are normally harvested while the pods are tender and green and the seeds are still immature. At this stage the seeds are not removed but are eaten with the pod. They may, however, be left until dry, but the seed size is generally smaller than most dry bean types.

Soils and Rotations

Beans grow on a wide range of soils that are well drained, ranging from sandy to those relatively high in clay. Soil pH should range between 5.5 and 7.0. If the pH is less than 5.5, lime should be applied (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium). The remainder should be a calcitic lime.

Crops should be rotated so that beans are not planted on the same land area more than once in 2 years. Some beans are hosts to the bacterial wilt organism that affects solanaceous crops (tomato, pepper, potatoes, eggplant, etc.). Soils with a history of this disease are best avoided.

Fertilization

There is a widespread tendency to supply beans with too much nitrogen. Rates above 60 - 80kg/ha will likely not increase yields and will promote excessive leaf growth and lodging. If soils are very sandy or early rains have been excessive and the crop is to be held for multiple harvests, a sidedress application of 20 kg/ha about 3 weeks after planting may be beneficial. Basal applications should be banded and the fertilizer worked into the soil before seeding.

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken about every three years and sent to a reliable soil testing laboratory. However, in the absence of a soil test, the following can be used as a guide:

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
40-60-40	40-60-40	at planting
Sidedress		
0	20-0-0	3 wks. after planing

Time of Planting

Beans can be grown in most areas during summer and in regions that do not get frost in winter months. If flowering occurs during periods of very cool or hot temperatures, pod set is often reduced and pods may develop shorter with a curved shape. See Tables 14 through 16 beginning on page 17 for recommended times to plant.

Field Spacing

Single Row Prod. System		
Between Rows	Between Plants	
90cm	40 to 50cm	
Double Row Prod. System		
Between Beds	Between Rows on Bed	Between Plants
1.5m	30 - 35cm	60 -75cm

Field Planting

Beans are sown directly to the field in which they will be grown to maturity. Before seeding the soil should be well prepared, free of stones, clods, and other debris. Sow seeds about 25 to 30 mm deep in a moist soil, with about 50 mm between individual seeds. Place seeds slightly deeper (40 mm) if soil is dry. Cover seeds with fine soil, firming it lightly over the seeds. Soil moisture must be maintained carefully during germination and establishment of the young seedlings.

Irrigation

There are several critical times during the bean growing season when it is most important that adequate water be available to the plant for obtaining desired yields. First, to develop strong and healthy seedlings, it is necessary to apply frequent light irrigations during the seed germination stage. After the seedlings are well established, 5 or so cm in height, sufficient irrigation water needs to be applied to fill the soil to a depth of about 40 cm. This will ensure a rapid early-season plant growth and a good deep root development.

The third critical time when the plant needs sufficient water is throughout the flowering stage. This is also the time when beans are continually being harvested. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to the section on irrigation beginning on page 8.

Variety Information

Cultivar	Source	Maturity (days)	Pod Shape	Pod Colour	Disease tolerance	Use
Champ	SA	55	Round, straight	Green	A, BMV, HB, As	Fresh market, processing
Clyde	SA	50	Round, straight	Dark gr.	A, BMV, R	Fine bean, export
Contender	H, MF, P, SA	55	Oval, curved	Light gr.	BMV	Fresh market, processing
Derby	H	55	Round	Green		Fresh market, processing
Espada	SA	55	Round	Dark gr.	A, BMV, HB	Fresh market, processing
Flash	P	55		Light gr.		Fresh market, processing
Gitana	SA	55	Round	Green	A, BMV	Fresh market, processing
Labrador	MF	60	Round, straight	Dark gr.	A, BMV, HB	Fresh market, processing
Masai	H	55	Round. straight	Dark gr.		Fine bean, export
Provider	MF, SA	55	Round, slight curve	Light gr.	BMV	Fresh market, processing
Rambo	P	55	Round, straight	Med. gr.	R	Fresh market, processing
Spurt	MF	60	Round, slight curve	Green	BMV, CT, R	Fresh market, processing
Strike	MF	60	Round, straight	Green	BMV	Fresh market, processing
Golden Podded Wax	MF	55	Oval, curved	Yellow	None	Fresh market

Disease Reaction Key:

A = Anthracnose	HB = halo blight
BMV = bean common mosaic virus	R = rust
CT = curly top virus	

Source key: MF = MayFord; H = Hygrotech; P = Premier; SA = Starke Ayres

Disease and Insect Control

American Bollworms

Damage : Larvae feed on foliage and bean pods.
Pest Description : Full-grown larvae are about 40 mm in length and vary in color from near black, brown, or green to pale yellow or pink with a characteristic dark band along the back and light bands along each side.
Cultural Control : Hand pick larvae and infested pods from plant.
Chemical Control:

Chemical(s)	# 15ml scoops 15L	# 15ml scoops 20L	Rate per 100ml	Rate per ha	Days to withhold
Spray when larvae are less than 1 cm; repeat at 10-14 day intervals as needed.					
Decis 25 ec	0.7	1	-	250ml	7
Ripcord 200 ec	0.5	0.7	50ml	150ml	7

Anthracnose

Symptoms: A seed-borne fungus disease that infects leaves, stems, pods, and seed. Early symptoms are reddish brown streaks on the petioles and lower leaf surfaces. Foliar lesions correspond to the veins, resulting in a typical discoloration. As these lesions enlarge, they become visible on the upper leaf surface. Pod infections result in sunken areas surrounded by a raised brown-black border. In severe cases, the disease infects the whole plant, causing leaf drop, flower and pod abortion, and discolored seed.
Cultural Control :

- Use only disease-free seed.
- Practice crop rotation to allow 2 years between bean plantings.
- Remove crop residues following harvest.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	# 15ml scoops 20L	Rate per 100ml	Rate per ha	Days to withhold
If necessary, spray at 7-10 day intervals after disease appears. Check label closely because mancozeb is not labeled for use on beans in all countries.					
Dithane 80% wp	24	32	0.7-1.3kg	2-4kg	3

Aphids

Damage: All stages of the insect feed in colonies by sucking plant juices from the tender growing parts, resulting in stunted, distorted growth.
Pest Description: Small green, soft-bodied insects with or without transparent wings.
Cultural Control: Remove weeds surrounding the field.
Chemical Control:

Chemical(s)	# 15ml scoops 15L	# 15ml scoops 20L	Rate per 100ml	Rate per ha	Days to withhold
Apply when aphids are present; repeat as necessary.					
diazinon 275 ec	1.2	1.6	120ml	360ml	14
Rogor 400	0.8	1	75ml	225ml	14
Malathion 25% wp	3.7	5	250g	350g	7
Malathion 500 ec	1.3	1.7	125ml	375ml	7
Malathion 5% dp	dust	dust	dust	15-25kg	7

Bacterial Wilt

Symptoms: A disease caused by the bacterial wilt bacteria invading the vascular system, disrupting water and nutrient uptake, and resulting in wilted, yellow, stunted plants, especially when young plants are infected.

Cultural Control:

- Avoid planting in contaminated soil.
- Practice crop rotation.
- Use resistant varieties.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100ml	Rate per ha	Days to withhold
Apply at 7-14 day intervals in the rainy season and after hail injury in areas where bacterial blight can appear					
copper oxychloride 85% wp	5.8	7.8	400g	1.2kg	3

Bean Mosaic

Symptoms: Diseases caused by several viruses that produce mottling of the foliage, stunted bushy plant growth, and pod mottling and distortion.

Cultural Control: Grow virus resistant varieties.

Chemical Control: None

Chafer Beetles

Damage: Adult beetles feed on young leaves and flowers.

Pest Description: Medium-sized brown to yellowish brown, hard, shiny beetles.

Cultural Control: None recommended.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100ml	Rate per ha	Days to withhold
Apply at 7-10 day intervals when the beetles are present.					
Sevin 85% wp	18.8g	25g	125g	375g	14
Malathion 5% dp	dust	dust	dust	15-25kg	7

CMR Beetles

Damage: Adult beetles feed mainly on flower petals.

Pest Description: Group includes several species of small to large beetles with bright yellow and black bands across the wing covers.

Cultural Control: None recommended.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100ml	Rate per ha	Days to withhold
Apply when the beetles are present.					
Malathion 5% dp	dust	dust	dust	20-25kg	7
Malathion 500 ec	2.5	3.3	250ml	750ml	7

Plusia Loopers

Damage: Larvae feed on all stages of developing pod.

Pest Description: Green larvae which move by making a characteristic looping motion.

Cultural Control: Hand pick larvae from plants.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100ml	Rate per ha	Days to withhold
Apply when the looper is present.					
Fastac 100ec	0.3	0.4	33ml	100ml	7
Devipan 1000 ec	1	1.3	100ml	300ml	7
Ambush 500 ec	0.3	0.4	33ml	100ml	7

Powdery Mildew

Symptoms: A fungus disease that infects the above-ground plant parts. A darkening of the leaves usually follows the veins. Stems and pods may be infected, resulting in dwarfed, shriveled, and distorted growth. The pods actually turn black, while the foliage becomes yellow and falls off.

Cultural Control:

- Destroy crop residues following harvest.
- Practice crop rotation.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100ml	Rate per ha	Days to withhold
Apply at first sign of disease; repeat in 7-14 days if needed.					
sulphur 80% wp	37-63g	49-85g	243-425g	0.7-1.3kg	0

Red Spider Mites

Damage: Mites feed in colonies on the undersides of leaves, producing a yellowing or bronzing color.

Pest Description: Very small spider with reddish oval body and four pairs of legs.

Cultural Control: None recommended.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100ml	Rate per ha	Days to withhold
Begin application when pest is noticed; repeat after 10-14 days.					
diazinon 275 ec	1.6	2.1	160ml	480ml	14
Kelthane 18.5% wp	30g	40g	200g	600g	7
sulphur 80% wp	60g	80g	400g	1.2 kg	0

Rust

Symptoms: A fungus disease first appearing as small yellow-white spots on the lower surface of older leaves. These spots gradually enlarge, becoming reddish brown. Raised rust lesions may also appear on the bean pods. Heavy infections can result in severe yield reduction.

Cultural Control:

- Rust infection is less severe at low plant density.
- Plant early to avoid fungal spores and weather conditions favorable for fungal growth.

Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100ml	Rate per ha	Days to withhold
Apply at first sign of infection; repeat at 10-14 day intervals if needed.					
Bravo 500 sc	6.7	8.9	667ml	2000ml	3
Dithane 80% wp	4.8	6.4	200g	up to 1000L	3
Baycor 300 ec	0.8	1.1	84ml	420ml**	14

Thrips

Damage: Adults and immature insects feed on plant juices of flowers and young pods.
Pest Description: Very small, yellow to dark brown, elongated insects 1-2 mm long with four, long, narrow, fringed wings.
Cultural Control: None recommended.
Chemical Control:

Chemical(s)	# 15ml scoops 15L	20L	Rate per 100ml	Rate per ha	Days to withhold
Apply when pest is noticed; repeat after 10-14 days.					
Malathion 25% wp	5.3	7	350g	1050g	7
Malathion 500 ec	1.8	2.3	175ml	525ml	7
Malathion 5% dp	dust	dust	dust	15-30kg	7

Weed Control

Control of weeds is very important throughout the season if good yields of quality product are to be obtained. With some crops such as beans, chemical herbicides may be safely used to aid in weed control. However, herbicides must be used with care to obtain control and prevent damage to the crop or environment. Only chemicals labeled for the particular crop must be used and directions on the label need to be followed. Care must be taken to prevent the herbicide drifting to other crops during application and the sprayer used should never used to apply chemicals for disease or insect control. Page 10 contains additional information regarding the use of herbicides.

