AN EVALUATION OF THE FRUIT AND VEGETABLE RESEARCH PROGRAM OF AARD

Volume I - Main Report

JULY 1984

Agency for Agricultural Research and Development

Indonesia

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AGENCY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT (AARD)
Jalan Ragunan 29 Pasar Minggu
Jakarta Selatan, Indonesia

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This report is the first one from a series of reviews which will eventually embrace all the activities of AARD. The review was conducted jointly by a team of AARD staff and external consultants. Its principal objective was to carry out an analytical evaluation of the activities of AARD in fruit and vegetable research.

Since these activities, especially for fruit, have been limited in the past whilst AARD has focussed on creating a human and physical infrastructure, the review is forward looking in its orientation.

It examines in some depth the way in which priorities are currently set, programs formulated and research carried out. The relationship between research and extension in horticulture is then touched upon. The later parts of the report offer a number of suggestions for strengthening fruit and vegetable research in the future.

1.2 TERMS OF REFERENCE

(i) The team will review the program activities and management of the horticulture program of AARD.

(ii) The primary purposes of the review are: (a) to provide the Government of Indonesia, AARD and particularly its Institute Directors, with an analysis of the past, ongoing and proposed activities of the horticulture research program; (b) to identify ways and means of strengthening the horticulture research program; and (c) to increase the in-house evaluation capacity within AARD.

(iii) The review will form part of a series of about ten reviews which will eventually cover all of AARD's activities and which will examine both the achievements of the research programs to date and their objectives for the period until 1990.

(iv) The review is expected to report on the past, existing and proposed activities of the horticulture research program and to make recommendations with respect to:

- (a) their management;
- (b) the quality and relevance of the current and proposed research;
- (c) the adequacy of the human, physical and financial resources;
- (d) the effectiveness of the linkages of the program with the scientific establishment both in Indonesia and overseas;

(e) the nature and effectiveness of the linkages with the extension services and other agencies providing services to agriculture; and

(f) possible new areas of national, regional and international support.

(v) Each review team will be expected, so far as is practical and relevant, to report within the framework of the given outline so that its report can be incorporated into a global overview at the end of the series of reviews.

1.3 MEMBERS OF THE REVIEW TEAM

The review took place between January 30 and February 18, 1984 and was conducted by a team of AARD staff members and external consultants. The AARD horticultural research staff were:

Dr. Surachmat Kusumo.
Dr. Anggoro Hadi.
Dr. S. Camacho (NAR-II Consultant).

The external consultants on the team were:

Dr. W. Reuther (Riverside, California).
Dr. R. Opena (AVRDC, Taiwan).

The Secretariat for the review were:

Dr. Joko Budianto (AARD Secretariat).
Dr. B. Nestel (ISNAR).

1.4 ITINERARY

(EF - Experimental Farm)

	Fruit Group	Vegetable Group
Sun. Jan. 29	- assemble Jakarta -	
Mon. Jan. 30	- Briefing AARD Pasar Minggu -	
Tues. Jan. 31	Travel to Padang Visit Solok location and Sukarami station	Travel to Medan Visit Brastagi station and EF
Wed. Feb. 1	Meet principal agricultural staff, Padang. Return to Jakarta.	Meet principal agricultural staff, Medan. Return to Jakarta.
Thurs. Feb. 2	- Travel to Research Institute, Lembang, visit Margahagu EF - Visit Subang EF	
Fri. Feb. 3	Visit Garut (Exten. Service) Return to Jakarta.	Visit Cipanas Station Visit Segunung Station Return to Jakarta
Sat. Feb. 4	- Travel to Surabaya - Visit Malang Station Visit Indokilo EF Visit Tlekung EF	
Sun. Feb. 5	Visit Punten EF Visit Fruit Farmers	
Mon. Feb. 6	Visit Cukurgondung EF Visit Banjasari EF - Return to Surabaya -	
Tues. Feb. 7	- Travel to Ujung Pandang -	
	Visit Jeneponto EF Visit Takalar producing area	Visit Maros Research Inst. Visit Loka producing area
Wed. Feb. 8	- Meet Principal Agricultural Staff South Sulawesi -	
	Travel to Denpasar	Return to Jakarta
Thurs. Feb. 9	Meeting with Principal agric. staff, Bali Visit Buleleng area	Drafting in Jakarta

Fri. Feb. 10 Drafting in Jakarta Drafting in Jakarta

Sat. Feb. 11

- Drafting in Jakarta -

Sun. Feb. 12

- Drafting in Jakarta -

Mon. Feb. 13

- Meeting in Pasar Minggu with Directorate General of Food Crops & Ministry of Trade staff-
- Meeting with staff of Pasar Minggu station -

Tues. Feb. 14

- Drafting in Jakarta -

Wed. Feb. 15

- Drafting in Jakarta -
- Meeting with Senior Staff of CRIH in Bogor

Thurs. Feb. 16

- Meeting with Director General and Senior Staff of AARD in Jakarta -

Fri. Feb. 17

- Complete Drafting -

CHAPTER 2

BACKGROUND

2.1 AGRICULTURE IN THE ECONOMY OF INDONESIA

The economy of Indonesia is based on agriculture, which provides about 60 percent of total employment and contributes about 25 % to the GDP. Over 70 percent of the population live in rural areas and agriculture is the major source of income for about two thirds of rural households and one tenth of urban ones. There are over 17.5 million smallholder families providing subsistence and cash crops from holdings averaging under one hectare each.

Over the past decade the growth in agricultural production has exceeded 4 percent per annum. The driving force behind this growth has been the rice industry where yields, using new varieties, have increased spectacularly. Rather less progress has been made in other crops, especially export commodies, which offer good prospects for increasing rural incomes. This is also true for fruits and vegetables whose productivity is generally low.

The disappointing performance of the non-rice sector has been recognised in recent years by both the Government and aid donors. Considerable effort is now being devoted to developing production from a wide range of agricultural commodities in order to raise farmer incomes, improve nutritional levels and increase export earnings.

2.2 AGRICULTURAL GOALS OF THE NATIONAL PLAN

The third five-year plan, for the period 1979-84 (Repelita III) which is just terminating, had the objectives, in the agricultural sector of:

" (a) Increasing incomes, export and food production, in order to achieve a prosperous agricultural society;
(b) Improving the level of farmers' incomes and broadening the work opportunities towards the achievement of a stable and dynamic agricultural structure; and
(c) Improving a continuous source of production, based on natural and manpower resources, towards the development of an efficient agricultural sector, commensurate with its potential."

In the fourth five-year plan (Repelita IV), which has just been drawn up, and will commence in April 1984, these goals are continued with additional emphasis being given to:

(a) Improving nutrition;
(b) Generating gainful employment opportunities;
(c) Improving production to provide support for domestic industries through production of raw materials for domestic markets; and
(d) Maintaining an optimum ecological balance whilst improving the utilisation of natural resources and also conserving the environment.

2.3 THE IMPORTANCE OF FRUITS AND VEGETABLES IN THE INDONESIAN ECONOMY

The total area of utilized agricultural land in Indonesia, including 2.2 million hectares under estate crops, (mainly rubber, tea, sugar, palm oil and tobacco), is about 18 million hectares. Of this total, some 0.55 million or 3 percent is estimated to be planted in fruit trees. Estimates of the area under vegetables vary widely and range from 0.4 - 0.9 million ha.. The Agency for Agricultural Research and Development (AARD) has suggested that in addition to these areas, there are about 20 million home gardens, with a total area of up to a further million ha., which are also used for fruit and vegetable production. Indeed most horticulture production in Indonesia is back-yard, although commercial vegetable production does occur in Java and also, to a lesser extent, in parts of Bali, Sulawesi and Sumatra.

Fruit and vegetables are produced throughout Indonesia in both humid and dry tropical climates, as well as in the sub-tropical highlands, and a large number of different fruits and vegetables are marketed. In the case of fruits, about twelve species dominate production, most of these are tropical although in the highland areas temperate species such as apples and grapes are produced. Bananas which account for over 40 percent of the tonnage produced are the most important individual species. In 1980 total fruit production was 4.2 million tonnes (Table B-1).

Official statistics on vegetable production (Table B-4) are even less certain than those for fruit. They suggest an annual production of only 2.1 million tonnes which represents a very low productivity from the land allegedly used for vegetables. This level of production also implies a very low level of vegetable consumption (13 kg/caput/year or 13 calories a day) (Table B-5) and does not seem compatible with expenditure on vegetables in the 1980 national household consumption survey (Table B8). This appears to have been taken into account in the Agricultural Sector draft for Repelita IV, which shows a 1984 production estimate of 5.5 million tonnes for vegetables and 8.0 million tonnes for fruit. These figures appear to give a closer fit with the household expenditure data and regional consumption patterns than do the figures quoted earlier. They suggest a farm gate value for fruit and vegetable production of about Rp1500 b. (US$ 1.5 b). This is as large an order of value as that for corn and cassava production combined, it is equivalent to about 33% of the 1981 farm value of rice and 11% of the total value of agricultural production (Table B-9).

The demand for fruits and vegetables, other than basic staples, has a high income-elasticity and in Indonesia, with positive growth rates in both population and economic activity, this demand has grown sharply in recent years. Annual imports of fruit (mainly apples, oranges and grapes) were about 23,000 tones, valued at about US$ 12 m., between 1978 and 1982, (Table B-3). In 1983 the Government placed a ban on imports in order to conserve foreign exchange and encourage domestic production. Vegetable imports consist mainly of garlic and, to a lesser extent, onion and doubled in both quantity and value between 1978 and 1982, at which time they totalled 28,000 tonnes valued at US$ 19 m., (Table B-6).

In spite of this, few measures have yet been taken to increase the productivity of fruits and vegetables, both of which have received limited attention from research and extension agencies. These crops are

grown largely by smallholders, they are usually very perishable and a substantial part of production is consumed directly by the farm family. The diffuse distribution, species diversity and direct consumption have made it difficult to develop a compelling rationale for allocating appropriate resources to fruit and vegetable crop research, notwithstanding its overall significance in the agricultural economy of Indonesia. Only recently have concrete steps been taken to help remedy this situation, by strengthening research in fruit and vegetable culture and by providing adequate facilities for such research.

2.4 AGRICULTURAL RESEARCH IN INDONESIA

The prospects for raising the productivity, not only of fruits and vegetables, but of a large number of agricultural commodities in Indonesia are considerable. In order to realise this potential it is necessary to have available a continuous flow of pertinent and factual information and ensure that there is a mechanism for transmitting this to the farmer.

To help make this possible and to respond to the 1973 State Guidelines for National Development, decreed with the People's Consultative Assembly, which called for "The strengthening of national capabilities in science and technology and to support and provide orientation for national development", the Agency for Agricultural Research and Development (AARD) was established in 1974. Since its inception AARD has attempted to consolidate all agricultural research and both internal and external support for it into an integrated national programme, which both meets the goal of the national five -year plan and serves to strengthen AARD itself. The Agency has received substantial external support, particularly from the World Bank and USAID, to help it realise its objectives.

Since its origins in 1974, AARD has grown from a very small staff to an Agency with 1596 scientists, of which more than 300 are trained to M.Sc. level and over 80 have Ph.D's. The Agency has twenty eight major Research Centres/Institutes (Fig. A2) and a total of over 200 experimental stations and farms, which are distributed throughout the length and breadth of the Indonesian Archipelago. Some of these facilities are directed to fruit and vegetable research. Research on these commodities other than that carried out by AARD is a very limited, as few University or private sector funds are devoted to horticultural research, so that AARD carries the prime national responsibility for this task.

2.5 FRUIT AND VEGETABLE RESEARCH IN INDONESIA

Fruit and vegetable research in Indonesia has a long history, but has generally been conducted at a very low input level and in a limited number of locations. The main emphasis in the colonial period was on cultivar collection, especially of tropical fruits. However, during the years of World War II research was at a standstill and most of the germ plasm collections, mangos being a notable exception, were lost.

With assistance from FAO, an effort was made to rejuvenate fruit and vegetable research in the 1950's. The station for this work at Pasar Minggu later became the Central Research Institute for Horticulture

(CRIH), which became part of AARD in 1974. The CRIH, although a National Centre for fruit and vegetable research, suffered badly from a lack of trained staff and operational funds. In 1981 its status was reduced and it became a unit of the Central Research Institute for Food Crops, (CRIFC).

In 1983, in the context of the growth in scientific manpower within AARD and a clearer understanding of the importance that fruits and vegetables play in the rural economy, a decision was made for horticulture to resume its former status. This situation will become effective on April 1st 1984 when a small Coordinating Center at Pasar Minggu will be formally established and put in charge of the various sub-units working on fruits and vegetables.

Part of the reason for the re-organisation is the support given to fruit and vegetable research during the late 1970's and early 1980's by the World Bank, through the development of the Vegetable Research Station at Lembang, and by the Dutch Government through its support for horticultural crops at the Food Research Institute Station at Malang. These two donor programs have helped provide the physical resources and training activities that now make it feasible to upgrade the status of horticultural research.

In the case of vegetables, the Lembang Institute has served since July 1982 as the principal seat of activity. Vegetable research is also carried out in existing units of the CRIFC at Malang, Brastagi, Segunung, Cipanas and Bogor. On April 1st 1984, Banaran experimental farm in East Java and part of the post-harvest activities of the Fruit Research Station at Pasar Minggu will be assigned to vegetable research (Appendix Table C1). A small amount of research on ornamental crops will also be included in the vegetable research program at Cipanas. Thus a network of vegetable research is being established, centered on the Vegetable Research Institute at Lembang.

Currently vegetable research focusses on six species, potatoes, cabbage, tomatoes, beans, peppers (Capsicum) and onion/garlic, using a multidisciplinary research program. A small ornamental crop program deals mainly with chrysanthemums, roses and orchids.

For fruit research there is at present no Research Institute. A proposal has been submitted to the Asian Development Bank, requesting assistance for establishing a new Fruit Research Institute, located in the wet lowlands of Solok in West Sumatra, with new supporting stations, (A) in the dry lowlands at Malang (E. Java); (B) at Jeneponto (S. Sulawesi) - specifically for citrus; (C) in the dry subtropical (upland) area at Tlekung (E. Java); and (D) at Pasar Minggu for post-harvest work

This proposed new structure will require considerable upgrading as currently Jeneponto and Tlekung are experimental farms with very limited facilities and the Malang station is a Food Crop Research Institute Station about half of which is given over to horticultural activities. The Pasar Minggu station currently carries out fruit and vegetable post-harvest research. In addition to the stations mentioned above, all of which, other than Pasar Minggu, have experimental farms, ten other experimental farms, mainly small and in East Java, will be allocated to fruit research. (Table D1). The current fruit research program is limited in its scope and is principally concerned with mangoes, citrus,

grapes and apples. Its germ plasm collections and station facilities have deteriorated during the past six years. The new mandate for horticultural research and the proposals for a new Fruit Research Institute at Solok, and FAO/UNDP support for citrus research, are intended to redress this situation and to give fruit research a more prominent role in AARD's program.

However, it must be recognised that tropical fruit tree research presents some rather unique problems which need to be recognised in any discussion on fruit research in Indonesia. Brief mention of these problems is made in the following pages.

2.6 SPECIAL PROBLEMS IN TROPICAL FRUIT TREE RESEARCH

Because most (but not all) fruit are produced by large trees planted in semi-permanent orchards, they occupy the chosen plot of land the year round for many years. The planting density of tree fruit orchards is mostly between 150 to 750 plants per hectare. Only a few (pineapple, some vine fruits, strawberries, etc.) will greatly exceed this. Hence land requirements are very high. Research with tree fruits usually requires about 10 hectares for every hectare needed for annual crops.

Orchard research with tree fruits is inherently more ponderous than with most annual crops. Land requirements are more permanent, since field trials for variety and rootstock evaluation typically require 6 to 10 years to produce extendable results. Fertility studies, irrigation experiments, pruning treatments, etc., may need 3 to 5 years after initiation to reach reasonably secure conclusions. Orchard trials for crop protection may produce somewhat quicker results. Many orchard trials involving varieties and rootstocks may occupy the same land for 20 to 30 years.

Of prime importance in the development of experimental fruit farms everywhere is to understand clearly that selection is very likely to be a 50-year commitment. Thus more deliberation and care must be taken than for annual crops. The nature and problems of fruit growing in the region to be served, and its potential for further development, must be carefully surveyed. This involves evaluation of basic factors such as climate (especially rainfall distribution and temperature), soil, availability of water for irrigation, infrastructure, socio-economic conditions, and other factors. After the site is selected, development of experimental planting should be phased in a manner to assure sustained support. Experimental orchards which are neglected culturally, even for a few seasons, do not produce data on which to base reliable conclusions. Also, they can have a very negative influence on the image of credibility needed by any effective agricultural research institution.

In tropical regions both night and day temperatures remain favourable for very rapid growth throughout 12 months of the year, and moisture conditions are favourable most of the year also, except in dry locations. For this reason fruit crops are particularly vulnerable to pest and disease attack, and especially so in the more humid climates where conditions are favourable for very rapid reproduction of pathogens the year round. Similarly, weeds are especially destructive in tropical fruit orchards because they too thrive and compete effectively for the available moisture and nutrients.

In the humid lowland tropics, imperfect soil drainage is often a serious constraint to the culture of tree fruits, especially when they are grown in close association with bunded rice. During periods of low rainfall, roots tend to penetrate to deeper depths in the subsoil. Then, during periods of higher rainfall, the free water table may rise to levels of less than 1.25 meters, and can cause serious damage to the submerged subsoil roots, reducing productivity and profitable life-span. Most (but not all) tree fruits and vines are very deep rooted and quite intolerant of imperfect soil drainage. In the tropics, soil temperatures are usually high (in the 25-28°C range) and hence respiratory demand for oxygen by the roots is higher than in temperate regions, while at the same time oxygen solubility in the soil moisture is lower. Thus a rising water table in a warm tropical climate can cause severe damage to submerged roots within a few days, whereas in a cool temperate climate, several weeks might be required to produce similar damage.

Most tree crops, even the most drought tolerant, do not produce high yields of good quality fruit in tropical climates if the rainfall is less than 75 - 80 mm during any 90 day period. However, some species can survive and produce small crops of fruit with even six months of drought. Hence drought tolerant tree fruits are those that can survive drought, but do so largely at the expense of production. All yield more and better fruit if appropriate amounts of supplemental irrigation water is supplied.

