APPENDIX 1. Foliage plants collected, propagated and maintained at BPI-LBNCRDC

1. *Cordyline terminalis* "Pink top"
2. *Cordyline terminalis* "Kiwi"
3. *Cordyline terminalis* "Willy's Gold"
4. *Cordyline terminalis* "Golden Ti-plant"
5. *Dracaena marginata* "Tricolor"
6. *Dracaena marginata* "Red Margin"
7. *Dracaena marginata* "Ivory"
8. *Dracaena godseffiana* "Florida Beauty"
9. *Dracaena sanderiana* "Gold"
10. *Dracaena sanderiana* "Ivory"
11. *Dracaena godseffiana* "Milky Way"
12. *Dracaena godseffiana* "Gold Dust"
13. *Dracaena goldienna*
14. *Dracaena rotheina*
15. *Dracaena draco*
16. *Dracaena derumensis* cv. Warneckii
17. *Dracaena compacta*
18. *Dracaena sanderiana* cv. Virens
19. *Dracaena godseffiana* cv. Bausei
20. *Microsorium punctatum*
21. *Murraya paniculata* "Kamuning"
22. *Pleomele reflexa* "Song of India"
23. *Pleomele reflexa* "Song of Jamaica"

NEW TECHNOLOGIES FOR OFF-SEASON LEAFY VEGETABLES AND TOMATO PRODUCTION

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ABSTRACT

Leafy vegetables and tomatoes are important vegetables of the country. Nutritionally, leafy vegetables and tomatoes are good sources of fiber and nutrients needed to be healthy. Economically, leafy vegetables provide short turnover of investment because they are very easy to grow and could be harvested after 30 days. Tomato in the other hand is a valuable cash crop for the farmers.

Vegetable consumption of Filipinos is low at 106 g/capita. Socio economic studies showed that the reasons for low consumption are limited supply and unaffordable price. Unfavorable conditions (high temperature, abundant rainfall and high humidity) make production of vegetables seasonal. This project is conducted to enhance productivity and reduce seasonality of vegetables while simultaneously reducing the use of pesticides and inorganic fertilizers. Off-season production technologies such as raised beds, application of net structures, right fertilizer management, integrated pest management, proper cultural practices and use of improved varieties were generated.

In pechay, planting in raised beds and applying rice straw compost (1 kg/m^2), basal application of 90-20-20 kgs NPK/ha and twice foliar spraying of 19-19-19 + ME gave
47.5% increase in yield over the farmers' practice of applying chicken manure compost and urea fertilizers. The application of net tunnels over pechay beds to reduce impact of rain and prevent invasion of pests had 34.6% yield advantage.

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In tomato, seasonality of production is minimized with the introduction of technologies that can overcome seasonal stresses like using grafted tomatoes with eggplant rootstock, rainshelters and spraying of fruit set hormone. Grafted BPI-Tm9 grown under protected structure and sprayed with Tomatotone gave a yield advantage of 26% over the non-grafted.

This project was conducted at BPI-Los Baños National Crop Research and Development Center from April 1998 to March 2001.

RATIONALE

This project is part of the BMZ-Germany project entitled "Development of peri-urban vegetable production system for sustainable year-round supplies to tropical Asian cities", coordinated by the Asian Vegetable Research and Development Center (AVRDC), Taiwan, in collaboration with the Technical University of Munich (TUM), Central Luzon State University (CLSU) and the Bureau of Plant Industry-Los Baños National Crop Research and Development Center (BPI-LBNCRDC).

Vegetable production is highly seasonal. Abundant supply at cool-dry season result to very low price. At off-season, poor quality vegetables command high prices, affecting consumption of vegetables. Based on the survey of Food and Nutrition Research Institute (FNRI, 1993) in Metro Manila, Filipino urban dwellers have a very low per capita consumption of 39 kgs/year or 106 gms/day, far behind Japan with 137 kgs, Taiwan, 122 kgs and China, 98 kgs.

Off-season production of vegetable is made risky because of high temperature, high humidity and abundant rainfall brought about by monsoon rains and 20 or more typhoons every year. Poor fruit set of tomato as enduced by high temperatures and disease infections were the probable causes of low yield during the wet season in the Philippines (Hanson P. M. **et al.**, 1992). Midmore, **et al.** (1993) recommended the application of fruit-set hormone to alleviate the effects of high temperature

to a heat-tolerant hybrid which can double fruit yield and increase profitability of wet season tomato production.

Among the important vegetables of the country, AVRDC selected the leafys and tomato. Leafy vegetables are grown in 29% of the total vegetable production area in 1997 (BAS, 1998). They are short duration crops, harvested in 30 days, easy to grow and are good sources of nutrients needed for healthful living. Green leafy vegetables provide 9.7 to 13.2% fiber, 32 to 125 mg vitamin C, 2.9 to 4.6 mg Beta-carotene and 1497 to 2496 mg calcium per 100 g vegetables (AVRDC 1998 Annual Report).

