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FRUIT CULTIVATION

I. GENERAL INTRODUCTION

by

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On the recommendation of the Eleventh South Pacific Conference (1971), the South Pacific Commission, at its Thirty-fourth Session, made provision in its 1972 Budget for a Technical Meeting on Tropical Fruits (except bananas). At the kind invitation of the Cook Islands Government, the meeting was held in Rarotonga from 30th October to 7th November 1972, having been postponed for 2 days following flight cancellations due to the damage caused by hurricane "Bebe" in Nadi Airport.

Six South Pacific countries and territories were represented by official delegations: American Samoa, the Cook Islands, Fiji, French Polynesia, Niue and Western Samoa. The meeting was fortunate to have the services, as consultants, of Mr S.W. Turpin, Principal Fruit Officer, Ministry of Agriculture, N.S.W., Australia and Mr Warren Yee, specialist in horticulture, College of Tropical Agriculture, University of Hawaï. Mr W.A. Fletcher, Citriculturist, Department of Agriculture, Auckland, New Zealand, and Mr B. Wallace, Field Supervisor, W. Greeg and Co. Ltd., Dunedin, New Zealand, also took an active part in the discussions and gave technical information regarding the production and processing of fresh fruits.

(718/73)

Many working papers had been prepared by consultants and territorial delegates. These were distributed and commented on during discussions, and were followed by recommendations on action to be taken to solve certain fruit production problems in the South Pacific.

The working papers prepared by specialists in French Polynesia had not reached SPC Headquarters, so that it was not possible to translate them or distribute them to participants. As the technical quality of the papers and the value of the information contained therein was fully recognized during the discussions, it was decided to publish them in a South Pacific Commission Information Circular.

We are happy to be able to submit for your perusal, with the agreement of the Conference chairman and the French Polynesia delegates, the following documents of which the technical importance to the development of fruit crops is undeniable:

1. The Hydroponic Cultivation of Citrus Plants in French Polynesia, by Ah Shi YAU, Head of the Section for the Development of Plant and Animal Production.

2. The Propagation of Citrus Plants by cuttings, with mist control by R. AKUI and J.L. REBOUL Agricultural Research Department.

3. The Testing of Mite-control Methods in Citrus Orchards by J.L. REBOUL, Agricultural Research Department.

4. Grafting of Avocado in the early stage, by the Agricultural Research Department.

5. Mango Grafting by R. MILLAUD, Head of the French Polynesia Department of Rural Economics.

May I take this opportunity to inform you that an agricultural extension handbook on "Citrus Cultivation in the South Pacific" is being prepared with the co-operation of consultants and delegates to the Conference on Tropical Fruits. Moreover, seeds of citrus rootstocks that seem particularly adapted to the ecological conditions of Pacific islands have already been introduced in certain territories. Productive fruit species and varieties of high commercial value will be introduced in due course.

Before I conclude, I would request you all to kindly send me the results of agricultural research undertaken in the various Pacific islands, which could be of particular value in the area. These will be collated and published in Information Circulars. Do please keep your presentation simple and precise, so that they may be easily read and accessible to all.

Thank you very much!

II. THE HYDROPONIC CULTIVATION OF CITRUS PLANTS IN FRENCH POLYNESIA

by

Ah Shi YAU
Head of the Section for the Development
of Plant and Animal Production

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1. INTRODUCTION

French Polynesia's economic boom has led to a considerable increase in the consumption of fruits, oranges in particular. Thus in 1970, about 900 tons of oranges were imported. In order to deal with this increase in consumption, and taking into account the high prices, Polynesian farmers took steps to cater to the Territory's needs.

As private nurseries were non-existent, the supply of grafted citrus plants was one of the major problems faced by farmers. The Department of Rural Economics, therefore, undertook the supply of plants to citrus growers.

Faced with a growing demand for seedlings, the Department of Rural Economics sought methods of rapid production, that did not involve too much land area.

From 1970, the production of seedlings on irrigated sand (hydroponic cultivation) was adopted. By this method, seedlings have been produced in less than 16 months, over an area five times smaller.

To facilitate planting and transport in the islands, the practice of growing seedlings in individual pots filled with river sand has been adopted.

