RURAL DEVELOPMENT SERIES HANDBOOK: NO. 22

A GUIDE TO SUCCESSFUL VEGETABLE PRODUCTION IN THE HIGHLANDS OF PAPUA NEW GUINEA

MATTHEW B. KANUA[1], MIKE FREEMAN[2] AND PETER KAMIS[3]
1. Matthew B. Kanua, Agronomist, HAES Aiyura, Box 384, Kainantu.
2. Mike Freeman, formerly Agricultural Training Advisor with SSRDP.
3. Peter Kamis, Project Cordinator, SSRDP, Department of Simbu Province

ABSTRACT

The improved vegetable variety recommendations based on the experiences of many researchers, including a 4 years vegetable research in the highlands of Papua New Guinea are described. Extension notes developed as a result of experience gained from field exercises and extension training are given.

INTRODUCTION

In the highlands, as in other parts of Papua New Guinea, people are expert horticulturalists and there is great potential for the production of introduced vegetables. However, very few people have considered using their skill to grow introduced vegetables such as cauliflower, broccoli, onions and carrots in order to make money. In this document, some advice is given to extension officers for assisting farmers who would like to try growing introduced vegetables. Vegetable variety recommendations developed for Simbu and SHP is given and may be applicable to similar altitudinal zones and soil types in other highlands provinces. Pests and diseases, and cultural methods of control are discussed.

The notes provide detailed cultural techniques and discuss selected improved vegetable varieties commonly grown by farmers. The materials and methods are appropriate for typical village situation where most modern agricultural facilities are not available. The recognized conventional methods and procedures of disseminating extension services by DPI is acknowledged, and due reference is duly made were necessary in this document.

The recommendations given here are based on trials carried out by the first author with E.J.D'Souza, in SHP from 1984 to 1985 and supervised by Dr. C.N. Floyd, Senior Agronomist with the Agriculture Field Trials Studies and Extension Monitoring Unit (AFTSEMU). Further trials were carried out in Gumine, Simbu Province from 1986 to 1987, supervised by Dr. B.M. Thistleton, Team Leader of Highlands Farming Systems Research Team (HFSRT), based at Kuk research station. The whole report was initiated by the Training Advisor of SSRDP for agricultural extension officers and field staff of both DPI and SSRDP in Simbu Province. Therefore the extension notes developed bear particular reference to the Simbu Province.

SITE SELECTION

First of all choose a site for your vegetable garden. In site selection preference must be given to a flat piece of land.

Upland and slopes not only encourage wash off and erosion but the depth of top soil is often very shallow. Follow your own traditional practices of clearing and digging to prepare the land to a suitable tilt for subsequent operations. Farming Notes No. 10 should be referred to for further help. In village situation it will be necessary to build a strong fence around your garden to keep out wandering livestock.

Preference should be given to choosing sites with deep black soils i.e. those with higher organic matter. If black soils are not available the farmer will have to pay particular attention to fertilizer recommendations in these extension notes.

GARDEN PLAN

Then we suggest the farmer plans his garden on paper, or at least in his mind, as this will give him an idea of how many seeds, seed boxes and how much fertilizer to use. This is the principle of planning ahead

Table 1: **Fertilizer requirement by some selected vegetable species with corresponding bed sizes and plant spacings on Gumine and SHP soils.**

Crop	NPK: Triphos Mix ratio	g/plant	Plant spacing (cm)	Bed size (m)	NPK (g/bed)	Triphos (g/bed)	Other fertilizers
Cabbage	1:1	40	60 x 60	1.2x3.6	-	-	
Cauliflower	1:1	40	60 x 60	1.2x3.6	-	-	
Broccoli	1:1	40	60 x 60	1.2x3.6	-	-	
B/Sprouts	1:1	40	60 x 60	1.2x3.6	-	-	
C/Cabbage	1:1	40	60 x 60	1.2x3.6	-	-	
Lettuce	1:1	40	30 x 50	1.0x1.75	-		
Bean	-	-	25 x 40	1.0x2.0	93		276
Carrot (*)	-	-	5 x 25	0.5x2.0	51	10	35 g Muriate of Potash
Tomato	-	-	80 x 80	1.6x4.0	480	449	254 g Epsom salt 95 g Muriate of Potash
B. Onion	-	-	10 x 30	0.6x2.5	40	12	
Zucchini	1:1	60	100 x 100	4 x 1.5			top dressing 60 g NPK/TSP

** good yields of Carrot and Bulb Onions were also obtained using chicken manure.*

and it will help him make the best use of his resources, particularly if he is a small farmer. The unlearned farmer should seek the assistance of the district didiman for advice. The farmer should then follow the following directions:

(i) Mark out the garden areas;

(ii) Decide on what crops to grow. The didiman should assist in advising on the most economic crop and a suitable variety;

(iii) As an example, in Table 1 looking down crops column, select the crop to be grown. Then go across the table to find the necessary information required for fertilizer type and requirement, bed size and plant spacing.

(iv) Then with the didiman's advise, calculate by proportion the garden size;

(a) number of beds to fit garden;

(b) number of plants per bed using recommended spacing;

(c) number of seeds to germinate; and

(d) number of seed boxes to make. A standard seed box size of 45 cm x 45 cm using 2" x 1" timber, can germinate some 120 to 150 seedlings. This can be thinned to about 60-70 healthy and vigorous plants ready to be transplanted. The type of box is recommended because first, it is easy to make. Secondly, even with soil and seedlings inside, it is not too heavy to be carried to the garden site. The box can be used again and lasts a long time.

