

MODULE 5

SEEDS AND SEEDLINGS FOR SUSTAINABLE FRUIT AND VEGETABLE PRODUCTION



**CLIMATICALLY, ENVIRONMENTALLY AND
ECONOMICALLY SMART FARMING PRACTICES**



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1

INTRODUCTION

The contents of this module address the critical issue of supplying high quality open-pollinated fruit and vegetable seedlings to farmers in Fiji and the Pacific Islands. This module has been developed through extensive consultations with Sant Kumar of Bula Agro Enterprises. For decades, Sant Kumar has been spreading the word on the importance of growing nutritious food for your own family. In May 2020, to reinforce this approach, Sant launched a program called 'Tel-a-Woman' (TAW) in collaboration with the Pacific Islands Farmer Organization Network (PIFON) ¹. The program was established in an effort to assure a far more rapid uptake of the cultivation and consumption of nutritious fruit and vegetables – particularly during the difficult economic times of the COVID pandemic.

It was found that by working with women, who predominately cook the food for the family, there was a far greater uptake in the production and consumption of nutritious food. In addition, women tend to have a greater network of friends and neighbours with whom they share information. The experience of the TAW program has been that 'if you provide hands-on training for one woman, she will then share the knowledge gained, and plants and recipes with another ten women' and so greatly extend outreach and improve uptake

See the Moko Productions video [here](#)  introducing the TAW program



Sant Kumar demonstrating soil sterilization as part of the TAW outreach program (photo PIFON).

¹ This collaboration was funded through Farmers Organizations for Africa, Caribbean and the Pacific (FO4ACP), which is a joint partnership between the European Union (EU), Africa Caribbean and Pacific Region (ACP), International Fund for Agricultural Development (IFAD) and PIFON.

2.1 Healthy planting material: a necessity for sustainable farming

Whatever you are growing on your farm (vegetables, root crops, native trees or fruit trees) it is very important that you start with healthy planting material. Healthy planting material is an absolutely essential first step in ensuring that your farm is sustainably profitable. You can have fertile soil, good drainage and adequate rainfall, however, if you do not have healthy planting material you will not be able to produce quality productive crops.

2.1.1 Why do we need nurseries?

There are three main ways of getting your seedlings started. These are:

- Using seedlings first grown in a nursery
- Direct sowing of seed into the field
- Using seedlings that have naturally sprouted under mother trees



Using seedlings from the nursery that have been grown under optimum conditions (photo PIFON)



Direct sowing of seeds into the field (photo PIFON)



Using seedlings that have naturally sprouted under mother trees (photo PIFON)

2.2 So why use a nursery?

A seedling nursery protects young plants from insects etc. that can harm them until they are strong enough to go into the field. The main advantages of using seedlings from a nursery, compared with the direct planting of seeds are:

- Faster-growing crop which can be sold sooner - particularly important after a cyclone
- Less watering is required during early growth when seedlings are in a nursery compared to a field
- Healthier plants are produced
- Less time required in weeding compared to the field
- A 'headstart' is obtained against attack from insects, disease and weeds
- More uniform growth is achieved in the nursery compared to the field

It will cost you a bit more initially to buy or produce good quality seedlings when a nursery is involved.

2.3 A nursery for growing seedlings should provide a few basic things:

- An optimum environment for growing seedlings, especially for the first few weeks of vegetative growth.
- Separation of the plants from the ground (the soil contains many diseases that can be harmful to young vegetable seedlings).
- Protection from heavy rain (heavy rain can wash away newly sown seeds and damage young seedlings – too much rain will encourage disease and kill young seedlings).
- Protection from heat and intense sun by providing shade. There are different types of nurseries to suit different needs.

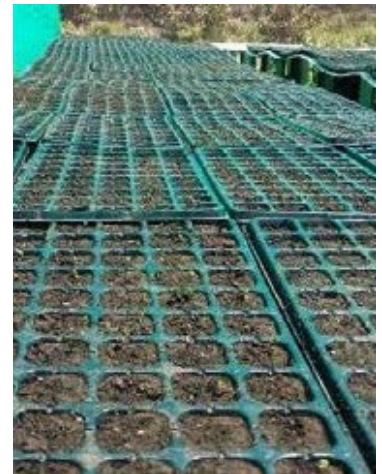
It is important that you select the type of nursery that suits your needs. If you are a village or backyard vegetable farmer then you do not need to spend much money to build a large nursery. A small simple nursery can be constructed to meet your requirements.