2. PRODUCTION TECHNIQUES

(a) Equipment required and seedling production

Sowing bins

The sowing is effected in bins placed about 80 cm from the ground. These bins are filled with finely-sifted river sand up to a depth of 20 cm. The granulation of this sand, which is of basaltic origin, is between 200 and 800 mμ.

The bins are placed at about 80 cm above the ground, so as to keep off snails, slugs and other predators. They are protected against heavy rain by a shelter covered with a plastic sheet 150 microns thick. Sour orange seeds, washed and dried in the shade, are sown in rows 8 to 10 cm long, 3 to 4 cm apart and 2 cm deep. Immediately after the sowing, a screen is erected through which 50% of light filters. This screen is removed a week after emergence of the young shoots. The bins are watered twice a day with a solution containing 2 g/litre of soluble fertilizer, the formula of which remains constant till the seedlings are delivered. When the weather is very hot and dry, watering is often carried out for a third time, at noon, using pure water.

The sowing bins must be regularly disinfected with formol after each sowing - i.e. every four months - a solution containing 2% of pure formol being used. When this is done, all the outlets of the bins are plugged up. The bin is now seeped in the formol solution for 48 hours. After 48 hours, the solution is drained out and the sand is turned up to facilitate the evaporation of formol. The bin is then exposed to sunlight for 1 or 2 days. It is swilled thoroughly till the formol smell has gone completely. The bin is now ready for re-sowing.

Sowing time

Sowing may be carried out at any time of the year. Best results, however, are obtained in March. Up to now, it has not been found necessary to disinfect the seeds.

(b) Planting the seedlings

When the seedlings are 25 cm high, they are transplanted in black plastic pots 200 microns thick and measuring 400 mm x 400 mm, with 40 holes, each 6 mm in diameter. These pots are filled with unsorted river-bed gravel, after the larger stones have been removed.

(c) Fertilization

The following mixture is broadcast on the soil:

- Potassium nitrate No3K (13%N, 44% K20)	42.5 kg
- Ammonium sulphate So4 (NH4)2 (20, 5%N)	19.5 "
- Calcium sulphate SO4 Ca 2H20 (22% Cao)	10.0 "
- Triple superphosphate CaH4 (Po4)2 2H20 (45% P205+17% Cao)	23.5 "
- Magnesium sulphate So4 MG, 7H20	16.5 "

To the above is added 140 g of the following mixture of trace-elements :

- Zinc sulphate	10.8 g
- Manganese sulphate	44.8 "
- Sodium borate	38.2 "
- Copper sulphate	10.8 "
- Iron sulphate	35.4 "

Fertilization is begun on the third day. Once a week, 4 to 5 g per pot of the mixture specified above are cast by hand.

After a month, the dose is increased to 100 g per 15 pots until such time as seedlings are distributed to farmers.

Meanwhile, the salinity of the substratum must be regularly measured. This should not exceed 1.4 g of salt per litre of soil.

In case the salinity is excessive, the substratum has to be leached.

Pest and Disease control

During the period of vegetative growth, the plants are thoroughly treated once a month with a mixture of oil-parathion and zineb or propineb.

Seedlings are raised for about three or four months.

(d) Grafting

Grafting is effected on sour orange seedlings (*Citrus aurantium*) when the main stem is pencil-thick, i.e. approximately 6 months after transplanting.

Prior to this operation, the leaves should be removed up to a height of 30 cm. All lateral buds must also be removed.

Selection of scions

From parent plants that have been declared healthy, small branches are cut that are generally one or two years old. Those selected must be fruit-bearing, healthy and vigorous.

The scions are dipped for 10 seconds in a 1/10,000 solution of oxyquinolein sulphate, for disinfection purposes.

Grafting

The shield - or eye - budding method is used. A T-shaped cut is made in the bark of the rootstock at a height of between 20 and 30 cm above the soil. The scion is removed with a clean stroke of the grafting knife. Care should be taken not to cut off any wood along with the scion.

The scion is then inserted into the T cut and firmly held in place with a "vitagreff OSV 30" binder.

Training the grafts

About a fortnight after grafting, the binding is removed to check that the bud is well started. When grafting has been successful, the top of the nurse-plant is cut off about ten days later, a claw being left however, bearing two buds. This claw acts as a support for the newly-grafted plant, drawing up the sap that is essential for its development.

