EVALUATION OF TWENTY FIVE VEGETABLE VARIETIES AT AIYURA, EASTERN HIGHLANDS PROVINCE.

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ABSTRACT

Two trials were conducted to compare 25 species of traditional and introduced vegetables. The object of the trials was to provide the basis for making recommendations to highland institutional farmers for suitable vegetable species to grow. Fresh and dry weight yield from first to final harvest are presented. The following species recorded yields of over 5 t/ha (fresh weight) and 1 t/ha (dry weight): Pumpkin (Cucurbita moschata), *choko* (Sechium edule), *silverbeet* (Beta vulgaris), Oenanthe javanica, *cabbage* (Brassica oleracea), *Russian comfrey* (Symphytum asperrimum), Rungia klossii *and* Dicliptera papuana. *Based on yield, nutritional value, acceptability to the consumer, ease of cultivation and period of harvest, the following vegetables are recommended to institutional farmers: Pumpkin, silverbeet, oenanthe and rungia. Cabbage is recommended with reservations.*

Key words: *vegetable species, nutritionally superior, high yielding.*

INTRODUCTION

Vegetables such as leafy greens and beans constitute a significant portion of people's diet in the Papua New Guinea highlands. Several species are generally grown by villagers in their gardens. Some of these species are recent introductions to Papua New Guinea (PNG), but many are traditional. Vegetables are also an important source of cash income for many people in the highlands. This is confirmed by the fact that vegetables constitute a significant proportion of produce offered for sale in the markets. The nutritional value of many of the traditional species has not been assessed adequately. The limited data available suggest that they are nutritionally superior to many of the introduced species.

Research work on vegetables has been done by staff of the Department of Agriculture and Livestock, University of Papua New Guinea and various Christian missions. This has mainly consisted of variety trials on introduced species. Results are presented in papers by Aldous (1976), Anon (1975), Blackburn (1976), Dever and Voigt (1976), Dodd (1977), Fowler (1976), Kemp (1976), Kesavan (1977a, b, 1980), Lambert (1975), Powell (1982), Rose (1980) and Westwood and Kesavan (1982). A complete listing of 250 agronomic field trials done on vegetables up to 1978 is given by Bourke (1982).

At institutions, such as high schools and corrective institutions, introduced vegetables are mainly grown in the gardens and the traditional PNG species are overlooked. We suspected that at least some of the traditional species would prove as productive as the introduced ones being grown. Between 1979 and 1982 two formal trials were conducted by the authors to compare yields and periods of production of 25 traditional and introduced vegetable species. The main purpose of the trials was to determine which species should be recommended to institutional farmers.

MATERIALS AND METHODS

Two trials were conducted at the Highlands Agricultural Experiment Station at Aiyura in the Eastern Highlands (6° 19' S; 146° E; 1600-1850 m alt.; 2200 mm mean annual rainfall). The trials were done at an altitude of 1610 m. Trial 1 was located on a heavy clay soil and Trial 2 on a dark clay loam rich in organic matter.

Twenty five species were compared. These are listed in Table 1. A randomized block design was used with four replications. Plots were 4 m x 4 m in size. Each

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Table 1. **Vegetable species entered in Trials 1 and 2.**

Botanical name	Common name
Abelmoschus manihot	Aibika
Amaranthus tricolor	Aupa
Basella alba	Ceylon spinach
Brassica oleracea var. *capitata*	Cabbage
Brassica chinensis	Pak choi
Cucurbita moschata	Pumpkin
Cyanotis moluccana	-
Dicliptera papuana	Dicliptera
Lagenaria siceraria	Bottle gourd
Nasturtium schlechteri	-
Oenanthe javanica	Oenanthe
Phaseolus lunatus	Lima bean
Phaseolus vulgaris	Climbing bean
Phaseolus vulgaris	Dwarf bean
Pisum sativum	Peas
Psophocarpus tetragonolobus	Winged bean
Rungia klossii	Rungia
Saccharum edule	Lowland pitpit
Sechium edule	Choko
Setaria palmifolia	Setaria
Solanum nigrum	Karakap
Spinacia olerarea	Spinach
Symphytum asperrimum	Russian comfrey
Vigna unguiculata	Cowpea

plot included a guard row 50 cm wide around the perimeter. A guard row of *Oenanthe javanica* was planted around the outside perimeter of each trial. The land was cultivated mechanically and the plots were prepared by hand. In Trial 1, coffee pulp was applied at a rate of 60 t/ha. No fertilizer was used in Trial 2 as the site was naturally fertile. Trial 1 was planted in November 1979 and Trial 2 in October 1980.