Typical small simple village nursery in Napil, Tanna, Vanuatu. Apart from the plastic cover and some shade cloth, it is built entirely out of local materials (photo Andrew McGregor)



Prakash's small-scale papaya seedling nursery (photo Livai Tora)



Commercial scale vegetable seedling nurseries at Bula Agro (photo Moko Productions)



Kava seedlings in a nursery at the Tutu Rural Training Centre, Taveuni (photo Fr. Isaia)



Native tree seedlings at the Fiji Water farm nursery in Yaqara (photo Kyle Stice)

2.4 Nurseries need to be resilient to natural disasters and climate change

Natural disasters, cyclones, drought and floods can be a farmer's worst nightmare with their crops destroyed and income lost. Climate change is expected to bring more such events – with stronger intensity. For farmers who have lost their crops due to natural disaster, the best thing they can do is to go back to the farm and replant. At such times, there is a big demand for vegetable seedlings as farmers work towards restoring their farms. The quicker these seedlings become available the better. Thus, it is very important that you try to protect, as much as possible, your nursery and seedlings from the damaging effects of natural disasters ².

A few tips to help protect your nursery against natural disasters include:



- **Choose a good site for your nursery.** Make sure that your nursery is in a flood-free area and is also close to water, in case of drought. Remember that so-called 'one in 50 year events' are projected to become more frequent with climate change. You should also try to choose a location that is protected from wind – such as where there are appropriate windbreak trees or where such trees could be planted.
- **Build your nursery 'cyclone ready'.** A 'cyclone ready' nursery is one built to go through a cyclone with only minimal damage. Some tips for building a 'cyclone ready' nursery include: using nursery clips to fasten your shade cloth or plastic; and, **not** cementing the poles so that they can fall over in a cyclone without breaking.



Sant Kumar standing in front of his disassembled nursery at Bula Agro immediately after TC Evan. It was reconstructed within two days of the cyclone passing. (photo: Kyle Stice).



Sigatoka nurseryman, Yeshwant Kumar, points to his disassembled nursery which has already been filled with fruit tree seedlings saved from TC Evan. (photo: Kyle Stice).

- **Have a safe place to store your seedlings when a cyclone or flood is approaching.** In more extreme events you may not be able to save your nursery but you may be able to save the seedlings in it. The seedlings will be very valuable immediately after the disaster when farmers are desperate for planting material. Have a designated 'safe' area in which you can store your seedlings in the event of a natural disaster. This could be in a shipping container, a shed or a room in your house. [See](#)  Andrew McGregor talking on Fiji TV "Green Pillars" on why we can expect more intense cyclones and Sant Kumar telling nursery operators what they can do to prepare for severe cyclones [video](#) 

2 Stice and McGregor, 2016, Vulnerability of high-value horticultural crops to climate change In: Taylor, McGregor and Dawson (Eds) Vulnerability of Pacific Island agriculture and forestry to climate change <https://www.spc.int/sites/default/files/wordpresscontent/wp-content/uploads/2016/12/Vulnerability-of-Pacific-Island-agriculture-and-forestry-to-climate-change.pdf>



Sant Kumar's seedlings placed inside a shipping container before the arrival of the cyclone (photo Moko Productions)

2.5 Growing seedlings in your nursery

2.5.1 What kind of seedlings can you produce in a nursery?

Most vegetables seedlings are best initially grown in a nursery. Nurseries can also be used for fruit trees, ornamentals, native trees, and root crops, although planting material for root crops such as, dalo, yaqona and ginger, are often grow in open field nurseries.

2.5.2 What sort of containers do I use for my nursery seedlings?

- Villages or backyard vegetable growers can grow these seedlings in low-cost containers such as recycled tins, plastic cups, small rice bags and empty egg containers, etc.
- Commercial vegetable nurseries need to use seedling trays – with larger planter bags used for fruit trees.