Given good drainage, tree fruits and vines can usually be made to grow and produce well on infertile sandy or rocky upland soils, if supplied with supplemental irrigation during the dry season, and appropriate fertilisation. Many such poor upland soils are quite unsuitable for annual row crops. Also, with contoured rows, tree crops can provide a viable cropping system on soils prone to erosion.

2.7 AARD's MANDATE FOR HORTICULTURAL RESEARCH

The Fruit and Vegetable Research Program of AARD has as its goal the task of carrying out fruit and vegetable research which will assist in enhancing national productivity of these commodities. The institutional structure of this program comprises a Coordinating Center plus a Fruit and Vegetable Research Institute, each with Research Stations and Experimental Farms (Figure A3). The Research Institutes are expected to:

a. Be recognized as a national point of reference on matters concerning fruit and vegetable culture, through having a clearly formulated and well directed programme of research and coordinating all AARD activities in this field;
b. Develop adequate research facilities in the form of buildings, laboratories, libraries and experimental fields;
c. Develop adequate staff, consisting of qualified researchers and supportive personnel; and
d. Be capable of providing effective support to regional and national fruit and vegetable crop development.

It is expected that a strong research programme on fruits and vegetables will lead to increases in production, which will:

a. Raise the income of many small farmers, who would benefit from the strong local demand for these commodities;

b. Increase employment, because fruit and vegetables are generally labour-intensive crops at the farm level, as well as in the transport, marketing and processing industries;
c. Increase the transference of capital to the rural areas, since fruit and vegetables are capital as well as labour-intensive;
d. Lower consumer prices for fresh fruits and vegetables and thereby increase their availability, especially to lower income groups;
e. Represent a potential source of foreign exchange.
f. Play an important role in the cropping pattern of trans-migration programs, especially in their early stages.

2.8 PHYSICAL RESOURCES CURRENTLY AVAILABLE FOR FRUIT AND VEGETABLE RESEARCH

The physical resources currently available for horticulture research are detailed in Figure A2 and Tables C1, C2, D1, D2, E1, and F1 of Volume 2 of this Report.

The situation when the review team was in Indonesia was one of flux since the new Coordinating Center was already operational, but was not yet officially in existence. It was due to be created on April 1st 1984 and to be located at the Pasar Minggu Station. Although, on paper the Coordinating Unit will have two main institutes, seven Stations and nineteen Experimental Farms under its charge, many of these are currently in poor condition. Only the Vegetable Research Institute at Lembang and its Stations at Segunung and Pasar Minggu are reasonably well equipped. The same can also be said of the Malang Reseach Station if this is transferred in its present form from food crops to horticulture.

Collectively the stations, substations and farms cover over 400 ha., although only at Lembang is there a high utilisation of land for research and much of the area is in germ plasm collections. There are about 4800 m^2 of office space and 4500 m^2 of laboratories, mainly at Lembang and Pasar Minggu.

Most of the improvements to Lembang were carried out under NAR I which invested US$ 1.7 m in construction and US$ 1.5 m in equipment for this station. Modest further support for this station and for improvements to the substations at Cipanas and Brastagi is being provided by NAR II at a total cost of US$ 2.2 m (Lembang 0.8 m, Cipanas 0.9 m, Brastagi 0.5 m).

A request to the Asian Development Bank has been made for covering the costs of developing a new fruit research station and farm at Solok. Until this is established fruit research will remain centred in the substation at Malang. However, the request to the ADB also includes support for upgrading the Malang substation and the experimental farm at Tlekung. This is discussed in more detail in Chapter 7.

2.9 HUMAN RESOURCES FOR FRUIT AND VEGETABLE RESEARCH

The current professional manpower resources available for horticultural research are as follows:

TABLE 1

CURRENT MANPOWER IN HORTICULTURAL RESEARCH

FRUIT	Ph.d.	M.Sc.	Sarjana/B.Sc.	TOTAL
On hand	2	6	25	33
Away training	2	10	0	12
TOTAL	4	16	25	45
VEGETABLES/ ORNAMENTALS				
On hand	3	9	55	67
Away training	5	15	0	20
TOTAL	8	24	55	87
DIRECTION				
On hand	1	0	3	4
TOTAL				
On hand	6	15	83	104
Away training	7	25	0	32
GRAND TOTAL	13	40	83	136

This total, especially in terms of manpower with higher degree training falls far short of the 1990 targets for horticultural research although the sizeable training program represents a very positive step in the right direction. However, as mentioned later, the review has some concern about the impact of local training at the post graduate level, given the absence of specialised training courses in fruit and vegetables in Indonesian Universities.

The AARD manpower targets in horticulture for 1990 are as follows:

TABLE 2

MANPOWER TARGETS FOR HORTICULTURAL RESEARCH

FRUITS	Ph.D.	M.Sc.	Sarjana/ B.Sc/	TOTAL
Target	26	38	63	127
On staff	4	16	25	45
To Identify	22	22	38	82
VEGETABLES				
Target	16	46	55	117
On staff	8	24	55	87
To Identify	8	22	0	30
TOTAL TO BE IDENTIFIED	30	44	38	112

Thus to meet the targets 74 professionals will have to be identified and given further training in addition to the 53 currently on staff or training at the Ph.D./M.Sc. level.

However, the review team (see section 7.4 and Table 15) has considerable misgivings about the manpower targets for fruit research which it considers as unlikely to be attainable before 1994. For 1990 it considers a goal of 15 Ph.D.'s and 25 M.Sc.'s to represent a more feasible target. This would reduce the number of new trainees from 74 to 50.

The targets for 1990 also contain a suggested disciplinary breakdown of the expertise required for horticulture research. Excluding the Coordinating Center and Pasar Minggu, this is as follows:

TABLE 3

PROPOSED STAFF STRUCTURE FOR 1990

DISCIPLINE	No. of Scientists FRUITS	VEGETABLES
Breeding/Var. improvement	17	17
Agronomy	19	15
Physiology	11	11
Pathology	15	) 29
Entomology	13	)
Post Harvest	14	12
Economics	15	10
Others	3	3
	107	97

We have not been able to break down these figures against existing staff or current trainees for the CRIH as a whole. Such an exercise would be useful in terms of long range manpower planning and an attempt has been made by the review team to do this for fruits (see Table G-3).

2.10 FINANCIAL RESOURCES FOR FRUIT AND VEGETABLE RESEARCH

AARD derives its budget from both domestic and external sources. In the last two years the downturn in the oil economy and the build up in the World Bank NAR II program have caused an increasing share of AARD's total budget to be derived from external sources. It is difficult to disaggregate this external support into commodity components but this can be done for the Government of Indonesia support to AARD through both its routine and its development budget. The figures shown in the table below indicate that about 4% of AARD's total GOI budget is given over to horticultural research with the major part of this being allocated to vegetables.

TABLE 4

FRUIT AND VEGETABLE CROP SHARE IN AARD'S BUDGET
1983/84 AND 1984/85

	1983/84		1984/85	
Routine Budget	M.Rp.	%	M.Rp.	%
Fruits	165	2.3	259	3.4
Vegetables	264	3.7	303	4.0
TOTAL BUDGET	7127	100.0	7542	100.0
Development Budget				
Fruits	215	1.3	218	1.5
Vegetables	765	4.4	532	3.8
TOTAL BUDGET	17359	100.0	14161	100.0
TOTAL BUDGET OF AARD (INCLUDING ESTATE CROP CESS)				
Fruits	380	1.1	477	1.5
Vegetables	1029	2.9	835	2.6
TOTAL BUDGET	34936	100.0	32130	100.0

The share of the routine budget has increased in 1984/85, largely due to the creation of the Coordinating Center and the upgrading to Central Research Institute status. The share of vegetables in the development budget appears to have fallen slightly but, in fact, this is an artefact as the 1983/84 development budget contained an extraordinary item of over 200 m Rps for land purchase.

The overall share of vegetables and, more especially, of fruit in the total research budget is well below the contribution of these commodities to the agricultural GDP. However, it has to be taken into account that about a third of AARD's budget is provided by the Estate Crop Cess which is designated purely for Estate Crops. There is little flexibility in the Routine Budget, and the Development Budget has to cover counterpart costs of external aid as well as support services that benefit all commodity programs. Nevertheless, even after taking these factors into account the Development Budget is not particularly generous to horticulture.

TABLE 5

AARD DEVELOPMENT BUDGET 1984/85

Institute	M.Rp.	% Total Commodity Budget	% Which Commodity Contributes to Agricultural GDP
Food Crops	3577	36	49
Horticulture	750	8	11
Fisheries	1434	15	8
Animals	1913	19	9
Non Food Crops	2292	23*	24
Sub-Total	9876	100	100
Development Projects	2747		
Support Services	1538		
TOTAL	14161		

*(In addition to this figure the estate crop cess (including sugar) totalled Rp 10,427 m).

AARD's budget can be broken down into four main categories, one of which 'research operations' gives an indication of the amount of funding available for actual research. Whilst the four budget heads are not sharply defined, the table below does indicate that a reasonable part of the station budgets should be available for experimental work.

TABLE 6

PERCENTAGE DISTRIBUTION OF TOTAL HORTICULTURAL RESEARCH BUDGET 1984/85

	%					
	COORD. CENTER	LEMBANG	BRASTAGI	MALANG	PASAR MINGGU	TOTAL
Adminstration	100	53	63	48	55	57
Research Operations	-	35	18	42	28	31
Communications	-	6	2	2	6	4
Capital	-	6	17	10	11	8
TOTAL	100	100	100	100	100	100
Share of Budget to each Station	8	52	8	19	14	100
Rp.m. to each Station	93	677	111	251	180	1312

It is not possible to disaggregate most of the research budgets down to the commodity level although an attempt has been made to do this for the research operations budget at Lembang (Table C11). This shows 80% of the research budget being devoted to only 5 vegetables with three-quarters of the 80% going for potato, tomato and cabbage research. The implications of this are discussed later in this report.

CHAPTER 3

PLANNING AND PROGRAM FORMULATION

3.1 INTRODUCTION

One of the topics which the review team examined was the mechanism for establishing priorities and formulating programs in fruit and vegetable research. This task was facilitated, in the case of vegetable research at Lembang, and to a lessser extent at Maros, by documentation relating to a highly structured planning procedure. Such a process was not followed in the case of fruit research, the pattern of which appeared to have changed little over a number of years. In addition the current level of activity in fruit research is so limited that the review team did not find an analysis of its planning and formulation sufficiently meaningful to report on in any detail. Rather, the team elected to focus its efforts on analysing the proposed reorganisation of fruit crop research into a separate and new institute, headquartered at Solok. Nevertheless, many of the comments, criticisms, and suggestions regarding programming and planning of the vegetable research program would be applicable to the existing fruit research program, if allowance is made for its very limited level of development.

3.2 SETTING PRIORITIES

A series of meetings were held at the Vegetable Research Institute at Lembang in 1981 and 1982 to define priority commodity and research program areas. Following these meetings the Institute established a 10-year research program (Program Penelitian, Balai Penelitian Horticultura-Lembang, Tahun 1982/83 - 1991/92). This program gave initial priority to five commodities:

a Potato
b Tomato
c Cabbage (including chinese cabbage)
d Beans (including red kidney beans and bush and climbing snapbeans)
e Pepper (capsicum)*

The major research goals for each commodity were defined, based on the reasons, according to a consensus of opinion among researchers, for the gap between high research station yields and low farm yields for the prioritized commodities.

The yield gap was attributed to unavailability of high quality seeds; lack of improved varieties; lack of appropriate cultural and management techniques; damages wrought by major pests and diseases; lack of improved postharvest technology, especially for highly perishable vegetables; agroeconomic problems such as insufficient farm capital to sustain a highly intensive vegetable farming system, inadequate transportation to major market centers and drastic price fluctuations; and to insufficient knowledge of appropriate cropping systems.

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* Whenever the term "pepper" is used subsequently in this report it refers to "capsicum" pepper and not to "piper" pepper.

As a consequence of this analysis major research programs were established at Lembang for the prioritized commodities in the fields of: varietal improvement, seed production technology and storage, agronomy and cropping systems, plant protection, post-harvest technology and agroeconomics.

At the Brastagi station the following five priority areas were identified, in each case the chosen area is both commodity and activity linked:

a) Post harvest technology - cabbages
b) Agronomy - tomatoes
c) Plant protection - tomatoes
d) Seed production - potatoes
e) Plant protection - potatoes

At Malang the three priority commodities are pepper, garlic and shallots with research on these crops being carried out on seed production, agronomy, cropping systems, plant protection and agro-economics.

Similar research areas but with cabbages and potatoes as the priority crops and tomato, pepper and shallots also being studied, were identified in the vegetable research program of the Food Crop Research Institute at Maros.

In all of these locations (and this is also true for fruit research), the determination of priorities was carried out principally by the research workers themselves. In discussing this point with the review team the researchers claimed that their contacts with the extension services through annual training programs for PPS's and their meetings with extension workers and key farmers at annual field days gave them an effective understanding of priorities at the farm level.

At Brastagi a formal consultation with staff of the North Sumatra University at Medan took place each year. In addition a mechanism existed for participation in extension service meetings with farmers whenever the theme topic of the meeting was a vegetable crop.

At Malang considerable importance was attached to the annual meeting with key farmers and to information provided by an officer of the Institute of Agricultural Information (BIP) who had an office at the research station.

Nevertheless, the real impact on the planning process from discussions with extension services, farmers and other private sector interests appeared to be very limited. This then posed the question as to how the scientists defined their priorities. This appeared to be based not upon any economic surveys or empirical model analyses but mainly through the value judgements of experienced senior scientists and as a result of a continuation of past programs.

This does not necessarily result in a poor selection of priorities even though wider consultation would be desirable. The review team did, however, note that for both fruits and vegetables the major research emphasis was on highland (temperate-type) crops whereas much of the population of Indonesia lives in the tropical lowlands.

However even taking account of the highland bias, the choice of vegetable priority commodities appears to be reasonable if the total recorded area, yield and production of the different vegetables grown in Indonesia are taken into account (Table B4). The priority vegetables at Lembang occupy a large proportion of the area devoted to vegetables and make up more than 50% of the total tonnage shown in table B4, (although this may seriously underestimate the volume of lowland tropical vegetables grown in home gardens).

In the process of establishing priorities at Lembang, the research team at that station tried to rate the importance of different areas of disciplinary research for each of the 5 prioritized commodities. This exercise, although highly subjective, is interesting in its involvement of a multidisciplinary team and in the very high priority that it allocated to potatoes on almost every count (Table 7). It provided an excellent start to the priority setting process and indicated that the Lembang research team is facing up to this important issue. What it does not yet do is to relate priorities to farmers views, to the chances of success, or to the resources available for carrying out the research.

TABLE 7

RATING THE IMPORTANCE OF COMMODITY AND DISCIPLINARY AREAS AT THE LEMBANG RESEARCH INSTITUTE

Research or Commodity	Potato			Tomato			Cabbage			Beans			Pepper			Others		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1. Breeder Seed Production	1	1	1	2	2	2	6	6	5	3	3	3	4	2	4	5	5	6
2. Seed Technology	1	1	1	4	4	4	3	3	2	2	2	3	5	5	5	6	6	6
3. Varietal Improvement	2	2	1	1	1	2	3	3	3	5	5	5	4	4	4	6	6	6
4. Plant & Environment Management	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6
5. Pest Managment	1	1	1	3	3	3	2	2	2	4	4	4	5	5	5	6	6	6
6. Disease Management	1	1	1	2	2	2	5	5	5	4	4	4	3	3	3	6	6	6
7. Pre and Post-harvest tech.	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6
8. Cropping Systems	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6
9. Economic Resources and Marketing	4	4	4	2	2	2	1	1	1	5	5	5	3	3	3	6	6	6
	13	13	12	20	20	21	29	29	27	35	35	36	39	37	39	53	53	54

Legend: A - Short-Term Program
B - Medium Term Program
C - Long-Term Program

Rating: 1, 2, ...6 = Priority order in decreasing importance (i.e a low number is a high priority)

We have mentioned elsewhere that the physical and financial resources available for vegetable research, whilst not generous, are adequate for many research purposes. In this context some current activities may need re-examination For example, varietal improvement is considered a vital component of most commodity research. Yet, while the total plant breeding personnel appears sufficient (see Tables C3, C5) only a few are really adequately trained in this discipline.

The same may be said of trained personnel in other disciplines, notably agroeconomics and postharvest technology. If these areas are as important as they are purported to be, the present personnel are insufficient in terms of both numbers and level of training. Among the various disciplines on the Lembang staff, plant protection and agronomy are relatively the best prepared to execute their mandates.

This dicusssion on manpower raises important questions regarding AARD's training strategy that will be referred to later in this report. At this point it is perhaps sufficient to draw attention to the importance of linking the manpower development strategy to the goal of being able to have appropriate personnel to conduct research on the identified priorities.

At Brastagi, the choice of priority commodities, such as potato, tomato and cabbage, was based mainly on the fact that these are the major vegetables grown in North Sumatra in terms of the total area and production. The prioritization of research areas is commodity - dependent and appeared to the review team as a worthwhile attempt to focus on a few major problems besetting each commodity in view of the limited number of trained personnel based at this station.

The selection of problem areas for research in each priority commodity was done in consultation with specialists from North Sumatra University. The final choices for each crop appeared to have been dictated more by the general consensus on the most urgent problems for research than by available resources. For instance, the review team noted the importance of seed production in potatoes but Brastagi does not have any qualified personnel to undertake this task (Table E-2). Pests and diseases are, without doubt, very important production constraints in all priority crops yet there is only one staff member at the station (Sarjana level) doubling as entomologist/pathologist. Thus the Brastagi staffing pattern (Tables E-5, E-6) needs strengthening in terms both of numbers and training level before it is likely to be able to fully realize its research mandate, however sharply focused that may be. The number of plant protection specialists needs to be further increased even at the expense of the one plant physiologist included in the manpower target for 1990. Agronomists, already outnumbering the other disciplines, may need to be asked to work on physiologically-orientated problems. This is particularly relevant in the Brastagi area where farmers practices are very progressive and future assistance from research is likely to be in fields other than straightforward agronomy.

The priority vegetable crops at Malang are considered by the researchers interviewed by the review team to have been chosen mainly for their economic importance. There is no clear cut evidence of prioritization of research areas within each commodity but a great deal of emphasis is generally placed on agronomic practices. Again, this could either be due to the preponderance of agronomists (6 out of 9 Sarjanas) working on vegetables or be influenced by what are perceived by researchers as the

most pressing problem areas. It appeared to the review team that the first of these two alternatives was the predominent factor in priority setting. As a result of this, potentially important crops like pepper, and research activities with possible quick pay-offs such as seed purification and integrated pest management, continue to receive inadequate attention.