Tomato is one of the most widely grown and economically important vegetable crops in Asia (Jansen, 1992). It is a good source of vitamins A and C and a valuable cash crop for farmers. As an important component of the Filipino diet, there is an urgent need to ensure a steady supply of tomato throughout the year (Soriano, **et al.**, 1989). The 1997 production area was 2.7% of the total vegetable areas. Year round supply of tomato is augmented by annual importation of 10 t tomato paste valued at 7 million USD. (1993-1996 Import-Export Stat.).

To check seasonality and make available continuous supply of vegetables to Metro Manila Markets the Peri-urban Project generated technologies and management practices for stressful environments for the past three years (1998-2001). These technologies include the use of rainshelters in leafys and tomatoes, cultivation of tomato grafted with eggplant rootstocks and cultivation of heat tolerant tomatoes and new leafy vegetables.

Eighty cultivars of eight (8) kinds of leafy vegetables were grown at Bureau of Plant Industry – Los Baños National Crop Research and Develeopment Center (BPI-LBNCRDC) to identify new leafy vegetable crops adapted to year-round production at Los Baños conditions. The vegetables were grown at various months to get potential yield at regular and off-season months. Recommended technologies such as raised beds, use of compost in combination with inorganic fertilizers, line sowing of seeds, use of net shelters to prevent pests and monitoring of pests before

spraying of insecticides were adopted.

In tomatoes, grafting eggplant as rootstocks were made with different tomato varieties for compatibility test. The use of grafted seedlings eliminates bacterial wilt and other soil borne diseases and flooding. Grafted materials were planted in hydroponics and open-field conditions with and without net shelters and sprayed with fruit-setting hormone, to determine treatment effects on yield during the off-season production.

OBJECTIVES

General: Stabilize production of leafy vegetables and tomatoes in peri-urban production areas of the Philippines.

Specific:

- Identify new leafy vegetable crops adapted to year-round production systems
- Compare combined effects of different off-season production technologies on leafy vegetable and tomatoes

METHODOLOGY

Leafy Vegetables:

During the first year, 60 accessions composed of 10 Non-heading Chinese Cabbage, *Brassica rapa L.* cvg. Chinese Cabbage, 5 Indian Mustard, *Brassica juncea*, coss, 10 Chinese Kale, *Brassica oleraceae L.* cv. Alboglabra, 5 Kangkong, *Ipomea reptans*, Poir, 15 Choysum, *Brassica rapa L.* cvg. Caisim and 15 Pak-choi, *Brassica campestris L.* cv. Pak-choi were started in seedling trays, transplanted October 1998. Seedlings were transplanted in raised beds, 1 x 5 m with 15 cm distance between and within rows to give 35 seedlings per entry in 3 environments.

Environment 1 was mulched with neem leaves in the open field.

Environment 2 was mulched with neem leaves and provided with 32 mesh netting as rainshelter. Environment 3 was provided with rice straw mulch and 32 mesh netting. Netting was removed temporarily on sunny mornings and permanently 35 days after transplanting (DAT). All plots were applied with compost at the rate of 10 t /ha and 48-64-48 kg/ha inorganic NPK as basal and twice foliar spray of 15-7-7 liquid fertilizer at 23 and 27 DAT. Carbaryl insecticide was sprayed to control ants and chewing insects.

For the second and third year, the same accessions with 10 lettuce, *Lactuca sativa L.* and 10 celery, *Apium graveolens* were evaluated for yield and pest incidence in February, March, June and November 1999 and January/February, August and October 2000.

Each cultivar was planted in 1 x 3 m raised beds distributed in RCBD with 3 replications. Seeds were sown 15 cm between rows with 95 plant population per three meters. A tunnel type rainshelter was installed in all croppings, from sowing to harvesting made up of 32 mesh net suspended in ¼ inch plain round iron bar. The net was lifted in the morning to release flying insects and brought down at noon to prevent intense sunlight. The beds were applied with organic fertilizer at the rate of 10 t/ha and 90-20-20 NPK inorganic fertilizer applied as basal. Supplemental application of 19-19-19 foliar spray was made at 10 and 20 days from sowing at the rate of 1 T/gal. of water. Data were collected from inner row plants within 2 m^2 area.

Data collected were yield, horticultural characteristics and observations on pests and insect damage.

Varied technologies for leafy vegetable production were adopted utilizing pechay, Black Behi variety as the test crop. Farmer's practice obtained from personal communication and secondary data were compared to recommended technologies.

