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POSTHARVEST TECHNOLOGY RESEARCH IN INDONESIA

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AARP PROJECT

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AGENCY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT
DEPARTMENT OF AGRICULTURE, R.I.

TABLE OF CONTENT

		Page
I.	JOB DESCRIPTION (TOR)	i
II.	BACKGROUND	2
	A. Institute in which consultant is placed	2
	B. Discipline with which consultant is working	7
	C. Resources available in specific discipline	13
	1. Physical resources	13
	2. Human resources	16
	3. Financial resources	16
III.	PRINCIPAL ACTIVITIES OF THE CONSULTANT	30
	A. Organizational/planning	30
	B. Training	31
	C. Research	34
	D. Publications	43
	E. Seminars, Conference etc.	44
	F. Miscellaneous	45
IV.	RECOMMENDATIONS	46
	A. Organizatonal	47
	B. Physical Resources	50
	C. Manpower Resources	52
	D. Financial Resources	56
	E. Research Activities	57

I. JOB DESCRIPTION

The Terms of Reference (TOR) for the consultant's position were developed in November, 1982, and are included as Appendix I. The objecuives described for the consultancy, in this TOR, may be summarized as follows :

1. assist BORIF and its Karawang station in development of its postharvest research program, with particular emphasis on cassava.

2. help acheive the government's goals of decreased losses, increased quality, improved farmer income and increased national food production.

3. improve existing farm-level technology and develop new, improved postharvest methods, with particular emphasis on cassava,

4. train staff in research methodology and food analysis.

5. assist in "institution building", equipment procurement and book recommendations for the field of postharvest technology.

The original TOR called for two consultants, however the Indonesian short-term consultant was unable to accept the position due to other responsibilities.

II. BACKGROUND

A. Institute In Which the Consultant is Placed

The original terms of reference for the position of post-harvest tuber crops processing specialist cited Bogor, or the Bogor Research Institute for Food Crops, as the location of work (Appendix I). However, after the consultant began her contract it was discovered that there were virtually no post-harvest research activities going on in Bogor. The tuber crops research group, however, was located in Bogor. Therefore, it was decided that the consultant would spend 2-3 days a week in Bogor and 3-4 days/week in Karawang, a sub-research institute which concentrates on postharvest technology. This schedule was followed from March, 1983 until February, 1984. In January 1984, the Karawang institute was unofficially transferred to the jurisdiction of the Sukamandi Food Crop Research Institute and the newly-appointed national coordinator of postharvest research, Dr. Djoko S. Damardjati, requested that the consultant be based in Sukamandi. This request was approved by Dr. B.S. Siwi, Head of the Central Research Institute for Food Crops (CRIFC) and agreed to by the consultant. Therefore, from February 1984 - March 1985 the consultant spent 5 days/week in Sukamandi and one day a week in Bogor, in order to maintain links with tuber crop research personnel and to fulfill administrative needs at the AARP office.

1. Brief history

The Karawang Sub-Research Institute for Food Crops, or Karawang Installation as it is now called, was originally formulated as the Center for Rice Research in about 1956.

At that time FAO assisted in procurement of large-scale rice processing equipment. The center functioned nominally until about 1965, when it closed down temporarily. In about 1974 the center re-opened as the "Technology Division" of the Central Research Institute for Agricultural (CRIA) and continued as such until 1981, when it was re-named the Karawang Sub-Research Institute for Food Crops. The most recent change in Karawang's position took place in 1984, when it was reduced to an installation and placed under the Sukamandi Research Institute for Food Crops (SURIF).

The Sukamandi branch of CRIA was established in 1971 and was up-graded to the level of a research institute in 1981. At this time, CRIA also changed its name to the Agency for Agricultural Research and Development (AARD). Today, the organization of AARD, which functions as the research arm of the Ministry of Agriculture, is as illustrated in Figure 1. Figure 2. shows the organization of the Central Research Institute for Food Crops, under which both SURIF and its installation in Karawang fall. SURIF's mandate is for research on crops which grow in irrigated areas. Emphasis is placed on rice, but experiments on corn, wheat, sorghum, legumes and cassava are on-going.