Suggested Chemical Controls

Dacthal (chlorothal) 75 wp.
Rate: 9 to 14 kg per hectare.
Time: Apply at time of transplanting or direct seeding to the field. May be applied preplant incorporated.
Control: Annual grasses and some broadleaf weeds.
Remarks: Rates vary according to soil type. Water should be applied within 5 days of application if rain does not occur. Do not graze cattle on treated areas.
Crop Rotation: Replanting crops other than those that are listed on the label within 8 months of application may result in crop injury.

Eptam (EPTC) super
Rate: 6 litres per hectare of 7ec formulation (5kg ai/ha). Check label for rate if different formulation is used.
Time: Preplant incorporated, or apply as directed spray at base of bean plants before plants have started to close rows.
Control: Annual grasses and broadleaf weeds, some control of nutsedge.
Remarks: Do not apply to flat podded beans.
Crop Rotation: Few restrictions.

Harvesting and Handling

Green beans reach the harvest stage within a short time. Thus, repeated plantings, spaced about 10 days apart, must be established in order to have a constant supply for marketing. For the fresh market, beans should be harvested as soon as the pods have reached an appropriate size and are still tender, dark green, and showing no bulge (swelling) from overdeveloped seeds. The length of time that pods remain in prime condition is often only 1 or 2 days. Choosing the correct time to harvest is very important. Overmature beans are tough and pithy.

Some markets demand a smaller sized bean, classed as a fine bean. Specific size limits for length and pod diameter, and staightness exist for this class. The market specifications must be known and followed.

Beans should be washed and graded to eliminate pods that are diseased, damaged, or discolored. Pods should be harvested early in the morning as soon as dew has dried from the plants and before heat from the sun has warmed the pods. They must be kept cool and marketed soon after harvesting (the same day). Acceptable yields should exceed 8 tonnes/ha.

Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

LETTUCE

While lettuce is generally considered a cool-season crop, cultivars have been developed in recent years that grow well under a variety of conditions, including very warm temperatures. Matching the proper cultivar to the season is essential in lettuce production. Attempting to grow a cultivar that lacks heat tolerance in summer will result in premature bolting of the plant before the head forms.

Several types of lettuce can be grown in Swaziland. Crisp head, the most common, features relatively firm, light- to medium-green heads with whitish ribs and crisp leaves. This type is generally the least nutritious and of the poorest eating quality of the different types. Butter head types form smaller heads, usually of yellowish green color and with tender, relatively smooth leaves. Cos lettuce heads are elongated with large, coarse, dark green leaves having thick ribs, and are usually of excellent quality. Leaf lettuces are nonheading with loosely bunched leaves, usually of light- to medium-green color. Large outer leaves can be harvested first and the plant left to continue producing.

Soils and Rotations

Lettuce grows best on loamy soils that are deep, loose, and well drained. Heavy soils high in clay and soils that are compacted should be avoided. The soil pH should range between 5.5 and 7.0. If the pH is less than 5.5 lime should be applied (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium); the remainder should be a calcitic lime.

Rotate crops so that lettuce, endive, and other leafy vegetables do not follow one another from one season to the next.

Fertilization

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken about every 3 years and sent to a reliable soil testing laboratory.

However, in the absence of a soil test, the following can be used as a guide:

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
40-60-40	50-75-50	at planting
Sidedress		
20-0-0	20-0-0	3 wks. after planting

The sidedress application should be made about 3 - 4 weeks after field planting using LAN, ammonium nitrate, or urea. Both basal and sidedress applications should be banded. In the case of basal treatments, the fertilizer should be worked into the soil before setting the seedlings. Additional information on fertilizer application can be found on pages 3 and 4, including the cold drink can method of application.

Time of Planting

Lettuce grows best under cool conditions and can tolerate light frosts. Its ability to withstand warm temperatures depends on the cultivar. Lettuce, using the proper cultivar, can be grown throughout the year in most areas, except for the summer months in the Lowveld. Summer production is not unusually difficult in other regions, since few serious summer diseases affect the crop. See Tables 14 through 16 beginning on page 17 for recommended times to plant.

Field Spacing

Single Row Prod. System		
Between Rows	Between Plants	
45cm	30 - 40cm	
Double Row Prod. System		
Between Beds	Between Rows on Bed	Between Plants
1.2m	30 - 35cm	40cm

The above general spacing suggestions are for head lettuce. Loose leaf types or those

that form loose heads, such as butter heads, can be spaced slightly closer.

Field Planting

Lettuce is generally transplanted to the field using seedlings started in a seedbed or in trays (see Seed and Seedlings beginning on page 5 for information on growing seedlings). Under careful management and proper conditions lettuce can be sown directly to the field, using a precision type planter. Sprinklers or drip irrigation is essential for success when direct seeding.

When transplanting, seedlings should be set to the field about 4 weeks after emergence (before they reach 10 cm tall). Seedlings left in the seedbed or seed tray too long become leggy and are less able to withstand transplanting. Remove plants carefully from the seedbed to avoid damaging roots. Plants should be kept in a bucket of water to prevent roots from drying during the transplant operation.

Cool, cloudy days are best for transplanting. On clear days it is best to plant in late afternoon. Apply sufficient water immediately after transplanting to thoroughly wet the soil to a depth slightly below the roots of the seedlings. If soil is extremely dry, a light irrigation one day prior to transplanting is recommended.

Irrigation

There are several critical times during the lettuce growing season when it is most important that adequate water be available for obtaining desired yields. First, to develop strong and healthy seedlings grown in beds, it is necessary to apply frequent light irrigations during the seed germination stage. Then, when the lettuce seedlings are being transplanted, it is important that sufficient irrigation water be applied to wet the soil to a depth of about 40 cm. This will ensure rapid early-season plant growth and a good deep root development.

The third critical time sufficient water is needed by the lettuce plant is for the entire period that the leaves to be harvested are developing through to harvest time. Never should the available water in the soil be depleted below 50%. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to pages 8 to 10.

Variety Information

Cultivar	Source	Maturity (Days)	Season	Type	Remarks
Buttercrunch	H, SA	80	Late Summer - Fall	Bibb	Medium tolerance to bolting
Jory	P	75	Fall - Spring	Bibb	Performs well under adverse conditions
Siletta	P	75	Late Summer - Fall	Bibb	Good resistance to tip burn and bottom rot
Ultra	P	75	Spring - Fall	Bibb	Tolerant to tip burn and bolting
Commander	MF, SA	55	Summer	Crisp head	Slow bolting
Great Lakes 659	H, MF, P, SA	85	Fall - Winter	Crisp head	Med. tolerance to bolting; very tip burn tolerance
Greenfield	SA	80	Winter	Crisp head	Uniform, heavy heads
El Toro	MF	90	Fall & Spring	Crisp head	Holds well in field
Emperor	MF	85	Spring - Summer	Crisp head	Very good tip burn tolerance
Empire	H		Fall & Spring	Crisp head	Slow bolting, very good tip burn tolerance
Excellence	MF		Fall - Spring	Crisp head	Uniform, large heads
Frosty	MF	100	Fall - Winter	Crisp head	Grows at normal rate in cool conditions
Murraylake	SA	60	Spring & Fall	Crisp head	Unifrom heads, well covered

Variety suggestions continued.

Cultivar	Source	Maturity (Days)	Season	Type	Remarks
Robinvale	SA	60	Summer (mild)	Crisp head	Glossy, firm heads
Summer Gold	MF	80	Summer	Crisp head	Reliable for summer
Paris White Cos	H, MF	70	Fall - Spring	Romaine	Slow bolting
Red Sails	H	60	Fall - Spring	Leaf	Red tinted leaves
Valeria	P	60	Fall - Spring	Leaf	Red-coloured

Source key: MF = MayFord; H = Hygrotech; P = Premier; SA = Starke Ayres

Disease and Insect Control

Aphids

Damage: All stages of the insect feed in colonies by sucking plant juices from tender plant parts, resulting in stunted, distorted growth.
Pest Description: Small green, soft-bodied insects with or without transparent wings.
Cultural Control: Remove weeds surrounding the field.

Chemical Control: Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when aphids first appear. Repeat as needed.					
Orthene 75% wsp	25.1g	33.4g	167g	500g	21
Malathion 25% wp	10	13.3	667g	2kg	14
Malathion 500 ec	4	5.3	400ml	1.2L	14
Phosdrin 150 ec	0.8	1.0	7ml	225ml	14

Bottom and Head Rots

Symptoms: Several fungal (Botrytis and Sclerotinia) and soft rot bacteria attack lettuce plants, resulting in gray mold, white mold, and soft rotting of the plant parts.
Cultural Control:

- Rotate crops on a four-year basis.
- Plant in well-drained soil on top of the irrigation furrow or on raised beds.
- Do not move loose soil against stems and leaves when weeding.

Chemical Control: None

Loopers

Damage: Young larvae feed on the undersurfaces of leaves, producing holes of irregular shape and size. Older larvae feed inside the head.
Pest Description: Larvae are green with white lines along the body and two white lines near the middle of the back. They move by making a characteristic looping motion.
Cultural Control: None recommended.

Chemical Control: Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when loopers are present. Repeat as needed.					
Orthene 75% wsp	25.1g	33.4g	167g	500g	21

Harvesting and Handling

Head lettuces should be harvested when they have reached a suitable size, but before they reach overmaturity. A mature head is fully developed and yields to slight pressure applied by the fingers. Lower leaves that are beginning to yellow and cracked leaf ribs are signs of overmaturity. A bitter taste, head rots, and other disorders develop rapidly when heads are overmature. Therefore, it is important to harvest at the proper stage.

All heads generally do reach maturity at the same time, so several selective cuttings are required. Cut heads just below the lowest leaf. Remove loose and damaged leaves. Wash heads if soiled before packing them in mesh bags. Remove heads from the field to a shaded area immediately after harvesting and sell the same day. In cool areas during winter only, the crop may be held in the field for several days until markets become available. Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

An acceptable yield should exceed 10 to 12 tons/ha.

MELONS (CANTALOUPE, HONEYDEW, SPECIALTY)

Melons are warm-season crops that grow well in hot, humid weather but are sensitive to frosts. Melons require insects such as honeybees for adequate pollination and good yields of high-quality fruit. Insects should be encouraged around melon plantings, even to the point of placing bee hives near the field. The term sweet melon is sometimes used to refer to several types of melons, including cantaloupes and honeydews. Cantaloupes are medium-sized, round to slightly oblong with varying degrees of netting on tan to light-yellow skin. Some have clearly noticable sutures on the surface while others are entirely even. The flesh ranges from pale to deep orange and has an aromatic odor. Honeydews have smooth, creamy white skin and light green flesh when ripe. There are other botanical varieties that are popular with certain specialty markets. In recent years breeders have developed new cultivars that combine features of the different types.

Soils and Rotations

Melons grow best on sandy or sandy loam soils that are deep, loose, and well drained. Soil pH should range between 5.5 and 7.0. If the pH is less than 5.5, lime should be applied (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium). The remainder should be a calcitic lime.