When the graft is about 30 cm high, the claw is cut off and seedling is staked. Next, in a regular manner, all the buds are removed from the rootstock. If several branches occur at the same time on the graft, these must be nipped off so that the main stem remains sturdy.

(e) Pruning for shape

Young trees are generally distributed after an initial pruning. The top is cut back at 90 cm above the ground when the seedling is 1.2 m high. All budds are then removed up to a height of 60 cm. Between this point and the 90 cm level, four limbs are selected, at different levels, growing in four directions. Further pruning for shape is carried by the grower.

(f) Results

Nursery trees reach suitable size for distribution about two years after sowing, i.e. fourteen months after grafting, which takes place when stock is ten months old. As compared to this, seedlings raised in the open can only be distributed to growers after three or three and a half years. The scion-take rate is of the order of 80%. As seedlings have been raised in individual pots, planting in the orchard presents no hazard; mortality is nil and there is a rapid initiation of vegetative growth. In fact, this is practically uninterrupted, whereas in the case of seedling transplanted with their roots exposed, vegetative growth does not begin for practically one year, with a loss meanwhile of about 30%.

APPENDIX

MIXTURE FOR SOLUBLE FERTILIZER USED IN HYDROPONIC CULTIVATION

HAUREZ FORMULA

Potassium nitrate	:	42.500 kg
Ammonium sulphate	:	19.500 "
Calcium sulphate	:	10 "
Triple superphosphate	:	23.500 "
Magnesium sulphate	:	16.50 "

To the above is added 140 g of the following mixture of trace-elements :

Zinc sulphate	:	10.8 g
Manganese sulphate	:	44.8 "
Sodium borate	:	38.2 "
Copper sulphate	:	10.8 "
Iron sulphate	:	35.4 "

III. PRODUCTION OF LEMON-TREE SEEDLINGS BY CUTTINGS UNDER MIST CONTROL

by

R. AKUI and J.L. REBOUL
Agricultural Research Section

In view of the considerable demand for plants and the lack of space available at the Pirae Station, tests were carried out in 1970 to produce citrus plants by cuttings under mist control, using rooting hormones.

The technique proved to be very profitable with thornless lemon-tree plants.

Tests with Pomeloes are still going on.

1. EQUIPMENT

This type of "cutting" technique requires a specially-built shelter with an automatic sprinkler system, which ensures that the cuttings remain moist all the time. The cuttings are placed in boxes, beneath the sprinkler nozzle.

(a) The shed

This is a wire-mesh shed with a roof of corrugated glass or transparent plastic plates.

(b) Sprinkler system

This has a mist blowing electronic device ("Aquatron" of Northern Electronics Limited) with nozzles placed at regular intervals on a spray rod. When the ambient humidity tends to drop, a sensitive hygrometer puts the sprinklers on.

(c) Substratum

The cuttings to be planted are placed in a neutral medium made up of perlite contained in fibro-cement boxes arranged under the spray rod.

2. TECHNIQUES USED

(a) Selection and preparation of cuttings

- Slender terminal shoots with four to six leaves are selected.
- Immediately after removal from the tree, the cuttings are placed in a polythene bag containing a wad of cotton-wool soaked in water. They should be kept in the shade.
- At the time of grafting, the leaves are split in halves with a grafting-knife and the base of each cutting is freshly cut off. The grafting-knife is again used to make three incisions at the base of the cutting and to remove the terminal bud.

(b) Hormone treatment

The slightly-moist grafts are dipped to a depth of 2 cm in Exuberone powder. Any excess of powder is shaken off.

3. RESULTS

Tests undertaken by the Agricultural Research Section produced the following results :

- on an average, 25 days after planting, the percentage of rooting of thornless lemon-tree cuttings was as follows:

  - 80% with Exuberone P
  - 96% with Exuberone W.

Exuberone W is routinely used at the Pirae Station Nursery. Rooting is excellent, and the resulting seedlings reach planting size (80 cm to 1 m) in 12 to 15 months.

IV. MITE-CONTROL TRIALS IN CITRUS ORCHARDS

by

J.L. REBOUL
Agricultural Research Section

Attacks of the citrus rust mite (Phyllocotrupta oleivora), turn the fruit a russet colour, spoiling both their appearance and quality. (In some neglected plantations of "Kara" tangerines, the damage caused by this pest is so extensive that the fruit produced are dry, "mummified", full of warts and totally unfit for consumption).