Seedlings in recycled tins (photo PIFON)



Seedlings in planter trays (photo PIFON)



Fruit tree seedlings growing in planter bags (photo PIFON)

2.5.3 Potting mix for raising your seedlings

The right combination of ingredients must be used to provide a balanced, rich potting mix for raising your seedlings. Below are two examples of potting mixes that have been successful for growing seedlings in different locations. What works best for you will depend on what ingredients are readily available and at what cost.

Sant Kumar (Bula Agro – Votualevu Nadi) mix is:

- 1 part compost manure (sterilized)
- 1 part river bank soil (sterilized)
- ½ part Yates potting mix plus 1 tuna can of NPK

Tutu Rural Training Centre mix is:

- 3 parts - rich top soil
- 1 part - composted and grated coconut husk

2.5.4 Soil sterilization for my potting mix: why and how?

- A clean, sterilized potting mix means that the soil is free of weed seeds, insects and diseases, thereby giving your seedling a healthy start to life.
- Store-purchased potting mix is already sterilized, however, this comes at a cost.
- You can clean and sterilize your potting mix that you make on the farm by using a drum steam sterilizer. You can either sterilize the made-up mix, or just the components of the potting mix, that have not been sterilized.

Using the drum method to clean the seed potting mix is quick and effective.

Using the drum method to clean the potting mix is quick and effective. The soil sterilization system successfully adopted by Sant Kumar at Bula Agro is shown in the pictures below and is shown in the PIFON [video](#) 



Place two (2) blocks at the bottom of a drum (photo PIFON)



Set steel mesh on blocks – with a modified steel pipe on top of the mesh. The steel pipe needs to be sealed at the top with holes made on the side. This is to allow the steam from the boiling water circulate through your seed raising mix (photo PIFON).



Fill with water half way up the blocks. (photo PIFON).



Spread the unsterilized seed raising mix over steel mesh at the bottom of the drum, keep filling and cover at the top with a couple of used bags(photo: PIFON). .



Build fire under the drum to heat water allowing steam to pass through the seed raising mix. This process will take approximately 1.5 hrs with full heat (photo: PIFON).



Once steam appears on the surface, time it for another 30 minutes. (photo PIFON).

2.5.5 Pests and diseases in the nursery

Keeping pests and diseases out of your seedlings: naturally and chemically

How?

- **Use a clean, sterilized potting mix.** This keeps the soil diseases out of your nursery (section 2.5.4).
- **Use a clean plastic cover to control the amount of heavy rain on your seedlings.** This prevents diseases from developing such as the fungi *Phytophthora* and *Pythium*, which cause damping-off disease.
- **Remove plants that are hosts to insects from around your nursery.** This will help to reduce the risk of insects that carry disease from entering your nursery. Host trees include *Erythrina* (drala), guava and banana.
- **Use sterilized tools by dipping them in a Janola solution (1 cap full to 1 litre of water).**
- **Wash your hands either using soap and water or the diluted Janola solution.**



Various chemical pesticide options that are available in Fiji (photo Kyle Stice)

If you find a high level of pests and diseases on your seedlings, you may need to use a pesticide or a fungicide. There are both natural and chemical options. When using chemical pesticides and fungicides, you **MUST ALWAYS** follow the directions on the label.

Neem leaves can provide a natural pesticide. These readily available leaves are simply soaked and crushed with water and then sieved and funneled into your knapsack sprayer. Wood ash, collected from an outside kitchen oven, is an example of a natural fungicide. Freshly dried vegetable seeds are dusted in the wood ash prior to planting.



Neem leaves that are crushed in water to produce a natural pesticide to spray on your vegetable seedlings (photo Kyle Stice)



Vegetable seeds being dusted in wood ash prior to planting (photo Kyle Stice).



Sant Kumar demonstrating the production of natural organic pesticides at TAW training workshop at Bula Agro (photo PIFON)

3.1 There are two main types of seeds available in Fiji – open pollinated and hybrid

Open pollinated seeds are those collected directly from a fruiting plant, which is also grown from open pollinated seed. The characteristics of the fruit that result from this open pollinated seed will be very similar to, and display the same characteristics as the mother plant; this is often referred to as true-to-type. Some examples of open pollinated vegetable varieties grown in Fiji are given in Table 1.

