

# Fruits and Vegetables

- 1. Broccoli
- 2. Cabbage
- 3. Cantaloupe
- 4. Carrot
- 5. Cauliflower
- 6. Celery
- 7. Corn
- 8. Cucumber
- 9. Hot Pepper
- 10. Lettuce
- 11. Parsley
- 12. Passion fruit
- 13. Pineapple
- 14. Pumpkin
- 15. Salad Beans
- 16. Sweet Peppers
- 17. Tomato
- 18. Watermelon

## TECHNOLOGY PACKS



## CABBAGE



November 2015

# Background

Production decisions concerning how much effort and resources to invest and which farming practices to follow, have consequences and create opportunities for the farm affecting production levels, input costs, time constraints, and the potentially size of the operation. They also may have implications for resource use and environmental quality.

Numerous information exist on the various aspects of production and handling/ marketing of crops and livestock, the majority of which are outdated, not easily understood and lacking the where with all for addressing present day challenges such as good agricultural practices (GAPs) and food safety and climate change that impact on the environment and rural livelihoods. These issues are also closely related to the importance of the role of primary producers in increasing the earnings of all actors along the value chain in supporting the development of a commercially viable and sustainable agricultural industry.

The production of high quality and easily understood information packages is critical as this forms a basis for farmers to obtain financing from lending institutions and to efficiently increase their production through the availability of modern technology. This will also result in a reduction of rural unemployment and will greatly help in alleviating poverty and other associated social ills.

# TECHNOLOGY PACKS

## **CABBAGE**



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# Introduction

This Technological Package (Tech Pack) deals with the production and post harvest aspects of cabbage.

Also included in the Tech Pack are appendices:

- Template for cost of production
- List of recommended pesticides and application rates
- Good Agricultural Practices data record sheet.

Notwithstanding the identification of any specific pesticide for the control of pests and diseases, this decision is for the discretion of the Ministry of Agriculture Area Extension Officer and the farmer.

However, the mention of any pesticides and other products used in the Tech Pack should strictly comply with local regulations and all instructions provided by the manufacturer. Also, the use of trade names in the Tech Pack is for the purpose of citing examples and is not meant to either endorse or discredit any particular product.

# Botanical Description

Cabbage (*Brassica oleracea*) belongs to the cabbage family Brassicaceae. The local name in Creole is Chou Pomm. It is a leafy green or purple biennial plant, grown as an annual vegetable crop for its dense-leaved heads

# Ecology and Environment

Plants perform best when grown in well-drained soil in a location that receives full sun. Different varieties prefer different soil types, ranging from lighter sand to heavier clay, but all prefer fertile ground with a pH between 6.0 and 6.8. For optimal growth, there must be adequate levels of nitrogen in the soil, especially during the early head formation stage, and sufficient phosphorus and potassium during the early stages of expansion of the outer leaves. Best growth is obtained between temperatures of 70 - 85 °C (20 - 30°C).

# Varieties/Cultivars

The main varieties are Constanza, Caribbean Queen, Sahel, Salvation, Tropicana and Green Challenger.

# Seedling Production

In order to produce strong and healthy seedlings, establish a seedling nursery, specifically for seedling production. The area should comprise two sections:

1. A seed germination section which is covered with solid roof to protect the germinating seeds from sun and rain
2. A hardening section with a transparent roof or netting that allows for the penetration of light for hardening the seedlings. Hardening protects seedlings from transplanting shock when planted in the field.

The entire nursery area should be weed free and preferably totally screened with polyvinyl insect netting to protect seedlings from any insect attack and/or transmitted insect diseases. Seeds are sown either in seedling trays containing peat moss as the growing medium or in peat moss blocks (Plates 1 & 2).

Though seeds can be directly sown in the field, the success of germination and survivability of most seeds is not guaranteed as both soil pests and diseases can affect them. To achieve 95 - 100% seed germination and strong and healthy seedlings, seedlings produced in nurseries is the preferred option.