AN EXAMPLE OF A GARDEN PLAN

Fig. 1 is intended to provide an example of a garden plan and should guide the didiman when helping the farmer in his plans. The example is taken from a field experiment carried out at Yani SDA Mission Station Gumine District. A budget for growing 100 broccoli plants at this site is given in Table 2. The costs of labour and land are not accounted for as it is assumed

Table 2: **Established production cost and returns from 100 broccoli plants grown at Yani, SDA Mission, Gumine District.**

Production and marketing costs	
Cost	*Kina*
Labour	-
Fertilizer *(1)*	4.00
Seeds *(2)*	0.50
Insecticides *(3)*	1.50
Land Rent	Nil
Transportation to market	Nil
Total cost	6.00
Returns from sales	
Returns from sales of 57.6kg of -- broccoli (80% yield) *(4)*	37.44
Total income	**37.44**
Total Cost	**6.00**
Profit (Net)	**31.44**

(1) Cost of fertilizer;
K25.00 each for 50kg bag of NPK (12:12:17:2) and 50 kg triple super phosphate. SSRDP at Gumine sells both NPK and Triphos at K1.00 per kg.

(2) Cost of seeds at 50t/5 g pkt.

(3) Cost of Karate (2.5EC) at K30/litre

(4) SSRDP price (65 t/kg).

to come from the farmer. To grow 100 broccoli plants to maturity, required a land size of 7.2 m x 7.8 m (56.16 m^2).

The crop matured in 12 weeks and gave an average marketable yield of 72 kg. Accounting for 20% crop failure, the returns obtained for 80% of harvest were K37.44 after spending K6.00 for fertilizers, seeds and chemicals. The SSRDP buying price at Yani SDA Mission is 65t/kg for broccoli.

BED CONSTRUCTION

During the wet season and in areas of the province where soil moisture is high all year round, the bed size suggested in Table 1 is recommended to farmers as it was found to concentrate on top soil, and raise plants above water table. During the dry spell or in dry areas of the provinces, larger bed sizes may be used. For example in Fig. 1, beds 1,2,6 and 7 may be combined into one large bed while, 3,4,5 and 8,9,10 put together into another large bed. This way extra space can be created to accommodate more plants. It is not a law to adopt the small raised beds of the dimensions suggested here. The farmer should be at a liberty to have it to the best of his judgement; provided he is guided by a good plan.

SEEDS AND SEEDLINGS

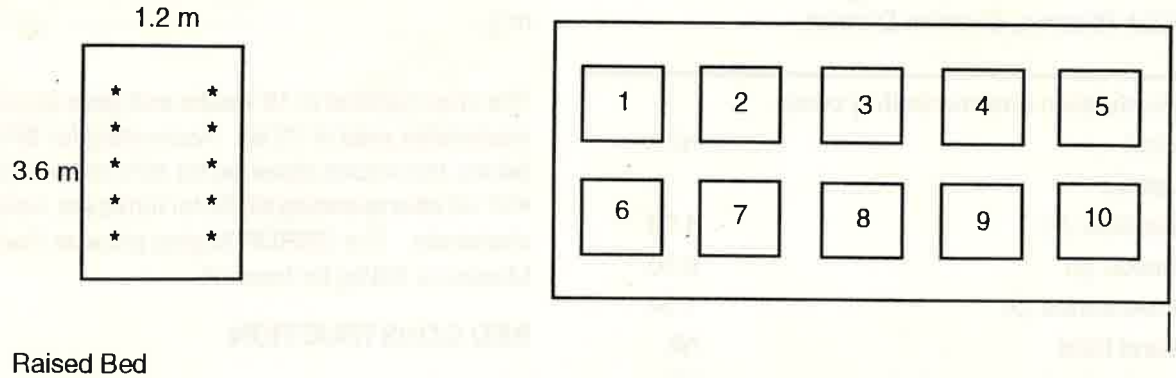
Count how many seeds you will need for your garden. You should germinate at least 2-3 times the number of plants required, depending on the germination percentage of the seed but plant more so as to cover

Table 3: **Planting guide for selected vegetables commonly grown by farmers.**

Crop	Planting Method	No. seeds per seed box	No. seedlings for trans-planting	Age (Wks) of seedlings at transplanting	No. of plants/bed
Beans (1)	Planted direct	N/A	N/A	N/A	16
Brassicas (2)	Transplanted	120-150	60-70	4-5	10
Carrot	Planted direct	N/A	N/A	N/A	-
Tomato	Transplanted	120-150	60-70	4-5	10
B/Onion	Transplanted	150-200	60-70	4-5	50
Lettuce	Transplanted	120-150	60-70	4-5	10
Zucchini	Planted direct	N/A	N/A	N/A	10

Note: *(1) Beans should be planted two seed per hole and thinned to one after germination.*
(2) Brassicas refer to broccoli, cauliflower, brussels sprouts, english and chinese cabbage

Fiogure 1. **An example of a garden plan.**



1. Raised Bed
Size: 1.2 m x 3.6 m
10 plants

NB: side and internal drains are approximately 1 spade wide and 1 spade deep (ie; 15-20 cm).

Notes

1. The total area of garden is 7.2m x 7.8 m (56.16 m²). The actual area of land planted to crop is only 36 m².

2. In a 56.16 m² piece of land 10 raised beds are made.

3. Each bed is planted with 10 plants (100 plants altogether).

4. n the nursery 2 seed boxes of seedlings (120-150) plants) are raised of which 100 were planted to the prepared beds. The remaining 20-50 plants are kept as spare for replacement of plants that may die in the field

risks of germination failure or deaths. The strongest and healthiest seedlings should be used for planting out. People often sow seeds directly into the garden from the packet. This practise wastes seeds. It is not recommended for small farmers who are prepared to invest some money in vegetable production and get some returns for it. Table 3 provides information on planting guide for selected vegetable species commonly grown by farmers in the highlands. The extension officers should follow this as a guide when advising farmers.

Further information on how to raise seedlings and which crops to sow direct can be found in other DPI publications, (Rural Development Series Handbook, No. 9. Introduced Vegetables and Farming Note No. 10: Vegetables).

YIELDS

Table 4 gives the marketable yields of selected introduced vegetables obtained from experimental trial plots grown at different altitudes and soil types in the highlands.