Crops should be rotated so that melons and related crops (cucumbers, pumpkins, and squash) are not planted on the same area more than once in 2 years. Melons respond well to additions of organic matter and are a good crop to apply kraal manure before planting. If manure is added, the amount of synthetic fertilizer to be applied should be reduced.

Fertilization

Lime and fertilizer, except for nitrogen, requirements can best be determined by use of a soil test. It is suggested that a soil sample be taken (see FSG 85) about once every 2 to 3 years. This should be sent to a reliable soil testing laboratory. In the case of nitrogen, the rule is to supply about 80 to 100 kg/ha of actual nitrogen to the crop during the entire growing season. The exception to this would be during period of exceptionally frequent or heavy rains, when excessive leaching of the nutrient may occur.

LAN is generally recommended for the sidedress applications, however ammonium nitrate, or urea may also be used. Both basal and sidedress applications should be banded. In the case of basal treatments, the fertilizer should be worked into the soil before setting the seedlings. Tables 1 through 5 beginning on page 2 provide a guide for making applications using different fertilizers.

The following table provides a guide for nitrogen application, and in the absence of a soil test, for phosphorous and potassium.

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
60-90-60	70-105-70	at planting
Sidedress		
20-0-0	30-0-0	4 wks. after planing

Time of Planting

Melons can be grown in most areas during summer and in regions that do not get frost in winter months. See Tables 14 through 16 beginning on page 17 for recommended times to plant.

Field Spacing

Rows: 1.5m apart
In row: 80cm between plants

Field Planting

Melons can be sown directly to the field in which they will be grown to maturity. The soil should be well prepared, free of stones, clods, and other debris.

Sow seeds in a moist soil to a depth of about 20 to 25 mm, placing two to three seeds every 75 cm. Cover seeds with soil that is free of large clods or clumps of sod. Firm soil

lightly over the seeds. After seedlings have emerged, thin so that only 1 or 2 plants remain at each location.

Soil moisture must be maintained carefully during germination and establishment of the young seedlings. A light grass mulch placed over the row after seeding helps prevent the soil from drying and crusting. The grass should be pulled to the side of seedlings after they have emerged and left as a mulch between the plants.

Melons responds well to a grass or plastic mulch. These help to reduce weed growth and to conserve soil moisture, often resulting in increased yields. Mulches can be readily used with a raised flat-topped bed system.

Seedlings may be started in trays but must be handled carefully to prevent the medium from falling away from the roots during the tranplanting operations. Tray seedlings should be transplanted to the field when about 3 weeks of age.

Irrigation

There are several critical times during the melon growing season when it is most important that adequate water be available to the plant for obtaining desired yields. First, to develop strong and healthy seedlings, it is necessary to apply frequent light irrigations during the seed germination stage. After thinning it is most important that sufficient irrigation water be applied to fill the soil to a depth of about 80 cm. This will ensure a rapid early-season plant growth and a good deep root development. The third critical time when the melon plant needs sufficient water is from flowering until harvest time. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to the section on irrigation beginning on page 8.

Variety Information

Cantaloupe Cultivar	Source	Relative Days	Rind	Flesh Colour	Fruit Shape	Disease Reaction
All Star*	MF	90	fine netting, lightly sutured	creamy orange	oval	Rest. F, PM
Easy Rider*	SA	70	course netting no sutures	orange	round	
Fiata*	SA	70	light netting, sutures	orange	oval	
Earlisweet*	H	70	medium netting	orange	round	
Mission	MF	80	heavy netting, no sutures	orange	round	Rest. PM
Otero*	P	85	heavy netting, no sutures	orange	oval	Tol. PM, WMV1
Saticoy*	H	90	heavy netting no sutures	orange	oval	
Star Rock*	SA	90	light netted	orange	oval	

Honey Dew Cultivars	Source	Relative Days	Rind	Flesh Colour	Fruit Shape	Disease Reaction
Milky Way	MF	90	white, smooth	green	nearly round	Rest. F
Galia*	P	75	fine netting, fine sutures	green	round	Tol. PM
HoneydewPMR	H, SA	95	green, smooth	green	oval	Rest. PM

Special types Cultivars	Source	Relative Days	Rind	Flesh Colour	Fruit Shape	Disease Reaction
Ela*	P		smooth	white	round	Rest. F
Prello	P		yellow, smooth	white	round	Tol. PM
Yellow Canaria PMR	SA	95	smooth, yellow	lt. yellow	oblong	Rest. PM

* indicates hybrid cultivar.

Disease Reaction Key:

F1 - fusarium race 1	P = powdery mildew
F2 = fusarium race 2	WMV1 = water melon virus race 1

Source key: Source key: MF = MayFord; H = Hygrotech; P = Premier; SA = Starke Ayres

Disease and Insect Control

American Bollworm

Damage: Larvae feed on plant leaves and flower heads.

Pest Description: Full-grown larvae are about 40 mm in length. They vary from near black, brown, or green to pale yellow or pink, with a characteristic dark band along the back and light bands along each side.

Cultural Control: Hand pick larvae from crop.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
American bollworm: Spray when larvae are less than 0.5 cm. Repeat at 10-14 day intervals if necessary.					
Ripcord 200 ec	0.5	0.7	50ml	100ml	7
Thiodan 47.5% wp	15g	20g	10 g	300g	1

Anthracnose

Symptoms: Symptoms appear as ragged spots on old leaves and circular sunken fruit spots. Spots may enlarge and tear, making the leaf appear scorched and torn. Similar but elongated spots develop on the stems. Sunken lesions appear on the fruit.

Cultural Control: Follow a 3-year rotation.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Spray at 7-10 day intervals when disease is present. When disease pressure is high, a low rate of Benlate added to the Bravo or Dithane sprays has helped in the US.					
Bravo 75% wp	30-60g	40-80g	200-400g	up to 1500L	3
Bravo 500 sc	5-9	7-12	500-917ml	1.5-2.75L	3
Dithane M45 wp	4.8	6.4	200g	up to 1500L	3
Benlate 50% wp	0.9	1.2	30g	90g	3

Aphids

Damage: All stages of the insect feed in colonies by sucking plant juices from tender plant parts, resulting in stunted, distorted growth.

Pest Description: Small green, soft-bodied insects with or without transparent wings.

Cultural Control: Remove weeds surrounding the field.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply aphicide when aphids are present. Repeat as necessary.					
Rogor 400 ec	0.8	1	75ml	225ml	14
Malathion 25% wp	3.8	5	25g	750g	7
Malathion 5% dp	dust`	dust	dust	15-30kg	7

Downy Mildew

Symptoms: Symptoms start as yellowish leaf spots with gray mold on the bottom leaf surface under yellowish spots. In advanced stages, the leaf appears to dry up and dies, sometimes beginning at the margin.

Cultural Control:

- Use good irrigation practices.
- For susceptible crops, grow them in dry areas with well-drained soil.
- Follow a system of rotation.
- Isolate new plantings from older plantings.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Start spraying at first sign of disease. Continue weekly when weather is humid. In South Africa, the 400 gm/100 litres of spray mixture may be needed at a rate of up to 1500 litres of spray per ha. If necessary, fosetyl Al/Dithane (Mikel-M) and propamocarb (Previcur N) are two new fungicides with systemic properties, and should provide excellent control.					
Bravo 75% wp	30-60g	40-80g	200-400g	0.6-1.2kg	3
Bravo 500 sc	5-9	7-12	0.5-0.9L	1.5-2.8L	3
copper oxychloride 85% wp	4.4	5.8	300g	90g	3
Dithane M45 wp	4.8	6.4	200g	600g	3
Mickel-M 44%/26%wp	37.5g	50g	50g	75 g	3

Powdery Mildew

Symptoms: This disease appears yearly as white powdery growth on leaves. It is prevalent when conditions are hot and dry.

Cultural Control: Grow tolerant varieties when possible.

Chemical Control: When sprays are needed, Benlate (benomyl) and Bayleton (triadimefon) are highly effective materials unless the fungus develops resistance to the fungicides. To slow or prevent development of resistance, alternate Benlate and Bayleton every 14 days, and apply Bravo each week when Benlate or Bayleton is not used.

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Benlate 50% wp	1.5	1.9	50g	0.5kg in 1000	3
Bayleton 50% wp	2.3g	3g	15.2g	45.6g	
Bravo 500 sc	5-9	7-12	0.5-0.9 L	1.5-2.8L	3

Pumpkin Flies

Damage: Adult flies lay eggs in young fruit, and maggots develop inside.
Pest Description: Adults are brown-colored flies with yellow bands or spots. Larvae are white, legless maggots found inside developing fruit.
Cultural Control: None recommended.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Fenthion (Lebaycid) should be applied as a full cover spray, and can be repeated at 1-2 week intervals. Malathion is applied as a bait to leaves; mix 3 gm of 25% wp, or 2 ml of 500 ec material with 80 gm of sugar and a small amount of water and apply as large droplets to leaves. Repeat weekly or after rain.					
Lebaycid 500 ec	1.2	1.6	120 ml	360ml	10
Malathion 25% wp	bait	bait	See above	300g	10
Malathion 500 ec	bait	bait	See above	175ml	10
Malathion 25% wp	bait	bait	See above	30g	10
Malathion 500 ec	bait	bait	See above	175ml	10

Red Spider Mites

Damage: Mites feed in colonies on the undersides of leaves, producing a yellowing or bronzing color.
Pest Description: Very small spiderlike mite with a reddish oval body and four pairs of legs.
Cultural Control: None recommended.
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when mites are noticed.					
Kelthane 18.5% wp	30g	40g	200g	600g	7

Scab

Symptoms: Symptoms always are most prevalent on the youngest plant parts. The symptoms include large ragged leaf spots (on the youngest leaves) surrounded by a yellow halo, spots and elongated streaks on young petioles and vine tips, dead areas on young leaves, and small dark depressed spots that later display a gray sooty growth on young fruit. Infection is promoted by wet and cool conditions.
Cultural Control: Scab is delayed by rotation and isolation from older plantings
Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Fungicides are needed before infection occurs and symptoms start to appear. Rates of Bravo that are labeled and effective in the US are lower than those in South Africa. If necessary, the following rates for 15 L, 20 L, and 100 L can be increased by 50% (e.g. from 5 scoops to 7.5 scoops). If necessary, it may be more helpful to increase the volume of spray material/ha than increasing the rate/ha applied in the same low volume.					
Bravo 500 sc	5	7	0.5 L	1.5-2.75 l	3
Bravo 75% wp	30g	40g	200g	0.6-1.2 kg	3

Thrips

Damage: Plant sap is removed by insects feeding on the lower leaf surfaces. Leaves become distorted, with a silvery sheen that often becomes russeted or bronze. Heavy feeding pressure can kill young plants.

Pest Description: Very small elongated insects about 1 mm in length with four long, narrow, fringed wings.

Cultural Control:

- Destroy crop residue following harvest.
- Use good cultural practices that encourage rapid plant growth.
- Plant early.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when thrips are noticed. Repeat after 10-14 days.					
Malathion 25% wp	3.7	5.0	250g	750g	7

Harvesting and Handling

Stages at which cantaloupes are harvested are referred to according to the ease with which the stem slips from the fruit. "Full slip" refers to the point at which the stem is cracked slightly all the way around and will fully separate from the fruit with only light pressure applied by the thumb. At this stage flavor is at its peak, but the melon will not withstand shipping and must be used within 1 to 2 days. At "half slip," stem cracks are just beginning to appear and only slightly more pressure is required to separate fruit from the stem. At this stage fruits can be shipped considerable distances if handled carefully. They can be kept for several days without cold storage.