Thirty (30) beds, 1 x 5 m were prepared which represented five (5) farmers practices, five (5) recommended and three (3) replications.

Planting was done March 8 and harvested April 10, 2001. Farmer's practices included (1) broadcasting 4 kg per hectare seeds; (2) application of 300 sacks compost (chicken dung and rice hull) fertilizing one bag ammonium sulfate as basal and 2 bags urea as top dressing at 7-10 and 20 days after seeding; (3) flat bed; (4) without net shelter; and (5) continuous chemical spraying without monitoring. Recommended technologies were: (1) line sowing, 2.6 kgs/ha; (2) application of rice straw compost, (200 sacks/ha), 3 bags Triple 14 fertilizer as basal and twice foliar spray of liquid fertilizer (19-19-19 + ME) at 10 and 20 days after seeding at the rate of 3 T/16 li of water; (3) raised beds (20-30 cm high); (4) installation of tunnel type net structure; and (5) monitoring of pests before pesticide spray.

Yield data was taken from 10 sample plants from 1 m^2. Incidence of pests was monitored from 5 m^2 area.

Tomatoes:

Eight (8) fresh market tomatoes composed of three (3) salad types, three (3) cherry and two (2) determinate fresh market varieties were grafted with eggplant variety EG-203 from August 1998 to October 1999. Number of seedlings that survived were recorded.

Grafting procedures:

Eggplant seeds are sown in potlets five to seven days ahead of tomatoes. Seedlings are raised in tunnel type net shelter to prevent white flies. Seedlings are grafted when stem diameters are 1.6-1.8 mm or when the third true leaves appeared. Rootstock is cut between the cotyledon and the first true leaf at 30□□ angle. One 1 cm long rubber tubing is inserted onto the stock. Scion is cut below cotyledon at 30□□ angle and inserted into the tube. Grafted seedlings are placed in a humidity chamber for four days after which seedlings are placed in a cool dry place for two days. Seedlings are hardened for five days and are ready for transplanting.

FMTT-22, a salad type tomato was planted in soil-less culture

in September 1998. CHT-261, an AVRDC Cherry tomato was planted in hydroponic greenhouse conditions and in the open field, with and without rain shelter in September 1998. In hydroponic, seedlings were set at 50 cm between rows and 30 cm between hills, following the Israel technologies of soil-less culture. In the open fields, seedlings were transplanted in raised beds, 1 x 5 m with 24 plants per bed. A 2 m high tunnel type rainshelter with 32 mesh net was installed in protected plots. All beds were provided with trellises and rice straw mulch.

Grafted and non-grafted seedlings of 8 tomato varieties were set in a 2 factor experiment where grafted/non-grafted planting materials were the main plot and the variety as sub-plot. The varieties were distributed in RCBD with three replications. Transplanting was done on December 22, 1998 following the standard procedure in variety trial.

A three (3) factor experiment where with and without rainshelter was assigned as main plot, grafted and non-grafted planting materials as sub-plot and variety as sub-sub-plot was conducted, transplanted July 14, 1999. Protected plants were provided with simple net structure of 32 mesh. Apollo and FMTT 586 were used.

Three tomato varieties, FMTT-22, CHT 261 and CL 143 were transplanted on July 14, 1999 in raised beds 1 x 5 m, under net structure. The indeterminates were provided with trellis, mulched with rice straw and pruned to 3 branches per plant. Tomatotone, a fruit set hormone was used at the rate of 20 ml tomatotone per liter of water with a hand sprayer. Spraying is done when 3-5 flowers have opened, in sunny mornings. Spraying is directed to the flower cluster. Each cluster is sprayed only once. The varieties were distributed with three replications. Data were collected from 10 sample plants of each cultivar.

Recommended technologies for off-season production of tomatoes were adopted on station, transplanted August 11, 2000. Three fresh market tomatoes, FMTT-586, CLN1466 A and BPI-Tm 9 (CL 143) were assigned as the main plot and use of grafted and non-grafted seedlings as sub-plots in a 2-factor experiment.

A protective net structure of 32 mesh net, 10 m wide, 20 m long and 2.4 m high was installed in the field after 18 plots, 1 m wide, 5 m long and 25-30 cm high were made.

The experiment was laid in split-plot design with 3 replications. The plots were applied with compost, (1 kg/m). Drip irrigation facilities were installed on each bed prior to the application of polyethelene mulch. Tomatotone was applied at 7-10 days interval in all plots. At early fruiting the plants were sprayed with diazinon insecticide followed by weekly releases of *Trichogramma chilonis* at the rate of 1 card/5 m^2 to check fruit worms.

Harvesting was done by pruning at green ripe stage. There were 8 times pruning from October 4 to November 6, 2000.

The combined effects used were evaluated from percent fruit setting, marketable yield and pest and disease incidence. Data were taken from 10 plants/plot.