As with the other research stations visited, the review team did not see any indication at Malang that past research prioritization took the available resources into account. With the advent of the new reorganization defining Malang as a fruit crop station, there should be ample opportunities to do this in order to assure that, under what could be a modicum of available resources for vegetable research, the research activities will not only be effective but also relevant.

With a total of only six research staff working on horticulture, the priorities for vegetable research at Maros are overly ambitious. Even in the former organizational structure where vegetable research was integrated in the food crops program, it would have been difficult to have made much progress with such a broad range of research and such limited manpower. Following the recent reorganization of horticultural research, vegetable research is no longer a part of the mandate of the Maros station so that unless adequate funds are directed from Lembang to Maros there will be no vegetable research conducted in South Sulawesi. The review team would regard this as a serious omission since, of all the areas that they visited, South Sulawesi appeared to be the most neglected in terms of meeting the needs for a vegetable research program.

In summary, the review team would like to recognize the immense effort that is being made by the horticultural research staff to effectively set priorities. It considers that the current emphasis in the vegetable program on highland crops such as potato, tomato and cabbage has a good economic justification on the basis of existing production statistics. However, very little emphasis, if any, is given to lowland-type vegetables such as kangkong, amaranth, yard-long bean etc., which could have a significant impact on nutrition for average households, although not necessarily being of high economic value. The current program also gives only limited priority to other economically important lowland vegetables such as pepper, shallot and garlic (which is the principal vegetable import to Indonesia). Thus the existing priorities should be re-examined and this needs to be done through consultation with a wide range of interests including policy makers, extension services and farmers.

The need for such a re-examination is even greater in the case of fruits where the rationale for devoting so much research emphasis to grapes and apples, which although of high value, are of negligible importance in terms of overall fruit production and consumption (Tables B1 andB2) and the relative neglect of bananas and other important lowland fruits whose value is much greater, needs to be re-assessed.

3.3 PROGRAM FORMULATION

Once priorities have been set they have to be implemented through the establishment of a work program. Here again the review team has looked closest at vegetables rather than fruits because the scientists in the former field have progressed much further in the program formulation process. This progress is relatively recent and is associated largely with the completion of the Lembang station and the return of the first Ph.D. level trainees.

At Lembang in the 1981/82 fiscal year individual researchers submitted detailed proposals for research that they wished to carry out in the agreed priority areas. The list of proposals exceeded the budget available and the station director selected proposals to fit the budget.

For 1982/83 the system was changed in that the research project director at Lembang allocated a budget to each research activity and a standard unit cost to each experiment so that the number of experiments in each research area was defined. Researchers then submitted titles against this program and the research project director, in consultation with senior colleagues, selected a number of proposals consistent with the budget, the authors of these proposals then submitted a detailed protocol for each experiment.

For 1983/84 the system was further refined with the Central Research Institute for Food Crops (the parent institute of Lembang), requesting from Lembang a short list of priority program areas (known as RPTP's or Rencana Penelitian Tingkat Peneliti). Twenty-four RPTP's were identified at Lembang (Table C-8), each one was led by a senior scientist (Ph.D or M.Sc.) with a maximum of 3 RPTP's being assigned to any one scientist who was responsible for the overall supervision of all experiments in a specific program (RTPT). The actual number of experiments per RPTP ranged in 1983 from 20 (Control of Potato Pests and Diseases) down to 3 (Control of Pepper Pests and Diseases), with the total experiments per commodity ranging between 45 for potatoes to 4 for Ornamentals in a total propram of 164 experiments.

At the individual experiment level it appears to be left largely to the individual researcher to define what he proposes to do, although this must fit into the overall RPTP package and the individual proposing several experiments is expected to list them in order of priority.

The RPTP's are both multi and inter-disciplinary in nature. Some RPTP leaders put considerable effort into including a comprehensive and integrated program, others are less discriminating. Such a situation is inevitable in an institution in the early stages of development and with a number of staff whose level of training is still very variable.

What is encouraging is to see the changes being wrought by the small core of 8 or so scientists who have benefitted from training in the NAR project and who are rapidly bringing an objective methodology to the program formulation process. The review team felt, however, that this process needed to go still further down the line with senior scientists giving more guidance to their juniors regarding which experiments were required rather than selecting from a list of experiments prepared by less experienced personnel. The team also felt that with this type of direction experiments could and should be written up earlier on as full proposals rather than just by title. This would make it possible to carry out an earlier and more accurate listing of the experimental program.

The program formulation process has advanced further at Lembang than at the other stations visited. All of these were nominally following the RPTP system but in rather less detail with each RPTP being a "commodity" rather than a "program" activity. Thus at Brastagi the 31 experiments on fruits and vegetables (Table E7) included only a few which appear to relate well to the priority areas at Brastagi referred to earlier in this Chapter. Furthermore 16 experiments out of 31 dealt with a total of 12 crops not included in the list of 5 priority commodities.

Part of the reasons for this is the lack of senior personnel outside of Lembang. Thus at Brastagi 5 consultants from North Sumatra University assisted in the program formulation and the output reflects their five areas of interest rather than being an integrated program focussed on Brastagi Station's priorities. However, Brastagi does seem to have carried out more farmer consultation, albeit informally, than other stations and its efforts to budget each experiment on an 'individual' rather than a 'unit' cost basis also represents a more realistic approach to costing.

At Malang the main emphasis is on palawija crops, and fruits and vegetables have been a low priority. The current program evolved by a process of iteration between an experimental list and a budget. The RPTP list, like that at Brastagi, is basically a commodity one (Table D7), i.e. for 1983/84 it has Red Peppers - 4 experiments, Garlic - 6 experiments, Shallot - 1 experiment. Again the list may reflect more the interests of individuals than the defined goals of the leadership, although to be fair to the scientists it must be recognised that until 1984/85, vegetable research has been a minor component of the activities at all the stations where it was carried out (excepting Lembang) and has not been a major interest of the direction of these stations.

In spite of this the Maros station has attempted to rationalise its vegetable program by surveying the needs of the area and then attempting to set up experiments which not only fitted into its priority areas but also offered some chance of success although, as noted already, this may be limited by the small size of the staff and the many vegetables of interest in South Sulawesi.

Overall, and disregarding the previous commentary on the validity of the priorities, the review team felt that much of the vegetable research undertaken fitted into the broad framework of the present priorities. It did, however, identify a need for a tighter direction and internal review of the research activities in order to eliminate duplication and repetition of experiments conducted previously and to optimise multi- and inter-disciplinary activities.

This view is supported by a study conducted by the review team in which it subjectively rated each one of the more than 200 research units at Lembang and Brastagi in terms of their relevance to the stated priorities. At Lembang the relevance rating was about 80% in both 1982/83 and 1983/84. Although this may appear to be a high figure, it indicates that about 40 experiments carried out each year at Lembang were either not relevant to the stated priorities, or relevant but of rather low priority, poor potential impact or with a limited chance of success. At Brastagi the relevance rating was much lower indicating an even greater need for an appropriate review mechanism prior to executing any research.

AARD now appears to have reached a stage in its development where its new horticultural Coordinating Center needs to play a vigorous role in monitoring the experimental program to ensure that the program actually carried out reflects national needs and not scientists' interests.

The review team has considerable misgivings about the program formulation process for fruit research. The 24 experiments at Malang (Table D-7) in 1983/84 include 7 each on mangos and grapes, 5 on apples, 4 on citrus and 1 on papaya. Many of these are not experiments in the true scientific

sense but represent observations on 'collections'. Very little work is under way on bananas which represent about 40% of fruit production, or on citrus, which probably offers the best prospects for a research impact.

The program appears to have undergone limited change since the colonial period and there is very little outside consultation on priorities or programs. The program has not benefitted from the NAR project in the way that the vegetable program has and the contrast between them is acute.

CHAPTER 4

RESOURCES AND ACTIVITIES

4.1 INTRODUCTION

This chapter discusses what research is being carried out, the adequacy of the methodology being used and the extent to which the necessary resources are both available and utilised. As with the last chapter, it deals almost entirely with the vegetable program and says little about fruit.

The reasons for this relates to the fact that one member of the present review team participated in an earlier (December 1977) review of horticultural research in Indonesia. This covered both fruits and vegetables (see "Development of a Strengthened Fruit and Vegetable Research Program for Indonesia" by Walter Reuther, dated January 10, 1978). This IBRD-GOI sponsored review had similar objectives to the present review. In the 1978 report Reuther noted: "Research on fruits is nearly nonexistent except for some variety collections and some good work on tropical apple culture" (sec. 3.2). Little, if any, development has occurred in the past six years in the level of research with fruits with the possible exception of post-harvest research at Pasar Minggu. Publications or other concrete evidence of productivity during the past three years have been very sparse (Tables D7 and D8). The reasons for this disappointing performance are essentially the same as they were six years ago:

1. The relatively low priority accorded to fruit research in terms of budget and manpower resources (see Tables G and G-2).
2. The scarcity of staff adequately trained to design and execute a research proposal. *
3. The vast number and diversity of species of fruit crops in Indonesia has been allowed to dilute available resources excessively. No serious effort has been made to concentate the sparse resources available on a few attainable goals with selected fruits.
4. Although not of basic importance, the very inadequate physical resources in land, irrigation water, and laboratory facilities have been significant constraints.

In contrast to this, vegetable research has made considerable progress and is at a level where an in-depth review of its activities was both feasible and, should be of value to AARD.

4.2 PROGRAM ACTIVITIES

The review team has examined in depth the on-going experimental programs for vegetables at Lembang (including Segunung and Cipanas), Brastagi, Malang and Maros.

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* Here "research proposal" is used in the sense of the basic element of a research program on a specific crop.

The program at Lembang is shown, on a commodity basis, in Table 8. Each experiment (including replicated ones) is allocated a set land area (usually 0.2 ha) and a fixed arbitrary budget of 0.8 m Rp, irrespective of the land or costs actually used. The table highlights the emphasis being given to the 5 priority crops and shows that resources are being focussed in depth on these commodities.

TABLE 8

COMPARATIVE RESEARCH EMPHASIS AMONG PRIORITY VEGETABLES BASED ON ALLOCATION OF LAND UNITS *; BPH-LEMBANG, 1983/84

COMMODITY	No. RPTP	No. Experiment**	Total Units	Total (ha)
Potato	3	45	77	14.6
Tomato	3	32	39	7.0
Cabbages	3	26	47	8.2
Beans	3	17	27	5.2
Pepper	4	14	16	3.2
Other Vegetables	2	13	20	2.4
TOTAL	18	147	226	40.6

* Does not include a total of 63 units allocated to seed production of potato (45 units), tomato (5 units), cauliflower (5 units), beans (5 units) and pepper (3 units).

** A number of experiments are repeated at several locations hence the number of units is larger than the number of experiments (experimental protocols).

We have taken the information in Table 8 and broken this down into discipline-oriented activities to indicate the main thrust of the research on a problem area basis. This is shown in Table 9 which highlights the fact that two thirds of the work is concentrated in the fields of plant protection and varietal improvement. The emphasis on plant protection underscores not only the importance of pests and diseases in vegetable production, but also reflects the emphasis that the past training program has given to plant protection, which now has more personnel with advanced training than do other disciplines represented at Lembang.

TABLE 9

COMPARATIVE RESEARCH EMPHASIS BASED ON ALLOCATION OF LAND UNITS TO VARIOUS DISCIPLINE-ORIENTED ACTIVITIES FOR THE PRIORITY VEGETABLES; LEMBANG, 1983/84

RESEARCH AREAS	COMMODITY						
	Potato	Tomato	Cabbages	Beans	Pepper	Other	Total
Varietal improvement/ collection	21	10	11	9.5	6	5	62.5
Agronomy/Cropping System	8	11.5	5	4	4	5	37.5
Seed production/tech. storage	12	1	2	2	2	3	20.0
Plant protection *	32	12	21	11.5	3	2	81.5
Postharvest technology	1	3	4	-	2	-	10.0
Agro-economics	3	1.5	4	-	1	5	14.5
	77	39	47	27	16	20	226

* Includes screening varieties and breeding lines for disease and/or pest resistance.

Tables 8 and 9 indicate that the ongoing program is currently directed at resolving the principal production problems of the priority crops and that the research effort is appropriately focussed in depth. At the same time it does not ignore problems of economics or of post-harvest technology (especially for relatively more perishable vegetables such as tomato and cabbage).

Of the various commodities that are commonly found in the highlands, potato research gets approximately 30% of the total operational research budget. The review team noted the development of research towards adaptation of traditionally temperate vegetables (i.e. potato and tomato) to medium/low elevations. Tropical adaptation research with these commodities has been one of the main thrusts in international centers such as CIP and AVRDC and research findings from these centers are relevant to the further development of the vegetable industry and improvement of human nutrition in Indonesia. In this context the excellent links that AARD has with CIP and AVRDC are commended and should be both continued and strengthened.

The physical location of the Lembang Institute is one that is considered by the review team to be strategic as far as the development of the

highland vegetable industry in West Java is concerned. The vast geographical expanse of Indonesia will, however, require the continuing development of a strong relationship with other research arms of AARD and with various agricultural agencies involved with technology transfer, to enable Lembang to fulfil its role in agricultural development at the national level.

An intensification of research activities to cover lowland vegetables is rightly within the framework of agricultural development set by the government under Repelita-III. In its current organizational structure, Lembang should be able to carry out this task through cooperative activities with the other strategically located institutes of AARD, particularly those concerned with food crop research. After March 1984 horticultural research will be organisationally separated from secondary ("palawija") food crops. As a result vegetable research in locations such as Maros will cease unless the Vegetable Research Institute develops an effective system of outposting staff and providing them with adequate support. The review team considers this to be essential and to be eminently preferable to creating new vegetable research stations or farms in the lowlands.

The review team was not able to obtain a breakdown of research units allocated to the various experiments in progress at Brastagi. However, the comparative research emphasis along discipline-orientated categories for each of the priority commodities was prepared from a list of research titles for the 1983/84 fiscal year (Table 10).

TABLE 10

RESEARCH EMPHASIS (BASED ON NUMBER OF EXPERIMENTS) AMONG DISCIPLINE-ORIENTATED ACTIVITIES FOR MAJOR VEGETABLES; BRASTAGI, 1983/84

Research Area	COMMODITY			
	Potato	Cabbage	Tomato	Others*
Varietal improvement	2	-	-	-
Agronomy/cropping systems	5	-	1	-
Seed production technology	-	-	1	-
Plant protection	1	2	-	-
Postharvest technology	1	-	-	-
Agro-economics	1	-		1
TOTAL	10	2	2	1

* One research title for Shallot.

Once again potatoes dominate the program with very little going to other vegetables. Among the different disciplines, agronomy/cropping systems received most attention. Given the importance of potatoes and cabbages in this area, the attention given to them is rational. However, we have already questioned the logic of the emphasis on agronomy in this region (Section 3.2) and greater emphasis on varietal improvement and plant protection is probably called for (see Table 12 in Chapter 8).

The Brastagi station is strategically located as far as the development of the highland vegetable industry is concerned. In relation to the availability of manpower resources, it is probably too distant from its current parent station at Sukarami for it to take advantage of the available expertise there. This situation will be worsened with the formal relationship with Sukarami ceasing after April 1984 and we have suggested in Chapter 8 that the future program of Brastagi should be strongly biased towards the adaptation of promising results from Lembang to North Sumatran conditions.

At Malang, the current vegetable program (1983/84) is centered principally on pepper and garlic, with five and six listed research titles respectively. One title on varietal improvement is listed for Shallot. On a discipline-oriented basis, all research titles on pepper dealt with agronomic practices. For garlic on the other hand, four experiments were on agronomic practices, one on agro-economics and one on varietal improvement. The emphasis on agronomic research is very apparent at Malang, for reasons that were discussed in Section 3.2.

As the priority crops at Malang are grown mainly in low to medium elevations, the physical location of the institute relative to the main production regions in East Java is considered to be strategic. However, consideration of Bali and its highland vegetable industry as part of Malang's mandate does not fit well with the program at Malang. The review team doubts whether Balinese vegetable farmers could benefit greatly from research carried out at the Malang Research Station.

Table 11 shows the comparative emphasis currently given to various commodities and discipline-oriented research areas at Maros. Foremost attention is focused on cabbage followed by tomato and pepper. Potato and shallot receive the least emphasis.

TABLE 11

COMPARATIVE RESEARCH EMPHASIS BASED ON ALLOCATION OF LAND UNITS TO VARIOUS DISCIPLINE-ORIENTED ACTIVITIES FOR DIFFERENT COMMODITIES: MAROS, 1983/84

RESEARCH AREA	COMMODITY					
	Tomato	Pepper	Cabbage	Potato	Shallot	Unspecified
Varietal improvement	3	3	-	-	-	-
Agronomy/physiology	3	2	4	1	2	-
Plant protection *	1	-	6	-	-	2
Agro-economics	-	-	3	1	-	-
TOTAL	7	5	13	2	2	2

* Involves mainly research on entomological problems.

Plant protection research is emphasized on cabbages but, overall, as at Malang, research on agronomy/physiology predominates.

In relation to traditional highland vegetables like potato, cabbage and tomato, the physical location of the Maros station is far from being strategic. The major highland production sites of these vegetables in Sulawesi (e.g. Enrekang, Sidrap, Bantaeng, etc), are accessible to the researchers but often require considerable efforts to reach. Whilst Maros provides suitable facilities for conducting research it will be necessary to develop a very effective TVT system if this research is expected to have an impact in the major vegetable producting areas.

4.3 RESEARCH METHODOLOGY

The review team examined a number of documents relating to research methodology. These included the protocols of experiments underway, progress reports, and write-ups of experiments completed in the last two years. We also reviewed a number of experiments 'on site' on various experimental stations and farms.

There is a wide range of difference in the quality of the planning, implementation and reporting of experiments both among and within the various stations and farms that we visited. At its best, particularly in some parts of the Lembang and Maros programs, the experimental designs, analysis and interpretation were of a high scientific standard and fully appropriate and relevant to the objectives of the experiments. In general a situation occured where experiments and sometimes RPTP's were

led by a scientist who had had the benefit of advanced training under the NAR project. This is a progressively improving situation and the review team felt that, although it will take time to obtain a uniformly high standard throughout all horticultural research stations, considerable progress had been made and there need be no major concerns on this score.