This is an indication to the farmer that by employing guidelines and recommendations given here similar yields can be obtained. The yields represent recommended varieties of the brassicas, carrots, beans, lettuce, tomato and zucchini varieties grown at Kuma (Upper Mendi, 2200 m.a.s.l), Wambip (Mendi Distict, 1800 m) and Piwa (Tari District, 1610 m) DPI base camps in Southern highlands; Yani (2000 m) in Gumine district of Simbu Province, and Aiyura (1680 m) in Kainantu District, EHP, and Kuk in WHP.

Quality of Produce and Harvesting

If your crops have not been hit by a severe natural disaster, good management will give good harvests. To satisfy market standards and to sell a bigger percentage of your produce the quality of produce must be excellent. This is why skilled management ability is essential in producing a quality crop.

To ensure for best quality;

(a) harvests must be made at the right time; early or late harvests often lowers the quality of your crop;

(b) transport your produce to market the same day. It is a good idea to seek buyers first before harvesting

Table 4: **Marketable yield of recommended vegetable varieties**

Crop	Variety	Yield (t/ha) at 5 sites					
		Kuma	Wambip	Piwa	Yani	Aiyura	Average
Bean	Top Crop	-	-	-	-	23.6	23.6
	Contender	4	9	11	-	-	8.0
	Tender Green	2	12	8	-	-	7.3
	Golden Wax	4	9	12	-	-	7.3
Broccoli	554 Early Value	7	13	7	-	-	9.0
	Hybrid Prominence	6	12	7	-	-	8.3
	Green Duke Hybrid	9	17	15	-	-	13.7
B/Sprouts	Hybrid J.C. Regular	9	17	15	-	-	13.7
Carrot	New Kuroda	-	-	3	-	11.9	7.5
	Chantenay	5	20	17	-	-	14.0
	Chantenay Red	-	-	-	-	40.1	40.1
	Eggmont King	8	25	11	-	-	14.7
	Eggmont Gold	3	24	12	-	-	13.0
	Manchester T. Nantes	-	-	-	-	39.6	16.6
C/Cabbage	Wongbok	21	37	58	-	-	38.7
Tomato	NG7536 (Island Red)	1	16	25	-	16.8	14.7
	Crosse Lisse	5	15	22	-	11.3	13.3
	Potentado	13	22	14	-	-	16.3
	Fireball	7	21	17	-	13.6	14.7
	Money Maker	7	17	18	-	15.8	14.5
*Bulb Onion	Gladalan Brown	-	-	-	-	-	11.0
	Gladalan White	-	-	-	-	-	8.8
	Awahia	-	-	-	-	-	10.5
	Superex	-	-	-	-	-	15.6
	BP036	-	-	-	-	50.6	-
	BP035	-	-	-	-	50.2	-
Lettuce	Sunny Lake	-	-	-	-	21.0	21.0
	Great Lake Regular	-	-	-	-	12.5	12.5
Zucchini	Black Jack Hyd	-	-	-	-	-	18.7
	Long Green Bush	-	-	-	-	-	25.2
(Marrow)	(Black Zucchine)	-	-	-	-	-	(20.9)

** Average yields obtained at Kuk Research Station. BP 036 and BP 035 Northrup King seeds can now be purchased from Farmset.*

your crop;

(c) take good care of the harvested crop when handling.

RAISING SEEDLINGS

The use of proper nursery techniques is important in vegetable production. A vegetable farmer should always bear in mind that the secret of producing a good quality crop is by raising strong and healthy seedlings in the nursery. One good vigorous plant is better than 10 sick looking plants. This must be emphasised because in the absence of chemicals to combat pest and disease out-breaks, the chances that a small farmer will lose all his plants are only slight if he plants healthy and vigorous seedlings. Two important practices are noteworthy;

1) Soil must be heat sterilized as illustrated in Fig. 2. 3 parts soil, 1 part chicken manure mixture is adquate for nursery plants. It is advised that farmers try where possible to sterilise the soil, but if this is not possible then soil from fresh unused ground should be used for raising seedlings. In Gumine, fragments of mudstrone and shale can be used, as this can hold water and help seedling root development.

The technique of sterilization by heat requires cooking the soil to kill bacteria and fungi, and weed seeds in the soil. A 200 litre (44 gallon) drum cut in half lengthwise is used to cook the soil in the following manner (Fig. 2);

(1) Fill the drum with soil;

(2) Add some water to make the soil moist (not too wet);

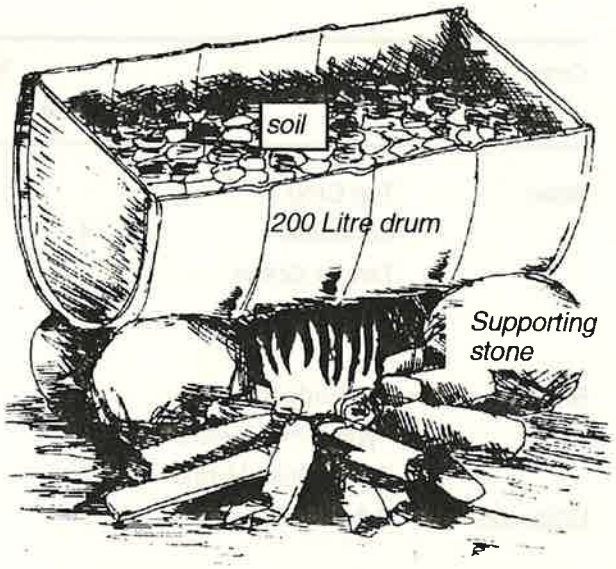
(3) Light a fire underneath the drum to cook the soil;

(4) Soil may be cooked for 1-2 hours;

(5) To ensure adequate sterilization of soil, it is advised to bury a sweet potato tuber in the soil before cooking. The soil will have been properly sterilized when the sweet potato is cooked.