Fruit stems on honeydew and some of the specialty melons generally do not slip and must be cut. They are usually harvested when the melons reach a creamy white colour (colour may differ with some specialty melons and variety). The spot where the fruit lies on the ground generally attains a darker color than the rest of the fruit at maturity. Tiny cracks also appear on the fruit surface at this time. Honeydews must be fully mature at harvest; immature melons will not ripen once they are removed from the vine. Short portions of stem should be left attached to honeydews and many of the specialty melons at harvest. Honeydews will store for up to several weeks but should be sold from the farm as soon as possible.

All melons should be brushed free of soil and graded according to uniform size and appearance, with soft, overmature fruit discarded. Never allow melons to remain in full sunlight. Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

An acceptable yield should be 10,000 kg/ha or greater.

ONIONS

Onion cultivars have specific daylength periods that are necessary for bulbing. Cultivars grown when the daylength do not meet the particular requirements will either grow to maturity quickly, or they will remain green for very long periods, without producing bulbs. In either case marketable sized bulbs are not produced. Therefore selecting the proper cultivar for the season is very important. Cultivars classified as short-day (SD) require daylength periods of about 12 hours and are suitable for winter in Swaziland. Long-day (LD) cultivars usually require 14 or more hours of day light to produce bulbing, however, each cultivar has very specific requirements. The LD cultivars recommended below for summer have been selected only after extensive testing under local conditions.

Soils and Rotations

Best yields of onions are obtained on well-drained, sandy loam soils, although many other soil types can be used for onion production. The pH of the soil should range between 5.5 and 7.0. If the pH is less than 5.5 lime should be applied, as onions are somewhat sensitive to acid soil conditions (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium), and the remainder should be a calcitic lime.

Onions or leeks should not be planted more than once every 2 to 3 years in the same field (area of land). Most other crops are satisfactory for preceding onions in a rotation.

Fertilization

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken about once every 2 to 3 years (see FSG 85) and sent to a reliable soil testing laboratory. However, in the absence of a soil test, the following table can be used as a guide.

The first sidedress application should be made about 4 weeks from field planting using LAN, ammonium nitrate, or urea. Both basal and sidedress applications should be banded. In the case of basal treatments the fertilizer should be worked into the soil before setting the seedlings. Onions grown for green harvest should receive about 25% more nitrogen in the sidedress applications. Tables 1 through 4 on pages 2 and 3 lists types of fertilizers that may be used and provides guidelines for applying them using a cold drink can.

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
40-60-80	60-90-60	at planting
Sidedress		
20-0-0	20-0-0	4 wks. after planing
20-0-0	20-0-0	8 wks. after planting

Time of Planting

Onions can be grown in both summer and winter, provided the proper cultivars for each season are used, in almost all areas of Swaziland. Various factors influence bulb formation, photoperiod (day length) and temperature being the most important. Highest prices for onions prevail in summer. See Tables 14 through 16 beginning on page 17 for recommended times for planting.

Average daily temperatures must generally exceed 15° C for bulbs to form. As temperatures rise above this level, maturity is hastened. If average daily temperatures are above 30° C, bulbs will form rapidly and therefore be reduced in size. On the other hand, average daily temperatures only slightly above 15° C will result in slow maturity and large bulbs.

For summer production, seeds of a proper intermediate day-length variety should be sown in seedbeds between June 15 and August 1. For winter production, both seedlings and sets can be used. Seedlings can be started beginning in January up to early March. Sets will produce the earliest crop and can be planted to the field in February and March for harvest beginning about June. Sets produce lower-quality bulbs than seedlings

Seedling Production

Seedbeds (summer and winter production)—Sow seeds in rows about 20 cm apart and cover with 5 to 8 mm of fine soil. Lightly firm the soil over the seeds using a wooden row marker or flat pieced of wood. Sow seedlings to obtain a final density of about 60 to 80 seedlings per metre of row. Thin to this stand about 1 week after emergence if necessary. Keep beds moist but allow the soil surface to dry slightly before watering. Disease control in the seedbed is important (see section on disease and pest control). Seedlings should be transplanted in about 4 to 6 weeks. Delaying transplanting can result in more disease problems. See "Seedbed Preparation and Care" in the introduction to this chapter.

Sets (winter production)—Seeds of SD varieties are sown between late August and late October in seedbeds for producing sets for planting to the field beginning in February. Seeding methods described above should be followed except that seedling density is increased to approximately 80 to 100 per metre. SD varieties at this time will mature quickly and form bulblets about 2.5 cm in diameter. These bulblets are left to cure in the bed for 2 to 3 months. After removing them from the bed store bulblets in a dry location with good air circulation until planting.

Direct seeding—Onions may be sown directly to the field, a method that requires careful attention to management practices. The soil must be well prepared with large clods and debris removed. Soil moisture during seed germination and early growth must be carefully controlled. Sprinkler or drip irrigation works best with direct seeding. A mechanical seeder that controls the rate of seed drop and the seeding depth works best for this method.

Field Spacing

The following spacing (for furrow irrigation) will result in about 350,000 plants per ha. This is the minimum population for efficient use of land. Populations of more than double this amount are possible with some systems.

Single Row Prod. System		
Between Rows	Between Plants	
45cm	6 - 8cm	
Multi-Row Prod. System		
Between Beds	Between Rows	Between Plants
1.2m	20 -25cm	6-8cm

An alternative system is to plant 4 or 5 rows per bed, each row separated by about 20cm. This will increase populations to over 500,000. With systems of this type the use of a herbicide is strongly suggested to aid in weed control.

Field Planting

Plants should be set to the field in about 6 - 8 weeks after seeding. Seedlings left in the seedbed too long are likely to become diseased and are less able to withstand transplant shock. Plants should be kept in a bucket of water to prevent roots from drying during the transplant operation.

Seedlings and bulblets should be planted shallow. Cover roots of seedlings with 1 to 2 cm of soil. Sets should be pushed into the soil to about the same depth. Planting too deep may retard bulb development; therefore, bulbs should form mostly above the soil surface.

Cool, cloudy days are best for transplanting. On clear days it is best to plant in late afternoon. Apply sufficient water immediately after transplanting to thoroughly wet the soil to a depth slightly below the roots of the seedlings. If soil is extremely dry, a light irrigation one day before transplanting may be beneficial.

Irrigation

There are a couple of critical times during the growing season when it is most important that adequate water be available to the onion plant. First, to develop strong and healthy seedlings grown in seedbeds, it is necessary to apply frequent light irrigations during the seed germination stage. Then, when seedlings

are transplanted, sufficient irrigation water must be applied to wet the soil to a depth of about 40 cm. This will ensure rapid early-season plant growth and a good deep root development. Subsequent irrigations throughout the remaining growing season until near harvest time should be scheduled when 50% of the available water in the root zone has been depleted. Avoid irrigating too often and keeping the soil overly wet. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to the section on irrigation beginning on page 8.

Summer Production

Successful production during summer requires an intermediate day- length variety to produce marketable bulbs. Numerous such varieties have been tested and only one variety is currently available that will produce satisfactory results (at least 75% marketable bulbs). Final results will depend upon weather conditions and other factors. The onion seedlings should be established in the field during July or August for best results, especially no later than September.

Variety Information

Cultivar	Source	Bulb Colour	Bulb Shape	Storage	Season
Benson (Ben Shemen)	P	tan	flat-round	very good	summer
Bon accord	MF	tan-yellow	flat-round	very good	winter
Carnival	P	tan-yellow	flat top	very good	winter
Granex 33*	MF	tan-yellow	flat top	fair	winter
Granex 429	MF	copper brown	flat top	fair	winter
Pacific	P	brownish	round	good	winter
Pyramid	MF, H, P, SA	tan-yellow	flat	fair	winter
Sonic*	SA	tan-yellow	round	fair	winter
Texas Grano 502 P	MF, P SA	tan-yellow	top	poor	winter

* indicates a hybrid cultivar.
Source key: Source key: MF = MayFord; H = Hygrotech; P = Premier; SA = Starke Ayres

Disease and Insect Control

Alternaria Blotch

Symptoms: Symptoms begin as water soaked circular spots which then expand into elongate purplish-gray blotches with somewhat orange bands at the blotch margin. Moisture promotes this disease.

Cultural Control:

- Use treated seed.
- Practice a 2-year rotation.
- Plant in well-drained soil.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Dithane M45 is the most economical fungicide for control. If needed, iprodione (Rovral) is labeled for Alternaria blotch but will not control downy mildew. Apply sprays at 7-14 day intervals beginning when moist conditions prevail					
Dithane 45 wp	2.5-4	4-5.8	121-182g	364-546g	7
Rovral 250 sc	6.5	9	667ml	2000ml	3

Downy Mildew

Symptoms: Symptoms start on old leaves as white flecks which elongate and later have white to purple mold when wet and cool. Severely affected leaves turn yellow and die. Moisture promotes the diseases..

Cultural Control:

- Do not overcrowd plants, especially in the seedbed.
- Use proper irrigation.

Chemical Control: Dithane M45 is most economical. If needed, the following two materials may soon be possible: fosetyl-Al (Aliette) for downy mildew **only**, and fosetyl-Al/Dithane (Mikel-M) for downy mildew and possibly Alternaria blotch **also**. Start applications when conditions are cool and wet.

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Dithane M45 wp	7.2	9.6	300g	3kg	0
Dithane M45 wp	3-4.3	4-5.8	121-182g	364-546g	7 (dry)
Bravo 500 sc	1.5-3.3	2-4.4	153-326ml	460-978 ml	14(green)

Mites

Damage: Mites feeding on leaves produce a typical stippling or silvering coloration.

Pest Description: Very small, dark to greenish brown, with four pairs of legs.

Cultural Control: None recommended.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply spray when mites first are present. Repeat as necessary.					
diazinon 275 ec	4	5.3	400ml	1200 ml	14

Thrips

Damage: Plant sap is removed by insects feeding on the lower leaf surfaces. Leaves become distorted, with a silvery sheen that often becomes russeted or bronze. Heavy feeding pressure can kill young plants.

Pest Description: Very small elongated insects about 1 mm in length with four long, narrow, fringed wings.

Cultural Control:

- Destroy crop residue following harvest.
- Use good cultural practices that encourage rapid plant growth.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when thrips are first present. Repeat in 7-10 days. Thoroughly wet plants with the spray.					
Decis 25 ec	0.5	0.7	-	100-200ml	2
Malathion 25% wp	5.3	7	350gm	1050g	7
Malathion 500 ec	1.8	2.3	175ml	525 ml	7
Malathion 5% dp	dust	dust	dust	20-30kg	7

Weed Control

Control of weeds is very important throughout the season if good yields of quality product are to be obtained. With some crops such as onion, chemical herbicides may be safely used to aid in weed control. However, herbicides must be used with care to obtain control and prevent damage to the crop or environment. Only chemicals labeled for the particular crop must be used and directions on the label need to be followed. Care must be taken to prevent the herbicide drifting to other crops during application and the sprayer used should never used to apply chemicals for disease or insect control. Page 10 contains additional information regarding the use of herbicides.