2. Available resources

Physical resources available at SURIF are quite extensive, when compared to its five sister institutes in CRIFC (Table 1). Funding for recent construction of laboratory and housing facilities and for procurement of laboratory equipment has been

FIGURE 1

Organizational Structure of the

Agency for Agricultural Research and Development

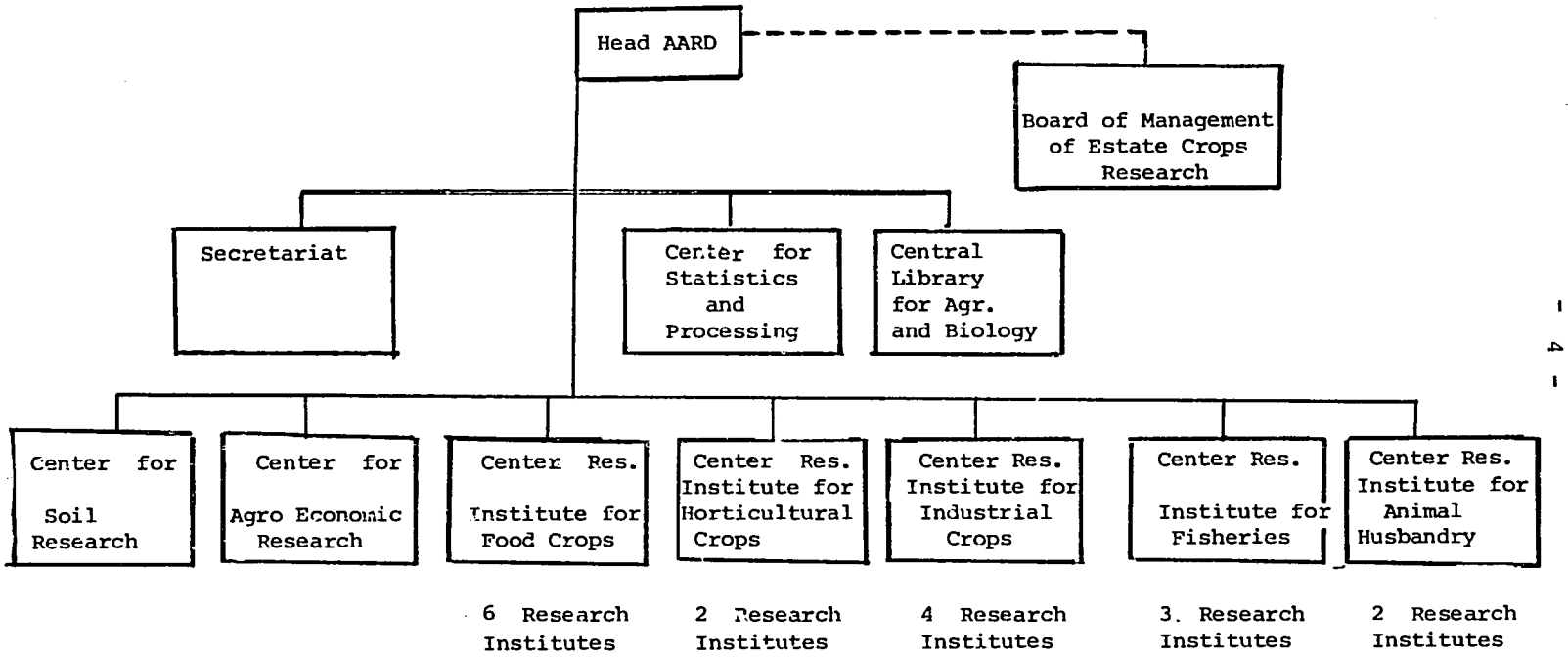

FIGURE 2

Organizational Structure of the

Central research institute for food crops

(Responsible both for rice and palawija crops)