Hybrid seeds are obtained through cross breeding different varieties of the same fruit or vegetable species. If you source your seed from a plant that came from hybrid seed, the characteristics of the resulting plant will be different from that of the mother plant from which the seed was sourced. You can usually expect this fruit to be inferior to the mother plant.

3.2 Open pollinated seeds

Sant Kumar on Fiji TV “Green Pillars’ introduces open pollinated seed [here](#)



Open pollinated vegetable seeds collected by Bula Agro (photo Kyle Stice)

Table 1: Examples of open pollinated vegetable varieties grown in Fiji. (Source: Sant Kumar, Bula Agro)

Vegetable or vegetable species	Varieties available for Fiji's farmers
Eggplant	Long purple, Chahat, Round purple, Sigatoka beauty
Okra	Dark green and Light green
Tomato	Alafua large, Alton
Chillies	Red fire, Hot rod, Bongo, Birds eye
Cow peas	Mana, Rachna
Pigeon Pea	Bharpoor, Kamica
Corn	Nirila, Hawaiian super sweet, Local yellow (sila)
Papaya	Fiji Red

3.2.1 The advantages of using open pollinated seeds

You should use open pollinated seeds collected from the ‘best’ fruit available for replanting. **To decide what is ‘best’ you have to consider yield and what the market wants** (sweetness, size, yield, shape and increasingly nutritional characteristics). Over time you can expect the quality of your fruit and vegetables to improve as you will be selecting your seed from those plants that perform best in the environment in which they grow. This provides an important advantage in adapting to climate change - because the seeds from your best plants will have responded to the ongoing changes in the environment and will produce more resilient plants³.

Other major advantages of using open pollinated seeds include:

- **Easily available locally at low cost.** You can collect for yourself a number of vegetable varieties that produce open pollinated seeds or obtain them from the Ministry of Agriculture (MoA). You can also purchase seeds from other reliable farmers, or purchase seedlings from nurseries. Obtaining open pollinated seeds is easier than sourcing hybrid seeds, which are imported and have to be purchased from shops at a much higher price
- **Usually available for replanting immediately after a cyclone** because they can be sourced locally. Hybrid seeds are imported and are often not available for some time after a cyclone when there is heavy demand. Also, seeds provided after a disaster by aid agencies, etc. are often not suitable because they have been sourced from overseas and usually from an environment with different growing conditions. Supplying vegetable seed after a cyclone provides an excellent income generating opportunity for farmers.

3.2.2 Where can I source open pollinated seeds or seedlings?

Ministry of Agriculture (MoA) research stations that provide open pollinated seeds are:

- Sigatoka Research Station – papaya, eggplant, chillies, tomatoes, corn
- Legalega Research Station – cow pea, pigeon pea, mung, peanut
- Nature’s Way Cooperative (Nasoso Rd Nadi) sells certified “Fiji Red” papaya seed and is the recommended source of papaya seeds.

A number of private nurseries sell seedlings derived from open pollinated seeds. They include:

Nursery owner	Location
Jai Ram Khelawan	Ba, Rarawai Flats
Prakash Chandra	Lautoka, Johnson Road
FRIEND	Lautoka, Tuvu Hill
Sant Kumar	Nadi. Carreras Road
Yashwant Kumar	Sigatoka, Lawai
Tutu Rural Training centre	Taveuni
Mun Sami	Tavua

Source: Sant Kumar

Some vegetable types, such as eggplant, chillies and okra are well suited to being produced by farmers themselves – for their own use or for sale. Some ‘how to do advice’ is presented in Section 4 as part of the ‘Tel-A-Woman’ (TAW) seed and seedling program.

3 Lana et al. 2017 Yield stability and lower susceptibility to abiotic stresses of improved open-pollinated and hybrid maize cultivars Agron. Sustain. Dev. 37: 30 DOI 10.1007/s13593-017-0442-x

3.3 Hybrid fruit and vegetable seeds



As defined above, in 3.1, hybrid seeds are obtained through cross breeding different varieties of the same fruit or vegetable species. The objective is to capture the positive characteristics of different varieties, often leading to what is known as hybrid vigour which is an increase in such characteristics as size, growth rate, yield etc. of the hybrid compared to the parent plants. Hybrid seeds are largely developed overseas by seed companies with the objective of achieving higher yields and particular quality characteristics such as taste and disease resistance. Remember hybrid seeds that you buy in the shop could have been developed in quite different climate conditions than those prevailing in Fiji and the Pacific Islands. Thus, they may not perform as well as you might expect in our particular tropical climate environment.