We did, however, feel that in the following three particular areas methodology could and should be tightened up fairly quickly:

1. The Management of Field Plots

Some of the experiements that we saw in the field at Lembang, Brastagi, Tlekung, Cukurgondung and elsewhere were poorly managed in terms of pest, disease and weed control, choice of homogeneous experimental plots, use of genetically true-to-type varieties, and choice of appropriate time, locale, and genetic material. These factors, which are bound to affect experimental precision and the relevance of results, could be prevented were there a more effective formal review mechanism of experimental plans prior to execution.

2. The Provision of Background Data and Information

Some experimental results would have had their value enhanced had they been accompanied by additional information on matters such as soil type, pH, nutrient level, etc. In other cases experiments were set up to relate treatments or methods to product quality without there always being a clear definition of 'quality'. Many experiments were conducted without first reviewing the appropriate literature - although the availability of this was often a problem. The review team has three recommendations to offer in this general area. The first, already noted, is for the establishment of a careful review of the protocol of each experiment before any field work is done. The second is for stronger central direction of the experimental program. Thirdly, and this is covered more fully in the next section of this report, there is a need for an improvement in the utilization of AARD library services within the horticultural institutes and stations.

3. A Closer Tie-up Between the Resources Available and the Research Activities

Several of the experiments reviewed by the team could have been combined with other experiments to give a more efficient utilization of resources without necessarily leading do any reduction in the information gained. Duplication of previous experiments either by the same researcher or by another is wasteful and costly. Some experiments observed did not appear to be relevant to problems in the farmers' fields. This observation endorses a comment brought to light by the recent AARD/CIP potato review and needs to be taken very seriously. It suggests the need for a re-assessment of the field program along the lines of the tentative proposals made in Chapter 8.

These critiques of current methodology should not detract from the progress that has been made and are offered because AARD now has the capacity to implement these sort of changes.

4.4 RESOURCE AVAILABILITY

The review team recognised the financial constraints under which AARD is operating. Within these constraints it is of the opinion that the budget for vegetable research, if optimised in its use, is adequate for carrying out a realistic national vegetable research program. To do the same for fruit research and to effectively utilise the proposed new institute at Solok it will be necessary to bring the fruit research budget up to the same level as that of vegetable research. Both fruit and vegetable research budgets will need enlarging in future years to accomodate the doubling of personnel supplied in the manpower targets (Table G2). But for the present the objective should be to get value for money from the existing budget whilst developing Solok and increasing other resources as fast as finances permit.

In order to do this the research will need to be sharply focussed on goals:

a) for which resources (especially manpower) exist;
b) which relate to farmers needs; and
c) which offer reasonable chances of success (which often implies that a minimal critical mass of manpower and money are available).

This will call for a very careful process of program formulation to ensure that:

a) there are sufficient resources to adequately tackle priority objectives;
b) only limited funding is allocated to low priority goals;
c) complementary use is made of domestic and external funding in order to maximize the total available;
d) the program is balanced geographically with appropriate allocations of funds for work on non CRIH stations.

The adequacy of existing physical resources varies from location to location. NAR-I has left the Lembang Research Institute fairly well endowed with physical resources (and NAR-II will improve these still further as well as assisting Segunung and Brastagi). Pasar Minggu is also reasonably well equipped although not all its equipment is functional. In contrast to this, Brastagi, Malang and Maros all suffer, to varying degrees, from shortages of equipment.

However, the main deficiency at all locations is the availability of literature. Only at Pasar Minggu is there anything like a reasonable library. Many stations have had no journals for several years. In theory such journals are supposed to be supplied by the central library in Bogor, in practice this does not seem to be happening. There are certain key journals that are as essential to researchers as the land for their experiments and yet such journals were absent from all the stations visited. This leads to wasteful and sometimes outdated research. We recommend that all horticultural research institutes and stations should be supplied with subscriptions to a limited number of key horticultural journals, although we recognize that the Central Library at Bogor should still retain its function of being the main information source for researchers.

The main weakness on the resource front at present is trained manpower. In numerical terms the training targets shown in Tables C-5, D-5, E-5 and F-3, and summarized in Tables 2 and G2 look reasonable, perhaps more for 1994 than 1990, especially for fruit. The key issue is the quality of the training. Where local training is unavailable in specialized fields, overseas training is mandatory, especially for the Ph.D. level. For M.Sc. training, where large numbers of trainees are needed a possible mechanism for developing one 'center of excellence' in horticultural training has been suggested (Section 7.4).

4.5 RESOURCE UTILIZATION

The review team has attempted to look at the efficiency of utilisation of the resources available for horticulture research. As far as utilisation of the available land is concerned, the review team received adequate information only from Lembang, its substation Cipanas and Brastagi. At Cipanas, only 2 hectares of a total of 10 hectares of experimental land are utilized. At Brastagi, the area utilised was also only 20% of the available experimental land.

A more thorough analysis of land utilization was possible at Lembang since a detailed listing of cropping sequence and duration for 1982/83 was provided to the team (Table 12). The data were used to calculate an approximate cropping intensity index (taking into account how long a piece of land was used for the priority commodities).

Cropping Intensity Index (%)= $(\sum_{i=1}^{N} fiXi / \sum_{i=1}^{N} fpXi)\ 100$, where

fi = duration of use for research commodities of a specific land block, expressed in year unit;

Xi = area of a specific land block (common unit for all blocks);

fp = 1 year (indicating perfect or full utilization through 12 months of the year);

N = number of blocks.

The denominator in the above formula really reduces to a simple $\sum_{i=1}^{N} Xi$ since fp = 1 or constant. However, it has been left in the form shown above so that both the numerator and the denominator are expressed in a "time-area" unit, thus cancelling the units and making the cropping intensity index unitless (unless expressed on a % basis as above).

The Index at Lembang was only 28%, showing a low utilization rate for experimental land.

However, the crop rotation system necessary for effective vegetable growing at the experimental station was not taken into account in this estimation. If this is done, it would appear that Lembang experimental farm is more frequently under alternate crops such as corn and green manure than under mandate crops.

TABLE 12

CROP ROTATION SYSTEM AT VEGETABLE RESEARCH INSTITUTE LEMBANG 1982/83

AREA (ha)	BLOCK	MONTH 4	5	6	7	8	9	10	11	12	1	2	3
3.3	A	----------		CCCCCCCCCCCCC						----------	PPPPPPPPP		
2.3	B			----------		PPPPPPPPPP			----------				
1.3	C	----------		TTTTTTTTTTTTTTT					--------				
1.2	D		----------		PPPPPPPPPPPPP				----------				
3.3	E			----------		BBBBBBBBBBBB			----------				
1.4	F	----------		CCCCCCCCCCCCC					----------		PPPPPPPPP		
0.2	G	----------		PPPPPPPPPPP					----------				
1.0	H		----------		PPPPPPPPP				----------				
0.3	I	----------		.....						----------			
1.3	Y	.....								--------			
2.2	Bl. Nangka Cikole I	----------		.....				----------					
0.3	A	----------									---	---	--
1.0	B	---	---	---	EEEEEEEEEE			---	---	--			
0.9	C			----------		TTTTTTTTTTTT				----------			
1.1	D							----------		CCCCCCCCCCC			
TOTAL 21.0													

CROP --- = corn
... = green manure

CCC = Cabbage
PPP = Potato
TTT = Tomato
BBB = Beans
EEE = Pepper

The facilities and equipment at Lembang appeared to be well maintained and operational at the time of our visit. At Segunung, the condition is less satisfactory - some equipment that broke down is deemed no longer functional because it could not be repaired locally; pilferages/theft

have resulted in the loss of other items, e.g. compound microscopes. The laboratory facility at Brastagi is practically bare although purchase orders have already been sent out and funds for further facilities are being made available under NAR-II. Laboratory equipment for vegetable research at Malang and Maros was limited but at both Stations the horticulture staff were able to use the facilities of the food crop research units. However, it is not clear to what extent this situation will continue after April, especially at Malang when the food crop staff move to their new buildings.

One of the better equipped units is Pasar Minggu which is the only station that we visited which had a reasonable library. The main defect at this station was that the well equipped pilot processing plant had been out of action for over a year because of a faulty steam generator (see Section 7.3).

The utilisation of manpower resources is difficult to assess but an approximation has been made for the current fiscal year by examining the average number of research units per researcher. In this approximation, it was assumed that all listed personnel under each discipline, starting from the B.Sc. level, undertake independent research (this may not be entirely realistic for certain disciplines or for some researchers.) The following table is based on various tables in Volume 2 of this report.

TABLE 13

EXPERIMENTAL PROGRAM (1983/84) IN RELATION TO NUMBER OF SCIENTISTS

	Program	Number of Scientists	Number of Research Units	Research Units per Scientist
Vegetables	Lembang/Segunung	38	226	5.9
Vegetables	Maros	6	26	4.3
Fruits	Lembang	2	8	4.0
Vegetables	Brastagi	7	20	2.8
Fruits	Brastagi	4	11	2.8
Fruits	Malang	20	24	1.2
Vegetables	Malang	7	7	1.0

The table above does not include Pasar Minggu or Bogor. It is noticeable that the work load per scientist is considerably greater at Lembang and Brastagi than at Malang, for both fruits and vegetables.

For whatever the figures are worth, the average number of experiments per person per year did not seem to the review team to be very high especially for short duration crops, like most vegetables. The contrast is particularly sharp when the work load per man at Lembang and Maros is compared with Malang.

None of the stations visited sub-contracted out any research to non AARD units, although both Lembang and Brastagi use consultants from nearby universities in their internal programs.

The review team has tried to carry out the same type of analysis as was used in Table 8 to examine station budgets in 1983/84 (Table 14).

TABLE 14

STATION BUDGETS IN RELATION TO EXPERIMENTAL PROGRAM (1983/84)

Station	Budget m Rp	Number of Research Units	Budget per R.U. m Rp*
Lembang/Segunung	858	234	3.6
Malang	255	31	8.2
Brastagi	68	31	2.2

* This figure includes all overheads and is not just operational research costs.

The contrasts are again quite sharp and could justify further study.

It is of interest that Lembang allocates 0.8 m Rp as "operational costs" for each experiment listed, whereas Malang and Brastagi allocate costs according to the nature of each individual experiment. The review team felt the latter, more accurate, approach was preferable although it has reservations about the costings at Malang in terms of the observed research output. The team questions the blanket allocation of 0.8 m Rp per experiment at Lembang irrespective of whether the experiment took 2 or 10 months, was a replica of an experiment at another location or even took place at all. A system of budgeting more closely linked to actual costs should result in a more cost effective program and may even lead to a greater number of experiments.

The team did feel that the RPTP system as practiced at Lembang, where a multi-disciplinary approach is now well entrenched, represented a very useful approach.

4.6 MONITORING AND EVALUATION

There is no formal mechanism for monitoring and evaluating progress or performance other than the preparation of an annual report which is supposed to record all work carried out during the previous year. No form of qualitative evaluation of an individuals performance occurs. It would be desirable to introduce some form of annual program reviews analogous to those held by the CGIAR centers to discuss research results analytically but structured to the specific needs of AARD.

Recently some of the RPTP leaders at Lembang have started requiring brief monthly progress reports from each member of their team, thus initiating a monitoring activity which the review team endorses.

Standard audit procedures are followed for fiscal control but from the research management standpoint, financial control could be improved by more accurate project budgeting, (rather than using unit costs as at

Lembang), and by giving individual researchers, or at least RPTP leaders, more information about their budgets. Currently there is no regular and progressive system of cross referencing expenditure versus available budget and there appears to be limited flexibility in the program of work and budget which would permit changes to be made during the year in the light of problems that arise or priorities that shift. Such changes could help to make the program more cost effective.

CHAPTER 5

LINKAGES

5.1 INTRODUCTION

For an agricultural research service to serve the agricultural community effectively it is essential that the service should have an appropriate system of communication channels. Communication needs to flow in both directions between policy makers, researchers, extension staff and farmers so that policies adopted and actions taken relate to farmers capabilities and needs. We can, thus, distinguish three levels of communication in an agricultural research system:

1. Communication between researchers and policy makers;
2. Communication within the research community itself, and
3. Communication between researchers, extension workers and farmers

5.2 LINKAGES WITH POLICY MAKERS

AARD is a relatively young organisation and is still in the process of establishing these linkages. This is particularly true in the case of its horticultural scientists who, until recently, have played a minor role in the Agency's program.

Nevertheless, the linkage with policy makers is well formed and as, in other areas of AARD, there is a regular dialogue between the Director of Horticultural Research and the Director General of AARD. This is encouraged by the broad nature of the horticultural research mandate which gives the Director considerable flexibility in action and leaves much of the choice in action programs to him rather than to any central planning unit in AARD.

5.3 LINKAGES WITH OTHER RESEARCH WORKERS

The second linkage referred to above is the one at the working level, at the scientific interface. AARD has gone to some lengths to develop this internally through an elaborate organizational structure of research coordinators, disciplinary coordinators, commodity coordinators and program (RPTP) leaders. But in spite of this, few of the scientists that the review team spoke to had much idea of the objectives and nature of the experimental program other than the experiments in which they were personally involved. This situation was not helped by the fact that few field experiments are labelled for the benefit of station visitors.

In our discussions much stress was laid on the role of annual meetings and reports as media for internal communication, but these do not seem to be entirely effective. Nor is there yet a regular seminar system at the stations we visited. There would appear to be considerable scope for using such a system as an in-house training exercise, supervised by more senior staff, especially in the latter months of the financial year when field work budgets may have been used up.

Currently horticultural research is carried out in different stations of the Central Research Institute for Food Crops (Lembang, Malang, Sukarami, Brastagi, Bogor and Maros) in a program that is not tightly integrated. This is largely due to the former regional nature of the mandates of the various food crop research institutes. The creation of the specific Institutes for horticultural research will necessitate a much closer relationship between fruit and vegetable research carried out at different locations if an integrated program is to be created. This will call for a major coordination effort by the Director of Horticultural Research who will also need to play a key role in allocating funds for research at institutes which are not under his direct control, such as the Maros Institute for Food Crop Research, in order to conduct horticulture research in areas where the Horticultural Institutes do not possess their own facilities

The need for a much greater communication between scientists working in fruit and vegetable research is important because the absence of other institutes carrying out research on horticultural crops (apart from limited amounts in the CRIFC), means that horticulturalists can easily become professionally isolated. The fact that horticulture research stations are not shared with other research institutes also limits communication and contact at the disciplinary level.

Most of the stations visited do, however, have good contacts with Agricultural Faculties in local universities and, until April 1984, university scientists are acting as leaders for some horticultural research projects. With the build-up in horticultural research staff this role is however, being phased down and after April, university staff will assist AARD's horticultural units only in a consultative capacity. The review team believes that these university links are important and should be maintained, even if only on a consultancy basis.

The Vegetable Research Institute also has well-established links with two international agencies, the International Potato Center (CIP) and the Asian Vegetable Research and Development Center (AVRDC). Collaboration with CIP is through an Australian funded regional project (SAPPRAD) in which AARD's prime role is in agronomic research. A recent (Sept. 1983) in-depth review of the potato program by a joint AARD/CIP team has reported favourably on the progress in developing trained manpower over the last five years, and has identified specific priorities for research, which are referred to elsewhere in this report.

The link with AVRDC has been reinforced by the secondment from mid 1981 to mid 1982 of a senior AVRDC scientist to the Lembang station and by his follow up visits. These have led to a joint program between AARD and AVRDC which is funded by the Asian Development Bank. Regrettably there are no relevant international programs to which the fruit research activities might be linked.

5.4 LINKAGES WITH THE EXTENSION SERVICES

The main problem area with respect to communication channels is the link between horticultural research and its clients - the farmers. The

links are through the Provincial Extension Services of the Governor's offices and through the Agency for Agricultural Education, Training and Extension (AAETE). These links are somewhat tenuous and strengthening them, throughout AARD as a whole, is a subject that is causing some concern in Indonesia at the higher policy making levels.

The review team met with representatives of the agricultural services in five provinces and formed the opinion that their input to research program formulation and their knowledge of research activities and results were both extremely limited. A formal mechanism for consultation exists on paper, but in practice, does not seem to work very effectively. This weakness goes through to the farm level, especially in fruits where farmers around the East Java station and experimental farms are practicing better husbandry and obtaining higher yields than the station itself. This hardly encourages confidence in the research organization.

One reason for the gap between research and the farmer is the limited scale of on-farm technology verification trials (TVT's). AARD has no mandate to do these on a large scale and the subject matter specialist (PPS) system of the extension services, which is responsible for on farm trials, is not yet fully operational. Activities in training PPS's in horticulture have hardly begun and need to be accelerated rapidly. Until a nationwide and effective system of TVT's is established horticultural research results are likely to have problems in passing from the research station to the farmers.

Although this rather generalised judgement applies to most horticultural research, it must be stated that there are exceptions where individual scientists have gone out of their way to try to communicate results and this can be seen in pockets of high technology vegetable farming and in the uptake of some of the post harvest work by womens groups. But the Horticultural Research Institutes are neither staffed nor funded to be extension agencies. Their role is to produce proven research for on farm verification by the extension services who are then in a position to promote the use of appropriate technology. Currently the research - extension interface is not functioning well and research of potential benefit to the farmer is not being adequately evaluated and utilised. The solution to this lies outside the control of the horticultural research workers but the problem is too great to be ignored on this report.

One measure that would help to improve the information flow to users would be to ensure that both the Fruit and the Vegetable Research Institute contained in their staff a person with special training in information science in order to strengthen the quality of the information being put out by each Institute.

CHAPTER 6

IMPACT

6.1 INTRODUCTION

Much agricultural research, even when very well endowed as in the CGIAR centers, takes 7 - 10 years from the planning stage until tangible results are available on farmers fields. When the research is based upon the sort of manpower, physical and financial faciltities that AARD had when it started to function about 1976, then a different sort of time horizon has to be considered. In effect the present vegetable research program started to have trained manpower and facilities about 1981 and the fruit research program still lacks facilities and is only now starting to get new generation manpower. So the program that the team reviewed was one that is in its infancy. For this reason this report has, in the case of vegetables, focused on the emergent activities in planning and implementation and for fruits has tried to lay down some guidelines for the development of a program that has yet to emerge. The team feels that the vegetable program is on the right track and we hope that our suggestions will help the fruit program to move the same way. But we are not able to identify an impressive list of farmer innovations resulting from farm research in the recent past. It is too soon for this and the research-extension link is still too weak.

What we can identify is a solid new infrastructure, a small core of competent and dedicated scientists and the emergence of a scientifically sound research methodology. These are also some useful but modest research findings that represent an encouraging start, given the time parameters. In the next section we record research outputs from the various units as represented to us by the staff of these units.