Suggested Chemical Controls

Dacthal (chlorothal) 75 wp.
Rate: 9 to 14 kg per hectare.
Time: Apply before weeds emerge, at time of transplanting or direct seeding, up to about 10 weeks after planting.
Control: Annual grasses and some broadleaf weeds.
Remarks: Rates vary according to soil type. May be sprayed directly over the crop without injury.
Crop Rotation: Replanting crops other than those listed on the label within 8 months of application may result in crop injury.

Fusilade 125 ec (fluazifop-P-butyl)
Rate: 1 to 2 litres per hectare.
Time: Apply after planting for a period of 4 weeks. Most effective when weed grasses are actively growing.
Control: Annual and perennial grasses.
Crop Rotation: Do not plant maize within 60 days of last application.

Goal (oxyfluorfen) ec
Rate: 3 litres per hectare.
Time: Apply postemergence, after two true leaves have fully developed.
Control: Some annual grasses and many broadleaf weeds.
Remarks: Rates vary according to soil type. More than one treatment may be applied, up to within 45 days of harvest.

Nabu (sethoxydim) 186 ec.
Rate: 1 to 3 litres per hectare.
Time: Apply postemergence, when grasses have reached the 2 leaf stafe. May be appllied at any stage of growth of crop.
Control: Annual grasses. If grasses become too old by tiime of application control will be reduced.
Remarks: Rates vary according to the type of grass to control. Avoid applying within 2 to 3 days of other pesticides to prevent crop injury. Observe a 30 day interval befor harvest.
Crop Rotation: see label.

Harvesting and Handling

Dry onions are ready for harvest when the tops (leaves) have broken over and the necks have collapsed and begun to dry. This can be hastened by withholding irrigation water once the tops show signs of dying back. After the bulbs are lifted, they may be placed in rows in the field to further cure for 7 to 10 days, provided conditions are dry. To avoid damage from sunlight, however, it is better to place bulbs in open containers and store in a shady location. Air circulation during curing is important; therefore, regardless of whether bulbs are left to cure in the field or placed in a protected area, they should be arranged so that air can circulate freely around them.

Curing is necessary to allow full dormancy to develop and to dry the onion bulbs sufficiently to stop development of diseases. A properly cured onion will have dry outer scales and a dry, shrunken neck. The remains of tops, roots, and loose scales should be removed either at harvest or after curing. Diseased, shriveled, or nondry bulbs should be removed at the time onions are packed for sale.

Green onions are normally pulled before bulbing occurs, when the basal diameter is about 10 to 12 mm. Roots should be trimmed near the base, discolored stalks discarded, and the marketable onions washed free of soil. They must be kept cool and sold almost immediately. Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

PEAS

Peas thrive in cool weather and can withstand frosts. Garden peas can be classified according to their growth habit (determinate or indeterminate) and certain pod characteristics. Seeds of some types are removed from pods and eaten when fully developed but still green and tender. With edible pod peas, the pod and seeds both are consumed when the seeds are still very immature (or in some cases nearly developed). Edible pod peas are grouped into sugar snaps and snow peas (mange toute). See "Harvesting and Handling" for a discussion of the difference between the two types. Within all groups, plants may be classified as normally leafy or leafless.
The time required for peas to mature is greatly influenced by prevailing temperatures during the growing season (heat units accumulated). Times to harvest will generally range from 90 to 120 days.

Variety Information

Shell (Green) Peas

Bikini - a leafless type with about seven seeds per pod; plants remain upright, allowing for good air circulation and fewer disease problems; a late-maturing cultivar; (F1)

Delsey - upright growth habit improves air circulation; about 120 days' (EMV, F1)

Greenfeast : a leafy type with about eight seeds per pod; a late-maturing cultivar.

Princess - a leafy type with about seven seeds per pod; a late-maturing cultivar; (F2)

Edible Pod

Oregon Sugar Pod - a snow pea eaten while seeds are still immature; bush type that does not need trellising; about 70 days; (EMV, PM)

Sugar Daddy - a snap pea with tender, sweet pods that can be used raw or cooked in the pod or shelled; produces two pods per node; about 75 days; (PL, PM)

Sugar Snap - a snap pea with tender, sweet pods that can be used raw or cooked; a climbing variety that requires trellising; about 70 days; (F1)

Star 6001 - a snow pea; bush type habit of growth that does not require trellising; ready in about 70 days; (F1).

Disease Reaction Key:

EMV = Enation mosaic virus	PL = Pea leaf mosaic virus
F1 = Fusarium race 1	PM = Powdery mildew
F2 = Fusarium race 2	

Soils and Rotations

Peas grow on a wide range of soils that are well drained, ranging from sandy to those relatively high in clay. Soil pH should range between 5.5 and 7.0. If the pH is less than 5.5, lime should be applied (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium). The remainder should be a calcitic lime. Crops should be rotated so that peas or beans are not planted on the same land area more than once in 2 years.

Fertilization

Fertilizer and lime requirements can best be determined by using a soil test. It is suggested that a soil sample be taken once every 3 years and sent to a reliable soil testing laboratory. However, in the absence of a soil test, the following can be used as a guide for P and K:

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
40-60-40	40-60-40	at planting
Sidedress		
	20-0-0	5 wks. after planing

Basal applications should be banded and the fertilizer worked into the soil before seeding. Although peas are a legume, they do not fix a significant amount of nitrogen. If soils are very sandy or early rains have been excessive, a sidedress application of 20 kg/ha may be beneficial. Tables 1 through 4 on

pages 2 and 3 provide guidelines for applying different fertilizers.

Time of Planting

Peas can be grown in the Middleveld and Highveld from late fall through early spring. However, if flowering occurs during very cool periods, pod set is sometimes reduced. Prolonged temperatures above 26° C are harmful to pea plants. See Tables 14 through 16 beginning on page 17 for suggested times to plant.

Field Spacing

Rows: double rows 20 cm apart with 0.9 m between the double rows or one row on each side of the irrigation furrow

In row: 35 - 50mm between plants

Field Planting

Peas are sown directly to the field in which they will be grown to maturity. Before seeding the soil should be well prepared, free of stones, clods, and other debris. Sow seeds about 25 to 35 mm deep in a moist soil, with 35 to 45 mm between individual seeds. Place seeds slightly deeper (45 mm) if soil is dry. Cover seeds with fine soil, firming it lightly over the seeds. Soil moisture must be maintained carefully during germination and establishment of the young seedlings.

Irrigation

There are several critical times during the pea growing season when it is most important that adequate water be available to the plant for obtaining desired yields. First, to develop strong and healthy seedlings, it is necessary to apply frequent light irrigations during the seed germination stage. After the seedlings are well established, 5 or so cm in height, sufficient irrigation water needs to be applied to fill the soil to a depth of about 40 cm. This will ensure a rapid early-season plant growth and a good deep root development.

The third critical time when the plant needs sufficient water is throughout the flowering stage. This is also the time when the peas are being continually harvested. For more detailed information on determining when to irrigate and how much irrigation water to apply, please refer to the section on irrigation beginning on page 8.

Disease and Insect Control

American Bollworms

Damage: Larvae feed on the exterior and later inside the seed pods.

Pest Description: Full-grown larvae are about 40 mm in length. They vary in color from near black, brown, or green to pale yellow or pink with a characteristic dark band along the back and light bands along each side.

Cultural Control: Hand pick larvae from plants.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Start when larvae are less than 1 cm. Repeat at 10-14 day intervals if necessary.					
Ripcord 200 ec	0.17	0.22	16.7ml	50ml	7

Aphids

Aphids: Apply when aphids are present. Repeat as necessary.

Damage: All stages of the insect feed in colonies by sucking plant juices from tender plant parts, resulting in stunted, distorted growth.

Pest Description: Small green, soft-bodied insects with or without transparent wings.

Cultural Control: Remove weeds surrounding the field.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Aphids: Apply when aphids are present. Repeat as necessary.					
Rogor 400 ec	2.5	3.3	250ml	750ml	14
Malathion 25% wp	12.5	16.5	83g	2.5kg	7
Malathion 500 ec	4	5.3	400ml	1200ml	7
Malathion 5% dp.	dust	dust	dust	15-25 kg	7

Damping Off and Root Rot

Symptoms: A group of fungus diseases that attack the root systems and stems of young seedlings at the soil line, causing a brown, watery, soft rot.

Cultural Control:

- Plant in well-drained soil
- Do not over irrigate, allow soil surface to dry between irrigations.
- Practice crop rotation

Chemical Control: Here are two possible seed treatments.

metalaxyl 35% wp; for control of damping-off and root rots caused by water molds:
Make a slurry by adding 10 gm of powder to 25 litres of water and mix with seed just before planting.

captab/metalaxyl 35%+35%; for control of diseases caused by water molds and Rhizoctonia fungi:
Use 200 gm/100 kg of seed; apply as a slurry in 500 ml of water. This treatment also will provide early season control of downy mildew.

Downy Mildew

Symptoms: Symptoms start on lower leaves. Yellowish-brown blotches appear on the top surface of these leaves. A whitish felt-like mold growth develops on undersides of leaves directly beneath the leaf blotch symptom. Sometimes systemic infection occurs and results in stunted plants with a strange shape, sometimes with mold on the plant . This is an early-season disease. When conditions turn dry, plants sometimes appear to outgrow the disease.

Cultural Control:

- Use clean seed
- Plant in well-drained soil
- Do not over fertilize with nitrogen
- Practice crop rotation

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
When significant disease is anticipated, apply one of the following fungicides when disease is first noticed or during periods of wet weather. Repeat every 7 days for as long as rainy periods last.					
Dithane M45 wp	4.8	6.4	200g	Up to 200L	3
Dithane/oxadixyl 56%/8% wp	100g	133g	667g	2kg	2

Powdery Mildew

Symptoms: White powdery growth develops on any surface of the plant. Heavily infected plants appear bluish-white when the mold spores are prevalent. The powdery spores are carried long distances with wind currents. Powdery mildew is most important during warm dry weather.

Cultural Control:

- Do not plant in hot summer months
- Plant in well-drained soil

Chemical Control: Sulfur is a good inexpensive treatment. Sulfur should be applied when disease is anticipated or when disease first appears, and then repeated at 10-14 day intervals. If more effective control is needed, triadimefon 250 ec (Bayleton; 125 ml/ha; 14-day intervals; 3 days to harvest) and triforine 190 ec (Funginex; 1-1.5 litres/ha; 7-10 day intervals; 4 days to harvest) can be applied after disease first appears.

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
sulfur 80% wp	40g	60g	300g	Up to 1000L	0
sulfur 98% dp	dust	dust	dust	10-40 kg	0

Post Harvest Handling

Peas reach the harvest stage within a short period of time. Thus, repeated plantings, about 10 days apart, must be established in order to have a constant supply for marketing. Quality is mostly determined by sugar content and tenderness. Shell peas remain at peak quality for only a short time, as the sugars convert to starch. For the fresh market, shell peas should be harvested as soon as the seeds within the pods have reached an appropriate size and are still tender.

Edible pod peas, depending on the type, can be harvested at different stages. Sugar snaps (for example, Sugar Snap and Sugar Daddy) can be harvested from as soon as seeds begin to develop until they are nearly full size (but are still tender) and eaten in the pods, either raw or cooked; or when seeds have reached full size they can be shelled and eaten as conventional green peas. "Snow peas" (for example, Oregon Sugar Pod) are used while the seeds are still small and immature. Since the length of time that any of the peas remain in prime condition is often only 1 or 2 days, harvesting must be carefully scheduled.