Also, you need to note that if you try to get seed from a hybrid plant the characteristics of the plant produced will be quite different from the mother (parent) plant from which the seed was sourced – and you can expect it to be distinctly inferior. Some examples of hybrid vegetable seeds that can be purchased in Fiji are:

Eggplant	Black Beauty and Black Bell
Okra	Clemson, Hybrid okra
Tomato	Rising sun #1 and #2, Beef Steak
Chillies	Know You seed
Watermelon	Emperor #2, Field Master
Capsicum	Blue Star
Head cabbages	KK cross, FF cross, Autumn Summer
Leafy cabbages	Pok Choy, Bok Choi, Petsi
Cucumber	Telegraphic, Money Maker
Long Beans	Long Bean
French bean	Contender

4.1 Vegetable varieties that are suitable for open pollination seed collection by small farmers and enterprises

There are a number of staple vegetable varieties for which cross pollination, if it does occur, is not a major issue. These vegetables include eggplant, chillies, okra and tomatoes, which provides an opportunity for small farmers, including backyard farmers, to produce their own open pollinated seeds for their own use and for sale.

Bula Agro, with support from PIFON has been promoting small farmer open pollinated seed production. This is being implemented through the ‘Tel-A-Woman’ (TAW) outreach program. Because of the involvement of women, the TAW outreach program has proven to be ideal for the spreading and strengthening the adoption of the simple technology of open pollinated vegetable production among small and backyard farmers. As a result, significant household health and nutrition benefits have occurred during the difficult economic times brought on by the COVID pandemic⁴.

The guidelines for eggplant, tomato and chilli seed production are presented below.

4.2 Eggplant seed production guidelines

The guidelines apply to all of Fiji’s recommended open pollinated eggplant varieties: Long purple, Chahat, Round purple and Sigatoka beauty.

4.2.1 Cultivation and isolation

The cultivation methods for the production of eggplant for seed are similar to growing the crop for the fresh market with the additional emphasis on rouging (removing defect plants) and isolation. Eggplants produce perfect flowers, which may be cross-pollinated, but self-pollination is more common. The extent of natural crossing depends on insect activity. To avoid outcrossing, eggplants being produced for seed should be planted at least 200 m apart from a different eggplant variety.

4.2.2 Rouging and selection

Plants that exhibit signs of disease susceptibility should be rouged out. Similarly, plants with misshapen or discoloured fruits should also be removed.

Selection for seed production should be from the most vigorous and healthy plants. Fruit meeting the described size, shape and colour parameters should be selected and left to mature on the plant.



Eggplant for seeds should be harvested when fully mature, displaying a brownish-yellow skin colour. (photo - Kyle Stice)

⁴ PIFON Covid 19 Pacific Overview Expected Impacts in the Pacific
<https://pacificfarmers.com/wp-content/uploads/2020/09/COVID-19-Pacific-Overview-Expected-Impacts-In-The-Pacific.pdf>

4.2.3 Harvesting

Harvesting for seed extraction is done when fruits are fully ripe (the skin turns brownish-yellow). Well matured fruits are processed on the same day. Sometimes the harvested fruits are stored in the shed for 2-4 days until they become soft. This allows the seed to mature fully.

4.2.4 Seed Processing and Drying

The first stage of eggplant seed processing involves cutting the fully matured and soft eggplants into pieces, discarding the top one-third of the fruit since it hardly contains seeds. The flesh with the seeds is cut into pieces, then packed into sacks and crushed to loosen the seeds from the pulp. The crushed pulp is then transferred to a tub filled with water where the viable seeds will sink and the floating pulp and non-viable seeds can be removed. Note - Eggplant seeds do not require fermentation as in the case of tomato.



Fully mature and soft eggplant fruit should be cut into small slices and soaked in water overnight in order to easily separate the seed from the fruit pulp (photo Kyle Stice).