Plate 1 Seedling production in seed trays



Plate 2 Seedling production in nursery



Plate 3 Hardening seedlings

The following practices should be adopted in the production of strong healthy cabbage seedlings:

- When purchasing seed material obtain from a reputable source
- Read the label on the seed package. Ensure that the seeds are 90 - 100% viable which must be indicated on the label and is in keeping with the expiry date
- Use seedling trays for sowing seeds. Ensure that they are sterilized by immersing into commercial bleach solution 1 tablespoon/gallon (5 cc/litre) of water
- Use peat moss as the planting medium
- Treat the planting medium with a broad spectrum fungicide, 6 ounces of Banrot in 15 gallons of water (170 g/68 litres), before placing in trays
- Seedling trays should be placed on raised platforms
- Make a planting hole in each cell and plant one seed per hole
- Water seeds to aid germination
- Spread peat moss lightly ensuring that the seeds are covered
- Cover trays with saran netting to hasten germination
- Place trays in the seed germination section of the nursery



- Remove the covering of saran netting at the first sign of germination
- Water seedlings at least twice per day
- Apply plant nutrient as a foliar spray once per week when seedlings are ½ inch (1.2 cm) in height
- Spray seedlings with insecticide and fungicide once per week for pest and disease control
- Apply fertilizer solution, Tropi-Gro 1 tablespoon/gallon (5 cc/litre) of water twice per week when seedlings are 1 inch (2.5 cm) in height
- Harden seedlings by placing them in the hardening section of the nursery for 3 hours during the early morning and late evening, for 2 - 3 days (Plate 3)
- Expose seedlings to full days of sunlight until ready for transplanting
- Transplant seedlings when they are 3 inches (7.6 cm) tall.

## Land Preparation

The soil must be ploughed and rotavated to produce a good tilth. During land preparation incorporate organic matter into the soil. The area must be well drained.

## Spacing and Planting

Cabbage seedlings should be planted in rows 16 – 24 inches (40 – 60 cm) apart and spaced 12 – 16 inches (30 – 40 cm) inches in the row depending on the variety (Plate 4). With large head varieties use the wider spacing.



Plate 4 Broccoli seedling planted in field

# Irrigation

Irrigation water, especially from streams and ponds, should be sent for analysis to ensure that the water is not polluted or saline. It must be of good quality for irrigation. The crop should be irrigated regularly, particularly in the dry season, using over-head or drip irrigation systems. During the wet season, limit irrigation as too much water can increase the incidence of pests and diseases.

# Fertilization

Specific kinds and rates of fertilizers must be determined from the results of soil and leaf analyses. Composted manure if available should be applied to the soil to help with the uptake of nutrients from inorganic fertilizers; it adds organic matter to the soil, enhances soil structure and growth of micro-organisms. All manure should be well composted to ensure that harmful microorganisms and weed seeds are destroyed. At transplanting, apply 4 cwt/acre (500 kg/ha) of 12:12:12+2 fertilizer followed by two applications of 12:12:12+2 at 2 cwt/acre (250 kg/ha) at 3-weekly intervals.




# Weed Control




Weeds can be controlled using a pre-emergence herbicide e.g. Dacthal W75 after transplanting and a contact herbicide during the growth of the crop. Use a shield when applying the herbicides to avoid spray drift on the seedlings. It is advisable to hand weed during the more advanced stage of crop growth.




# Pests and Diseases



The major pests and diseases, symptoms and control/management affecting cabbage are indicated in Table 1.


Table 1 Causal agents, symptoms and control of pests and diseases of cabbage

Pest & Diseases	Symptoms	Control/ Management
 <p>Plate 5 Diamond Back Moth</p>	<p>Young larvae feed between upper and lower leaf surface and may be visible when they emerge from small holes on the underside of the leaf; older larvae leave large, irregularly shaped shot holes on leaf undersides, may leave the upper surface intact; larvae may drop from the plant on silk threads if the leaf is disturbed.</p>	<p>Upon advice by your area extension officer, this pest can be controlled using a contact or systemic insecticide.</p> <p>Before harvest, ensure to use insecticides with a short harvest interval of 5 - 7 days such, as Dipel (<i>Bacillus thuringiensis</i>).</p>
 <p>Plate 6 Cabbage White Butterfly</p>	<p>Large ragged holes in leaves; green-brown frass (insect faeces) on leaves; caterpillar is green in colour and hairy, with a velvet-like appearance; may have faint yellow to orange stripes down back; slow-moving compared with other caterpillars.</p>	<p>Upon advice by your area extension officer, this pest can be controlled using a contact or systemic insecticide.</p> <p>Before harvest, ensure to use insecticides with a short harvest interval of 5 - 7 days such, as Dipel (<i>Bacillus thuringiensis</i>).</p>
 <p>Plate 7 Cabbage Looper</p>	<p>Young larvae scarify the leaves and older larvae eat irregular shaped holes of various sizes. Loopers can kill young plants if they destroy the growing point, or they can cause branching in brassicas by early feeding on the growing point.</p>	<p>Upon advice by your area extension officer, this pest can be controlled using a contact or systemic insecticide.</p> <p>Before harvest, ensure to use insecticides with a short harvest interval of 5 - 7 days such, as Dipel (<i>Bacillus thuringiensis</i>).</p>