6.2 RESEARCH OUTPUTS

The outputs from vegetable research at Lembang and its substations during the last 2 - 3 years are recorded in Table C9. The information listed includes some research carried out under the previous organizational scheme when Lembang was still a station of LPH (Lembaga Penelitian Hortikultura) headquartered at Pasar Minggu. The local development or identification of improved varieties from foreign introductions, especially tomatoes and potatoes, consitutes a principal achievement. Additionally, recommendations have been developed on culture practices, post-harvest technology, plant protection methods and agro-economics. The Lembang Institute has also been involved during the past three years in technology dissemination (horticultural research bulletins, annual field days, extension booklets), and information exchange (workshops, seminars).

At Brastagi, research findings of note include: biological control of diamond back moth (in cooperation with Lembang entomologists), identification of effective pesticides and correct dosages; recommended packaging methods (60 kg/basket) for freshly harvested cabbages; and the successful introduction and dissemination of a new rose variety from Cipanas.

At Malang, the following research results are considered significant accomplishments: promotion of the improved potato variety "Cipanas" and garlic cultivar "Lumbuh Hijau"; development of control measures for pests such as thrips for garlic and mites in pepper; development of control measures for Alternaria and late blight in potato and tomato.

No horticultural research findings with a potential impact at the farm level were presented during the visit of the review team to Maros.

At Pasar Minggu which specializes on post-harvest technology, the following research outputs were listed:

1. Development of a simple technique for wax coating guava, tomato and red peppers in order to prolong shelf-life.
2. Superiority of calcium chloride to calcium hydroxide as a dip for improving the quality of potato chips.
3. Determining a local technique for producing papayin. (Published in both the AARD Journal and a popular magazine).
4. Improvement of the appearance and storage life of chilli sauce by pre-heating prior to processing. (Now widely used in home industry).
5. Techniques for dehydrating rambutan, mango and papaya.
6. Chemical analysis in relation to physical and organoleptic qualities of rambutan and durian. (Part of a study for the Standards Bureau of the Department of Trade).

All stations reported various workshops, seminars, field days and publications as being research outputs, although it was hard to assess the effect of these. At Malang these were the only recent outputs that the fruit research staff identified to the review team, specifically papers recently published with respect to work carried out in 1980-83 on:

a) Effect of storage time on physical and chemical properties of mangos
b) Farm costings relating to apple production in Malang district
c) Potential for grape farming in Bali

6.3 THE ADOPTION OF TECHNOLOGY

The degree of acceptance by farmers of the new technological innovations from Lembang and the other stations visited is difficult to assess without some sort of a systematic monitoring program in farmer's fields. However, the review team has either observed or been informed that new varieties of potato such as Cipanas and Cosima are gradually replacing the old varieties in North Sumatra, East Java and Bali. The information on recommended fungicides and insecticides developed through plant protection research generally reaches the farmers through extension services but to what extent is unknown.

In some cases, full adoption of new technology is constrained by factors that are not inherent with the innovations. For example, the recommendation at Brastagi to reduce post harvest losses by using a 60-kg packaging weight for cabbage is not followed by farmers because they are usually charged similar transportation rates as with a 150-kg package. The review team also had the impression during discussion sessions with researchers at various stations that the recommended pesticide dosages are not strictly adhered to because vegetable farmers apparently are

extremely risk-consious and use more frequent spraying intervals and higher dosages. Clearly the farmers have doubts about the research findings, thus again stressing the importance of establishing a system of technology verification trials at the farm level.

The review team noted areas of research where constraints to full technological adoption are recognized and given consideration in further investigations. A case in point relates to varietal development where the newly released tomato cultivars, Intan and Ratna, which are both heat tolerant and bacterial wilt resistant have poor fruit quality. These varieties are currently being worked with to both improve their fresh market quality and to transfer their wilt resistance to highly favored cultivars such as Gondol and Moneymaker.

Another example of a non-technical constraint to adoption occured following the cabbage packaging study at Brastagi where the adoption of a technology which could both reduce post-harvest losses and ease handling was held back by an apparently illogical transport charge. Further experiments are now in progress to try to rationalize the use of the original research finding or to modify it in a way that will make it attractive to farmers.

CHAPTER 7

A FUTURE STRATEGY FOR FRUIT RESEARCH

7.1 INTRODUCTION

The previous four chapters of this report have focussed mainly on vegetable research and most references to fruit research have highlighted the weakness of the on-going program. However, the progress made with vegetables in the last 3 years, the fact that some scientists are now returning to AARD with higher qualifications in fruit research, and the vigorous efforts being made by AARD to seek funding for the establishment of a new fruit research institute at Solok, give every reason to believe that fruit research could, in the future, achieve the same success as that already attained by vegetable research. In this chapter the review team has accepted such a premise and attempted to lay out not only a long term program with respect to research priorities, station development and manpower planning, but also has suggested what measures could be adopted in the short term, given existing constraints, to make the fruit research program more effective.

7.2 RESEARCH PRIORITIES

From a crop species viewpoint, research priorities vary appreciably among different ecological regions, but the first four of the fruit crops listed below occur in most regions in Indonesia and are the most important from an economic viewpoint (Table B1).

1. Citrus
2. Papaya
3. Banana
4. Mango
5. Apple
6. Grape

Citrus tops the priority list at the national level because of its economic importance, widespread distribution and the severity of the CVPD disease problem. Apple and grape are listed because they present an opportunity to obtain quick results from short-term research rather than because of their economic significance. In addition, some other fruits in certain areas may present special opportunities for research having good prospects for a short-term impact.

From a disciplinary viewpoint, research priorities, in suggested order of importance, are as follows:

1. Production of disease-free true-to-type planting stock of adapted varieties.
2. Evaluation of cultivars and rootstocks in the principal ecological zones.
3. Crop protection, including weed control
4. Management of soil moisture, irrigation and drainage

5. Post-harvest studies aimed at quality improvement and reduction of losses between the producer and the consumer
6. Socio-economic studies of marketing aimed at providing clearer insights into the structure, functioning and deficiencies of handling, transport and marketing of fruit crops. Hopefully, such studies could suggest a course of action leading to improved profits to the small fruit grower.

A brief commentary on each of these six activities follows:

1. Planting Stock

As with rice, palawija, and vegetable crops, improved culture of fruits begins in a most basic way with the production of pest- and disease-free true-to-type planting stock. Since most superior cultivars of fruits are propogated vegetatively, planting stock is produced in nurseries. The standards of nursery management in Indonesia, as judged by visits to both private and Government nurseries, are poor. The planting stock distributed to farmers for orchard planting is low in vigor and often grown in soils prone to be infested with noxious weeds and pests, such as nematodes and fungus diseases. In the case of citrus, at least, no effective measures were taken in the nurseries visited to use propagative materials known to be free of systemic pathogens, such as the bacteria-like organism causing CVPD and the many virus and viroid diseases which afflict citrus. These can all be transmitted by using diseased propagative materials. Healthy propagative materials can only be obtained from isolated specially treated mother trees frequently tested to monitor health status. Further stringent measures must be taken in the nursery to control known vectors of CVPD and other diseases spread by vectors.

2. Variety Improvement

It is essential to start experimental fruit plantings in major ecological zones as soon as possible. Such studies are inherently ponderous, but nevertheless basic to providing nurseries and growers with factual advice on varieties and rootstocks best adapted to their conditions. At present such decisions are not generally based on solid experimental evidence. Thus, the first plantings in the development of an experimental farm should include well replicated and randomized plantings of a few selected varieties (on several stocks when applicable) of tree fruits and vines. Such experiments will not yield extendable information in the near term, but will provide a fundamental component of any program of research with fruits.

It is recommended that variety improvement through hybridization, of fruits with long reproductive cycles, such as tree fruits, should not be undertaken until after the new Research Institute for Fruits is fully staffed and well developed. Until then, efforts should be concentrated on the evaluation of existing cultivars and selections, both indigenous and exotic.

3. Crop Protection

Effective control of insects, diseases, and weeds are very important elements of good orchard management in all climates, but are especially important in the tropics. Warm temperatures the year around favour short life cycles and a rapid increase in populations. Hence a strong crop protection component is at least as essential for an effective fruit crop production technology as for other crops in the tropics.

4. Management of Soil Moisture

As indicated in a previous section (2.6), some deep-rooted tree fruits have the ability to survive five or six months of drought, but do so largely at the expense of production. In dry climates (those which frequently have three or more months of drought) supplemental irrigation is required to improve production and quality. With some fruits, manipulation of the period of drought, through irrigation, can cause a shift of the timing of major blooms, and hence spread the harvest period appreciably.

In lowland soils with fluctuating water tables, poor aeration causes periodic damage to roots of tree fruits, most of which require deep, well-drained soils for good productivity and acceptable longevity. Hence a technology widely practiced elsewhere should be adapted to Indonesian lowlands if successful fruit culture is to be developed on imperfectly drained soils. Research should be started to evaluate planting on raised beds, together with various drainage systems, to prevent excessive damage to roots from the periodic rising of the water table too close to the bed surface.

5. Post-harvest

The export of a significant tonnage of fresh tropical fruits to overseas centers of population near Indonesia will require, among other elements, a sound basis of production and post-harvest technology. Without this, the lack of a secure, stable source of supply of first quality fruit will act as a key disincentive to the development of fruit exports as an earner of foreign exchange. Another difficult problem in fruit export is to secure the necessary producer discipline, in view of the prevailing pattern of production by small holders, to supply the demands of exporters for delivery of large tonnages (cargoes) of first quality fruit within a short time span.

Thus it is the view of the team that post-harvest research efforts should, in the near term, focus on the technology necessary to improve the internal market for fruits. In the course of time, this will lead to an improved capability for exploiting the apparently good potential for exporting some Indonesian fruits to foreign markets. Important lines of research should include studies defining objective standards of quality and maturity, and techniques for packaging, handling and shipping that reduce post-harvest losses, and contribute to a longer shelf life and consumer satisfaction.

A similar emphasis on quality applies to the processing of fruit products for export. Small processing plants in Indonesia must become sufficiently well established to produce a good product consistently and in a reasonably large volume, before possible foreign markets can be significantly exploited. Markets such as Japan, Australia, the United States, and Europe are especially exacting in the quality control standards demanded for canned or frozen fruits and fruit products.

6. Marketing

Poor marketing conditions were frequently cited by both the extension and research people, as well as senior officials of the Ministry of Trade, as the major restraint to the development of fruit and vegetable culture in Indonesia. Thus marketing might have been identified as the top priority line of research needed. It is listed here in sixth place not because it is less important than other lines, but rather because it is much broader

in scope than can be addressed by AARD alone. In addition to biological components, marketing involves trade regulations, transport, infrastructure, trading systems, socio-economic conditions and other factors. Thus it is suggested that any study aimed at improving the marketing of horticultural products should involve other appropriate government and private agencies, with AARD addressing the biological components, and perhaps some of the socio-economic factors.

The team noted that preliminary discussions along these lines were already underway through a proposal submitted to the Asian Development Bank (see Section 7.5).

7.3 A STATION DEVELOPMENT POLICY

In order to implement the type of strategy outlined in the previous section of this report, AARD will need to develop an appropriate network of fruit research stations. In this context the review team has certain reservations about the fruit station network that AARD is proposing to develop (Table D1). It considers that the number of stations and experimental farms to be developed during the next five years should be restricted in number. This is concordant with the likelihood of only a limited number of new research personnel being in place soon, and the probability of budget constraints to support them and their research. In the following sections, each of the proposed units is discussed and recommendations are made concerning its siting and development.

Solok

This recently acquired site for the National Fruit Research Institute at Solok (SOHRI) is located about two hours by road from Padang, West Sumatra. It is in a sizeable inland valley 400 to 600 meters in elevation, completely surrounded by mountainous terrain. Agriculture in this valley is dominated by rice and palawija crops, but also has many small citrus and other fruit orchards, mostly on upland soils. In other lowland and inland valley areas of West Sumatra, small fruit orchards are common, along with other tree crops such as cloves.

The new site consists of about 200 hectares of rolling to hilly land, largely in grass, rising from about 400 meters at its river boundary to over 600 meters at its highest point. Rainfall is around 2100 mm annually, with a dry period, normally during June, July and August. As a site for the national headquarters for the Fruit Research Institute it has the following advantages:

1. The climate is fairly representative of many fruit growing regions of West Sumatra and indeed of many others in the Indonesian archipelago.
2. The predominantly loamy soil appears deep and well drained, very important physical requirements for the culture of most fruit crops.
3. The large area of land permits ample scope of flexibility for development of long-range research programs with fruits (see Section 2.6).
4. Water for dry season irrigation can be developed by pumping from the river. This is a basic requirement for fruit culture in many regions.

Some disadvantages are:

1. The site is relatively isolated from the nearest sizeable town (Padang) with good communications and services. Staff people located here, especially those with families, may suffer from the lack of accustomed amenities, such as good schools, social contacts with peers, opportunities for discussions with other scientists, etc. This latter may be partially alleviated by the proximity (20 kilometers) of the Food Crop Research Institute at Sukarami.
2. Geographically it is not centrally located in the widely dispersed major growing regions of Indonesia, and is far removed from AARD headquarters.
3. The institute will have to struggle to maintain its identity as a national headquarters rather than a regional facility serving West Sumatra.

The soil of the Solok site, as judged by a very cursory examination,appears to have good physical characteristics for tree culture, but it is probably low in fertility. However, poor fertility caused by low levels of one or more plant nutrients is not a serious problem for the culture of tree fruits. The technology concerning their basic fertility requirements is well developed and lends itself to easy transfer. If, however, there is a toxicity problem associated with, for example, a very acid subsoil very high in exchangeable aluminum, the soil could present serious problems for the culture of most fruits.

The best use of much of Indonesian upland soil with low availability of essential nutrient elements may be the culture of permanent crops such as fruit trees. In addition, fruit trees planted on contours may be a better cultural system for erosive slopes of such upland soils than annual crops.

Hence an important first step would be the preparation of a detailed soil type and contour map. An expert evaluation of soil fertility and possible toxicity problems should be sought.

Malang-East Java

Some doubt was raised about the future tenure of the present site at Malang housing the staff concerned with research on fruits. Assuming this can be clarified with the local government so that at least another five years of tenure can be assured, the present Malang facility should continue to house the fruit research staff serving this important fruit growing region. When the new food crops building is completed at its new site near Malang, the space vacated could be taken over by the current fruit research staff and the existing facilities of the CRIFC be converted to become a fruit research station (sub-Balai). This would avoid the need for construction of new station facilities, at least in the short term. Concurrently, a new field station site should be sought in close proximity to the present Malang site. It should have at least 25 to 30 hectares of deep, well-drained (or at least readily drainable) land and ample water for irrigation of most of the site during the dry season. It should be close enough to the Malang station (with only about 3-1/2 hectares) so that it can handily serve as the main experimental farm facility for the station personnel. Some indication was made to the review team that such a site might be found.

Tlekung

The experimental fruit farm at Tlekung is not regarded as a suitable site for upgrading to station status because it is too small (12.5 hectares), its elevation is too high (950 meters) and there is doubt about the availability of adequate water for irrigation (4 to 6 month dry season). The present neglected condition of the experimental apple, citrus, and other plantings here contrast sadly with some nearby commercial plantings. The five-to-seven-year-old trees have suffered so badly from lack of adequate irrigation in the dry season, and from inadequate crop protection and other factors, that the trees are appreciably below a reasonable standard for commercial viability. Tree vigor, size and productivity are strikingly below those of good commercial orchards in the vicinity, such as the Taman International Orchard located only about 3 kilometers distant. Hence the overall impression of the Tlekung orchards detracts from AARD's credibility.

The Tlekung site should be retained as an experimental farm for research on highland fruits. However, a strong effort should be made to provide both adequate water (a 3 to 4 fold increase) for irrigation during the dry season and, of course, a suitable budget and competent farm management staff to maintain experimental orchards here at an acceptable level of vigor and productivity.

Cukurgondung

This mango collection, planted in 1941, should be phased out gradually during the next five years or so. The more valuable cultivars (scions or stocks) of commercial promise for fruit production, and those that might be valuable contributions to genetic diversity of Mangifera indica in a germplasm collection, should be repropogated and planted at Subang and other appropriate sites.

This experimental planting is no longer yielding significant new information. Its planting design does not lend itself to experimentation on cultural practices. The major results of the variety trials were summarised by Mr. Surachmat Kusumo in 1975.

This site (12.5 hectares) should be retained as an experimental fruit farm if an adequate supply of water can be developed for irrigating it during the dry months. Then, as needs arise and budget permits, small blocks of old trees could be removed in phases and replanted with experimental blocks of mangos or other fruits suitable for experiments with cultural practices, stimulation of flowering or other purposes.

Banjasari

This small station is only about 2 meters in elevation above the nearby sea and has almost no rainfall for six to eight months in some years and heavy rainfall during the rest of the year. There is sufficient irrigation water for about 3 of the 4.8 hectares total area. Research on grape culture currently being conducted here is severely handicapped by poor drainage during the wet season. Free water was observed (February 6, 1984) standing in ditches about 25 to 30 cm below the soil level on which the vines were planted, no doubt causing root damage which eventually will cause lowered vigor and productivity.

This would be a good location on which to conduct studies on the effect of bed structure, drainage and irrigation systems on perennial fruit crops. Attempts are being made to grow tree fruits and vines in many poorly drained lowland soils in Indonesia. Some of these wet lands could

be utilized effectively for fruit culture if planted on raised beds together with appropriate ditch and water level control systems (see Young, T.W., 1953, Florida Agricultural Experiment Station Bulletin 526).

Thus it is recommended that this site be retained as an experimental farm on which to conduct irrigation and drainage studies with tree and vine fruits, together with nursery management and other studies.

Punten

This small (2.7 hectares) experimental farm is at about 950 meters in elevation and has an ample supply of irrigated water. It should be retained as an experimental farm for nursery management studies with tree fruits, and for small collections of the most important cultivars of adaptable tree fruits in the dry highlands. The practice of growing paddy rice in close proximity to such tree plantings should be eliminated. Because of drainage problems, paddy rice and tree fruits are not compatible unless the trees are planted on beds raised considerably above the paddies.

Maros-South Sulawesi

It is recommended that a decision on the development of a fruit experiment station (sub-Balai) at Jeneponto or elsewhere in the area be deferred until adequate information on water resources, both present and potential, becomes available. In this dry region adequate water for irrigation and a well-drained soil are essentials for tree fruit research as well as for good commercial production.