RESULTS AND DISCUSSIONS

Leafy Vegetables

Sixty (60) cultivars of six (6) leafy vegetables were planted in three (3) different environments. In environment 1, the plots were mulched with two (2) inches neem leaves. In environment 2, the plots were mulched with neem leaves and covered with 32 mesh net suspended by iron rods formed in low tunnels. Environment 3, the plots were mulched with rice straw and provided with 32 mesh net tunnels. The net was lifted in sunny mornings to release trapped insects and brought down at noon to reduce strong light intensity. Net also disperse strong raindrops in case of rain. In Table 1, the results showed that except for kangkong, the leafy vegetables gave highest yield in environment 1.

The pest population in the brassicas was observed to be very minimal, unlike during the dry season. Since Kangkong is not a host of

diamond back moth and cabbage web worm, it can produce good yield in open conditions.

Low yield of vegetables with net structure compared to open field conditions was due to heat build-up and reduced light intensity.

In general, high yield levels of all vegetables in the trial was due to over maturity. Data gathering from 20 sample plants per cultivar delayed harvesting at the right stage.

During the field evaluations in 1999 and 2000, the cultivars were planted following the prescribed procedure of Asian Vegetable Research and Development Center (AVRDC), like planting in raised beds, providing net structures right fertilization and minimal use of pesticides.

In 1999, the leafy cultivars performed well in February, March and June croppings, (Table 2). There seems to be a trend that the yield is getting low towards the fourth quarter of the year (Table 3) because of high rainfall.

The leafy vegetables, similar to other food crops prefer the cool-dry season for maximum production. However, low yield levels obtained was due to heavy pressures of pests during the dry season, Table 4. Highest incidence of leaf miner and striped flea beetle were observed in March cropping while crops grown in June had the highest percentage of insect damage. These were partly minimized with the application of net structures. But the effect of nettings on insect damage and/or yield is dependent on the efficiency of the net installation. The efficiency is reduced when the nets do not properly enclose the bed allowing entrance of pests.

The November 1999 and October 2000 croppings had very low yield because of too much rainfall. These results are in conformity with the macro-level studies on seasonality in vegetable prices. It was shown that vegetable price indices were generally low in March to May and

high from September to December, reflecting great demand relative to supply (Librero, A.R. and A.C. Rola, 2000).

Varied off-season technologies for pechay production were compared to the traditional farmers' practice. Yield comparisons, (table 5) shows that there was a slight increase in yield in line sowing against broadcasting and so with the raised beds against flat bed. Since the trial was made during the dry season, the impact of strong rain was not seen in flat bed and broadcasting of seeds. Highest increase in yield (47.5%) was observed in plots treated with rice straw compost, triple 14 basal fertilizer and twice foliar sprays. This was attributed to high plant density of 176 plants/m^2 against 132 plants/m^2 of farmers practice of fertilizer application.

The application of net shelter gave 34.6% increase in yield against no net, because of the very minimal (less than 1%) pest incidence in plots with net. Plots without net had 2.3 and 4.3% incidence of leaf miner and striped flea beetles, respectively.

Monitored plots with 5 and 3.3% incidence of striped flea beetle and leaf miner, respectively were sprayed with carbaryl insecticide at planting time and at 14 days after seeding (DAS). Not monitored plots were sprayed with carbaryl at 14 and 18 DAS, Xentari at 22, 26 and 29 DAS and Sherpa at 33 and 36 DAS.

Pests observed were striped flea beetle, leaf miner and adult DBM. With 7 times spraying in not monitored plots, the pests surely developed resistance against the pesticide used. Monitored plots had 22.6% increase in yield.

Tomato

Grafting was conducted following the prescribed procedure of AVRDC in 8 tomato varieties. Done from August 1998 to October 1999. The number of grafted seedlings and those that survived were recorded. Percent survival by cultivars is in table 6. Low range of survival was

observed during the earlier period of grafting. However the rate of survival increased when the skill on grafting was developed. Although survival was influenced more by environment, grafting skill contributed to high survival rates.

Grafted materials were planted in different environments to compare the yields of grafted and non-grafted tomato varieties.

FMTT-22, a fresh market indeterminate tomato was planted in hydroponic greenhouse, grown in soil-less medium. In contrast with non-grafted FMTT-22, the grafted plants exhibited delayed maturity, shorter plants, higher yield per plant, bigger fruits and longer harvesting period, table 7. Flowering, fruit setting and maturity are hindered by the grafting operation which take 4-7 days after the wound created by cutting is healed. Longer harvesting period for grafted plants resulted when the plants are not infected with soil-borne disease or bacterial wilt, which is the main reason for grafting. However, with this experiment, infection of bacterial wilt was observed to be attributed to the presence of wilt organisms on the soil-less medium. The differences on the rate of infection between the grafted and non-grafted plants was due to the bacterial wilt resistance of the EG-203 eggplant stock.