Pest & Diseases	Symptoms	Control/ Management
 <p data-bbox="201 552 367 575">Plate 8 Bud Worms</p>	<p data-bbox="613 306 1016 426">Larvae feed on all plant parts, but prefer to feed around the bud of young plants.</p>	<p data-bbox="1036 306 1421 468">Upon advice by your area extension officer, this pest can be controlled using a contact or systemic insecticide.</p> <p data-bbox="1036 520 1421 720">Before harvest, ensure to use insecticides with a short harvest interval of 5 - 7 days such, as Dipel (<i>Bacillus thuringiensis</i>).</p>
 <p data-bbox="201 1041 402 1064">Plate 9 Cabbage Aphids</p>	<p data-bbox="613 795 1016 957">Aphids cause damage by sucking plant sap, which causes heavily infested leaves to curl and stunts plants.</p>	<p data-bbox="1036 795 1421 957">Upon advice by your area extension officer, this pest can be controlled using a contact or systemic insecticide.</p> <p data-bbox="1036 1010 1421 1209">Before harvest, ensure to use insecticides with a short harvest interval of 5 - 7 days such, as Dipel (<i>Bacillus thuringiensis</i>).</p>
 <p data-bbox="201 1591 370 1614">Plate 10 White Flies</p>	<p data-bbox="613 1293 1016 1665">Common noticeable symptoms are an abundance of white, waxy material covering leaves and fronds, a sugary substance called “honeydew” produced by the leaf-sucking insects, and excessive dark sooty mold on leaves or fronds that grows on the honeydew.</p>	<p data-bbox="1036 1293 1421 1455">White Flies have developed resistance to many synthetic pesticides making chemical control difficult.</p> <p data-bbox="1036 1507 1421 1665">Insecticidal soap, neem oil and botanical insecticides can be used to “knock down” heavily infested areas.</p>

Pest & Diseases	Symptoms	Control/ Management
 <p>Plate 11 Slugs and snails</p>	<p>Snails and slugs are most active at night. They chew irregular holes with smooth edges in leaves and flowers and can clip succulent plant parts and leave a silvery mucus trail.</p>	<p>Use metaldehyde baits, 4% active ingredient. Do not water heavily for at least 3 - 4 days after bait placement; watering will reduce effectiveness of the bait.</p>
 <p>Plate 12 Black Rot caused by <i>Xanthomonas campestris</i> pv. <i>campestris</i></p>	<p>The fungus infects the plant tissue resulting in wilting of the plant, initially turning pale green then yellow eventually brown and dies. Affected areas are usually wedged or V-shaped.</p>	<p>Diseases affecting cabbage can be controlled with hot water treatment of seeds, crop rotation, the removal of crop residues in the field, the use of resistant varieties and a number of fungicides available on the market.</p>
 <p>Plate 13 Bacterial Soft Rot caused by <i>Erwinia carotovora</i> var. <i>carotovora</i></p>	<p>Early symptoms first appear as water-soaked areas on the heads of cabbage, which rapidly break down into a soft, mushy rot.</p>	<p>Soft Rot often follows insect damage to the leaves as well as Black Rot attack. It is advisable to control insects for the control of Soft Rot.</p>

Pest & Diseases	Symptoms	Control/ Management
 <p data-bbox="201 575 597 625">Plate 14 <i>Phytophthora</i> Stem and Root Rot caused by the spores of <i>Phytophthora</i></p>	<p data-bbox="613 306 1019 926">Symptoms first appear as a V-shaped yellow patch on the edge of a cabbage leaf. As the infection progresses, a black discoloration appears on the exterior of the roots and the bottom of the cabbage closest to the root structure. Eventually, the disease will spread inwards, turning the inside of the cabbage root black. In later stages, Root Rot will cause the veins on cabbage leaves to darken and eventually, the entire cabbage will turn black.</p>	<p data-bbox="1036 306 1425 548">Plant cabbages in well-draining soil that does not easily get waterlogged. Avoid overhead watering, as droplets of water on cabbages can encourage Root Rot.</p>
 <p data-bbox="201 1253 461 1325">Plate 15 Alternaria Leaf Spot caused by the fungal pathogen <i>Alternaria brassicicola</i></p>	<p data-bbox="613 984 1019 1524">Symptoms of Alternaria Leaf Spot on cabbage may first develop on young plants in seedbeds, where leaf spots, stunting, or damping off may occur. Dark brown to black leaf spots may appear on tissues of any age and vary in size from pinpoint to 2 inches (5 cm) in diameter. The leaf spots enlarge in concentric circles and mature lesions have a bull's-eye type appearance.</p>	<p data-bbox="1036 984 1425 1104">Use disease free seeds. Crop rotation is recommended. Also use protectant fungicide.</p>