A careful study should be made of the underground water resources in the upland soils of the Takalar-Jeneponto area of South Sulawesi. The question is: can wells provide enough water at a bearable cost to irrigate fruit crops during the five to six months of dry weather in this region? In addition, a related study should be made of current or projected plans, if any, by the appropriate public works or similar agencies for providing farmers with water for fruit crops from surface irrigation projects during the dry months. It makes little sense to have an irrigated research station in an area unless the farmers in that area also have irrigation.

The proposed survey should also gather information on the present distribution, hectarage, production, and value of fruits growing in South Sulawesi. In addition, attention should be given to estimating the potential for future expansion of fruit culture in the area.

Information provided by the above studies is needed before sound decisions can be made regarding the establishment of a fruit research station in the area. The present fruit research staff should remain at Maros until a new site is selected and adequate new facilities are provided.

Jeneponto

This site is not considered suitable for a sub-Balai for fruits in South Sulawesi because it does not have available irrigation water during the dry season. Also, it is rather remote from a town with good communications (Ujung Pandang). The deep, well-drained soil appears suitable for fruit culture even though it is low in fertility and somewhat stoney.

When this site was visited by an IBRD team six years ago, the irrigation canal forming one boundary of this station was under construction. The team at that time was led to believe that ample water from this canal would be available for irrigation during the dry season not only for all of the station, but also for a substantial area of this region devoted to tree culture. Local information now indicates that there is no water available for irrigation in the dry season except for rice, not even for the Jeneponto AARD farm.

Subang

The developing fruit collection at Subang is planned to contain most of the cultivars and related materials located at Pasar Minggu, Curkurgondung, and Lembang, together with other valuable selections of indigenous and exotic cultivars and species.

It is clear that a germ plasm collection of perennial fruits cannot be equated to that of seed-propagated annual crops such as rice or corn. With such annuals, seeds of many thousands of lines, cultivars or species can be preserved in one facility at a reasonable cost per accession. However, a fruit collection, with most of the most important cultivars represented by large vegetatively propagated trees, requires a large area to accommodate a density of 100 to 750 plants per hectare, depending on species. Hence fruit germ plasm collections are severely restrained by practical propagation, space and budget considerations. A comprehensive tropical fruit germ plasm collection is currently beyond the resources of AARD. In the future, it is probable that techniques may be developed for the long term preservation of viable vegetative propagation material of fruit using cryoscopic 'in vitro' techniques, or other methods having a similar economy of space and cost. Until such technology becomes available, fruit germ plasm collections need to take special care in selecting their materials in order to provide only the most important sources of genetic diversity.

In view of the above, the Subang collection, as a part of the Fruit Research Institute, should have two parallel and complementary functions: (1) the preservation of genetic diversity of selected fruits; and (2) the primary screening of cultivars of selected fruits of promise in Indonesia. Included in the germ plasm collections should be indigenous and exotic selections of wild stands and planted seedlings, as well as materials from near relatives which might be useful as rootstocks or as sources of genetic diversity for future breeding. Most indigenous and exotic cultivars selected for screening for commercial promise will also serve the germ plasm function.

Thus Subang, because of its unique mission, should be attached directly to the Solok headquarters as a specialized facility (Figure 1).

Pasar Minggu

Post-harvest research (including processing) with horticultural crops is currently centered in several laboratory and office buildings taken over from the former Pasar Minggu Horticultural Research Institute, now abolished. Almost no research of this nature is done elsewhere on horticultural crops. Currently about 25 percent of the effort is concerned with fruits, and about 75 percent with vegetables. Thus there are currently fewer man/year staff equivalents devoted to fruits than is indicated in Table G2, which was calculated on a 50:50 distribution.

The laboratories are fairly well equipped, but some instruments for measuring fruit respiratory and related activities for studies of post-harvest physiology are lacking. The pilot plant for processing work has been inoperative for several years because of a faulty steam generator. The productivity and impact of experiments with fruits at this station in the past two or three years has been pedestrian. Some waxing studies for prolonging the shelf life of guava and other fruits show promise. Analyses have been made (unpublished) describing chemical and physical characteristics of fruits in relation to variety and maturity. These should be useful in developing maturity and quality standards. Packaging of rambutan in polyethylene also shows similar promise. Some of the processing studies on dried and canned fruits, and bottled fruit juices are aimed mainly at kitchen use by housewives.

It is suggested that post-harvest research on both fruits and vegetables should remain at Pasar Minggu, at least for the next two or three years. Tenure of the post-harvest research in its present site is not secure, and the facilities may soon be pre-empted by other uses according to information from AARD headquarters. Thus a careful study should be made of possible alternative locations. One would be to develop a post-harvest research facility for fruits at either Solok or Malang and a similar facility for vegetables at Lembang. Another alternative would be to develop another facility for both fruits and vegetables at either Lembang or Malang. There are advantages and disadvantages to both possibilities.

There is a distinct advantage to having post-harvest research coupled as closely as possible with pre-harvest activities. Inputs from both types of specialists will greatly improve research design and the validity and attainability of objectives. On the other hand, requirements of both fruits and vegetables for laboratories, equipment, and special facilities such as cold storage, housing for grading and packing machinery, etc., are quite similar, and could be used more economically if shared. Probably the most viable long term solution, despite the disadvantages, would be to provide a post-harvest staff and facility for fruits at Malang and a similar staff and facility at Lembang for vegetables.

Whether or not processing research should continue to be a part of post-harvest research should be a subject for careful study in consultation with the Indonesian private processing industry, agricultural production leaders, and with appropriate government agencies such as those concerned with extension, marketing and trade. If the processing industry were supportive, development of an interagency or even an autonomous research insitutute with a substantial component of funding by the private sector would be an excellent solution. If no support for either of the above alternatives appears likely, then AARD should continue to consider processing as a part of post-harvest research, and proceed to plan for manpower (Table G2) and facilities for this activity. It should, however, look forward to industry ultimately taking over the major cost of such research.

However post-harvest research on horticultural crops is reorganized in mandate and location, it should have better linkages with producers, trade organizations, wholesalers, retailers, agricultural extension, and other appropriate government and university organizations and consumers. There is a strong need for inputs from such clientele. For this purpose

the review team recommends that an advisory committee should be appointed by AARD to review, at least annually, proposals for future post-harvest research, and progress made during the past year. This should stimulate a better setting of priorities, and encourage more cooperative efforts at solving problems.

The review teams recommendations regarding locational structure of fruit research over the next five years are summarised in the organogram presented as figure 1.

7.4 MANPOWER TARGETS

In order to mount a full fruit research program there will need to be a major build up in scientific staff. The review team has examined the manpower targets of AARD (Table G2). It considers that the number of staff proposed is of the correct order of magnitude for staffing the proposed new institute at Solok with supportive stations and farms. However, it does not believe that it will be feasible to develop the proposed number of staff by 1990 given the time element involved in post-graduate training. Rather it proposes that the AARD 1990 target should be seen as a 1994 (ten year) goal, the team itself has suggested (Table 15) an interim goal for 1989.

Annex Table G3, which gives a comprehensive staffing plan for fruit research, is essentially a modification and extension of part of Annex 3, Table 4 presented in the document, "Proposal for an Indonesian Fruit Research Institute", prepared by AARD dated October 23, 1983. Except for some breeding with papaya and possibly other short reproductive cycle fruit, no actual breeding involving hybridization with tree fruits is envisioned until after the Solok Fruit Research Institute is fully developed. Weed control specialists are identified because this is a modern crop protection discipline of special importance in tropical fruit production. Post-harvest pathology is identified as a discipline of special importance in reducing spoilage losses occuring between the producer and the consumer. The term 'water management' is clarified to identify its two principal components, irrigation and drainage.

The total of 161 research workers listed in Table G3 represents a judgement of the target size for scientific staff that will ultimately be needed to adequately support the development of the great potential for tropical fruit culture in a country as large and diverse as Indonesia. It is, however, fully recognized that budget constraints and other problems may impose some limitations in achieving this full staffing. Again, it is emphasized that special care is needed in phasing the staff training and support budget to avoid an imbalance which might cause neglect of experimental plantings. These cannot be discontinued as easily and with as little penalty as with annual crops (see Section 2.6).

The major problem likely to be encountered in developing the overall fruit research program is that of building up an adequate cadre of trained staff sufficiently rapidly.

It is evident that all the Ph.D. level staff training for horticultural research will have to be done at qualified institutions overseas. However, the large number (Table G2) of M.Sc. level staff should, with a few exceptions, be trained locally if possible. This will probably be

FIGURE 1

SUGGESTED ORGANOGRAM FOR FRUIT RESEARCH WITHIN AARD (February 1984)

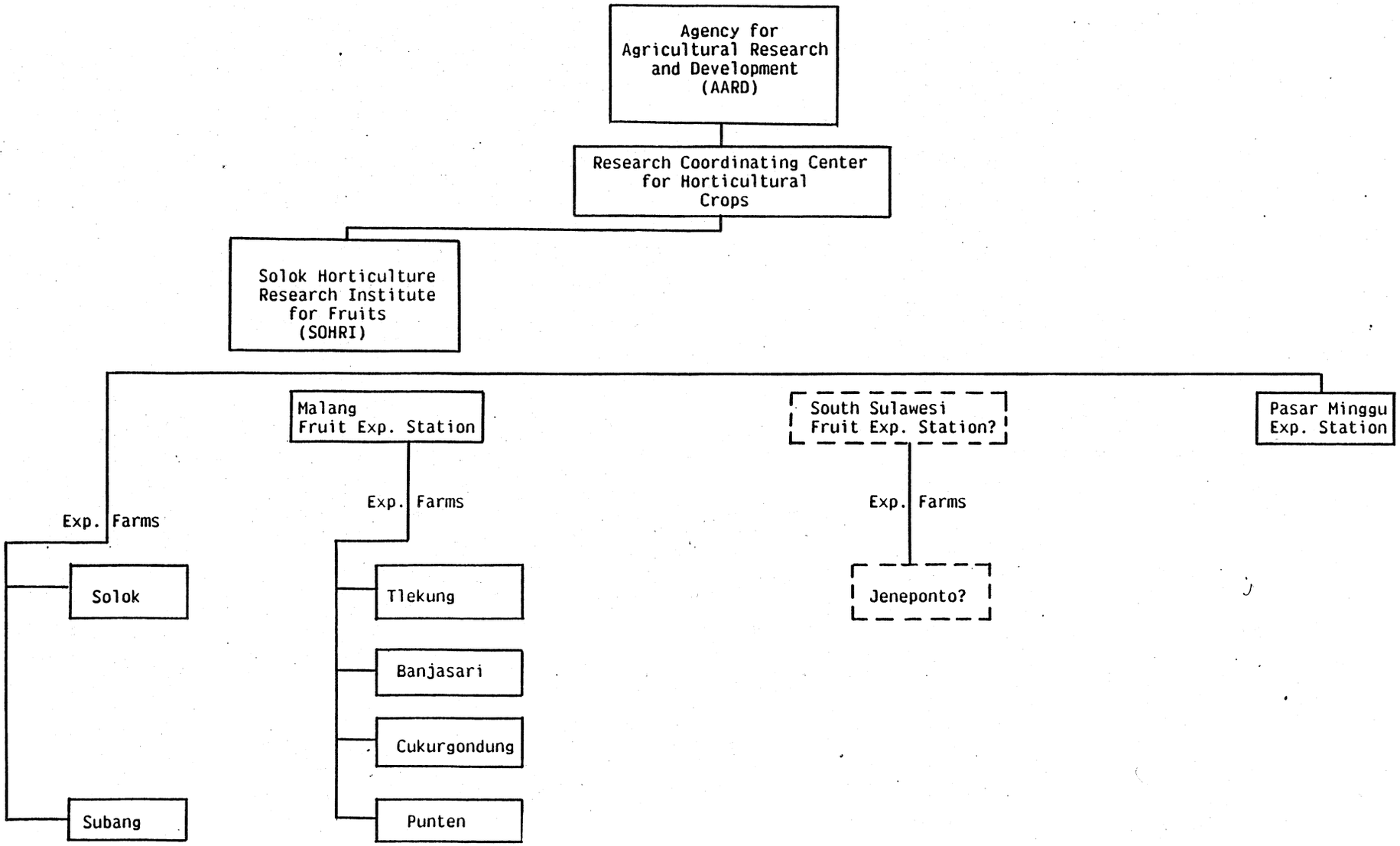

TABLE 15

CURRENT AND PROPOSED MANPOWER LEVELS FOR FRUIT RESEARCH

Proposed Staff Training Level	Current Staff						Proposed Staff	
	Lembang	Malang	P. Minggu	Sub-Total	In-Training	Total	1989	1994
Ph.D.	0	1	1	2	2	4	15	28
M.Sc.	1	3	2	6	10	16	25	45
B.Sc/Sarj.	1	16	8	25	0	25	50	88
TOTAL	2	20	11	33	12	45	90	161

In examining the 1994 target the team has attempted to define in some detail the type of disciplinary inputs likely to be required on each component unit of a fully staffed fruit research program (Table G3).

Suggested needs for the 1984-89 and 1990-94 periods are presented because plans for tree fruit research, by virtue of the long-lived nature of most of the plant species dealt with, must project further into the future than is necessary for annual crops.

more cost effective, and in the long run will provide an important step toward becoming self-sufficient in producing locally-trained research staff. In addition, it will provide a badly needed upgrading of the specialized undergraduate training needed by students in horticulture and related disciplines.

Local training as the M.Sc. level might be accelerated by entering into a contract with a suitable, recognized overseas university to supply experienced professors to teach the specialized horticulture, plant protection, statistical and other related courses needed, and to supervise thesis projects. Such thesis projects should be essentially an apprenticeship in the design and execution of research involving real problems in horticultural crop production in Indonesia. Such a capability will be essential for sustaining the growth of horticultural research and development in Indonesia.

7.5 EXTERNAL ASSISTANCE

Reference has been made earlier in this chapter to three areas where external assistance could benefit the fruit research program. the first related to a study on fruit marketing and it is noted that this is already a subject that is being considered for assistance by the Asian Development Bank (ADB).

The ADB is also examining the proposal for an "Indonesian Fruit Research Institute" on lands that AARD now owns at Solok. The review team has been asked to comment on this proposal. In general it finds it to be soundly conceived and worthy of strong support. The following specific comments seem appropriate:

(1) No mention is made in the proposal of the very important and difficult task of organising and managing the training necessary to meet the targets shown in Annex 3, Table 4. The review team has commented on the time perspective of the manpower targets and their disciplinary breakdown and has offered a suggestion regarding M.Sc. training in the last section of this report.

(2) The cost estimates shown globally in Annex 3, Table 2 will have to be phased very carefully to avoid imbalances between trained staff in place and necessary facilities to accommodate tham. Any imbalances between experimental fruit plantings and funds to support them properly could also cause not only wasted effort and resources, but damage to the new Institute's credibility.

(3) Decisions on the sites of the new research stations for fruit in East Java and South Sulawesi should be deferred a few months in order to make more detailed surveys of water resources for irrigation and other factors of importance in the selection of sites for these sub-institutes (Section 7.3). Likewise, decisions with respect to where postharvest research component(s) should be conducted should be deferred until a more thorough study is made, (see also Section 7.3).

(4) The estimate of technical assistance may be too low if it is desired to use such help to push ahead rapidly with the development and implementation of an expanded fruit research program during the next five-year period, while local staff are away training. For good progress to be achieved with the numbers proposed, particular care will need to be taken in their selection.

Another major proposal for external assistance is entitled "Citrus Rehabilitation Pilot Project" (CREPP) and enlists support from UNDP, or another donor agency, for a 5 year program to demonstrate the feasibility of rehabilitating citrus culture in Indonesia. this is currently ravaged by a number of problems including a severe bacterial pathogen (CVPD) transmitted by insects and infected propagating material. The proposal calls for research and extension to be given major emphasis and to be strongly linked.

The review team's citrus specialist has given particular attention to this proposal and regards it as sound in principal and overdue. The following comments are relevant:

(1) To be successful, such a project needs a strong resident leader with a four- to six-year tenure who can manage people of diverse backgrounds and interests. He should be a well-qualified scientist, prerably with a strong horticultural or crop protection background.
(2) There are some important gaps in our knowledge of CVPD. Is this disease identical with 'greening' in South Africa? Will it be possible to limit the rate of spread by vectors to an acceptable level? Are there other as yet unidentified, vectors in Indonesia? Have all the alternate hosts been identified? Will systematic treatment of infected trees with antibiotics prevent or appreciably limit their ability to infect vectors? How effective will systematic eradication of infected trees be in retarding spread? Can a practical, reliable technique for positive early detection of CVPD infection be developed shortly? To what extent do poor cultural practices aggravate the ravages of CVPD?

Although all of these questions need answering under Indonesian conditions, there is encouragement that many of these can be answered favorably during the progress of the program. Hopefully, a technology can be developed which will enable growers to live with the disease.

Thus it is judged that the prospects are good (but not excellent) for a viable rehabilitation program to be developed which will sustain profitable citrus culture in Indonesia.

7.6 A RESEARCH PROGRAM FOR THE 1980's

Much of what has been written so far in this Chapter has a 5 to 10 year plus horizon and sets the framework for a fruit research program of the future. But to establish credibility, the scientists working in fruit research during the developmental period of the Fruit Research Institute need first to work in some areas where a quick impact from limited resources is feasible, and second to start the groundwork in top priority areas whose impact is not likely to emerge until the medium term. With this in mind, the review team has five suggestions to offer:

1. Citrus Nursery Technology

Citrus would provide the best opportunity to demonstrate the value of starting a new fruit orchard with vigorous, healthy planting stock. The technology is mostly available but remains to be adapted to Indonesian conditions. Such adaptive research is an integral part of the "Citrus Rehabilitation Pilot Project", referred to earlier in this Chapter.

In view of the likelihood of the above proposal receiving support, it is recommended that the production of vigorous, true-to-type citrus nursery stock free from pests and diseases be the top priority research activity of the new Fruit Research Institute. Despite some gaps in our knowledge of the CVPD disease, the activities and facilities needed to implement the nursery phase of the Citrus Rehabilitation Pilot Project should be pushed vigorously. Whatever the outcome, it should serve as a model for improving planting stock for fruit culture in Indonesia, and for strengthening the training of the staff involved.