(2) Raise seedlings in Green House or in an adequate shelter, anything like the one shown in Fig. 3.

Figure 2: **Sterilization of Soil by Heat.**



A step by step description of all the necessary stages used in raising seedlings is given in Appendix 1(A), and a guideline for transplanting seedlings into the field is given in Appendix 1(B).

Farmer's Challenge

Farmer's management input in raising nursery plants is important and it tests his skill and enthusiasm. This involves:-

(i) Daily checks and watering of plants;

(ii) Thinning of plants - this is done at about 2 weeks after germination. The technique is simply pulling out weak plants to facilitate adequate spacing. The number of seedlings allowed to stand must be in excess by 40-50 plants of the required number for the planned garden. The extra seedlings will supplement for deaths and other incidents. Thinning minimises competition between plants for *nutrition.*

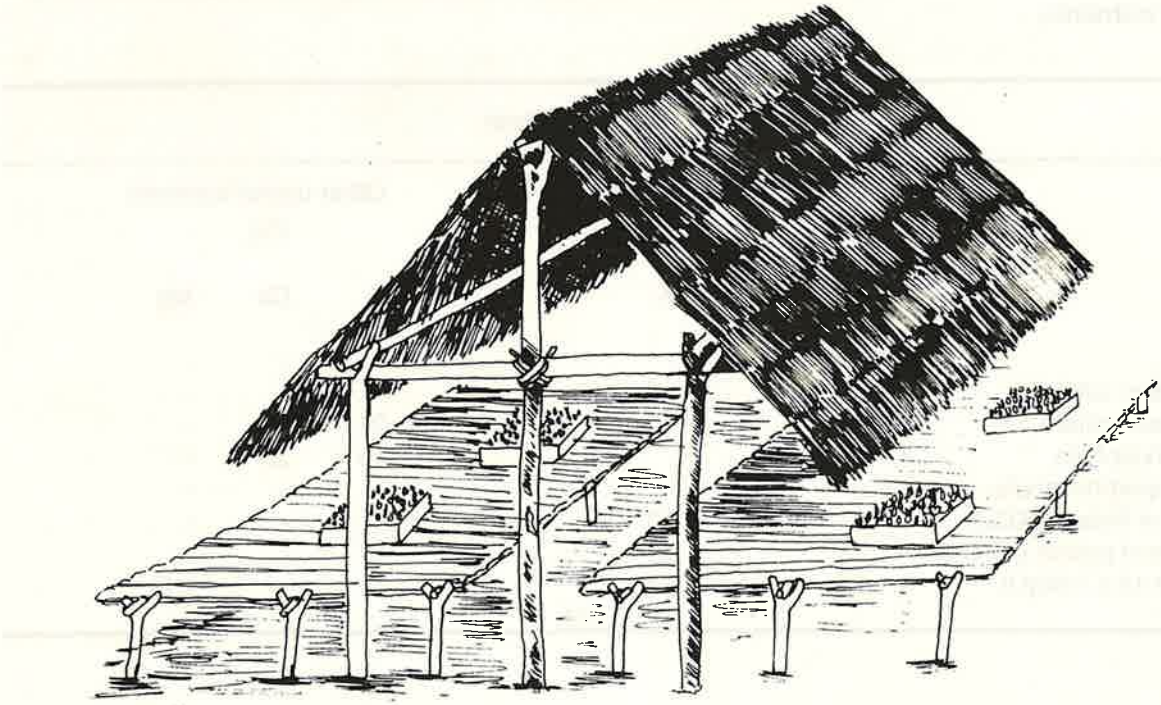
(iii) Insect and disease problems must be attended to immediately;

(iv) Harden off the seedlings in the last week of their nursery life. This is the gradual process of introducing a plant to adapt to a new environment. This involves placing the seedling box in the sun for a few hours a day for a week before transplanting in to the field.

FERTILIZERS

Inorganic fertilizers must be used with care to obtain

Figure 3: **Nursery shade house made of bush material.**



best results, otherwise you will be wasting money. There are many different kinds of fertilizers sold in the market, therefore there is need to familiarize oneself with these. Table 5 gives a list of the most common fertilizers that are likely to be encountered by the farmer. The main nutrients (NPK) and other useful (micro) nutrient composition of this fertilizers are packed in 50 kg bags, the approximate prices for these are given in Table 6.

For the purpose of vegetable production on most highlands soils two types of fertilizers are more important than others. These are:

1. Compound fertilizer NPK (12:12:17 + Trace elements) and;

2. Triple super phosphate (Triphos). This fertilizer is especially necessary in most highlands soils because of the influence of volcanic ash materials in these soils. Volcanic ash soils often do not have enough phosphates available for good plant growth. This has been shown from work carried out by the Land use Agronomist working with AFTSEMU and from initial HFSRT trial work in Gumine. If a heavy dose of Triphos is given to the soil when it is first cultivated, the effect should last for quite a long time. **From trials carried out in Gumine a dose of 40 g of NPK/ Triphos mixture at a ratio of 1:1 is adequate for growing one brassica plant.**

Some guide for the smallest amount of fertilizer required per plant or per prescribed bed area for selected introduced vegetables is given in Table 1. Usually proper scales for measuring fertilizers are not available in the village. Some common units which can be used instead of scales to measure quantities of fertilzer are as follows.