A locally grown variety was used for each species, except for cabbage, Chinese cabbage, silverbeet and spinach where Yates seed were used. The planting technique varied with different species, but it was generally done as would be normally done by village women in their subsistence gardens. Planting was done directly in the field for most species. Seedlings were raised in the nursery for cabbage, Chinese cabbage, silverbeet and spinach, and later transplanted into the field. The methods of propagation varied between species. These are detailed in Table 2. Replanting was done for several species when germination failed completely. Spacing between plants varied with species. Plant densities were determined after field establishment and are given in Table 2. Lima bean, winged bean and climbing bean (*Phaseolus*) were grown on stakes. Plots were weeded regularly.

Harvesting was done weekly until all species had finished producing. For most species the young leaves, petioles (and stems) were harvested, but fruit were also harvested for pumpkin and choko, and tubers were harvested from winged bean. The edible plant parts harvested are given in Table 2. Fresh weight of the edible portion was recorded at harvest and a sample taken from each plot to determine dry weight yield. The samples were oven dried for seven days before being weighed.

RESULTS

Fresh weight and dry weight yields and times to first and final harvest for each species are presented in Table 3. Yields in Trial 1 were generally greater than those in Trial 2, but there was reasonably good agreement in the rank of different species between trials (Table 3). There was considerable variation in yield between species. Mean fresh weights ranged from 300 kg/ha (spinach) to 68 t/ha (pumpkin fruit plus tips). Dry weight yield ranged from 40 kg/ha to 8.1 t/ha. The period taken to first harvest was also very variable. Some species were ready for harvest from 12 weeks after planting (*Nasturtium schlechteri*, peas) whilst lowland pitpit (*Saccharum edule*) was not ready to harvest till 49 weeks from planting. The harvesting period (first to last harvest) ranged from 2 weeks (peas) to 62 weeks (*Oenanthe*).

The species which recorded the highest yield were pumpkin (*Cucurbita moschata*), choko (*Sechium edule*), silverbeet (*Beta vulgaris*), *Oenanthe javanica*, cabbage (*Brassica oleracea*), Russian comfrey (*Symphytum asperrimum*), *Rungia klossii* and *Dicliptera papuana*. All these species recorded yields of over 5 t/ha fresh weight and over 1 t/ha dry weight.

DISCUSSION

A vegetable suitable for growing by an institution would have the following characteristics:

(i) High yielding
(ii) Nutritious
(iii) Acceptable to the consumer
(iv) Easy to cultivate
(v) Have an extended harvest period
(vi) Easy to prepare for cooking.

Table 2. **Method of plant propagation; parts of plant harvested; and plant density used (average of Trials 1 and 2).**