Peas should be graded to eliminate pods that are diseased, damaged, or discolored. Pods should be harvested early in the morning before heat from the sun has warmed them. They must be kept cool and marketed soon after harvesting (the same day). Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

PEPPERS

This section includes production information for both sweet (bell) type and hot type peppers.

Soils and Rotations

Peppers grow best on soils that have a good organic matter content and are well drained. The pH of the soil should range between 5.5 and 7.0. If the pH is less than 5.5 lime should be applied (see Table 6 on page 4). No more than 1 tonne of the lime should be of the dolomitic type (high magnesium); the remainder should be a calcitic lime.

Crops should be rotated so that pepper are not planted on the same land more than once in 3 years. Other crops that should not be grown for 1 or more years before peppers, includes chilies, are potatoes, tomatoes, eggplant, groundnuts, tobacco, and cowpeas. Diseases that survive in the soil (bacterial, Fusarium, and Verticillium wilts) often develop when these crops are grown year after year on the same land. Once these diseases are present, it generally takes a 7-year period in which none of these crops are grown to eliminate the organisms from the soil.

Fertilization

Lime and fertilizer (except for nitrogen) requirements can best be determined by use of a soil test. It is suggested that a soil sample be taken about once every 2 to 3 years. In the case of nitrogen, the rule is to supply not more than about 90 kg/ha of actual nitrogen to the crop during the entire growing season. The exception to this would be during period of exceptionally frequent or heavy rains, when excessive leaching of the nutrient may occur. Under these conditions the amount may be increased to about 110 kg/ha. Applying more nitrogen is generally a waste of money and may delay fruit. The following table provides a guide for nitrogen application, and in the absence of a soil test, for phosphorous and potassium.

Rates of N-P-K (kg/ha)

Basal		
Medium yields	High yields	Timing
50-75-50	70-105-70	at planting
Sidedress		
20-0-0	20-0-0	4 wks. after planing
20-0-0	20-0-0	9 wks. after planting

LAN is generally recommended for the sidedress applications, however ammonium nitrate, or urea may also be used. Both basal and sidedress applications should be banded. In the case of basal treatments, the fertilizer should be worked into the soil before setting the seedlings. Tables 1 through 5 beginning on page 2 provide a guide for making applications using different fertilizers.

Time of Planting

Peppers are a warm season crop that is sensitive to temperature extremes. They make their best growth when temperatures are between 21 to 25°C. When night temperature drop below 15°C or day temperatures exceed 30°C, poor fruit set and blossom drop often result. Given these limitations, peppers can be grown throughout the year in areas of the low and middleveld where temperatures below 0°C do not occur and in the highveld during the warmer months of the year. See Tables 14 through 16 beginning on page 17 for recommended times to plant.

Seedling Production

The use of good-quality seedlings free of diseases is very important for successful production of tomatoes. Seedlings grown in trays can be purchased ready for field planting. If purchased from a reliable source and handled properly, these are worth considering. When good management practices, as outlined below, good-quality seedlings can be grown by the farmer, either in trays or in seedbeds.

Trays, either plastic or styrofoam, with individual cells of about 3 sq cm or larger

size, can be used. A suitable disease-free medium should be used to fill the trays. Several peat-based mixes with fertilizer materials already added can be purchased for filling the trays.

Moisture levels in the trays must be carefully managed. The soil mixture in the cells must never be allowed to completely dry. On the other hand, the trays must not be kept too wet. Allow the soil surface to dry slightly before adding more water. Enough water should then be added to completely wet the medium in the cells. Check trays regularly, often two or three times daily on hot, sunny days. Keep trays elevated off the ground and protected from animals.

Seedbeds should be prepared according to directions in "Seedbeds" beginning on page 6. Space rows about 20 cm apart and cover with 5 to 8 mm of fine soil. Lightly firm the soil over the seeds using a wooden row marker or flat piece of wood. Sow seedlings to obtain a final density of about 40 to 60 seedlings per metre of row. Thin to this stand about 1 week after emergence if necessary. Keep beds moist, but allow the soil surface to dry slightly before watering.

Field Spacing

Single Row Prod. System		
Between Rows	Between Plants	
90 cm	40 to 45cm*	
Double Row Prod. System		
Between Beds	Between Rows on Bed	Between Plants
1.5m	30 - 35cm	50cm

* 80cm for Birdseye chilies

Field Planting

Planting peppers on raised beds that have a slight slope from the centre to the edges improves drainage and aids in disease control. Double rows should be planted on each bed. Beds should be about 75 cm wide and raised to a height of 15cm. This crops responds very well to a mulch, such as black plastic or grass, often resulting in yield increases of more than 50%. Mulches can be readily used with the raised bed system. When using the ridge/furrow system necessary for furrow irrigation, plants should not be set on the side of the ridge as opposed to the bottom of the furrow.

Plants should be set to the field in about 6 to 8 weeks (when they reach 12-14 cm in height). Seedlings left in the seedbed or seed tray too long become excessively hardened and are less able to withstand transplant shock. Remove plants carefully from the seedbed so as not to severely damage roots. Seedlings from the seedbed should be kept in a bucket with water to prevent roots from drying during the transplant operation.

Cool, cloudy days are best for transplanting. On clear days it is best to plant in late afternoon. Apply sufficient water immediately after transplanting to thoroughly wet the soil to a depth slightly below the roots of the seedlings. If soil is extremely dry, a light irrigation one day before transplanting may be beneficial.

For transplanting on hot, dry days a spray application of an antitranspirant material (e.g., VaporGard) may help reduce water loss from the plant. Spray plants immediately after transplanting, covering the entire leaf surface, using a mixture of 1 part VaporGard to 100 parts water.

Irrigation

There are several critical times during the pepper growing season when it is most important that adequate water be available to the plant for obtaining desired yields. First, to develop strong and healthy seedlings grown in beds, it is necessary to apply frequent, light irrigations during the seed germination stage. Then, when the pepper seedlings are being transplanted, it is important that sufficient irrigation water be applied to fill the soil to a depth of about 50 cm. This will ensure rapid early-season plant growth and a good deep root development.

The third critical time when sufficient water is needed by the pepper plant is during flowering and as the fruit is developing until near harvest time. For more detailed

information on irrigation management, including determining when to irrigate, how much irrigation water to apply, and different methods of irrigation please refer to the section on irrigation beginning on page 8.

Variety Information

The varieties listed below are suitable for both summer and winter production. For hot summer months varieties that have good leaf cover are recommended to reduce sunscald injury to fruit.

Variety Information Table

Bell Types Cultivar	Source	Relative Days	Foliage Cover	Fruit	Disease Reaction
California Wonder	H, MF, P, SA	75	good	blocky, thick walls	TMV
Jupiter	SA	75	good	blocky, thick walls	TMV
Komati	H	80	good	blocky, thick walls	
Lady Belle*	MF	80	good	deep blocky	TMV
Keystone Resistant Giant	MF	80	very good	large, blocky, thick walls	
Indra*	SA	75	good	blocky	TMV, tol.to PYV
Pip	MF	75	very good	blocky fruit	
Sharina*	MF	75	good	medium	TMV

Hot Types Cultivars	Source	Relative Days	Foliage Cover	Fruit	Remarks
Jalapeno	H	75	-	top shaped, small	very hot
Birdseye	MF		-	small pointed	extremely hot
Long Slim Cayenne	H, P, SA	75	-	slender, 14 cm long	very hot
Passion*	P	75	-	slender, 14 cm long	mildly hot

* indicates hybrid cultivar.

Disease Reaction Key:

	TEV = tobacco etch virus
PVY = potato virus Y	TMV = tobacco mosaic virus

Source key:
MF = MayFord H = Hygrotech
P = Premier SA = Starke Ayres

Disease and Insect Control

Aphids
Damage: All stages of the insect feed in colonies by sucking plant juices from tender plant parts, resulting in stunted, distorted growth.
Pest Description: Small green, soft-bodied insects with or without transparent wings.
Cultural Control: Remove weeds surrounding the field.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Apply spray when aphids are first present. Continue applications as needed.					
Malathion 25% wp	4	5	250g	Up to 500L	3
Malathion 500 ec	1.3	1.7	125ml	Up to 500L	3

Bacterial Spot

Symptoms: Bacterial spot can cause major loss. It appears as brown leaf spots that can enlarge and result in ragged leaves. Dark green to brown scabby spots develop on fruit surfaces.

Cultural Control:

- Use disease-free seed.
- Use pathogen-free and well-drained seedbeds.
- Rotate to avoid tomato and pepper for 2 years.
- Avoid working in plantings when leaves are wet.
- Destroy plants soon after harvest.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
To minimize chance of bacterial spot development, Copper oxychloride is labeled to control bacterial spot. Use of copper oxychloride may help minimize total spray costs since it will help control powdery mildew as well as bacterial spot. Begin sprays as soon as disease is anticipated or noticed. Repeat at 7-14 day intervals as needed.					
copper oxychloride	5.8	7.8	40g	120g	3

Erinose Mites

Damage: Mites feed on buds and interior leaves, making leaf edges curl downward and inward. On older leaves, feeding area becomes swollen, with excessive growth of fine hairs.

Pest Description: Very small, torpedo-shaped mite with a cream-colored body.

Cultural Control: None recommended.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Start miticides as soon as mites are present. Repeat application in 2-3 weeks.					
Kelthane 18.5% wp	7	9	200g	500g	7
Kelthane 420 ec	1	1.3	100ml	500ml	7
sulphur 80% wp	60g	80g	400g	2kg	0
sulphur 98% dp	dust	dust	dust	20-30kg	0

Powdery Mildew

Symptoms: Mildew starts on youngest leaves and is favored by warm humid conditions. First, yellowish spots appear on leaves. Then a white powdery mold appears on yellowish spots which can dry out at later stages of disease.

Cultural Control: Plant varieties vary greatly in their susceptibility.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Complete plant coverage with fungicides will enhance control. Apply fungicide at first sign of disease. Repeat in 7-14 days if needed. If good coverage is obtained, it may be possible to get					

control with considerably lower rates of Benlate 50% wp; the highest labeled rates on any crops in the US are nearly one-third the maximum rate listed here for pepper powdery mildew control.

Benlate 50% wp	1.5	1.9	50g	750g	3
copper oxychloride	5.9	7.8	400g	1.2kg	3

Red Spider and Rust Mites

Damage: Mites feed in colonies on the undersides of leaves, producing a yellowing or bronzing color.

Pest Description: Very small spider with reddish oval body and four pairs of legs.

Cultural Control: None recommended.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Start miticides as soon as mites are present. Repeat application in 2-3 weeks.					
Kelthane 18.5% wp	7	9	200g	500g	7
Kelthane 420 ec	1	1.3	100ml	500ml	7
sulphur 80% wp	60g	80g	400g	2kg	0
sulphur 98% dp	dust	dust	dust	20-30kg	0

Thrips

Damage: Adult and immature insects feed on plant juices from tender foliage, floral parts, and fruiting bodies.

Pest Description: Very small, yellow to dark brown, elongated insects 1-2 mm in length with four, long, narrow, fringed wings.

Cultural Control: None recommended.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply insecticide when thrips first appear. Repeat sprays after 10-14 days.					
Malathion 25% wp	5.3	7	350g	Up to 500L	3
Malathion 500 ec	1.8	2.3	17ml	Up to 500L	3

Verticillium Wilt

Symptoms: A soil-borne fungus disease that results in small, yellow leaves and stunted growth due to shortening of internodes, progressing to a wilting stage and finally death of infected plant parts.