Grafted and non-grafted planting materials of CHT-261, a cherry tomato were planted in soil-less hydroponic and open field with rainshelter and without. Non-grafted CHT-261 in hydroponics produced a mean fruit weight of 780 gms/plant over a period of 113 days, whereas non-grafted plants in the open produced 46 g/plant over 55 day, table 8. The incidence of bacterial wilt among plants in hydroponics exceeded 80% yet yield was relatively high and this was due to regular spraying of the fruit-set hormone, beta naphtoxy-acetic acid. In the open field, the rain shelter contributed to the better yield (222 g/plant) of CHT-261. The high incidence of pests and diseases in the open field with and without rainshelters and lack of heat tolerance of the variety explained for the low yields.

The yield performance of 8 tomato varieties significantly varied when grafted and non-grafted seedlings were used, table 9. Grafted plants

of six out of 8 varieties gave better yields than the non-grafted. However, yield differences produced from grafted and non-grafted plants of all varieties were insignificant. Since the trial was conducted during the cool-dry season, suitable production environment existed. The effect on yield on grafted tomatoes is more remarkable when there is water-logged conditions and high infection of bacterial wilt and root knot nematodes.

Apollo, a local variety, and FMTT-586, a fresh market salad type were evaluated for yield in open field and under net structure by using grafted and not grafted planting materials.FMTT-586 significantly outyielded Apollo across environment. With rainshelter, yield advantage was 17%, table 10. Under rainshelter, grafted plants of both varieties outyielded the non-grafted, while in the open, the non-grafted plots gave better yield than the grafted. This was due to improper crop management where grafted tomatoes were left lying on the ground after the trellis were blown down by wind and rain. When adventitious roots from the scion tomatoes reach the soil, the roots acquire bacterial wilt organisms. Low yield of Apollo and FMTT-586 grown without rainshelter was due to high infection of bacterial wilt.

Another technology to increase off-season yield of tomato were tried in three (3) cultivars FMTT-22, a salad type, CL-143 a determinate fresh market and CHT-261, a cherry tomato. Grown under protected structure, the three (3) tomato cultivars gave better yield when sprayed with Tomatotone, but differences were insignificant, Table 11. The hormone sprays, done twice, did not have positive effect on increasing the yield as shown by high yield levels of the unsprayed plots. Moreover, mulching, pruning and trellising helped the plants to attain better yield despite the incidence of leaf miner, TMV and BW. Hormone spray is made at sunny mornings at 7-10 days interval. The unfavorable weather conditions prevented further spraying on this experiment.

Yield of FMTT-586, CLN 1466A and BPI-Tm9 significantly varied under protected structure, Table 12. Highest yield of BPI-Tm9 was comparable to FMTT-586 and significantly different to CLN-1466A. Among the varieties, grafted plants of BPI-Tm9 gave significantly higher

yield than the non-grafted. BPI-Tm9 a small fruited determinate type may have increased its yield to some degree because of the application of fruit set hormone. Low yield of CLN-1466A was due to lack of heat tolerance, less effective hormone spray and high incidence of virus and bacterial wilt infections.

Economic Benefits

Based on field experiments under BPI-LBNCRDC conditions, cost of production for pechay and tomatoes were analyzed. In Appendix I, cost of pechay production in 1,000 sq.m. amounted to P7,721.60. With potential yield of 2 kgs/m^2 and farm gate price of P10.00 net returns was P12,278.40 with 159% ROI. By using grafted tomato in 10 beds, 1 m wide, 10 m long, cost of production was P4,744.77. With potential yield of 1.2 kg/plant, net returns was estimated at P2,455.23 and 52% ROI, Appendix II. Actual cost of grafted seedlings is P3.30 per price, Appendix III.

CONCLUSION AND RECOMMENDATION

Vegetables are produced year-round with great quantities during the cool-dry season. At off-season, supply is limited because of unfavorable weather conditions. Technologies to alleviate environmental stresses were generated to stabilize supply of safe and nutritious vegetables. The technologies included the use of heat tolerant varieties, net structure and proper crop and pest management. Adopting the recommended technologies, leafy vegetable and tomato cultivars were identified to perform well at local conditions. Pechay, mustard and kangkong are most popular and commonly used among the leafy vegetable species evaluated. However, there is a need to popularize the consumption of choy-sum, chinese kale and non-heading chinese cabbage. Nutrition wise, chinese kale has the most vitamin C and Beta-carotene content among the leafys.