Vegetable species	Method of propagation	Plant parts harvested	Plant density (plants/ha)
Abelmoschus manihot	2-Stem cuttings	Young leaves, petiole, stem	23,000
Amaranthus tricolor	Seed	Young leaves, petiole, stem	383,000
Basella alba	Seed	Young leaves, petiole, stem	59,000
Beta vulgaris	Seed	Leaves, petiole	68,000
Brassica oleracea var. *capitata*	Seed	Leaves	54,000
Brassica chinensis	Seed	Leaves, petiole	25,000
Cucurbita moschata	Seed	Fruit, young leaves, petiole, stem	6,000
Cyanotis moluccana	Stem cuttings	Young leaves, petiole, stem	33,000
Dicliptera papuana	Stem cuttings/ splits	Young leaves, petiole, stem	21,000
Lagenaria siceraria	Seed	Young fruit	32,000
Nasturtium schlechteri	Seed	Young leaves, petiole, stem	2,560,000
Oenanthe javanica	Stem cuttings	Young leaves, petiole, stem	29,000
Phaseolus lunatus	Seed	Seed	11,000
Phaseolus vulgaris (climbing)	Seed	Pods, seed	34,000
Phaseolus vulgaris (dwarf)	Seed	Pods, seed	27,000
Pisum sativum	Seed	Pods, seed	29,000
Psophocarpus tetragonolobus	Seed	Tubers, pods, seed	94,000
Rungia klossii	Stem cuttings	Young leaves, petiole, stem	31,000
Saccharum edule	Stem cuttings	Inflorescence	17,000
Sechium edule	Seed	Fruit. Young leaves, petiole, stem	50,000
Setaria palmifolia	Stem cuttings	Young stem	20,000
Solanum nigrum	Seed	Young leaves, petiole, stem	1,092,000
Spinacia oleracea	Seed	Leaves, petiole	10,000
Symphytum asperrimum	Splits	Young leaves, petiole	25,000
Vigna unguiculata	Seed	Pods, seed	26,000

Each of the eight species which gave over 1 t/ha of dry weight yield will be discussed and these criteria considered. Nutritional information is obtained from WHO (1979). Pumpkin (*Cucurbita moschata*) gave a very high yield (mostly of fruit not tips). Both the fruit and leaf tips are nutritious, as they contain useful quantities of vitamin A precursor. Possible inadequate intake of vitamin A in the diets of residents of institutions is of concern in PNG (J. Badcock, pers.comm.). Both fruit and tips are acceptable to highlanders. The crop has an extended harvest period and is easy to cultivate. For these reasons it can be recommended to institutional farmers.

Choko (*Sechium edule*) was also high yielding. Again this occurred because of a high yield of fruit rather than tips. The fruit are of very low nutritional value and are rarely eaten by Papua New Guineans. Hence the fruit cannot be recommended.

Silverbeet (*Beta vulgaria*), also called Swiss chard, gave the third highest yield in the trial and the highest yield of leaf/petiole, although this was from Trial 1 only. A high proportion of the yield came from the petioles rather than the leaf blades. Silverbeet is rich in vitamin A. It is not usually eaten by Papua New Guineans. The harvest period of 47 weeks is extended, although

Table 3. **Fresh weight and dry weight yield and time taken to first and final harvest of various vegetable species (Trials 1 and 2).**

Vegetables species	Fresh weight yield (t/ha)			Dry weight yield (t/ha) (1)	Time to first harvest (weeks) (1)	Time to final harvest (weeks) (1)
	Trial 1	Trial 2	Mean			
Abelmoschus manihot	2.0	3.6	2.8	0.5	24	76
Amaranthus tricolor	1.5	-	1.5(2)	0.3(2)	14	54
Basella alba	8.7	3.3	6.0	0.7	15	68
Beta vulgaris	16.4	-	16.4(2)	1.9(2)	16	63
Brassica oleracea var *capitata*	13.5	7.4	10.5	1.3	20	63
Brassica chinensis	2.1	4.7	3.4	0.3	20	25
Cucurbita moschata (tips)	13.4	3.4	8.4	0.9	16	74
Cucurbita moschata (fruit)	79.3	40.3	59.8	7.2	19	71
Cvanotis moluccana	11.3	8.8	10.1	0.8	14	76
Dicliptera papuana	7.2	2.8	5.0	1.0	15	76
Lagenaria siceraria	10.3	6.8	8.6	0.5	19	27
Nasturtium schlechteri	0.7	1.0	0.9	0.1	12	21
Oenanthe javanica	12.2	7.2	9.7	1.3	14	76
Phaseolus lunatus	4.9	1.2	3.1	0.5	23	72
Phaseolus vulgaris (climbing)	3.9	2.6	3.3	0.6	15	25
Phaseolus vulgaris (dwarf)	2.3	2.7	2.5	0.6	14	22
Pisum sativum	0.7	0.6	0.7	0.2	12	14
Psophocarpus tetragonolobus (pod)	3.3	2.9	3.1	0.6	20	29
Psophocarpus tetragonolobus (tubers)	2.3	-(3)	2.3	0.7	45	45
Rungia klossii	8.6	4.1	6.4	1.0	15	76
Saccharum edule	0.6	0.3	0.5	0.2	49	82
Sechium edule (tips)	9.0	2.7	5.9	0.6	15	74
Sechium edule (fruit)	28.7	40.3	34.5	4.8	18	74
Setaria palmifolia	3.2	3.0	3.1	0.3	17	69
Solanum nigrum	3.4	2.1	2.8	0.5	14	70
Spinacia oleracea	0.3	-	0.3(2)	0.04(2)	27	34
Symphytum asperrimum	15.6	7.6	11.6	1.5	15	77
Vigna unguiculata	4.0	3.0	3.5	0.8	19	56