Pest & Diseases	Symptoms	Control/ Management
 <p data-bbox="201 583 594 655"><b>Plate 16 Peppery Leaf Spot</b> caused by <i>Pseudomonas syringae</i> pv. <i>Maculicola</i></p>	<p data-bbox="613 289 1016 961">Symptoms consist of leaf spots that first begin as small water-soaked points. After some time these points develop into dark brown or purple spots surrounded by translucent haloes. Individual spots are generally slightly sunken and up to 1/8 inch (3mm) in size. Often spots will join together forming an irregular angular lesion and giving a puckered, ragged appearance to the leaf. On severely affected plants the leaves may turn yellow and drop off.</p>	<p data-bbox="1036 289 1417 531">Use clean seed material; use only plant beds free of the organism and practice good crop rotation. A rotation should provide at least 1 year between susceptible crops.</p>

Good Agricultural Practice (GAP) related to the use of pesticides, requires farmers to maintain up to date records on the application of pesticides to the crop. These records should include trade names, application rates and dates of application. During the harvesting period use pesticides with a very short harvest interval.

## Harvesting/Maturity

The crop matures between 8 - 15 weeks from transplanting depending on the variety. Heads should not be allowed to become over-mature as they may crack. If rain follows cracking heads may rot. Maturity is governed by firmness. The crop should be harvested very early in the morning by cutting stems leaving the roots in the ground (Plate 14).



Plate 14 Harvesting

## Field Handling

Leave all leaves intact on the cabbage head and pack in ventilated field crates or baskets.

## Preparation for Market

Select out damaged or diseased heads. Remove outer leaves that are usually old in appearance and normally in contact with soil. Stems should also be trimmed (Plate 15)



Plate 15 Selecting cabbage in the field for market



# Yields

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It is possible to obtain yields of 20,000 lb/acre (22,000 kg/ha). However, the risk of loss of crop due to pests and diseases is high.

# Storage

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Harvested heads should be held temporarily in a well-ventilated area. The best storage condition is 35°F (1-2°C) and 95-100% relative humidity. Avoid storing cabbage with ethylene producing commodities, as leaves will turn yellow.

# APPENDICES



## APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: CABBAGE

	Input	Quantity	Units	Unit Cost	Total Cost
<b>1.</b>	<b>Seedling production</b>				
	Seed material				
	Seedling trays				
	Peat moss				
	Saran netting				
	Fungicide, plant nutrient, insecticide, fungicide, fertilizer (specify names used)				
	<b>Total cost for seedling production</b>				
<b>2.</b>	<b>Land preparation</b>				
	Land preparation costs (e.g. equipment rental)				
	<b>Total cost for land preparation</b>				
<b>3.</b>	<b>Crop maintenance</b>				
	Water/irrigation				
	Fertilizer (specify types used)				
	Weed control (specify chemicals etc used)				
	Pest and disease control (specify chemicals etc. used)				
	<b>Total cost for crop maintenance</b>				
<b>4.</b>	<b>Harvest/storage</b>				
	Crates/baskets				
	Estimate any utility costs				
	Transport to market				
	<b>Total cost for harvest/storage</b>				
<b>5.</b>	<b>Labour</b>				
	Seedling production				
	Land preparation				
	Crop maintenance				
	Harvest/storage				
	<b>Total cost for labour</b>				

**APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: CABBAGE**

	<b>Input</b>	<b>Quantity</b>	<b>Units</b>	<b>Unit Cost</b>	<b>Total Cost</b>
<b>6.</b>	<b>Rent/insurance</b>				
<b>7.</b>	<b>Miscellaneous costs</b>				
	<b>Total cost of production</b>				