Seeds should be dried immediately after washing. For this, salon cloth or fine wire mesh is ideal. The seeds should then be placed in the shade and gradually moved to full sun over the drying process (2-3 days). Frequent turning of seeds will ensure uniform drying. When the seeds are dry, they can be graded again to remove any fruit debris and any light or immature seeds.

4.2.5 Seed storage and treatment

The optimum moisture level for storage of eggplant seed is 8 per cent or below. Well dried seeds are best stored in moisture proof containers in a cool, dry place with protection from rats and other pests. Small quantities can be kept in an airtight container inside a refrigerator. For long term storage, temperature should be 5 °C and relative humidity (RH) in the storage area should not exceed 30%. Silica gel will assist in removing any remaining moisture trapped within the package or container.



Eggplant seeds drying in the sun. Seeds should be turned regularly to ensure uniform drying. (photo Kyle Stice).

4.3 Tomato seed production guidelines

The guidelines apply to both of Fiji's recommended tomato varieties: Alton and Alafua Large.

4.3.1 Cultivation and isolation

Tomato seed production is best done in the dry season when humidity levels are low and there is less disease pressure. Seed production during the rainy season leads to poor seed quality. It is best to avoid fields where the previous crop was tomato as this prevents the new seed crop from being contaminated with seeds from volunteer tomato plants. Staking and training of tomato plants generally results in early ripening, fewer diseases, higher yields and better seed quality. Isolation of tomato plants of the varieties (Alafua large and Alton) is usually not that critical because they produce perfect, self-pollinating flowers. However, an isolation distance of at least 100 m is recommended to prevent solitary bee cross-pollination.

4.3.2 Rouging and selection

Plants showing signs of off-type growth in height (too tall or too short) and foliage should be rouged from the field before they blossom to eliminate the possibility of cross-pollination. Similarly, plants affected by diseases such as Early Blight, Leaf Spot, Mosaic Virus, and Tomato Leaf Curl viruses have to be removed from the field and destroyed. As the first fruits reach edible maturity, plants with undesirable fruit type must also be rouged out. Similarly, occasional plants with off-colour fruits have to be removed.

For selection, look for early maturing, vigorous and attractive plants. Selected plants should be marked, staked and inspected during the growing season for resistance to disease. Fruit that meet the parameters of described size, shape and colour should be selected and left to mature on the plant.

4.3.3 Harvesting

Tomatoes for seed extraction should be allowed to completely ripen on the plant before harvesting. Picking at mature green stage and fruits of last picking should be avoided for seed extraction. For determinate varieties such as Alton, most of the tomato crop will ripen at the same time and therefore there are generally only 2 – 3 harvests where all of the fruit is taken from the field.

4.3.4 Seed Processing and Drying

Fruits are cut in half and seeds with gelatinous material should be squeezed or spooned into a container. The fruit wall, pulp and skin are all discarded – leaving the seeds. The gelatinous coating needs to be separated from around the seed which is generally done using natural fermentation.



For seed extraction, tomatoes should be left to fully ripen on the plant before harvesting (Kyle Stice)



Ripe tomato fruit are cut in half and the seeds (still covered with the gelatinous coating) are emptied into a container. (Kyle Stice)



Fermentation is required to separate the tomato seed from the gelatinous coating. This process usually takes about 24 hours and must be monitored closely. (photo: Kyle Stice)



After fermentation the gelatinous coating can be easily removed by rinsing the seed with fresh water and pouring away the flesh, skin and seed coating while the seed will sink to the bottom of the container. (photo: Kyle Stice)

Fermentation

Fermentation is a simple process where the mix of seed and juice is left to ferment. Under Fiji conditions this is often achieved within 24 hours. The mixture should be stirred several times a day to achieve a uniform rate of fermentation in the container and to avoid discolouration of the seed.

Regularly checking the seed will determine when the seed skin has broken down. The fermentation time must not go on longer than that required for breaking down the mucilage or else the seed quality will be affected by premature germination. Covering the containers with a light mesh cover will reduce fruit fly activity. A layer of fungus may begin to appear on the top of the seed mixture. This fungus is actually beneficial to the process as it eats the seed skin and prevents germination. It also produces natural antibiotics that help to control seed-borne diseases such as Bacterial Spot, Canker and Speck.