BPI-Tm9, a fresh market determinate variety increased its yield by 26% when grafted materials were used. Planted inside a net shelter,

the plants were provided with trellis and mulch and sprayed with fruit set hormone.

Pechay line sown in raised beds, with right fertilizer application and provided with net structure produced 47% more yield than the farmers' practice.

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Table 1. Summary of yield (t/ha) of leafy greens under different environments, 1998 [1/]

Crop	Environment I	II	III	Average
15 Choysum	30.33	25.53	27.00	27.62
10 Chinese kale	18.20	13.10	10.70	14.00
15 Pak-choi	27.73	18.60	19.07	21.80
10 Non-heading Chinese Cabbage	25.20	16.20	13.80	18.40
5 Indian mustard	20.80	13.00	17.20	17.00
5 Kangkong	33.20	30.80	35.00	33.00
Average	**25.91**	**19.54**	**20.46**	

[1/] Transplanted October 5-6, 1998

Table 2. Summary of yield (t/ha) of leafy vegetables, 1999

Crop	Month February	March	June	November	Average
15 Choysum	18.6	14.7	13.0	6.4	13.2
10 Chinese kale	6.3	5.8	8.9	6.7	6.9
15 Pak-choi	14.2	11.9	11.4	9.9	11.8
10 Non-heading Chinese cabbage	14.1	11.9	17.0	7.2	12.5
5 Indian mustard	10.9	15.6	13.8	4.3	11.1
5 Kangkong	22.8	28.5	26.9	8.4	21.6
10 Lettuce	17.7[1/]	5.7	14.1	14.5	13.0
10 Celery	5.7[2/]	--	5.5	4.5	5.2
Average	**13.8**	**13.4**	**13.8**	**7.7**	

[1/] Planted December 1998

[2/] Low germination

Table 3. Summary of yield (t/ha) of leafy vegetables, 2000

Crop	Month			
	January/ February	August	October	Average
15 Choysum	17.2	11.1	2.1	10.1
10 Chinese kale	4.6	10.3	2.0	5.6
15 Pak-choi	23.8	8.2	9.0	13.7
10 Non-heading Chinese cabbage	13.0	5.5	12.3	10.3
5 Indian mustard	5.9	12.2	9.8	9.3
5 Kangkong	17.4	10.9	9.2	12.5
10 Lettuce	18.7	13.0	6.8	12.8
Average	**14.4**	**10.2**	**7.3**	

Table 4. Percent incidence of pest and insect damage, 1999

Cropping	Leaf miner	Striped Flea Beetle	Insect Damage
February	1.87	1.8	2.12
March	3.6	2.7	2.14
June	2.25	2.55	2.57
November	1.67	2.03	2.0

1 - 0 %
2 - < 20 %
3 - 21-60 %
4 - 61-80 %
5 - 81-100 %

Table 5. Yield (kg/m^2) comparison of various technologies [1/]

Practice		Yield kg/m^2	%Increase
Recommended	Farmers'		
Line sowing		2.3	3.2
	Broadcasting	2.1	
Compost + Complete fertilizer + Foliar spray		2.25	47.5
	Compost + Urea	1.8	
Raised beds		1.7	5.9
	Flat bed	1.6	
With shelter		1.3	34.6
	Without shelter	.85	
Monitoring		1.55	22.6
	Without monitoring	1.2	

[1/]Means of 3 replications

Table 6. Percent survival (%) by cultivar grafted onto EG 203 rootstock

Cultivar	August-November 1998	December-October 1999
Apollo	13-95	89-100
FMTT-22	45-95	93-100
FMTT-586	47-97	78-83
FMTT-589	40-100	87-100
CHT-437	57-98	87
CHT-261	95	86-100
CHT-264	67-98	83-100
CL-143	100	87-100
Total grafted	**1132**	**1365**

Table 7. Performance of grafted and non-grafted FMTT-22 tomato grown in hydroponics

	Grafted	Non-Grafted
Date transplanted	09-03-98	09-03-98
Population	86	23
Population after 12-01-98	66	16
Number of days to flower	34	27
Number of days to fruit set	43	41
Number of days to first harvest	70	56

Average plant height (cm) (10 WAT)	175	190
Yield (kg)	80.21	6.90
Average yield per plant (kg)	1.2	0.43
Average fruit weight (gm)	125	121
% infection by bacterial wilt	23.3	28.2
Harvesting period (days)	50	41
Number of harvesting	11	9

Table 8. Performance of CHT-261 in hydroponics and open-field conditions

	Hydroponics non-grafted	Rainshelter grafted	Open field non-grafted
Date transplanted	09-03-98	09-16-98	09-04-98
Population	34	48	48
No. of days to			
Flower	18	26	25
Fruit set	36	40	30
First harvest	61	64	49
Last harvest	113	83	55
No. of harvests	7	5	2
Yield (kg)	26.6	10.7	2.3
Ave. yield/plant (gm)	780	222	46
Pest and disease rating[1]			
insect damage		5	5
leaf spot/blight		5	5
virus complex			3
leaf miner		3.3	5
aphids			4
Epilachna beetle			4
bacterial wilt	5		