Weights in grams of fertilizers as measured by common materials

A. 1 MATCH BOX FULL

1.	NPK (12:12:17+2)	= 24 g
2.	TRIPHOS (21%P)	= 23 g
3.	NPK/TRIPHOS Mix (1:1 ratio)	= 22 g

B. 1 SMALL FISH CAN FULL

1.	NPK (12:12:17+2)	= 236 g
2.	TRIPHOS (21%P)	= 214 g
3.	NPK/TRIPHOS Mix (1:1 ratio)	= 225 g

C. 1 MEDIUM SIZED FISH CAN FULL

1.	NPK (12:12:17+2)	= 303 g

Table 5: **Simple fertilizers supplying Nitrogen (N), Phosphorus (P) and Potassium (K) and other useful (micro) nutrients.**

Name	Analysis						
	Main Nutrient (%)				Other useful Nutrients (%)		
	N	P	K	Na	S	Ca	Mg
Urea	46	-	-	-	-	-	-
Ammonium sulphate	21	-	-	-	-	-	-
Ammonium nitrate	33	-	-	-	24	-	-
Super phosphate	-	-	-	-	13	20	-
Triple superphosphate	-	-	-	-	-	-	-
Muriate of Potash (KCL)	-	-	50	-	-	-	-
Sulphate of potash (KSO4)	-	-	42	-	17	-	-
NPK (12:12:17+MgO)	12	5.1	14.1	-	-	-	1.2

NOTES

1. Nitrogen is expressed as the element (N)
Phosphorous is expressed as phosphorus pentoxide (P_2O_5)
Potassium is expressed as potassium oxide (K_2O) or 'potash'

2. The % N, P_2O_5 stated on the bag is the number of kilograms of these plant foods in a package of 100 kg. Fertilizers are uaually packed in 50 kg bags. For example the NPK compound fertilizer described as NPK (12:12:17+2 MgO); has 12%N, 12% P_2O_5, and 17% K_2O plus 2% MgO. On elemental basis, this is equivalent to 12%N, 5.3% P, 14.1% K and 1.2% Mg.

Table 6. **Approximate prices of fertilizer in 50 kg bags sold by Farmset and Harcross at Banz as of 27/4/90.**

Fertilizer type	Prices (Kina) as per			
	50kg Farmset	1kg Prices	50kg Harcross	1kg Prices
Urea	23.20	0.46	24.00	0.48
Ammonium sulphate	16.90	0.34	20.00	0.40
Ammonium nitrate	N.S	-	N.S	-
Calcium nitrate	N.S	-	19.00	0.38
Superphosphate	N.S	-	N.S	-
Triple Superphosphate	27.25	0.55	24.00	0.48
Muriate of Potash	20.50	0.41	19.35	0.39
Sulphate of Potash	N.S	-	N.S	-
NPK (12:12:17+MgO)	26.95	0.54	23.74	0.47
NPK (13:3:20)	26.15	0.52	N.S	-
NPK (15:9:15+6)	25.50	0.51	21.00	0.42
NPK (15:15:6+4)	29.00	0.58	24.63	0.49

N.S. = Not sold

2. TRIPHOS (21%P) = 275 g
3. NPK/TRIPHOS Mix (1:1 ratio) = 293 g

D. 1 LARGE FISH CAN FULL

1. NPK (12:12:17+2) = 577 g
2. TRIPHOS (21%P) = 533 g
3. NPK/TRIPHOS Mix (1:1 ratio) = 566 g

When fertilizer is used, the farmer must remember the following points:

1. Calculate exactly how much you will need and how much it will cost compared to the selling price or the farmer will make a loss.

2. Use the right kind and only the amount of fertilizer recommended;

3. Do not broadcast handfuls of unknown quantities - you will end up wasting fertilizer and your money. Broadcasting fertilizer usually does not have the desired effects;

4. Place fertilizer carefully so that it can be best used by the plant;

5. Be careful that the roots of the plant are not burnt by the fertilizer.

PESTS AND DISEASES

The farmer himself must decide whether or not he can afford to control diseases and pests using chemicals. The local or district didiman should always be available for advice.

A pest is a living organism competing with man for food. Insects are regarded as pests when they reduce quality and quantity of a plant on which they live.

A plant is sick when its normal functional processes (physiology) are disturbed. This irritation can be caused by a primary agent called a pathogen. Diseases are often associated with symptoms. And a farmer can tell from these symptoms if a plant is sick or not.

There are many ways in which a disease or a pest can affect the crop:

(i) It may kill the plant (eg, bacterial wilt of potato);

(ii) It destroys a commercially important part of the plant; (eg, fruit borers on tomato);

(iii) It destroys a reproductive part of the plant;

(iv) It generally weakens and stunts the plant; (eg, viruses, root knot nematodes);

(v) It affects and reduces photosynthetic areas of plants, (eg, leaf damaging insects, sigatoka disease of banana);

(vi) It affects storage organs, (eg, taro beetle).

Conditions ideal for pest and disease activity can be one or a combination of the following;

(i) Repeated cropping - allows diseases to build up;

(ii) Monoculture or growing of one crop allows for fast spread of diseases and pests;

(iii) Transport of infected seeds and crops;

Pest and diseases may be controlled either chemically or biologically (ie; non chemical control).

Chemical control measures encourage the use of Agricultural Chemicals such as insecticides, fungicides, nematicides, etc.. It involves a basic knowledge of how to use a chemical and at what rates to apply them. The farmer should consult the local didiman for advice. Common pests of vegetables and recommended chemical control measures are given in Appendix II.

Biological control discourages the use of chemicals and aims at accomplishing comlete control by natural means. This usually involves using one living organism to control another. For example, insects are controlled by parasites, predators or diseases. By changing cultural practices and production techniques, pests and diseases can also be controlled.

Some cultural practices that can reduce pests population and reduce disease incidences, without the use of chemicals are:

1. Change from monoculture or sole cropping to mix cropping or intercropping;

2. Use disease - free planting materials;

3. Use resistant varieties;

4. Plant alternative crops to attract the insects and then destroy that crop with pests and plant the cash crop.

5. Dig and bury suspected areas or objects of insect activity;

6. Crop rotation - subject your land to a good rotation program;

7. Sanitation - use of clean working tools.

VARIETIES

Choosing the right variety is a very improtant consideration. The best varieties usually have the following features;

- good seed quality gives good germination;
- vigorous growth features;
- suitable for local environmental conditions.