Tomato seeds, extracted by fermentation are immediately washed when the coating has broken down. The seeds are placed in an open plastic container (metal containers should not be used) which is then filled to one third capacity with tap water and then stirred. The flesh, skin and seed coating will float and the seed will sink. The container is gently tipped to remove the floating material. The washing process is repeated several times, adding fresh water to the container every time until all the flesh and gel are removed, leaving clean seeds at the bottom.

Drying should start immediately after the washing process has finished. Seeds can be placed in clean nylon mesh bags to remove excess water by hanging the seeds in the shade for a day. Seeds should then be spread in a thin layer on a tray, bag or material for drying. They should be turned often to loosen any clumps. If seeds are clumped together during the drying process, this can result in improper drying, fungus growth and poor vigour. It is best to cover seeds with a net nylon bag/ cloth. Initially seeds should be dried in the shade for the first 8 to 10 hours. Following that, seeds can be dried in direct sunlight avoiding the strongest sun in the middle of the day. Stir the seeds 2 to 3 times daily so that seeds dry uniformly. The best moisture content for tomato seed is 6 - 8 per cent. Further cleaning and processing of seeds, following drying and prior to storage, will assist in maintaining the viability of the seeds. In processing, remove broken, immature and diseased seeds, other crop and weed seeds, mud and other matter using a thin wire mesh or a sieve.

4.3.5 Seed storage and treatment

Seeds are best stored in moisture proof containers in a cool, dry place. Small quantities can be kept in an airtight container inside a refrigerator. For larger quantities, a designated room with controlled humidity and temperature is ideal. If possible, the temperatures should not exceed 20 °C. For long term storage 5 °C and a relative humidity (RH) in the storage area of 30 per cent is ideal.

4.4 Chilli seed production guidelines

4.4.1 Cultivation and isolation

Seed production of chilli varieties is best done during Fiji's dry season when lower humidity levels result in lower disease incidence and an overall better crop. These chilli varieties are generally self-pollinated but cross-pollination can occur via insects both within and between cultivars. The recommended isolation distance between varieties is 400 m , which is much longer than for tomatoes (100 m) and eggplant (200 m).

4.4.2 Rouging and selection

Off-type plants should be removed as soon as they are noted in the field. As the first fruits are approaching edible maturity, plants with undesirable fruit type (misshapen or discoloured) must be removed. In addition to off-type plants, plants affected by diseases such as Leaf Blight, Anthracnose and virus diseases have to be removed from the seed production field. The earliest maturing and more attractive plants should be marked and inspected during growth. Selection should be from the most vigorous and healthy plants. Fruit that meets the required size, shape and colour parameters should be selected and left to mature on the plant.

4.4.3 Harvesting

Harvest mature, fully-ripe chillies for seed production. In the case of the Red Fire and Bongo chilli varieties this is when they are fully red (although some fully ripe Bongo chillies may be orange or yellow).

For seed extraction, allow chillies to fully ripen on the plant before harvesting (photo Kyle Stice).



4.4.4 Seed Processing and Drying

Chilli seeds may be extracted from fresh fruits or from fruits that have been dried in the sun for a few days. Seeds can be removed by hand or extracted by grinding the fruits and separating the seeds from the fruits with a series of water rinses. Seeds should be spread on a screen for sun drying for 2-3 days. They should be brought into a shed during the evening time of the drying process. The recommended seed moisture content for storage is 8 per cent or below.

Safety Warning: Manual handling of hot varieties will irritate skin and eyes and precautions should be taken.

4.4.5 Seed storage and treatment

Chilli seeds are best stored in moisture proof containers in a cool, dry place with protection from rats and other pests. Small quantities can be kept in an airtight container inside a refrigerator. For larger quantities, a designated room with controlled humidity and temperature is ideal. If possible, the storage temperatures should not exceed 20 °C and relative humidity (RH) in the storage area should not exceed 30 per cent. For long-term storage a temperature of 5 °C is required.