2. Citrus Varieties and Rootstocks

Several experimental plantings of a few carefully selected varieties of orange (C. sinensis) and mandarin (C. reticulata) cultivars (both standard commercial and other) grafted on a few carefully selected rootstocks (including the standard Japanese Citron) should be planted in three or four selected locations in Indonesia. Such plantings should incorporate statistically sound designs that will permit sound conclusions to emerge. Most of these should be another integral component of the "Citrus Rehabilitation Pilot Project", mentioned in the previous Nursery Technology Section. One of these trials should be among the first experimental plantings of the new Solok headquarters station, as soon as adequate facilities are available to provide for suitable planting stock and orchard care. Such plantings will serve as good indicators of fertility problems for all tree crops, since fertilization technology for citrus is highly developed.

3. Papaya Breeding

There is great diversity in papaya fruits offered for sale in the markets of Indonesia. Much of the fruit offered is of inferior eating quality, and poorly adapted to prevailing handling and transportation conditions. It is an important crop produced for market by small-holders near the major population centers, and also as a fruit for home consumption. Even though it is an herbaceous perennial, it has a reproductive biology with a short life cycle, and thus lends itself to improvement through breeding within a time-frame comparable to some annuals. There is a substantial technology base for breeding, developed in Hawaii and elsewhere. Improved varieties would have potential for export both fresh and as industrialized products. Experience in Hawaii, Venezuela, Australia, and elsewhere has shown that superior papaya varieties mostly have a narrow range of adaptation to ecological conditions, and hence varieties have to be specifically selected for the conditions in which they are to be grown. A recent report, to AARD, "Development of a Papaya Improvement Program", by H.J. Nakasone (University of Hawaii) dated June 1983, outlines some of the methodology required.

In view of the above considerations, it is recommended that papaya variety improvement be given top priority as a line of research. With rigorous prosecution in at least one major producing area, it would have an excellent chance to lead to the introduction, within three or four years, of a superior variety identified with AARD.

4. Stimulation of Mango Flowering

Poor yield of mango, apparently caused by erratic and sparse flowering, is a common problem in its culture in Indonesia, and indeed in many regions of tropical Asia. The low yields reported for mangoes at the Cukurgondung station appear to be typical of mango plantings elsewhere in Indonesia. Part of this may be due to extreme water stress during the dry season, but part is also due to erratic, sparse flowering and poor set. Experiments in the Phillipines[1] and elsewhere indicate that flowering may be stimulated by treatment with chemical sprays of the foliage. Such studies with KNO3 sprays at Cukurgondung have been already started, but so far without encouraging results. It is recommended these studies with KNO3 be enlarged to include other locations and other cultivars. Also, greater attention should be given to dosage and timing in relation to growth conditions. Further, selected growth regulating chemicals, particularly those which have shown stimulation of flowering in other crops, should be tested. A short-term consultant should be brought in to help in the design of experiments to be conducted and to monitor results after one year. In view of the success of this work in the Phillipines and elsewhere, adaptive research with such treatments should have a good potential for quick success in Indonesia.

5. Chemical Defoliants

In the culture of temperate zone apples under tropical conditions, an essential feature of flower induction is the removal of leaves, mostly by hand stripping.[2] The culture of grapes in the tropics is similarly dependent on a combination of pruning and stripping of leaves to promote flowering.

It is recommended that studies be initiated to evaluate chemical defoliants[3] as a means of leaf removal in both apple and grape production. A short-term consultant should be engaged to help design future experiments, and to evaluate results later. This could be an area of research with the potential for a quick impact on the culture of these two temperate fruits.

[1] Bondad, N.D., and E. Linsangan. 1979. Hort. Science 14: 527-528

[2] Surachmet, K. 1970. Bertojotjoktanamapel. Tjabank Lembaga Penelitian Hortikultura, Malang.

[3] Larsen, F.E., and G.D. Lowell. 1977. Hort. Science 12: 580-582.

CHAPTER 8

PRIORITIES FOR VEGETABLE RESEARCH

8.1 INTRODUCTION

The review team has noted, in a number of places in this report, its broad agreement with the strategy being pursued in vegetable research. It takes issue with the current program in a number of points of detail but only one of substance, namely that more emphasis should be given to working at lower elevations. We feel that this should be done not by establishing new stations, but by outposting Lembang staff and funds to locations such as Maros, Malang and Bogor, where land and facilities associated with the Food Crops Research Institutes at these locations could be used for vegetable research. We believe that the most cost-effective way for the Lembang institute to broaden its regional coverage would be by establishing cooperative programs of this nature within AARD and that the Director of Horticultural Research should ensure that sufficient budget is available for such work off the Lembang station.

We also suggest that within this conceptual framework the time is appropriate for an in-depth review of vegetable research priorities, program areas and experiments and that this should be an early task for the Vegetable Research Institute. We were specifically asked by the Director General of AARD to offer some proposals towards such a review and the rest of this Chapter is a detailed response to that request.

We would, however, like to stress that our proposals should be interpreted as no more than suggestions for consideration by the Vegetable Research Institute. We had neither the time nor the manpower to prepare an exhaustive master plan for vegetable research and offer the following proposals as a framework for a discussion amongst those national scientists who will ultimately have to conduct the research.

8.2 PROGRAM AREAS (RPTP's) AT LEMBANG VEGETABLE RESEARCH INSTITUTE

As a first stage in tightening the existing program priorities at Lembang, we propose that the existing 18 program areas (RPTP's) might be reduced to the 10 shown below. (See Table 16).

8.3 A DETAILED RESEARCH PROGRAM FOR LEMBANG VEGETABLE RESEARCH INSTITUTE

Within the suggested revision of program areas and taking into account existing staff and those likely to shortly return from training we have, in the rather detailed table below, attempted to map out a proposed overall research program. This links the likely available resources to program priorities as defined by the recent AARD - CIP review (for potatoes) and by this review team (for other vegetables). (See Table 17).

TABLE 16

PROPOSED REVISION OF PROGRAM AREAS FOR VEGETABLE RESEARCH INSTITUTE LEMBANG WITH THE PRESENT PRIORITY COMMODITIES

COMMODITY	PROGRAM AREAS (RPTP's)
1. Potato	1. Strengthen seed productions technology 2. Varietal improvement and development of appropriate production technology for new agroecological zones (medium elevation).
2. Tomato	3. Varietal improvement for highland and new agroecological zones (medium/low elevation). 4. Development of appropriate production/post-harvest technology for new agroecological zones and continuing studies on specific problem-oriented practices for highland production zones.
3. Cabbages (including Chinese Cabbage)	5. Continuing studies on plant protection practices. 6. Adaptation trials of introduced cultivars for highland and new agroecololgical zones (medium/low elevation). 7. Post-harvest technology for highland and new agroecological zones (only once production is reasonably established in these new zones).
4. Beans	8. Varietal improvement (with emphasis on introduction/testing).
5. Pepper (for lowland culture)	9. Varietal improvement. 10. Development of appropriate production technology for lowland and for off-season production.
TOTAL PROGRAM AREAS	10

TABLE 17

DETAILED PROPOSED PROGRAM FOR WORK FOR LEMBANG ASSUMING EXISTING 5 PRIORITY CROPS AND INDICATING AREAS OF RESEARCH AND DISCIPLINARY INVOLVEMENT

COMMODITY	MAJOR PROGRAM AREAS ("RPTP") AND SUBJECT MATTER AREAS	DISCIPLINES INVOLVED/RESEARCH PRIORITIES AND/OR MAJOR RESPONSIBILITIES
Potato	RPTP-I STRENGTHEN TECHNOLOGY FOR SEED PRODUCTION	
	A Production of virus-free nuclear stock seeds for eventual production of healthy commercial seed tubers	A-1 Tissue Culture Specialist (i) Production of "healthy" seed stocks through tissue culture (TC) - pre-basic seeds. (ii) Rapid multiplication of virus-indexed healthy stocks to produce healthy pre-basic seeds in relatively large quantity (iii) Maintenance of healthy status of such seed stocks.
		A-2 Virologist (i) Virus-indexing of tubers derived from tissue culture. (ii) Monitoring of eventual seed production lots for extent of virus reinfection.
		A-3 Seed Production Specialist* (i) Multiplication of pre-basic seeds in stages in preparation for certified seed production (as eventual target) in suitable areas. All types of seed production lots should be monitored for virus reinfection by virologist and carefully rogued.
	B Continuing Studies on Relevant Aspects of Seed Production	B-1 Seed Production Specialist* (i) Adaptation of technology developed by agronomists in maximising seed-size tuber production on relatively large scale basis (actual seed production).
		B-2 Agronomist (i) Continuing studies on methods to maximise production of seed-size tubers. (Note: This research area need not be duplicated if technology is already available).
	C Development of TPS (True Potato Seed) Technology for Production of Seedling Tubers to be Used for Commercial Production	C-1 Potato Breeder (i) Evaluation of TPS families for yield and other horticultural characters. (ii) Selection of promising clones from such families for the purpose of replacing old families. (iii) Evaluation of first generation tuber families for commercial production feasibility for remote areas like Sulawesi.
		C-2 Agronomist (i) Development of TPS production technology.

* This function may be eliminated if production of basic and foundation seeds is contracted with a private seed company (e.g. "Sang Hijang Sri").

TABLE 17 (continued)

	RPTP II	CONTINUING IMPROVEMENT OF CULTIVARS AND DEVELOPMENT OF APPROPRIATE PRODUCTION TECHNOLOGY FOR NEW AGROECOLOGICAL ZONE	
	A	Evaluation of introduced germplasm and those derived from local breeding work (with emphasis on major diseases such as Late Blight and Bacterial Wilt	A-1 Potato Breeder (i) Evaluation of horticultural characters. (ii) Selection of promising clones for direct release/use in breeding program.
			A-2 Plant Protection Specialist (i) Evaluation of resistance to late blight and bacterial wilt if such lines are available.
			A-3 Tissue Culture (Propogation) Specialist (i) Rapid multiplication of healthy stocks (introduced/local); (ii) Maintenance in healthy state of clones under test.
	B	Adaptation trials under medium elevation	B-1 Potato Breeder (i) Evaluation of test clones for heat tolerance and other major characters.
			B-2 Plant Protection Specialist (i) Evaluation of test clones for bacterial wilt and other major diseases in the medium elevation area. (ii) Development of control measures for known controllable diseases (note: BW is difficult to control chemically).
			B-3 Agronomist (i) Development of appropriate cultural practices to improve yield (e.g. mulching, ridging, cropping system such as after rice, etc.,) and also in relation to pest/disease control. Note: In such studies, use of cultivars identified by breeders as adapted to new agroecological zones will be necessary to see if further improvement through appropriate practices can be achieved.
Tomato	RPTP III	DEVELOPMENT OF IMPROVED CULTIVARS FOR HIGHLAND AND NEW AGROECOLOGICAL ZONES (MEDIUM/LOW ELEVATIONS) AND FOR OFF SEASON PRODUCTION	
	A	Pure line selection among locally grown cultivars	A-1 Tomato Breeder (i) Derivation of improved lines and maintenance of pure stock seeds for eventual release.
			A-2 Plant Protection Specialist (i) Cooperation with breeders to evaluate pure lines for resistances to major diseases (if such are available).
	B	Varietal testing of cultivar introductions	B-1 Tomato Breeder (i) Evaluation of introductions for adaption to different agroecological zones (as specified by nature of cultivars based upon information from source), and maintenance of pure stock seeds.

TABLE 17 (continued)

			B-2 Plant Protection Specialist (i) Cooperation with breeder to evaluate resistances to major diseases (or pests) among new introductions in different agroecological zones to which they are being tested for adaptation (e.g. highland - late blight, lowland - bacterial wilt and other diseases).
	RPTP-IV	DEVELOPMENT OF IMPROVED TECHNOLOGY OF PRODUCTION/POST-HARVEST HANDLING FOR NEW AGROECOLOGICAL ZONES AND CERTAIN PROBLEM-ORIENTED AREAS FOR HIGHLAND PRODUCTION	
	A	Agronomic practices /cropping system	A-1 Agronomist (i) Development of appropriate cultural and management practices for new agroecological zones (using cultivars identified as suitable by breeders) to see if further improvement can be attained/also in relation to disease control (cooperation with plant protection specialists). (ii) Further studies on techniques to improve highland tomato productivity, taking into account methods that have not been tested/studied before (problem-oriented areas).
	B	Plant protection methods	B-1 Plant Protection Specialist (i) Develop control measures for major diseases in new agroecological zones (note: Bacterial wilt is difficult to control chemically and efforts should be directed on finding resistant varieties; other fungal diseases that constrain production in these new areas should be emphasized in finding control measures). (ii) Continuing studies on serious diseases (e.g. late blight), for highland production and their control.
	C	Post-harvest handling practices	C-1 (i) Development of appropriate, economical postharvest handling methods to reduce losses (assuming this to be a significant constraint) not only in highland production, but also in the new agroecological zones once these are reasonably developed (assuming that the same problem exists).
Cabbages (including Chinese Cabbage)	RPTP-V	CONTINUING STUDIES ON PLANT PROTECTION PRACTICES*	
	A	Control of common pests and diseases through chemical Means	A-1 Plant Protection Specialist (i) Continuing work on the identification of effective, economical means of chemical control of pests and diseases.
	B	Studies on other methods of control (either by itself or in combination with chemical control).	A-2 Plant Protection Specialist (i) Exploration or intensification of non-chemical (biological and other methods), means of pest/disease control if already tested.

* Special emphasis on diamond back moth for pest and possibly clubroot for disease (especially if deemed serious).

TABLE 17 (continued)

	RPTP-VI	ADAPTATION TRIALS OF INTRODUCED CULTIVARS FOR HIGHLAND AND NEW AGROECOLOGICAL ZONES (MEDIUM/LOW ELEVATION)	
	A	Variety trials of introductions	A-1 Cabbage Breeder (i) Evaluation for adaptatability of new introductions for areas they have been specifically bred for.
			A-2 Plant Protection Specialist (i) Evaluation of new introductions for major disease resistance in different agroecological zones where they are being tested for adaptability.
	B	Agronomic practices/cropping systems for new agroecological zones **	B-1 Agronomist (i) Development of appropriate cultural practices/cropping pattern for production in the new agroecological zones (use adapted varieties).
	C	Seed production studies on species (e.g. Chinese Cabbage) that can be multiplied locally	C-1 Seed Production Specialist (i) Studies on techniques to induce full flowering, time of seed production, etc., to produce good quality seeds economically.
	RPTP-VII	POST-HARVEST TECHNOLOGY FOR HIGHLAND PRODUCTION/NEW AGROECOLOGICAL ZONES	
	A	Post-harvest handling techniques	A-1 Post-harvest Technologist (i) Development of appropriate/economical post-harvest handling methods to reduce losses in highland production. (ii) Identification of post-harvest problem areas in new agroecological zones once production is reasonably established, and problem solving studies.
Beans	RPTP-VIII	VARIETAL IMPROVEMENT PROGRAM	
	A	Variety evaluation trial of new introductions	A-1 Bean Breeder (i) Evaluation of new introductions for performance/other important horticultural traits, and maintenance of pure stock seeds.
			A-2 Plant Protection Specialist (i) Evaluation of new introductions for resistance to major diseases.

** These studies may be undertaken once the potentials of certain cultivars in the new environment have been extensively tested.

TABLE 17 (continued)

Pepper (especially for lowland culture	RPTP-IX	VARIETAL IMPROVEMENT	
	A	Pure line selection, among commonly grown local cultivars	A-1 Pepper Breeder (i) Identification of improved lines and maintenance of pure stock seeds for eventual release. (ii) Maintenance of pure seed stocks of outstanding introductions
			A-2 Plant Protection Specialist (i) Evaluation of pure lines for resistance to major diseases/pests.
	B	Variety evaluation of new introductions	B-1 Pepper Breeder (i) Evaluation of new cultivar introductions for performance/ other horticultural characters
			B-2 Plant Protection Specialist (i) Evaluation of new introductions for resistance to major diseases and pests.
	RPTP-X	DEVELOPMENT OF IMPROVED PRODUCTION TECHNIQUES FOR LOWLAND AND FOR OFF-SEASON PRODUCTION ***	Agronomist Plant Protection Specialist

*** It appears that nothing much has been done to improve production practices in lowland pepper production so a wide range of studies may be envisioned for agronomists/cropping systems specialists to undertake. Some emphasis should be given for off-season production to diversify/ distribute production over time to minimize drastic price fluctuations.
Similarly, plant protection measures need to be developed by plant protection specialists to minimize, if not totally control, production problems imposed by common/major pests and diseases.

8.4 PROGRAM AREAS FOR OTHER STATIONS

We have not attempted the very detailed exercise carried out in Section 8.3 for stations other than Lembang. We have however, tried to indicate what we consider to be the priority program areas (RPTP's) for vegetable research at Brastagi, Malang and Maros and we recommend that all such research at these locations should be fitted into these rather specific programs (See Table 18).

8.5 POSSIBLE PROGRAM AREAS FOR LOWLAND VEGETABLES

The final table in this chapter offers suggestions as to which lowland vegetables and in what areas of research the review team considers worthy of further consideration. These are but preliminary ideas which the CRIH will need to be refined and sharpened before implementation. In doing so it will need to recognise that the clients for this research are likely to be home garden owners rather than commercial agriculture, because these crops are not high income cash crops but are grown for their variety and nutritional value. (See Table 19).

TABLE 18

PROPOSED PROGRAM AREAS FOR OTHER STATIONS *

STATION	CROP	PROGRAM AREAS
1. Brastagi	Cabbage	1. Adaptation of Lembang developed technology with emphasis on post-harvest and improved cultivars/or develop new techniques if not applicable.
	Potato	2. Same as above with emphasis on testing of cultivars, (especially those with resistance to Late Blight.
	Tomato	3. Same as above with emphasis on testing of new introductions.
2. Malang	Garlic	1. Variety trial/clonal selection. 2. Plant protection methods.
	Shallot	3. Variety improvement. 4. Post-harvest technology 5. Agronomic practices for off-season production. 6. Plant protection.
	Pepper	7. Adaptation of Lembang developed technology with emphasis on improved cultivar, cultural practices, plant protection methods, etc.
3. Maros	Cabbage	1. Adaptation of developed technology from Lembang especially improved varieties, post-harvest handling, plant protection measures; or develop new techniques if not applicable.
	Potato	2. Same as above with emphasis on new improved cultivars, appropriate practices and plant protection measures.
	Tomato	3. Same as above with emphasis on new cultivars (highland/lowland), agronomic practices (highland/lowland) and plant protection techniques (highland/lowland)

* Other stations are to be considered testing grounds for technology developed at Lembang with special emphasis on problems common in the region covered by each station. Certain stations (e.g. Malang) may be given primary responsibility for developing technology for crops that are major commodities in that area which cannot be effectively covered by Lembang.