Many government and private researchers, including HFSRT and AFTSEMU have carried out experiments on vegetable varieties for the highland provinces. However, these trials have not been exhaustive and other varieties not tested may perform satisfactorily. Moreover the list is one in which varieties are known to perform adequately.

Table 7 is a summary list of recommended vegetable varieties and their source of seed supply based on trials carried out in the Simbu, Eastern (Aiyura), Western and Southern Highlands provinces. Elaborate discussion on the performance of these varieties is given under the appropriate headings. Highlands farmers may selectively choose the crop and the variety deemed appropriate for their environments.

Beans

The bean variety "Contender" is recommended for use at high altitudes. "Top Crop" has not been tested across many sites, but nevertheless it may be tried. "Golden Wax" is not a popular eating variety but this may change in the future.

Broccoli

Broccoli varieties "554 Early Value" and "Hybrid Prominence" are recommended for all highland areas. However these seeds are sometimes difficult to obtain. "Green Duke Hybrid" is a popular variety, yields are good and performance is reasonably stable across the highlands. Fertilizer recommendation for broccoli and other brassicas is a 40 g NPK/Triphos Mix at 1:1 ratio.

Brussels Sprouts

Brussels sprouts varieties available in markets are not suitable for village production in highland areas because the quality of produce is poor. However for the interested, the variety "Jade Cross Regular" may be tried. No trials were conducted for Brussels sprouts at altitudes above 2300 m, therefore it is suggested this crop should be tried between 2300 m and 2500 m, as it is known to perform well at higher altitudes.

Carrots

The varieties "Eggmont King" and "Chantenay" are recommended for use throughout the provinces, especially for altitudes between 1800 and 2200 m. "Eggmont Gold" and "New Kuroda" are recommended for altitudes lower and between 1600 and 1800 m. The other varieties "Chantenay Royal", "Chantenay Red" and "Manchester Table Nantes" are also recommended for lower, drier and more fertilie areas.

Cauliflower

"Snowball Y" and "Hybrid Snow Diana" varieties of cauliflower are recommended for areas at altitudes between 1700 m and 1800 m. These varieties may also grow well below 1700 m. "Snowball A" is recommended for altitudes above 1800 m.

Chinese Cabbage

The Chinese Cabbage cultivar "Wong Bok" is given a general recommendation for use at all highland sites. Chinese cabbage variety "Pak Choi" is recommended

Table 7: **Recommended vegetable varieties based on trials carried out in Gumine, Aiyura and Southern Highlands Provinces.**

Species	Variety	Seed source	Commets
Bean	Top Crop	Cooper, NZ	Dwarf
	Contender	Longlife, NZ	Dwarf
	Long John	Longlife, NZ	Dwarf
	Tender green	Longlife, NZ	Dwarf
Broccoli	554 Early Value	Known-You	
	Hybrid Prominence	Takii	
	Green Duke (Hybrid)	Yates	
Brussels Sprouts	Hybrid Jade Cross1		quality of produce satisfactory
	Regular	Takii	
Carrot	New Kuroda	Takii	
	Chantenay	Longlife	
	Chantenay Red	Longlife	
	Chantenay Royal	Longlife	
	Eggmont King	Watkins	
	Manchester T/Nantes	Longlife	
Cauliflower	Snowball Y	Takii	get seeds through B. Bell POM
	Snowball A	Takii	
	Hybrid Snow Diana	Takii	
	Selection	Yates, NZ	
C/Cabbage	Wongbok	Longlife and Watkins	
Tomato	NG7536/Summer Taste		resistant to bacterial wilt
	Grosse Lisse	Longlife	
	Potentado	Longlife	
	Fireball	Longlife	
	Money Maker	Longlife	
Bulb Onion	Gladalan Brown	Yates/SPM	brown, elongate, good storage
	Gladalan White	Yates Aust/SPM	white, elongate, poor stage
	Awahia	Uni of Hawii	redishbrown, good storage
	BP036	Northrup King	obtain seeds through
	BP035	Northrup King	Farmset
	Superex	Takii/Brian Bell	brown elongate
Lettuce	Sunny Lake	-	good sized heads and
	Great Lakes Regular	-	no bolting probs
Zucchini	Black Jack Hybrid	-	good marrow crops
	Long Green Bush	-	good zucchini crops
	Black Zucchini		

for direct sowing in the field, as when transplanted, it produce flowers and therefore cannot be marketed.

Tomato

Tomato varieties "Fireball" and "Money Maker" are recommended for use anywhere. "Potentado" is particularly recommended for altitudes between 1800 m and 2200 m, while "NG 7536" and "Grosse Lisse" are recommended for use in warmer and lower altitudes (1600 m). "NG7536" is resistant to bacterial wilt disease of tomatoes.

Bulb Onion

From trials conducted between 1972-1981, the varieties Gladalan Brown, Gladalan White, Awahia and Superex were recommended as commercial varieties. These recommendations are enforced pending further variety selections. Recently, trials carried out at Aiyura and Gumine found 2 superior Northrup King varieties. These are BP 035 and BP 036. Seeds of these can now be obtained from Farmset.

Lettuce

The varieties "Sunny Lake" and "Great lakes Regular: are initially recommended for all highland sites, but especially for commercial planting at altitudes between 1670 m and 2000 m.

Zucchini

As a preliminary recommendation variety Long Green Bush will give good zucchini yields and variety Black Zucchini will give good marrow crops. The variety Black Jack Hybrid may be grown as an all purpose zucchini and marrow crop.

CONCLUSION

Growing introduced vegetables requires some skill and attention but this is worthwhile as it can be sold for money. Future patterns of consumer demand in PNG and prices for vegetables in the highland provinces may be predicted with some caution, one of promising good returns. If the present import ban stays on, and with increasing population and increased economic activity in the highlands, vegetable growing is expected to become a good business. Therefore it is imperative that the management skills of farmers continuously be upgraded. Using the variety recommendations and employing cultural practises suggested vegetable production can become a successful business for interested farmers in these provinces.