[1]Ratings from 1 to 5 where: 1 = less than 20% damage
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = greater than 80%

Table 9. Mean yield (t/ha) of 8 tomato grafted and non-grafted planting materials[1/]

Variety	Grafted	Non-grafted	Variety mean
1. Apollo	29.4 cd	15.9 d	22.6
2. CL-143	31.2 b-d	29.4 cd	30.3
3. FMTT-22	46.2 ab	36.6 a-c	41.4
4. FMTT-586	24.7 cd	28.5 cd	26.6
5. FMTT-589	29.6 cd	30.0 cd	29.8
6. CHT-261	48.2 a	40.8 a-c	44.5
7. CHT-264	36.6 a-c	40.6 a-c	38.6
8. CHT-437	33.6 a-c	35.2 a-c	34.4
Grafted/Non-grafted Mean	34.9*	32.1*	
Variety mean			33.5[ns]
CV (%)			24.03

[1/]Transplanted December 22, 1998; harvested 12 x from February 9 to March 23, 1999
* Significant at 5% level
[ns] not significant

Table 10. Yield of 2 tomato varieties as affected by rainshelter and grafting[1/]

Variety	Rainshelter		Open		Mean
	Grafted	Non-grafted	Grafted	Non-grafted	
Apollo	3.4 b	3.0 b	3.0 b	4.3 b	3.4
FMTT-586	12.6 a	10.2 a	6.0 b	10.8 a	9.9
Mean: Variety					6.6*
Rainshelter					7.3
Open					6.0
Grafted					6.2
Non-grafted					7.0
CV (%)					23.95

[1/]Transplanted July 14; harvested 5 x from September 17 to October 11, 1999

Table 11. Effect of Tomatotone on yields of 3 tomato cultivars grown under protected structure[1/]

	Yield[2/]		Pest and disease rating[3/]		
Cultivars	w/ spray	w/o spray	Leaf miner	TMV	BW
FMTT-22	13.4	10.7	2	2	1.3
CL 143	13.4	12.4	2	2	1.7
CHT 261	17.1	15.1	2	2	2.0
Grand mean	14.6	12.7	2	2	1.7
CV (%)	27.95	30.6	0	0	24.5

[1/]Transplanted July 14, 1999; harvested 6 x from September to October 4, 1999.
[2/]Data were means of 3 replications
[3/]Rating scheme: 1 = no infection
2 = less than 20%
3 = 21-60%
4 = 61-80%
5 = 81-100%

Table 12. Yield of tomato varieties as affected by using grafted and non-grafted seedlings[1/]

	Yield t/ha		
Variety	Grafted	Non-grafted	Mean
FMTT-586	11 b	9.3 bc	10.15 a
CLN-1466A	4.9 c	5.0 c	4.9 b
BPI-Tm9	14.4 a	10.7 bc	12.5 a
Grand mean	10.1	8.3	9.18
CV (%)			

[1/]Transplanted August 11, 2000

Appendix I

Cost of Pechay Production (1,000 m²)

Labor[1/]	
Land preparation (1 M/A day)	250.00
Bed formation (4.0 M-day)	720.00
Line sowing (1.25 M-day)	225.00
Applic. Fertilizers (1.5 MD)	270.00
Watering (1.0 MD)	180.00
Spraying (.5 MD)	90.00
Weeding (5.0 MD)	900.00
Netting (2.0 MD)	360.00
Harvesting (1.0 MD)	180.00
Sub-total	3,175.00
Materials	
Seeds - (420 kg x 550/kg)	231.00
Compost - (20 kgs x 100/bag)	2,000.00
Fertilizer - 14-14-14 15 kgs x 430/bag (50 k)	129.00
20-0-0 33 kgs x 260/bag (50 k)	171.60
Foliar - 19-19-19 - 1 kg	115.00
Sevin - 1 kg	580.00
Net[2/] - 1,000 m/11 rolls x 1,200/roll = 13,200/10	
1,320.000	
Sub-total	4,546.60
Total	**7,721.60**

[1/]Labor cost 250/Man-animal day
180/Man-day

[2/]can be used for 10 times

Cost and Return Analysis

Potential Yield (kgs)	2,000.00
Farm gate price (P)	10.00
Gross income (P)	20,000.00
Cost of Production	
a. Labor - 3,175.00	
b. Materials - 4,546.60	
Total Cost (P)	7,721.60
Net returns (P)	12,278.40
ROI (%)	159.00
Breakeven yield (kgs)	772.16
Breakeven price (P)	3.86