TABLE 19

SOME POSSIBLE PROGRAM AREAS FOR LOWLAND TYPE VEGETABLES *

CROP	PROGRAM AREA**
1. Amaranth	1. Variety evaluation 2. Management practices (including plant protection) 3. Seed production/storage techniques
2. Upland Kangkong (water convulvulus)***	1. Agronomic practices 2. Seed production techniques/storage techniques for seeds.
3. Yard Long Bean	1. Variety trials/pure line selection 2. Seed production/storage techniques for seeds 3. Plant management practices (including plant protection).
4. Other Leafy Vegetables, e.g. Chaisim, Leafy Chinese Cabbage, etc.	1. Variety trials 2. Management practices (including plant protection).
5. Other Fruit Vegetables, e.g. Eggplant, Cucumber etc.	1. Variety trials 2. Management practices (including plant protection). 3. Seed production/storage techniques for seeds

* As the Lembang Station is situated in the highlands, research on the lowland type vegetables may be carried out by other stations in better/appropriate locations like Bogor, Pasar Minggu, Maros or Malang, but coordinated by Lembang. As the clients for most of this research will be home gardeners, the research should be tailored to meet the needs of these small scale users.

** These are areas considered by the review team to have a good potential for a quick impact. Other areas of research, although of equal importance overall, may not have the same "image building" impact for Lembang as those stressed here.

*** Upland Kankong has few pest and disease problems and plant protection studies do not appear to be necessary for this crop.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

9.1 BACKGROUND

Fruits and vegetables each comprise about 5% of the total value of agricultural production in Indonesia although per capita intake of these commodities, particularly vegetables, appears low by regional standards. The country is largely self-sufficient in horticultural products, small quantities of exports consist mainly of cabbages and mangoes, and with fruit (mainly apple and citrus) imports prohibited since 1983, the principal horticultural import is garlic ($15 m annually).

There are a very wide range of fruits and vegetables produced in the country but their diffuse distribution, species diversity and the high level of on-farm consumption coupled with the seasonality of production, wide variations in market prices and the long term nature of fruit tree production have made it difficult to develop a compelling rationale for a major research effort in horticulture. The current research budget of US$ 1.3 m is only 4% of the budget of AARD and less than 0.1% of the value of horticultural production.

Two thirds of the budget for horticultural research is allocated to vegetables where, since the development of the Lembang Institute and the implementation of a training program for its staff, considerable progress has been made. AARD is now beginning to mount a fully fledged vegetable research program. Whilst the formulation and implementation of the on-going program can and is expected to be strengthened with experience, it is currently, by and large, being conducted using appropriate and relevant scientific methodology. As such, it indicates the marked progress that AARD has made in vegetable research in the last five years. It also indicates the potential that exists for upgrading fruit research if this is provided with facilities and personnel equivalent to those available for vegetable research. The contrast between the two areas at the present time illustrates the extent to which vegetable research has benefitted from the additional support that it has received through the NAR projects.

The review team noted that a similar type of support is now being sought for up-grading fruit research. It warmly endorses this proposal and believes that the provision of such support is important if Indonesia is to be able to carry out research on fruits compatible with their current value to the economy and potential for future development.

Against this encouraging background the review team wishes to offer a number of observations and recommendations relating to the future of fruit and vegetable research.

9.2 PROGRAM PLANNING

At present the selection of priority commodities for research is made, almost entirely, by the scientists with a minimum of formal outside consultation.

(i) The review team recommends that there should be a much wider consultation with the private sector, extension services, key farmers and other interest groups in the selection of priority crops and areas for research. The need for such a broader consultative mechanism applies not only to production research but also to postharvest activities where there is a need for a specific advisory body to provide, at least annually, inputs from industry, extension, the universities and consumer related interests. Better linkages with industry, especially, is needed.

(ii) There is also a need for closer links between the planned research program and the resources available for implementing it. This is particularly important at a time of budget stringency and while so many personnel are away training. In some disciplines and commodities it wiill be several years before an optimal research program is feasible on the designated priorities. In such circumstances the prioritised program should be built around the available resources by concentrating in depth in fields where specific results are feasible, rather than by spreading them thinly across a vast range of crops. This concentration of activities is already being done at Lembang and some examples have been given as to how this approach might be carried out for fruit crops (see Section 7).

(iii) The present system of budgeting operational research costs at Lembang by assigning a set sum of money and 0.2 ha of land to each replicated research title (Kegiatan) is unsatisfactory and not cost effective as experiments on different vegetables have different land, time and cost elements. The review team is not clear as to how widespread is this system of budgeting but recommends that it be reviewed and, if possible, superceded by a costing system that is based on anticipated 'actual' costs for each experiment. This would allow much more flexibility in the face of over-or-under-runs, would permit earlier repetition of promising work and would allow easier economic analysis of experimental findings than is possible, at present.

(iv) The review team was of the impression that the selection of priority crops had focussed too heavily on the highlands and that there is a need to devote more emphasis to lowland fruits and vegetables. The rationale for this is that much of the population of Indonesia lives in the lowlands where the use of highland fruits and vegetables can be limited by distribution or cost factors. In addition, the bulk of fruit and vegetable production occurs in lowland home gardens and these commodities are often of considerable nutritional importance.

In the case of fruits, the team identified citrus, papaya, mango and banana as the crops which should receive top priority in the immediate future, with relatively less emphasis being given to grapes and apples which, although of economic interest, benefit a rather smaller number of producers. Because of the long time period and high capital expenditure involved in fruit research, consideration should be given to utilizing expertise from well-developed fruit industries elsewhere in the world in order to build up these programs.

There are a number of leafy vegetables that can be grown easily in the lowlands. In addition, rapid advances are being made at AVRDC and elsewhere in research to develop tropically adapted varieties of vegetables such as tomatoes and Chinese Cabbage. Advantage should be taken of these developments to increase Indonesian research with these crops in the lowland tropics.

(v) For the specific fruits and vegetables selected as priority crops for research there is a need to ensure that the research actually conducted is sharply and appropriately focussed and fully relevant. For example, about 30% of the current vegetable research budget is utilised for potatoes, but the findings of both our review and the recent AARD-CIP potato research review indicated that farmers potato production technology is reasonably well advanced in most major production centers. The ongoing research program would benefit from re-orientation to take account of this. Greater priority needs to be given now to seed quality, effective disease and pest control, varietal improvement and storage and less emphasis to be placed on agronomy. A similar type of analysis relating to the current status and problems should be carried out for other prioritised commodities in view of the team's findings that 20% or more of ongoing research at some sites was of questionable relevance to the stated priority goals. In this context further thought needs to be given as to the level of resources that should be devoted to ornamentals where the current program utilised noticeable resources but appears to benefit few farmers, and to cropping systems where the existing program is small but the number of potential beneficiaries, especially in transmigration programs, may be very large.

9.3 RESEARCH ACTIVITIES

(vi) The review team noted that the stronger units conducting horticultural research were using appropriate and relevant methodology in their experimental planning, layout and reporting and recognised the very positive influence that NAR-II consultants have had in this respect. We anticipate that improved methodology will spread as staff capacity develops. We would, however, recommend that more attention should be devoted to the appearance of experimental farms on which few plots are currently labelled and a number are poorly maintained. It is important that these farms be open to visitors and that they should, at all times, exhibit a high level of husbandry thus illustrating the credibility of the research personnel.

(vii) The one research activity that does require drastic review is the system of monitoring. Each year all research proposals for the forthcoming year should be reviewed by senior personnel in terms of not only experimental design but also the relevance of the research to the prioritised objectives. Approved proposals should be assigned a specific budget. Individual researchers should continue to make brief monthly progress reports to their RPTP leader (as some are now doing) and RPTP leaders should make available to individual researchers quarterly information on the status of the budget for individual experiments.

(viii) At the end of the year each major research unit should hold an in-house program review lasting several days at which each researcher (and not just RPTP leaders) should present the results of the work that he has done during the past year. Such reviews should be used to evaluate not only research but also personnel. Reviews should be chaired by the director of Horticultural Research and be attended by a small number of outsiders from extension agencies and other AARD units (communications, planning etc.,) as well as the horticultural research staff. Ideally, such annual reviews should take place in January/February and should precede the meetings which finalise the research program for the subsequent fiscal year.

9.4 RESOURCE UTILIZATION

(ix) There are certain features of resource use which appear to justify some reconsideration. For example, at the present time the Vegetable Research Institute at Lembang is limited in its geographical coverage to parts of West Java and North Sumatra. In order to realise its national mandate the institute has two options open to it. Either it can build a range of new farms and stations or it can operate some form of collaborative program using the facilities of other farms and stations belonging to AARD. The review team strongly endorses the latter alternative.

(x) We believe that the first stage in the implementation of such a strategy is for fruit and vegetable research facilities to be shared. Thus some fruit research should continue to be done at Lembang and some vegetable research at Malang (and later at Solok). Concurrently, past research activities at Bogor and Maros (and if necessary, at other food crop research institutes) should not be abandoned but should be continued by staff outposted from Solok and Lembang who should share Food Crop Research Institute facilities and logistic support at these stations, possibly offering reciprocal support at Horticultural Research Stations in return.

(xi) This type of decentralisation of staff and funds will call for very careful planning and budgeting. It will be important that the Director of the Horticultural Research should lay down guidelines as to the geographical distribution of his budget to ensure that research activities are spread throughout the country particularly in the context of expanding activities in the tropical lowlands. Indeed, the new organisational structure of the horticultural research after April 1984 is unlikely to be effective nationally unless there is some degree of centralization in its direction and budget allocations to ensure that regionally based research stations operate programs that are national in outlook.

(xii) Another aspect of resource utilisation that justifies a closer examination is the use of land on existing research stations and farms. Our report draws attention to the apparent under-utilisation of land on some existing locations in terms of the percentage of land used for experimental work. In some locations a significant area of land is used for vegetable seed production, which is not primarily a research activity and in

many countries is a function of the private sector. Sometimes seed is produced for the extension services who fund part of its cost of production. We were not able to obtain precise figures for expenditure on seed production but consider that the Vegetable Research Institute should examine closely whether or not its "research" budget is being used for seed production and also whether this could or should be a function of private industry.

(xiii) Both the Fruit and the Vegetable Research Institute need to look at all of their plant collection material in terms of its cost and use. Clearly it is mandatory that major research institutes should retain working collections of important germ plasm. The key words here are 'working' and 'important', the institutes must not allow themselves to collect for the sake of collection, there are too many species of fruit and vegetables in Indonesia for that to be feasible. Nor should they persist in increasing outlays on collections that have served their purpose such as much of the mango material at Cukurgondung.

(xiv) We have drawn attention early in this report (Section 2.6) to the special problems and requirements of tropical tree crop research and have stressed the need for careful long range planning of staff and facilities in order to insure sustained support. In this context the review team has suggested some major changes in AARD's proposed organogram for the locations of its new Fruit Research Institute and its associated stations and farms. It has endorsed 'in principal' the proposal to locate the institutes's headquarters at Solok, but stressed the need for some detailed soil surveys before embarking on a major investment in civil works. With certain qualifications, it recommends that the fruit sub-institute for East Java remain at the Malang station. Tlekung is considered unsuitable for a sub-institute. Further, it is recommended that a decision on the location of the sub-instititute for South Sulawesi be delayed until further studies can be made, particularly concerning present and potential water resources available for fruit culture in this region. Jeneponto is not considered a suitable site for a sub-institute unless there is an assurance that irrigation water for fruits will be made available to both the station and to farmers in the area. The post-harvest research now located at Pasar Minggu should remain there until a decision is made regarding processing research. Several alternatives for the permanent location of facilities are evaluated. It is recommended that the Subang facility be attached directly to the Solok Headquarters Institute having dual and complimentary functions as a germ plasm collection and a facility for primary screening of cultivars and species for promise as scions or rootstocks.

(xv) No major changes are recommended regarding the location of the physical facilities used for vegetable research

(xvi) The manpower resources available for horticultural research appear to be unevenly utilized at the present time with a low research load per scientist at Malang and a much more satisfactory level at Maros and Lembang. There is a management need to examine this in both qualitative and quantitative terms.

(xvii) The review team noted the efforts being devoted by AARD to manpower development. It considered the manpower targets for vegetable research to be feasible as long-term goals although possibly optimistic for 1990, given the difficulty in identifying sufficient trainees and the time involved in training. For fruit research, the team prepared a very detailed long term manpower plan whose overall total differed only slightly from the original AARD figures although we felt that even 1994 would be an optimistic date for the full staffing of the proposed Fruit Research Institute and to do so by 1990 would be impossible. Given the limited number of fruit crop personnel with higher qualifications currently on staff, the attainment of the future targets will require extremely careful planning and monitoring, to ensure that the requisite mix of disciplinary and commodity expertise is trained.

(xviii) A number of staff are likely to require overseas training, especially in fruit research, throughout the next decade. However, the number of staff required at the M.Sc. level and the long term need for some Ph.D. training to be done locally both highlight the importance of studying the feasibility of developing specialised training in horticulture locally. At present no specialised post graduate training in this field exists in Indonesia. The review team considers that the most cost-effective way of developing such training might be through some form of contractual arrangement with a recognised overseas university with specialised experience in this area. This would appear to be a potential area of priority for overseas technical assistance.

(xix) The review team did not examine in any depth the financial management of the resources for horticulture research. It has the clear impression that given the existing level of staff and facilities the horticultural research budget is sufficiently large to carry out a significant volume of research. The budget is on the low side in terms of congruence (i.e. horticulture represents a bigger percentage of agricultural production then horticultural research represents as a percentage of agricultural research) and this will need to shift to accommodate the new facilities at Solok and the concurrent staff build up. But, given the economy of Indonesia and the competition for funds, the budget is always likely to be tight and the key issue here is not to stress this constraint but to emphasise that a lot more mileage may be feasible from the existing budget if priorities are carefully selected, experiments properly budgeted and funds, manpower and equipment resources optimised in their use.

(xx) The budget could be stretched even further were the GOI to permit the products of experiments to be sold and the revenue to be used for additional research activities. This system is widely used abroad and in the International Agricultural Research Centers of the CGIAR and could add materially to the operational research budget for horticulture.

9.5 RESEARCH LINKAGES

(xxi) The Fruit and Vegetable Research Institutes need to promote the recognition of their role especially to the level of policy-makers, administrators, private industry, fund donors and the general populace. This can only be achieved with an adequate information budget and qualified personnel who can handle the task of 'selling' the research program and subsequent on-farm developments. An information specialist should also carry out the task of strengthening the institute's linkages with agricultural information specialists, extension services, key farmers, etc., by calling their attention to significant research developments.

(xxii) Although a complex formal coordination mechanism exists at each horticultural research station, junior research staff often do not seem to have a clear picture of their own role in relation to the goals of the station as a whole. There is a need for a greater awareness of what other researchers are doing. This might be helped by a more regular seminar system involving all staff, not only senior personnel, and also by a better labelling system for field plots.

(xxiii) The level of communication between horticultural scientists and with scientists in other national and international institutes could be improved if documentation and library material were more readily available. This should include the provision of subscriptions to selected key journals at all institutes and stations. Research is unlikely to be sharply focussed if those doing it are unaware of what others working in the same field have achieved and found out. Currently the library facilities at all horticultural research stations other than Pasar Minggu are inadequate and the link with the central library in Bogor appears tenuous.

(xxiv) The weakest linkage of all at present is the interface between research and extension. There is a major need to have adequate and well trained PPS's from the extension services located at all major research stations and institutes and for these PPS's to coordinate a large network of technology verification trials.

(xxv) Before this can be done, the extension specialists involved with horticultural crops will need to be well-prepared to deal with problems in the farmer's field. The training program for these specialists needs to be upgraded and expanded in order to insure that these personnel are effectively grounded in all important aspects of fruit and vegetable production. Although the extension personnel themselves are not part of AARD staff their training is a role in which AARD can and must play a part. The development of top quality training courses for extension personnel needs to be perceived by the Coordinating Center as being one of its highest priorities if research results are not to languish on the station doorstep.

9.6 TECHNICAL ASSISTANCE

(xxvi) The review team has identified M.Sc. level training and postharvest technology research as being areas where new technical assistance projects could play an important role. It has also commented positively on several technical assistance proposals currently under consideration namely:

(a) Establishment of an Indonesian Fruit Research Institute - this proposal was carefully reviewed and judged sound in principal. Some comments have been made regarding staffing, phasing and other aspects (see Section 7.5).

(b) Citrus rehabilitation proposal - this proposal is worthy of early implementation. It has some elements of vulnerability which have been identified as has the importance of strong leadership and continuity of approach (see Section 7.5).

(c) Fruit and Vegetable marketing - this is a component of an inter-agency proposal which AARD would be part of. It relates closely to the proposed Fruit Research Institute and to the needs for reducing both the seasonality of production and the extent of postharvest losses. Both of these areas of research relate closely to supply and price factors which have important implications in terms of farm income. The review team notes that this type of market-related research is viewed by the extension services as of high priority and it considers that a project in fruit and vegetable marketing could have a big pay-off.

On-going technical assistance links through NAR-II and with CIP and AVRDC were noted. In all 3 cases AARD appears to have an effective partnership with the external agency and the benefits of the relationships were apparent.

9.7 PRIORITY ACTIONS

(xxvii) The review team was asked to offer specific guidelines for fruit and vegetable research over the next five years. These guidelines are spelled out in some detail in Sections 7 and 8, assuming that the manpower development targets would be met. For fruit we recommend citrus, papaya, banana and mango as the top priority crops with apple and grape also being included in the program. From a disciplinary viewpoint, the priorities are: (1) production of disease-free planting stock; (2) variety improvement; (3) crop protection; (4) irrigation and drainage: (5) post-harvest studies; and (6) marketing. It is recommended that breeding through hybridization of long life cycle tree fruits be deferred until after the new Fruit Research Institute at Solok is fully developed.

(xxviii) Since it will take some years before the program proposed above will start to achieve results, we have also identified for immediate implementation five specific research proposals most of which we consider to have a potential for a rapid impact on production technology (see Section 7.6 for details).

(xxix) For vegetable research the prime task is two-fold. First, to identify commodities and programs for lowland vegetable research. Second, to review in depth the ongoing research program on five prioritised crops in terms of assessing the importance and relevance of the disciplinary areas of research being undertaken, and the staff available to do the research, in order to sharpen the focus and relevance of the current experimental program. A suggested outline for such a review is presented in detail in Section 8.