ACKNOWLEDGEMENTS

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Finally, Ms Susie Antiko deserves a hearty thankyou for her tireless efforts in typing this document.

ABOUT THIS MANUAL

This manual is not just 'another' text on the extension message, which everyone complains is not reaching home. This manual, however, you will find, provides practical answers to many of the commonly asked questions about growing introduced vegetables.

This manual puts together the experiences of many

people, including farmers and agricultural researchers, a FIELD GUIDE to successful vegetable production in the highlands of PNG. The manual is intended for use by Agricultural Extension Officers as a Field Hand Book. Its main purpose is to serve as a safe guide for field extension officers in the course of executing their duties, particularly when advising and assisting farmers who want to grow introduced vegetables for earning cash.

The notes are not intended directly for village farmers. But educated farmers can make meaningful use of its content, as the technical information and the language have both been simplified to the level where someone with a minimum of grade six education can use it.

FURTHER INFORMATION

Further information on growing introduced vegetables can be obtained from the following DAL publications;

1. Farming Notes No.10 Vegetables;

2. Rural Development Series Handbook No.9 Introduced Vegetables;

3. Horticulture Notes (published in Harvest and also available separately);

4. Recommendations for the control of Pests 1983; Department of Primary Industry. Entomology Section.

These publications can be obtained by writing to:

The Senior Publications Officer
Department of Agriculture and Livestock
P O Box 417
KONEDOBU
Telephone: 258191

SSRDP TRAINING UNIT

Notes on how to grow carrots and cauliflower, and posters on soil conservation can be obtained by writing to;

Media Coordinator
Simbu Media Unit
P O BOx 192
KUNDIAWA
Simbu Province
Telephone: 751155

FURTHER READING

Bourke, R.M. (1984 a). Making Money from Fresh Food in the Kainantu Area, (1). Harvest 10 (2): 59-64.

Bourke, R.M. (1984 b). Making Money from Fresh Food in the Kainantu Area, (2). Harvest 10 (2): 65-75.

Bull, P.B. (1983). Growing introduced vegetables in the lowlands. Four vegetable variety recommendatiion for the Port Moresby lowlands. Harvest 9(2): 80-83.

Gunther, M.T. (1985). Horticulture Note No.9. Vegetable variety recommendations for the Highlands of Papua New Guinea. Harvest 11(3): 126-128.

Kanua, M.B. (1990). Farming Systems Research in the highlands of Papua New Guinea: results on introduced vegetable research. HAES - Aiyura, Occasional Paper No. 1/90.

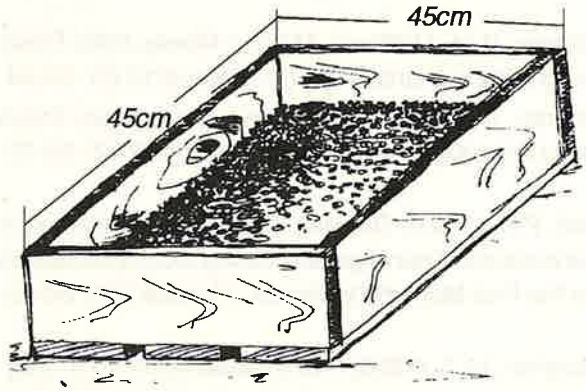
Kanua, M.B. and D'Souza, E.J. (1985). Evaluation of introduced vegetable varieties on Volcanic Ash Soils in the Southern Highlands of Papua New Guinea. Technical Report 85/13. DPI Konedobu, (AFTSEMU Technical Report No. 10, 1985).

Pitt, A.J. (1988). Report on the Potential for Establishing an Onion Industry in Papua New Guinea highlands (DAL internal unpub. Report). ❑

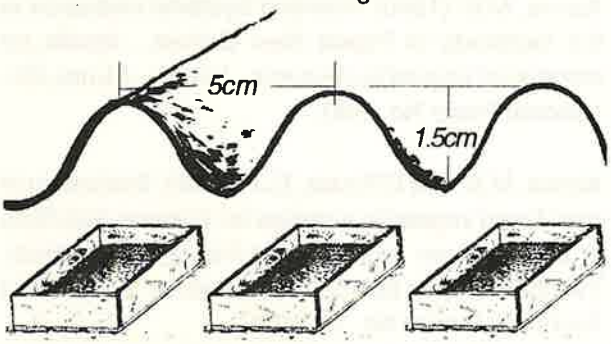
Appendix I (A).

RAISING SEEDLINGS IN NURSERY

1. Put sterilized soil mixture (3 parts soil; 1 part chicken manure) in the seed box.



2. Make trenches at about 4-5 cm apart and 1-20 cm deep. the soil lumps in the furrow should be broken and a fine bed made for sowing the seeds.



3. Sow the seeds along the furrows at about 0.25 cm apart. Then cover the furrows with soil mixture.

4. Watering:

(a) Water the soil carefully using a watering can. Do not flood the box.

5. *(a)* First week, water the boxes everyday early in the morning.

(b) Second week, water every second day.

(c) Third, fourth and fifth week, water only when necessary.

6. After 2 weeks thin out weak seedlings. Thinning is pulling out the weak seedlings and giving room and space to strong plants to stand.

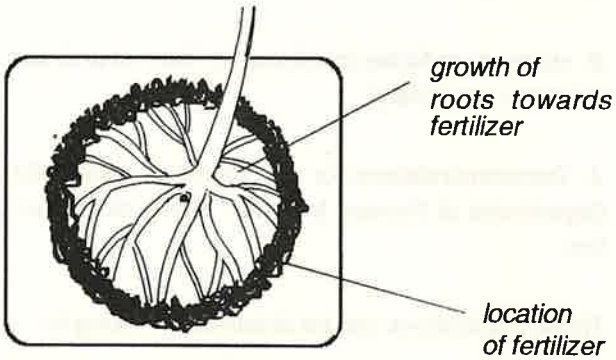
7. If you had flooded the seed boxes with water, it should be relatively easy to dig out a plant (seedling) with minimum damage to the roots. Lift the seedling out carefully with as much soil as possible around the roots.