Cultural Control:

- When possible, grow vigorous hybrids which tolerate disease best.
- Use disease-free planting stock or seed.
- Practice crop rotation; avoid tomatoes, peppers and potatoes for a period of 3 years.

Viruses

Symptoms: Viruses that may occur on peppers include tobacco mosaic (TMV), Potato virus X (PVX), cucumber mosaic (CMV), tobacco etch (TEV), and potato virus Y (PVY). Symptoms vary according to the virus, time of the year, and environmental conditions. The range of symptoms may include leaf mottling, puckering, or curling; stem and petiole streaking; deformed or spotted fruit; stunted plants; and blossom and fruit drop.

Cultural Control:

- Control weeds in the area that may be alternate hosts and remove old plantings of crops that are infected with viruses.
- Remove from the field the first plants that show the virus symptoms.
- Follow crop rotation.
- Grow virus-resistant varieties when available.
- Avoid field that have a history of virus problems.
- Follow good sanitation when viruses are present to reduce chances of spreading.

Chemical Control: Aphid control may slow spread of aphid-borne viruses somewhat.

Harvesting and Handling

Bell peppers (sweet) are generally harvested when they have reached full size but are still fully green. There is some demand for ripe (red or yellow) fruit, these often command a premium price. However, ripe fruit must be managed carefully and marketed promptly to prevent softening. Most other peppers (hot chili, paprika, etc.) are allowed to fully ripen on the plant before harvesting. Do not allow harvested fruit to remain exposed to sunlight but keep in cool shaded areas, except for hot types that are to be dried before marketing.

Fruit should be wiped clean, removing those that are not crisp and firm, and sorted into size groups. Without refrigerated storage, peppers should be sold within 1 or 2 days after harvesting. Lightly waxing fruit or wrapping with cellophane reduces moisture loss and lengthens the storage period. Exposure to extended periods below 10°C often results in damage to fruit. Additional information on post harvest handling of vegetables can be found beginning on page 13, and Table 26 (page 28) contains a summary of handling data.

An acceptable yield should exceed 25,000 kg/ha.

POTATO

Production Considerations

Before planting to the field, the following points should be considered:

1. The availability and price of quality seed tubers.
2. Foliar disease are often difficult to control during the summer months.
3. Labour requirements for planting, hilling, weeding, and harvesting the crop is excessive on non-mechanized farms.
4. The costs of potato production and capital outlay is higher than most of other vegetable crops.
5. Potato sale prices are subject to wide variations, and are dependent upon the quality of your crop and the supply on the market at the time of harvest.
6. Never plant potatoes where nematodes are expected to be a problem.
7. Fine-textured soils, such as clay and silty-clay loams promote misshapen, variable size potato tubers.
8. Irrigation is required to protect your investment and grow a salable potato crop, even during the rainy season.

Soils and Rotations

Suitable soils for potatoes are sandy to sandy loams with a pH of 4.5 - 5.5. Clay soils tend to retard tuber formation and make lifting of the crop difficult. Soils with high pH may encourage scab disease. Potatoes should not be planted following tomatoes, pepper, eggplant, groundnuts, sunflowers, tobacco, cowpeas, and beans because of susceptibility to the same disease problems.

For best results, plant potatoes once every 3 or 4 years in the same soil and rotate with maize and/or sorghum.

Seed Production

Fields for production of seed tubers should be rogued and periodically inspected by Plant Pathologists. A seed field must be grown using careful management to avoid spreading diseases through the seed tubers.

The major periods for planting seed potatoes are as follows:

1. Winter crop - March planted with irrigation in the lowveld and middleveld.
2. Summer Crop - September planted with supplemental irrigation in the highveld and middleveld.

The March planted crop should be harvested for seed in July. Dormant, immature tubers need to be stored under warm, humid planting.

The September planted crop would be ready for harvest in January. When stored under warm, humid conditions, the dormancy is broken for planting in the fall. These must be considered as trial suggestions that should be tested by growers before adopted as a recommended seed production practice. Cold storages would allow other possibilities.

A November planted crop (harvested in April) is normally grown where there is the best likelihood of producing consistent quality seed. The seed might have to be held for up to a six-month period at a 4° C and 95% relative humidity. Air storage and compensation for the risks involved would be assessed to the seed price. Stored seed should be removed from cold storage about one month before desired planting date and held at 15° C to promote sprouting. This seed could be used for the highveld, summer season.

Seed and Seed Rates

Pest problems can be transmitted through potato seed tubers. Diseases commonly found in tubers are caused by viruses, fungi, and bacteria. Several organisms can be carried on the surface of the potato tubers. Most of these pests are not observable when the tuber is checked. To eliminate a major portion of these problems only clean, certified-quality, government inspected and tagged seed of a known variety and origin should be purchased and planted. With small seed pieces (35 to 45 mm diameter) about 60 bags (30 kg) per hectare are needed. This is equivalent to 3 bags per 500 m of row. Large seed (over 45 mm diameter) requires 85 bags (30 kg) per hectare, or 4 bags per 500 m of planted row.

Seed Handling

When seed is received, check to see if it is tagged and appears to be sound (not wet or diseased). Observe the condition and length of the sprouts. Never plant seed that does not have sprouts beginning to form. If the sprouts are over 2 cm in length be careful not to break the sprouts. A 1 cm long green sprout is ideal.

Seed may be stored inside a building for several days at temperatures between 15 to 20° C. Open paper seed bags and daily observe the condition of the sprouts. If sprouting has not started, spread the tubers out in a thin layer on the floor where they are subject to air movement and light (open shade). When dormancy is broken you will observe strong, short, stubby green sprouts. This seedpiece is ready to plant.

Seed cutting is required if the size is greater than 60 g. Cut seed can be planted immediately into warm, moist soils. The cut seed be between 43 to 57 g each and have one or more sprouts or eyes.

Occasionally cut seed will have to be held after cutting before the date of planting. If this is necessary, the storage conditions for the 3 or 4 days after cutting are very specific to promote wound healing (suberization) and allow the cut surfaces to heal. The requirements are 18° C, 90% relative humidity, and good ventilation. After this the tubers should be spread in a thin layer on a floor in high but open shade to promote green sprouting (chitting) as previously described.

Suggested Varieties

BP1 - Oval-shaped tubers of medium size with smooth tan yellow skin and shallow eyes. Maturity is from 110 to 130 days.

Cedara - Mostly round tubers of medium size. Skin is slightly rough and tan with deep eyes. Maturity is from 120 to 140 days.

UP-to-Date - Tubers are often irregular but tend to be oval and medium-sized with deep eyes. Flesh is yellow. Late blight susceptible. Matures in 100 to 130 days.

Soil Testing

Soil fertility levels of the field should be established by soil analyses. Once these levels are known, fertilizer and liming practices may be suggested. Soil pH values below 4.5 may be too acid for profitable production. The economics of and response to lime application are presently being investigated.

Fertilization

Fertilization requirements for potatoes can be best determined from a soil test performed by a reliable soil testing laboratory. In the absence of a soil test, the following can be used as a guide.

Rates of N-P-K (kg/ha)

	Med. management	High management	Timing
Basal	60-90-60	70-105-70	at planting
Sidedress	20-0-0	30-0-0	4 wks. after planting
	20-0-0	20-0-0	8 wks. after planting

A cold drink can (340ml) is recommended for applying the fertilizer in a band along the row as described in the Table 3, Chapter 5. Any one of the fertilizer types in the table can be used for basal application. A nitrogen material should be topdressed 3 to 4 weeks after emergence, during ridging.

Land Preparation

Prepare potato lands in advance of planting. Maintain organic matter in soils at as high a level as possible while keeping the planting area weed-free before planting. A deep, friable seedbed is desirable. Be cautious not to work soils while they are wet and keep soil compaction minimized when using tillage equipment.

Planting Dates

Plant on the dates that will maximize your profit potential. Yields are important but the market price at harvest is an important part of the profit formula. Consider the date you wish to harvest, some 100 to 150 days from planting. This varies with the variety and production season.

Potatoes grow best when days are cool but will not tolerate frosts. Satisfactory yields can be obtained in summer, except lowveld, if a good program of disease control is followed.

Based on a six-year average, market prices have peaked in July and December. Prices have been the lowest in the fall months of March to May. November through February have been months with the consistently high sale prices.

Planting Techniques

The sequence of the planting events are as follows:

1. Furrows are formed on 90 cm centres.
2. Irrigate the furrow or time the planting to follow rain.
3. Do not work in the soil while it is wet an d muddy. About three days after irrigation the soil will be moist and ready for planting.
4. Apply the fertilizer in a narrow band, cover the fertilizer band with 2 to 4 cm of soil. Fertilizer must not be in contact with potato seedpieces. This is extremely important.
5. Potato seedpieces are placed at the desired spacing above the fertilizer band in the furrow. Spacing may vary from 20 to 30 cm dependent upon the variety, sizing desired, and the experience of the farmer.
6. Cover seed pieces with 5 to 8 cm of soil. This might be increased to 10 cm if washing is expected with subsequent irrigations.
7. If the soil is moist around the seedpiece a waiting period is desirable before irrigation. If it is too wet around the seedpiece, decay is promoted. Dry soil around a fresh-cut seedpiece will remove moisture from the seed and adversely effect sprouting. Common sense, experience, and good luck are needed during this period.

Remember a satisfactory stand (at least 80%) is required for profitable yields. Stands below 60% are not normally satisfactory.

Spacing

Rows: 0.9 m apart.
In row: Place the tubers 20 to 30 cm apart

Irrigation

Potatoes need frequent irrigations until the root system is fully developed. The first irrigation should be heavy. This heavy irrigation will fill the expected root zone of the crop. This will help the roots to develop to their maximum potential. Irrigations can be done less frequently after the crop is established. Care must be taken not to allow irrigation water to uncover the seeds.

Potato roots do not do a good job of taking up water. For this reason, potatoes should be irrigated often, especially when the tubers are forming. If the soil is allowed to become too dry before irrigating then small, poorly-shaped tubers will be formed.

Further information on the irrigation of vegetable crops is available in the irrigation Recommendation Guides produced by the Ministry of Agriculture and Cooperatives.

Hilling and Weeding

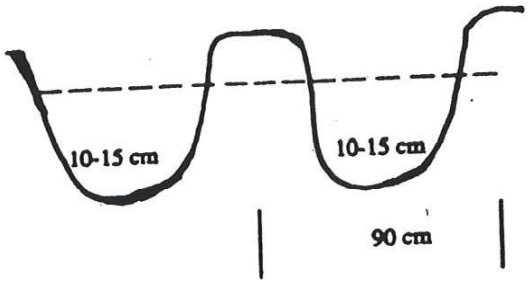
It is generally accepted that hilling is a desirable practice in potato culture. Weeding is accomplished as the hills are being built. Hilling should be started when the plants are 10 cm in height. Never cover more than one-half of the plant.

The process is usually repeated every week or every other week until the desired hill has been built.

Hilling reduces the risk of sunburned and green tubers. Tuber moth problems are also reduced. A steep, deep hill with a flat top will help eliminate excessive moisture problems when irrigation or heavy rainfall occurs after tubers are formed. Finally, it is

easier to harvest from hills by hand or with harvesting machines.

By the time the plants are 20 to 30 cm high, the plants should be fully ridged or hilled to a depth of 10 to 15 cm. See the following illustration.