In 1968, the Agricultural Research Section of the Department of Rural Economics carried out a series of trials with a view to protecting citrus plantations from the mite.

These trials were carried out on a private plantation of New Zealand citrus, spaced 6 m x 6 m, started in July 1965, belonging to Mr Timi HAPAITAHA, in PAPARA District, Tahiti.

Several treatments were compared on the basis of their mite-killing efficiency over a period of one year.

A different treatment was tried in each plot. Weekly observations were made on selected plants in each plot to assess the changes in the mite population as well as fruit damage.

The following notation system was used:

(a) Infestation:

0 = nil
1 = very slight
2 = slight
3 = average
4 = heavy
5 = very heavy.

(b) Fruit damage:

0 = 0 to 5 clearly visible brown spots - allowance made for 1 fine brown streak;

1 = more than half the fruit healthy - brown spots scattered over 1/8 of the fruit, or minute spots all over it;

2 = half the fruit healthy - larger spots (3 to 10 mm) over 1/8 to $\frac{1}{4}$ of the fruit;

3 = very large spots over 1/3 of the total surface;

4 = spots over more than a third of the total surface, large brown streaks all over the fruit;

5 = entire fruit affected.

1. 1968-1969

(a) Treatments

A comparison was made during that year between PHOSALONE (Zolone) and ZINEB (Dithane Z - 78) sprayed monthly from 25/10/1968 to 26/6/1969.

The plantation was divided into four blocks, each containing three six-tree plots:

- A plots = Phosalone
- B plots = Zineb
- C plots = Control

(b) Results

The following results were obtained from observations made on two trees per plot:

(i) Infestation: A - average = 1.57
B - average = 1.80
C - average = 3.74

Thus, Phosalone was found to be superior to Zineb (difference between 1.80 and 1.57 = 0.23 + least significant difference = 0.30).

(ii) Fruit damage:

A - average = 1.81
B - average = 2.01
C - average = 4.52

Here again, Phosalone was found to be superior to Zineb (difference between 2.01 and 1.81 = 0.20 + least significant difference = 0.30).

(c) Conclusions

Monthly treatment with PHOSALONE ensures better protection of citrus fruit against mite attack than ZINEB. However, control is not very satisfactory, since the pest is not completely eradicated and there are still some fruits with spots over 1/8 to $\frac{1}{4}$ of their surface.

2. 1969-1970

(a) Treatments

The object of the 1969-1970 trials was to determine the optimum frequency for PHOSALONE treatment (600 g/ha).

2 frequencies were tried:

A - Once in three weeks
B - Once in six weeks.

i.e. 2 plots per block, 4 replicates.

(b) Results

It appeared that spraying with PHOSALONE once in three weeks was more effective, though control was not complete (observations: infestation = 0.66 damage = 1.37).

3. 1970-1971

(a) Treatments

A comparison was made between
PHOSALONE (Zolone - 1.6 l/ha) = B plots; and
PROPINEB (Antracol - 2.0 kg/ha) = A plots,
with two different spraying frequencies:

- Once in three weeks = Blocks I and II
- Once in six weeks = Blocks III and IV.

(b) Results

- PROPINEB was found to be slightly more effective than PHOSALONE.

(observations: infestation = 0.33 as against 0.46
damage = 3.00 as against 3.81).

- Once in three weeks for PROPINEB treatment, was the frequency most effective.

(observations: infestation = 0.24 as against 0.42
damage = 2.21 as against 3.79).

(c) Conclusions

Treatment with PROPINEB (Antracol = 70% a.i.) 2.0 kg of Antracol being used per hectare, once in three weeks at an average, affords good protection to a citrus plantation against the rust mite "Phillocotrupta oleivora" (a spray of 1,000 l/ha solution).

4. 1971-1972

(a) Treatments

Comparison was made between the effectiveness of a monthly spraying of:

- PROPINEB (Antracol) = A plots; and
- CHLOROPROPYLATE (Gesakar 25) = B plots.