8. Rotate the stick around a few times and remove it from the hole. You should now have a hole sufficient enough to insert a seedling. The seedling should NEVER be forced into the hole.

9. Allow the seedling to freely settle onto the bottom of the hole; but don't dump it there; hold it in mid-air and fill the hole. The end of the roots should be at least 5cm above the base of the hole. Do not firm the soil around the base of the plant.

10. Water the plant. If you followed step 9 carefully; now when you water the plant, the seedling will be firmly held together as heavy (water logged) soil settles.

11. Now you have a plant anchored in the soil. In a few days as the roots grow they are directly in contact with the fertilizer. This allows for maximum utilization of fertilizer.



12. *(a)* Spray or in a watering can apply Karate (see Appendix II for rates) to base of each plant to protect it from cut worm damage.

(b) Or use an empty tinned fish can placed around the plant.

Appendix I(B).

TRANSPLANTING SEEDLINGS INTO FIELD

Transplanting must be carried out with minimum stress to the plant. The steps outlined below demonstrates the technique used in applying fertilizer and transplanting seedling. Further information can be obtained from Farming Notes No. 10. Vegetables.

TRANSPLANTING

1. Transplanting must be done late afternoons or on a cloudy day.

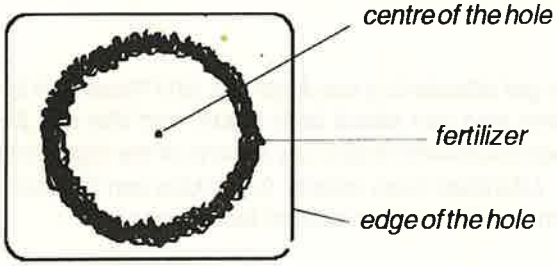
2. Have your garden and beds prepared before hand. And mark out with sticks the exact position for each plant.

3. Seed boxes must be carried to the garden. Make holes 10-15 cm deep and 10-15 cm wide for brassicas and tomatoes

4. Give the seedlings a lot of water; flood the boxes with water while awaiting transplanting. This makes it easy for the plants to be uprooted with minimum damage to the roots. This should be done as soon as the boxes are taken to the garden site.

5. Mix fertilizer in a container (refer table 1). Apply this mixture in a circle around the base of the holes you've dug.

(Top View)



6. Plant a stick in the centre of the hole; leave it there to mark the central position of the hole and fill the hole with soil.

7. INSECT & DISEASE CONTROL

(a) As the seeds begin to germinate watch out for any pest and disease outbreak. If you are confronted with a problem you're not sure of handling seek advise from a didiman quickly.

(b) Look at your plants evey day to see if there are any insects. If insects are found to be destroying plants apply the correct chemicals.

8. Refer to Appendix II for common pests and recommended control measure.

9. Diseased plants must be pulled out and burned.

10 HARDENING OFF

This is done to minimize transplanting shock to the seedling and to help it adapt to the new environment where it will spend the rest of its life.

At 4th week the seedling boxes must be put out in full sunlight a few hours each day. When it begins to rain, take them inside.

11. At 5th week leave boxes in full sunlight all day.

12. By the end of 5th week, seedlings will have 3 or 4 leaves and will be about 10cm high.

At this stage the seedlings are ready to be transplanted.

13. Check everyday for insect damage and dead plants. Replace any plants that die.

FIRST WEEK

The plants must be watered everyday. If you have plenty rain in your area this may not be necessary.

14. After the first week mulch may be put around the plants and over the soil.

Watering maybe done when the soil gets dry. But this may not be necessary in many highlands areas as there is a lot of rain.

APPENDIX II

Common pests of vegetables and recommended control measures.

Source: **DPI Technical Report 83/4, Entomology section. Recommendations in this table were updated and checked by Entomologists Roy Masamdu and Malcus Arura of DAL Bubia.**

Crop	Insect pest	Insecticide		Insecticide Recommendation				
	common name	common name	trade name	amount a.i per ha	applied ml/g per 10L Water	application	waiting period (days)	other remarks
Brassicas (1)	Diamond backmoth	Acephate	Orthene	0.05%	6.5gms	spray wkly, ensure that both upper and lower leaves are adequately wetted	3	Destroy remains of plants after harvesting
	Cabbage cluster caterpillar	Halothrin	Karate 2.5/EC	0.005%	12.5 mls			
	Cutworm	Halothrin	Karate 2.5EC	0.01%	25 mls	spray base of plants, wkly for three weeks	3	
Beans	Beanfly	Dimethoate Formothion	Rogor Perfek-thion	0.03%	6.5 mls	spray 3 days after emergence and wkly for 3 weeks	7	
	Bean pod sucker	Acephate	Orthene	0.03% 0.05%	6.0 mls 13 gms	2-3 sprays once pod sets begin then spray as required	7	
Zucchini	fruitfly	Dimethoate	Rogor	0.03%	6.5 mls	spray as required	7	
Lettuce	see notes							
Onion (2)	see notes							
Carrot (2)	see notes							

Notes

1) Brassicas refers to the family of cabbages including english and chinese cabbages, broccoli, cauliflower and brussels sprouts.

(2) Carrot is a relatively disease free crop. Bulb onions often get attacked by black aphids, and these can be controlled with malathion at 2.5 ml/litre water. Downy mildew also can attack bulb onion, and this can be controlled with ridomill at 2.5 ml/litre of water. Purple blotch was found affecting crops in parts of the highlands but to date no chemical control measures have been given. Literature says copper fungicides can be used. Burning of crop debris, good drainage and rotation are recommended cultural control techniques.