During processing, chili seeds need to be separated from fruit and other debris through a series of water rinses. (Photo - Kyle Stice)

Vegetable production in Fiji is highly concentrated in the main season between May to October – particularly for temperate vegetables (English cabbage, French bean, lettuce, cauliflower, zucchini and carrots). These vegetables grow poorly during the summer months (November to April). This is due to higher rainfall, temperature and humidity, which lead to a high incidence of pest and diseases - a situation that is becoming even more challenging with climate change. Most farmers do not bother to grow these temperate vegetables during the off-season, and those farmers who do grow off-season vegetables do not see good results. The result is a large over-supply of vegetables during the main season and low prices; during the off-season there is a severe shortage of vegetables and high prices for what is available.

This price differential of the average monthly price for capsicum, English cabbage and tomato on municipal markets is illustrated in the graph below. For farmers, prices are often too low to make a reasonable income during the main season,, while, during the off-season most farmers have no fruit and vegetables to sell. For consumers, they cannot afford to buy nutritious vegetables for five months of the year and the health of their families suffers.

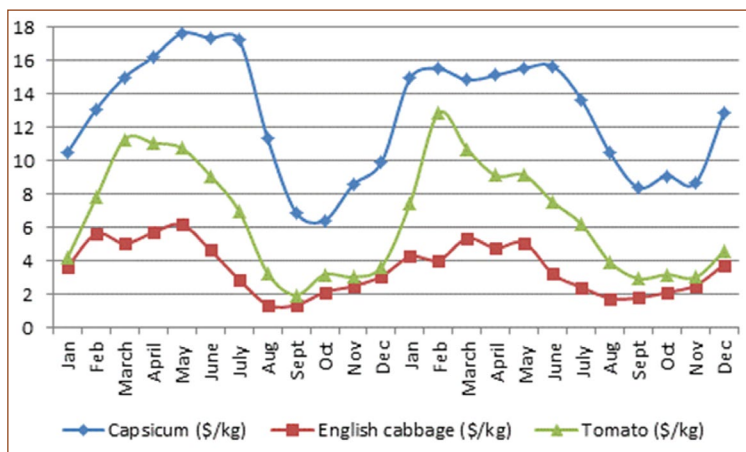


Fig 1 Monthly average prices of vegetables in Viti Levu municipal markets⁵.



Tomatoes and cucumbers (FJD 2/heap) for sale at a road side market in Suva, Sept 2021 (photo Andrew McGregor)

⁵ Source of data the Economic Planning and Statistics (EP&S) Division of the Fiji MoA

5.1 The Tutu Rural Training Centre's Model for Off-season vegetable production

The Tutu Rural Training Centre recognized the need and opportunity for off-season vegetable production. They have invested in a few modifications in their nursery production system to allow for efficient vegetable production during the November to April off-season window. The ACIAR-funded project 'Integrating protected cropping systems into high-value vegetable value chains in the Pacific and Australia', has also demonstrated the effective use of protective structures, such as greenhouses and walk-in tunnels, to enable farmers to grow high-value crops such as tomatoes, cucumbers and capsicums all year round⁶.

5.1.1 The mini tunnel model that Tutu has adopted

This model is a low technology high output system that works well under constant rainy conditions. The TRTC staff are well versed with the technology and have been using the off-season period to their advantage for several years. This system can be used throughout the year for intensive and efficient high quality vegetable production.

Fr. Isaia talks [here](#)  about COVID off-season vegetable Tunnel at Tutu.



Here is a Tutu off-season vegetable tunnel in Nov (Fr. Isaia).

The materials required to build and use the mini tunnel

- PVC ½ inch pipes (2 lengths)
- White clear plastic sourced from any hardware store
- Shade cloth (50 per cent) 1 roll
- Compost for growing your vegetables. See Module 6 for the Tutu system for making and using compost.

How do you construct your mini tunnel?

- A raised bed is constructed using blocks and mesh wire
- PVC pipes are cut into 1m lengths and fitted into pegs on both ends of the raised bed along the length of the bed in a semi-circle hoop
- Seedlings are then planted out on the mesh
- Shade cloth is placed on top of the raised PVC hoops
- Clear plastic is then placed over the shaded bed during rainy events to protect seedlings.

⁶ <https://www.aciar.gov.au/media-search/blogs/greenhouse-grown-crops-open-doors-high-value-markets>