(b) Results

The results of observations made to determine the level of infestation between 28/9/1971 and 23/5/1972, were as follows:

- Chloropropylate: average = 0.28
- Propineb : average = 1.08.

The damage was not assessed as the fruits had been severely attacked by mealy bugs. Further, sooty black was present.

- It was found that, with a monthly treatment, Chloropropylate was far more effective than Propineb.

- No difference is observed if a comparison is made between the average efficiency of Chloropropylate treatment once a month, and that of Propineb sprayed once in three weeks. However, the following facts have to be taken into account: as the Chloropropylate sprayer was not in good working order, treatments carried out up to 29/12/1971 were not effective.

On the other hand, the average results recorded from 29/12/1971 to 23/5/1972 are found to be:

- Chloropropylate = 0.02
- Propineb = 1.09.

(c) Conclusions

Very good control of Phyllocotrupta oleivora in citrus plantations is achieved through a monthly treatment with CHLOROPROPYLATE (Gesakar 25) at a dose of 500 g of a.i. per 2,000 litres of water/ha.

However, considering the present price of Chloropropylate in French Polynesia, it is still preferable from the economic point of view to continue the use of Propineb for controlling this pest.

V. THE GRAFTING OF AVOCADO IN THE JUVENILE STAGE

by

the Agricultural Research Department

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1. ADVANTAGES

(a) Propagation of a good variety that do not come true to type when propagated by seed.

(b) Rapid growth, early bearing.

(c) Seedlings are less cumbersome and easy to handle.

2. PROCUREMENT AND PREPARATION OF ROOTSTOCKS

(a) Fresh seed stones, split lengthwise, are sown in plastic pots (or tin cans) containing light earth (or a sand-earth mixture).

(b) The seedlings can be worked twenty or thirty days later, when they reach a height of 25 to 30 cm. The less vigorous ones are discarded.

(c) The stem is disinfected with a solution of quinoline-oxide (sold commercially under the name of cryptonol) in a solution of 1/10,000, i.e. 1 packet of cryptonol to 10 litres of water. This solution is applied with a paint brush. A well-sharpened grafting knife is used to cut off the stem 5 cm above the kernel.

(d) A vertical cut, about 2 cm long, is made in the rootstock with a razor blade disinfected in 70° alcohol.

3. SELECTION AND PREPARATION OF SCION

(a) Scions are prepared from slender, terminal shoots of about 15 cm. Care should be taken not to expose them to sunlight and to place them in plastic bags when collected.

(b) Clip off one half of leaves.

(c) Wash in a disinfecting solution (cryptonol 1°/000).

(d) Thickness of scion and stock should be uniform.

(e) Cut end of the scion into a 7 cm long wedge. As the tip of the wedge is often too fine, it is advisable to cut it off so as to avoid decay.

4. GRAFTING OPERATION

(a) Insert the scion into the cut on the stock.

(b) Make sure that the growing areas of the stock and scion are well superimposed.

(c) Hold together with a needle (disinfected in spirit) then with an elastic band.

(d) Disinfect all the wounds with cryptonol solution.

5. AFTER-CARE OF THE GRAFTED SEEDLINGS

(a) To keep the shoot from drying up, place above the pot a plastic bag fastened with an elastic band.

(b) Place the pot for two hours in a vessel containing a little water.

(c) See that the grafted seedlings are not exposed to too much light (50% shade).

(d) When the callus has formed (10 to 12 days later), gradually bring the pot into the sunlight. Take off the protective plastic bag, removing all weeds and flower buds. Leave only the stem, disinfecting all scars.

(e) Transplant into large pots (28 x 28 x 50 cm) after 2 months.

(f) Fertilization: sprinkle with a hydroponic cultivation solution of 160 cc/l, once a week.

(g) Eight months after grafting, the young plants are 0.80 to 1.20 m high, and are ready for planting.

6. CONCLUSION

Although grafting in this case is not a delicate operation, certain precautions have to be taken. The scion-take rate is good (60 to 75%, recorded regularly in the Agricultural Research Department). The same procedure may be adopted for mango.

VI. MANGO GRAFTING

by

R. MILLAUD
Head of the Department of Rural Economics

A grafting technique similar to the one used for avocado has been developed by the Agricultural Research Department and practised by the Pirae Station Nursery.

1. ADVANTAGES

As in the case of the avocado.