Disease and Insect Control

American Bollworms

Damage: Larvae damage leaves and flowers.

Pest Description: Full-grown larvae are about 40 mm in length. Their color varies from almost black, brown, or green to pale yellow with a dark band along the back and whitish bands along each side.

Cultural Control:

- Ploughing has been recommended to destroy pupae overwintering in the soil.
- Early plantings tend to escape serious damage.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Spray when larvae are less than 1 cm. Repeat at 10-14 day intervals if necessary					
Ripcord 200 ec	0.5	0.7	50ml	150ml	3
Agrithrin 200 ec	1.3	1.7	125ml	375ml	3
Ambush 500 ec	0.3	0.4	33ml	100ml	3

Aphids

Damage: All stages of the insect feed in colonies by sucking plant juices from young leaves. This may result in stunted, distorted growth. Often no visible symptoms occur.

Pest Description: Aphids range in color from dark green to olive and have an elongated body. They may or may not have transparent wings.

Cultural Control—Plant early.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	# 15ml scoops/ 20L	Rate per 100L	Rate per ha	Days to withhold
Apply spray when aphids are present. Repeat as necessary.					
Orthene 75% sp	25-38g	3.3 450g	167-250g	500-750g	14
Rogor 400 ec	2.7	3.7	267ml	800ml	14
Pirimor 6.25% wp	60g	80g	400g	1200g	14

Bacterial Wilt

Symptoms: A soil-borne disease caused by bacteria that damage the plant by blocking the plant's vascular system, resulting in wilt. Tubers may be infected. Visible tuber symptoms begin browning of vascular tissue beneath the skin, followed by the development of a sticky, milky white ooze that develops in the dark tissue and sometimes exudes from the eyes and stem end.

Cultural Control:

- Plant only disease-free seed tubers.
- Plant only on pathogen-free land.
- Practice long crop rotation.
- Plant early and mulch the bed to reduce soil temperatures.
- Disinfect all farm equipment and footwear that has been in infected soil.

Chemical Control: None recommended.

CMR Beetles

Damage: Beetles feed on flower petals.

Pest Description: Beetles are small to large, with bright yellow and black bands across the wing covers.

Cultural Control: None recommended.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply when pest is noticed.					
Orthene 75% sp	25-38g	33-50g	167-250g	500-750g	14

Common Scab

Symptoms: A soil-borne fungus disease that attacks tubers. Infection results in loose corky tissue with either raised or sunken spots.

Cultural Control:

- Plant only disease-free seedpieces.
- Avoid liming before planting, as calcium encourages infection.
- Reduce soil pH by adding sulfur.
- Add green manure to sandy soils before planting.

Chemical Control: Dip seed tubers in a solution of Dithane 80% wp (30 gm in 10 litres of water) before planting.

Early Blight

Symptoms: First symptoms are moderate size leaf spots with faint dark rings within the spot. As spots enlarge, parts of affected leaves may turn yellow and die. Early blight always starts on oldest leaves and progresses up the plant. Early blight is favored by wet conditions associated with rain and dew.

Cultural Control: Use cultural practices that favor a rapid-growing, vigorous plant.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Begin sprays before symptoms appear, especially in wet seasons. Repeat spray at 7-14 day intervals and after rains.					
Bravo 75% wp	35g	47g	233g	0.7-2kg	3
Bravo 500 sc	3.3	4.4	333ml	1-2.75L	3

Fusarium Wilt

Symptoms: A fungus disease that infects the lower leaves, resulting in wilting of plants until all leaves turn yellow and hang limp. Tubers can be infected and become darker, with wrinkled and sunken skin.

Cultural Control:

- Practice crop rotation.
- Use resistant plant varieties.
- Avoid using infected seed tubers.
- Plant early to avoid high soil temperatures and low soil moisture.

Chemical Control: None recommended.

Late Blight

Symptoms: This can be a devastating disease. When unchecked, during wet cool seasons, it can destroy a planting within a couple of weeks. On both young and old leaves, first symptoms appear as large pale green areas which die rapidly and turn brown or black. During wet conditions, a white mold develops on the undersurface of leaves at the margin of dead areas. Late blight is favored by cool wet weather. Tuber infection rarely occurs in Swaziland.

Cultural Control: Early plantings may mature before climatic conditions become favorable.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Dithane and Bravo are good protective fungicides for both early blight and late blight. Several new fungicides (cymoxanil, metalaxyl, and oxadixyl), some with systemic properties, are highly effective for late blight but are more expensive. If such fungicides are needed, follow directions to minimize chance for development of resistance to the fungicides. The new fungicides are used at 14-day intervals; when necessary, Dithane or Bravo can be applied between these applications.					
Bravo 500 sc	See above under early blight.				
Dithane M45	See above under early blight				
Ridomil MZ 60%-10% wp	75g	100g	500g	2 kg	14
Milraz 60%-70% wp	75g	100g	500g	2.5kg	14
Recoil 56%-8% wp	75g	100g	500g	2.5kg	21

Potato Tuber Moths

Damage: Primary damage is caused by larvae tunneling inside the tuber and leaving excrement near the entrance hole. Larvae may also feed on tender leaves and stems.

Pest Description: Full-grown larvae are about 11 mm long and pale green in color, with pink markings.

Cultural Control:

- Larval populations are reduced by natural enemies.
- Tuber damage may be avoided by early planting of insect-free seedpieces deeper than 20 cm and by keeping the tuber crop buried at least 25 cm deep.
- Do not leave harvested tubers in the field overnight.
- Clean up crop residues following harvest.
- Practice crop rotation.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold
Apply spray when the insect appears. Repeat after 10-14 days.					
Orthene 75% wsp	25g	33.5g	167g	500g	14

Nematodes (Various Kinds)

Descriptions: Microscopic slender, transparent worms.

Damage: Attack roots and tubers causing lesions that may allow entry of bacterial or fungal organisms, or cause knotty swellings.

Chemical Control:

Chemical(s)	# 15ml scoops/ 15L	20L	Rate per 100L	Rate per ha	Days to withhold

The chemical, aldicarb (Temik), is available to control nematodes. However, it is a very toxic, dangerous, deadly material. Aldicarb should be used only by experienced applicators who are wearing protective clothing and who follow all precautions on the label. Aldicarb is applied and incorporated into the soil at planting time.

Temik 15% gr	500 g/100m of furrow	50kg	120

Harvest Dates

The major factors affecting the harvest dates are the potato variety, the elevation of the production location, production season and the planting date. Some general guidelines for a 120 day variety are as follows:

Planting Date	Harvest Date	Comments
Jan.	May	Normal maturity
Feb.	June	Normal maturity
March	July	Delayed 1 or 2 wks.
April	Aug.	Delayed 2 to 3 wks.
May	Sept.	Delayed 2 to 3 wks.
June	Oct.	Delayed 2 to 3 wks.
July	Nov.	Delayed 1 or 2 wks.
Aug.	Dec.	Normal maturity
Sept.	Jan.	Normal maturity
Oct.	Feb.	1 to 3 weeks early
Nov.	March	1 to 3 weeks early
Dec.	April	1 to 3 weeks early

Harvesting Techniques

Finally, we have arrived at the most important step in producing a saleable product. Farmers must now harvest a bruise free potato crop. Moist, sandy loam soils are preferred. Avoid wet soils because of soil compaction and muddy tubers that give cleaning problems. Dry soils are usually cloddy and increase tuber bruises.

If the plant has green foliage, tubers will skin easily during harvesting. This type of harvest is common for some of the from-the-field processing potatoes. Chip and fry color is normally excellent for many varieties at this time, because starches have not had the opportunity to convert to reducing sugars that promote a dark color fry. If this crop is to be used for tablestock, and the tuber temperature is above 20° C, it is desirable to cool tubers to about 15° C for a three to four-day period before shipment and/or sale.

Tablestock potatoes are more likely to be matured in the farmers field. These will not be harvested until the plants are completely dead and the skin is "set" or cannot be easily rubbed with the thumb. Tubers should be harvested in temperatures between 10 and 30° C. Do not harvest if it is too hot or too cold.

Lift the tubers with a machine to remove the druggery from harvesting operation. Take every step possible not to bruise the tubers. Handle them like eggs. Bruising is increased when tuber temperature is too high.

Do not allow harvested tubers to remain in direct sunlight at any time. Sun greening will quickly reduce the saleable value of your crop. During hot weather move tubers to a cool storage. In cool weather, hold tubers at 15° C for two weeks and then move to a cooler storage area, if possible.

Weed Control

Control of weeds is very important throughout the season if good yields of quality product are to be obtained. With some crops such as potato, chemical herbicides may be safely used to aid in weed control.

However, herbicides must be used with care to obtain control and prevent damage to the crop or environment. Only chemicals labeled for the particular crop must be used and directions on the label need to be followed. Care must be taken to prevent the herbicide drifting to other crops during application and the sprayer used should never used to apply chemicals for disease or insect control. Page 10 contains additional information regarding the use of herbicides.

Suggested Chemical Controls

Lasso (alachlor) 384 ec
Rate: 5 litres per hectare.
Time: Apply any time after planting up to just before the crop emerges, may be applied as a tank mix with Sencor.
Control: Annual grasses and some broadleaf weeds.
Remarks: Rates vary according to soil type.
Crop Rotation: Crops listed on the label may be planted the following season. Other crops should not be plant for approximately 18 months after application.

Sencor (metribuzin) 480 sc
Rate: 1.1 to 2.5 kg per hectare.
Time: Apply any time after planting up to just before the crop emerges.
Control: Annual grasses and some broadleaf weeds, repeated applications will provide some control of nutsedge.
Remarks: Rates vary according to soil type, heavier rates are for the heavier soils
Crop Rotation: Most crops that are not on the label should not be planted for 8 months; onions, beets and similar root crops should not be planted for 1 to 1 1/2 years after sencor has been applied.

Fusilade 125 ec (fluazifop-P-butyl)
Rate: 2 to 4 litres per hectare.
Time: Apply after planting for a period of 4 weeks. Most effective when weed grasses are actively growing.
Control: Annual and perennial grasses.
Crop Rotation: Do not plant maize within 60 days of last application.

Marketing

The saleable product must be sized, dry, dirt-free, and free from diseased, misshapen and mechanically damaged tubers. While sizing is not controlled by goverment regulation, market tuber diameters commonly found in Swaziland are as follows:

4 to 9 cm diameter some packs,
4 to 6 cm diameter commonly found, and
6 to 9 cm diameter some packs.

Special sales would be required with tubers smaller than 4 cm diameter (40 g) and tubers over 9 cm diameter. Many of the marketing problems can be controlled by good potato production and harvest management practices. Tubers will normally require brushing or washing, or both when sold in city markets. Washed tubers should be packed in paper to reduce greening when sold to farmers markets or on super market shelves. Consumer preference should always be considered when growing, packaging, and selling the potato crop.

Holding Potatoes

Following the two-week healing period after harvests, potato tubers are best stored at 4° C and 95% relative humidity with air movement through the potato pile. Special storages are required to meet these conditions. Use good judgment when piling potatoes and do not pile too high.

For a two-month period, a temperature of 10° C would be acceptable, and 15° C is satisfactory for about a month. Temperatures below 0° C will freeze the flesh of the potato tuber, and make it unusable.

In cool soils, potato storage in the hill may be satisfactory for short periods. Storage in wet soils will normally create significant rot, harvesting and cleaning problems