**Notes**

1. It is recommended that the above data be completed on a per crop basis.
2. The cost of any fixed structures should be considered. For example if a seedling nursery is solely used for to produce cabbage seedlings in the year and is expected to last for 10 years, then one tenth of the cost of construction (plus any annual maintenance) should be added at item 7. If, however seedlings for other crops are also produced then these also need to be considered. If cabbage seedlings account for half the seedlings in a year, then the annual cost calculated as above needs to be divided by 2. Similar consideration should be given to the cost of any refrigerator if the crop is stored at a low temperature and to an irrigation system.
3. The revenue obtained from sale of the crop should be compared with the cost of production to determine the profit/loss on the operation.

**APPENDIX II: LIST OF RECOMMENDED PESTICIDES AND APPLICATION RATES**

<b>INSECTICIDES</b>	<b>APPLICATION RATE</b>
Pronto 35 SC	3 - 5 teaspoons/gallon of water
Target	1 - 2 teaspoons/gallon of water
Pirate	½ - 1 teaspoons/gallon of water
Fastac	1 - 2 teaspoons/gallon of water
Caprid	½ - 1 teaspoon/gallon of water
Diazinon (Basudin)	¾ - 1½ pints/acre
Admiral	¼ teaspoon/gallon of water
Dipel	1½ - 2 teaspoons/gallon of water
Aza-direct	1 - 2 teaspoons/gallon of water
Cure	½ - 1 teaspoon/gallon of water
Danitol	1 - 2 teaspoons/gallon of water
Cypro	½ tablespoon/gallon of water
Dimethoate (Perfecthion, Rogor 40)	1 pint/acre
Phosvel	1¼ - 2 pints/acre
Orthene	3.2 ounces/acre
Permethrin (Ambush)	½ teaspoon/gallon of water
Padan 50 WSP	2 - 3 teaspoons/gallon of water
Lannate	1 teaspoon/gallon of water
Decis	½ teaspoon/gallon of water
Kelthane 42%	1¼ lb/acre
Orthene 75S	1 lb/acre
Malathion	½ - 1 pint/acre
Sevin	1½ lb/acre
BT ( <i>Bacillus thuringiensis</i> )	Label rates
Rotenone	1 - 2 teaspoons/gallon of water
Neem X.	8 - 10 oz/gallon of water
<b>FUNGICIDES</b>	<b>APPLICATION RATE</b>
Bellis	2 teaspoon/gallon of water
Acrobat	2 - 4 teaspoon/gallon of water
Mancozeb (Dithane M45)	1.5 lb/acre
Cabendazim	2 teaspoon/gallon of water
Daconil	1½ - 2 pints/acre
Benomyl (Benlate)	6 oz/acre
Captan	2 - 3 teaspoons/gallon of water
Peltar	3 teaspoons/gallon of water
Manzate DF	2 - 4 teaspoons/gallon of water
Bravo	1½ - 2 pints/acre
Tri-Miltox-Forte	3 teaspoons/gallon of water
Botrilex	5 - 200 lb/acre
Kocide 101	2 - 4 teaspoons/gallon of water
Cupravit	2½ lb/acre

**APPENDIX II: LIST OF RECOMMENDED PESTICIDES AND APPLICATION RATES**

<b>WEEDICIDES</b>	<b>APPLICATION RATE</b>
DCPA (Dacthal W-75)	10 lb/acre
Diphenamide	4 - 10 lb/acre
Paraquat (Gramoxone)	1 - 2 pints/acre
Dymid 80W	5 lb/acre
Atrazine 80 (Gesaprim).	1¼ - 1½ lb/acre
Linuron (Lorox)	1 pint/acre
Prometryn (Caparol)	0.8 - 1.6 lb/acre
Sethoxydim (Poast)	1¼ - 3½ lb/acre
Clethodim (Select)	0.094 - 0.25 lb/acre
Prometryn 50WP (Geagard)	2 - 3 lb/acre
Herbicidal Oil (Stoddard Solvent, Kerosene oil)	40 - 80 gallons/acre

**APPENDIX III: GOOD AGRICULTURAL PRACTICES DATA RECORD SHEET**

Grower name:							
* Name of applicator	Date	Brand and product name	Rate	Size of area/no. of plants treated	Total application (amount of the product used)	Notes/target pest	Start/finish time

\*The applicator should be trained or, if not, supervised by a trained or certified person. Proof of training required.