Appendix II

Grafted Tomatoes with Rainshelters (10 beds, 1 m wide, 10 m long or 100 m²)

Activities	**Value (P)**
I. Labor	
1. Land preparation (10 beds) 1 ½ MD x 150/day	225.00
2. Application of plastic mulch - ½ MD	75.00
3. Installation of net, 3 MD	450.00
4. Transplanting - ½ MD	75.00
5. Side dressing of fertilizer (2x) - ½ MD	75.00
6. Trellising - 1 MD	150.00
7. Harvesting (4x) - 2 MD	300.00
Sub-total	1,350.00

II. Materials	
300 pcs. Grafted Seedlings - 3.30/pc.	990.00
100 m plastic mulch - 5.65/m	562.50
Net Structure	372.00
51 m x 10 beds = 510 m at 10/m - 5,100.00	
4 rods x 24 ft. x 10 = 40 pcs. at 12/pc.- 480.0/15 uses	
¼ kg wire (finest gauge)	30.00
Plastic straw	50.00
Organic Fertilizer (chicken manure) 20 sacks x 20/sack	400.00
Inorganic Fertilizer 14-14-14 (5.58 kg) - 9/kg	50.22
0-20-0 (3.9 kg) - 5.5/kg	21.45
Tomatotone	600.00
Trichocards	100.00
Pesticides	
100 grams Lannate at 510/500 gms	102.00
200 gms Sevin	116.60
Sub-total	3,394.77
Total Cost of Production	**4,744.77**

Cost and Return Analysis

Potential Yield (kgs)	360.00
Farm gate price (P)	20.00
Gross income	7,200.00
Cost of production	
a. Labor - 1,350.00	
b. Materials - 3,394.77	
Total Cost (P)	4,744.77
Net returns (P)	2,455.23
Return on investment (%)	52.00
Breakeven yield (kgs)	237.40
Breakeven price	13.20

Appendix III

Production Cost of Grafted Tomato Seedlings (1000 seedlings)

Seedling Production

I. Labor Cost (tomato & eggplant)

- Hauling of soil media (1/4 MD x P150.00)	37.50
- Potting in plastic potlets (3" x 4") (2000 pcs x .05/pc)	100.00
- Sowing of seeds (1/2 MD x P150.00)	75.00
- Care of seedlings (1 MD x P150.00) (pricking, watering, spraying & fertilization)	150.00
- Grafting (140 pcs/day at P380.00/day) P2.70/pc for 1,000 grafted tomato	2,700.00
Total Labor Cost	**3,022.50**

II. Material Cost (seeds)

- eggplant (1.50 x 10 gms)	15.00
- tomato (F_1) 70,000/kg x 4 gms	280.00
- 5 bags garden soil (P5.00/bag)	25.00
- 2 bags hog manure (P11.00/bag)	22.00
- 2 bags burnt rice hull (P14.00/bag)	28.00
- 2 bags composted soil dust (P25.00/bag)	50.00
- 1 can Peter solution (starter) 100 gm at P175.00	17.50
- 1 kg Crop Giant (19-19-19 + M.E.) 100 gms at P115.00	11.50
Total Material Cost	**449.00**
Total Production Cost	**P3,471.50**

DESIGN AND DEVELOPMENT OF MANGO PICKER

By

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ABSTRACT

Mango is one of the leading export agricultural products of the Philippines. Bruised mango which is usually caused by the improper handling and harvesting may not qualify in the export market. Harvesting mango is one of the major difficult operations in the mango industry because of the height and profile of the mango tree.

Existing mango picker in the Philippines, which is locally known as ***"Sigpao"*** is usually seen in the provinces of Batangas, Rizal, and Pangasinan - the mango growing areas of the country. Based from the results of field tests of the three (3) "***Sigpao"***models, it showed that Batangas model has an average picking time of 3.58 minutes/kaing with an average of 13.7 kgs. of mangoes. Rizal and Pangasinan models showed slightly longer picking time with an average of 4.34 minutes/ kaing of 13.24 kgs. and 5.38 minutes/kaing of 12.8 kgs., respectively.

Picking losses of the three (3) models were recorded. Rizal model showed the highest losses with an average of 3% considered as fallen mangoes during picking.

The two (2) BPI designs called BPI "***Sigpao***" Models I & II have the advantage over the existing "***Sigpao"*** models. These are on the aspect of convenience in terms of height factor of the mango tree since these models have an extended aluminum handle especially when harvesting under the tree. The picking time recorded for Model I & II is 3.20 minutes/kaing & 2.32 minutes/kaing, respectively. Model I has 2.67 % losses while Model II has no losses while conducting the field trial testing.

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