Notes:- *(1) Mean of Trials 1 and 2*
(2) Crop failed to establish in Trial 2. Results are from Trial 1 only.
(3) Winged bean tubers were stolen from Trial 2.

it is shorter than some of the other high yielding species (Oenanthe, rungia, pumpkin fruit). Silverbeet is not easy to cultivate if seedlings are raised in a nursery. (Note the crop failure in Trial 2). However seeds planted directly in the field have established successfully under institutional conditions (B. Calcinai, pers.comm.). We recommend silverbeet as a vegetable for institutional farmers, provided problems with crop establishment can be overcome.

Oenanthe (*Oenanthe javanica*) satisfies all criteria for recommendation. It is high yielding, acceptable to Papua New Guineans, has an extended cropping period and is easy to cultivate. It also can be harvested from 14 weeks from planting. We have no information on its nutritional value, but presume it to be moderately nutritious as the leaves are medium dark green in colour.

Cabbage (*Brassica oleracea*) is high yielding and acceptable to highlanders. It is less nutritious than species with dark green leaves. Its harvesting period of 43 weeks is less than some other species, but still extended. Seedlings have to be raised in a nursery and it is very susceptible to insect attack. Hence it is a more difficult species to grow. It could only be recommended with reservation. The average fresh weight yields in these trials (13.5 and 7.4 t/ha) are lower than yields reported elsewhere in PNG (Blackburn 1976; Dever and Voigt 1976).

Russian comfrey (*Symphytum asperrimum*), rungia (*Rungia klossii*) and dicliptera (*Dicliptera papuana*) yielded 1.0-1.5 t/ha of edible portion on a dry weight basis. All these species have dark green leaves and are presumably nutritious. All have an extended harvest period, can be harvested from 15 weeks after planting and all are easy to cultivate. They can only be separated on their acceptability. Rungia is a very popular highland green and has a an acceptable flavour, cooked or uncooked. *Dicliptera* is coarser than rungia and is only a minor species in the highlands. Russian comfrey is not eaten by people in the highlands and there have been health concerns about the crop overseas. For these reasons we recommend rungia as a species suitable for institutions to grow, but not dicliptera or Russian comfrey.

Further work is needed to determine the length of time after planting that certain species can be economically maintained. Most of the high yielding species considered here (pumpkin, silverbeet, choko, oenanthe, rungia, Russian comfrey) can be maintained for extended periods. The period is dependent on the level of weed control and soil fertility. In the present trials, weeds were controlled regularly, but we suspect that the economic harvesting period would be less under actual farming conditions. Further information is needed on the nutritional value of the traditional Papua New Guinea greens, especially *Oenanthe javanica*, *Rungia klossii* and *Dicliptera papuana*.

Crop yields are affected by the planting density and variety used. Hence different results from those reported here would be expected if these two variables were different. Nevertheless we believe that these trials have given a good indication as to the most productive vegetable species in the highlands.

CONCLUSION

Based on yield and other criteria the following vegetables can be recommended for use by institutions in the highlands: Pumpkin, silverbeet, oenanthe and rungia. Cabbage is also a high yielding species, but it is recommended with reservation because it does not satisfy other criteria.

ACKNOWLEDGEMENTS

The assistance of the following is gratefully acknowledged: Michael Bourke who established Trial 1 (together with Alfred Nigel), gave technical advice and finalized this paper for publication; Clement Tumana who assisted with data collection and field work; and Arthur Charles who commented on the paper.

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