2. PROCUREMENT AND PREPARATION OF ROOTSTOCK

(a) Split fresh seed stones are sown in plastic pots.

(b) Grafting is carried out after 1 or 2 months.

(c) The stem is cut off 5 cm above the seed and disinfected with quinoline-oxide.

(d) A 2 cm vertical split is made on the rootstock.

3. SELECTION AND PREPARATION OF SCION - Same technique as for the avocado.

(a) Scions: slender, terminal shoots 15 cm long.

(b) Clip off one half of leaves.

(c) Leaves are disinfected.

(d) Thickness of scion and stock should be uniform.

(e) Cut end of scion into a 7 cm long wedge.

4. GRAFTING OPERATION

Same technique as for the avocado.

5. AFTER-CARE OF THE GRAFTED SEEDLINGS

(a) Plastic bag placed above pot.

(b) Pot kept for two hours in a vessel containing a little water.

(c) The grafted seedlings are kept away from light that is too bright (50% shade) and, if possible, placed in an atmosphere that is constantly humid (mist control).

(d) When the callus has formed (20 to 30 days later) proceed exactly as with the avocado.

(e) Transplant into large pots (28 x 28 x 50 cm) after 2 or 3 months.

(f) Fertilization.

(g) 6 to 8 months after grafting, the young plants are ready for planting.

6. CONCLUSION

The scion-take rate recorded by the Agricultural Research Department ranges between 75 and 95%.

ISSUED IN THIS SERIES

		Classification
1.	Annual Conference of O.I.E. held in Paris 13th - 18th May, 1968. Report of S.P.C. Observer. September 1968.	Livestock Production and Health
2.	South Pacific Commission Publications Series. October 1968.	Publications
3.	Free Diving Without Breathing Apparatus - Its Accidents. March 1969.	Public Health
4.	"A" Level : Australia's Notification on Bovine Pleuropneumonia Regulations. March 1969.	Plant and Animal Quarantine
5.	Study Tour to Noumea, Brisbane, Territory of Papua and New Guinea and British Solomon Islands Protectorate. March 1969.	Tropical Crops
6.	"A" Level : Agricultural Education - Bulletin N° 1. April 1969.	Agricultural Education
7.	Introduction and Spread of Culicoides and Other Insect Species by Aircraft. May 1969.	Public Health
8.	Diarrhoeal Diseases in Adults. May 1969.	Public Health
9.	"A" Level : Agricultural Education - Bulletin N° 2. May 1969.	Agricultural Education and Extension
10.	"A" Level : Agricultural Education - Bulletin N° 3. November 1969.	Agricultural Education and Extension
11.	Agricultural Extension Workshop - Western Samoa. November 1969.	Agricultural Education and Extension
12.	Asian-Pacific Weed Science Society. December 1969.	Tropical Crops
13.	The Status and Potential of the Chilli Industry in the Solomon Islands. December 1969.	Tropical Crops
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29.	O.I.E./F.A.O. Regional Conference on Epizootics in Asia, the Far East and Oceania. January 1971.	Livestock Production and Health
30.	Plant Pest Control. January 1971.	Tropical Crops Plant and Animal Quarantine

31.	The Effect of Cultural Method and Size of Planting Material on the Yield of Colocasia Esculenta. February 1971.	Tropical Crops
32.	Shell-fish and Public Health. April 1971.	Public Health Engineering
33.	Weed Control. August 1971.	Tropical Crops
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45.	How to deal with the sludge produced by sewage farms in the South Pacific. January 1973.	Public Health Engineering
46.	The convenience of the metric system. February 1973.	Public Health Engineering
47.	Useful references for animal production and agricultural extension workers of the South Pacific Commission territories. March 1973	Animal Production

48.	Twelfth World Congress of Rehabilitation (Sydney, Aug. 27 - Sept. 1, 1972). March 1973.	Mental Health
49.	Primary Amoebic Meningo-Encephalitis. April 1973.	Epidemiology
50.	South Pacific Agricultural Extension Survey - 1967. April, 1973.	Agricultural Education and Extension
51.	Collection and Shipping of Serum Specimens for Antibody Studies. May 1973.	Public Health
52.	Fruit Cultivation. June 1973.	Tropical Crops