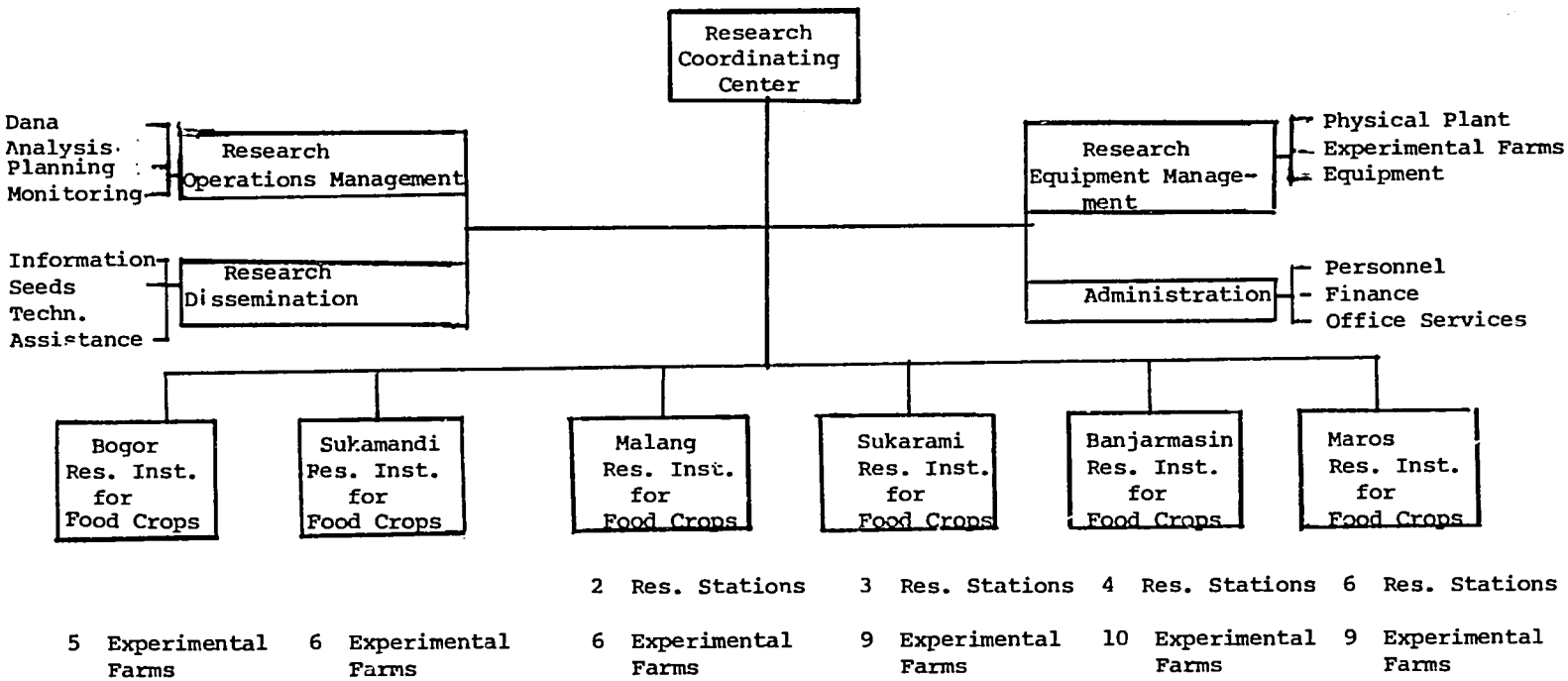

TABLE 1

Current physical resources of the
Central research institute for food crops

	BORIF	MARIF	SURIF	SARIF	MORIF	BARIF	TOTAL
Institute	1	1	1	1	1	1	6
Stations	0	2	0	4	5	4	15
Farms	5	6	7	9	8	10	45
Total Area (ha)	8	123	556	443	430	230	2056
1. Offices m^2	9269	2307	4320	2022+	2060	1282	21260+
2. Laboratories m^2	4331	185	3390	1075	452	56	9489
3. Library m^2	274	100	260	440	96	164	1334
4. Auditorium m^2	700	100	588	276	92	265	2021
5. Green/Screenhouses m^2	3341	N/A	2170	1580	2380	472	10,000+
6. Stores m^2	9750	4176	1267	N/A	1790	N/A	17,000+
7. Drying Floors m^2	N/A	7252	N/A		2570	N/A	10,000+
8. Guest Houses m^2	3527	909	4441	1180	240	318	10,615
9. Staff Houses m^2	9145	3078	7728	13708	4711	915	39,321
10. Vehicles	99	N/A	N/A	50	36	N/A	200

Note : N/A = not available to review team

Source : ISNAR Palawija Review, 1984.

provided through IBRD loans, IRRI support and annual DIP allocations from the Indonesian government.

As far as available manpower, SURIF's staff currently ranks fourth, behind BORIF, SARIF and MORIF, in number of B.S. level and above staff (Table 2). This would not seem to be in proportion to the wealth of physical resources available at SURIF. The answer may lie in the fact that Sukamandi is located farily far from a large city and schooling is not of the best quality, therefore it is difficult to attract researchers to work there. This situation is, however, improving.

SURIF presently receives the third highest budget allocation, after BORIF and SARIF (Table 3). This may be justified, based on number of staff, however future allocations should be increased due to SURIF's recent acquisition of the Karawang Installation and other units. When the Karawang Installation changed hands in 1984, its budget, which was previously administered by BORIF, was not given to SURIF. This is causing financial difficulties. Although SURIF is happy to add on the Karawang staff and facilities, they do not wish to cut their own budget in order to do so.

Discipline In Which the Consultant is Placed

The consultant was placed in the chemistry and postharvest technology discipline, under which research on cassava postharvest processing is done. At the present time, this discipline actively exists in only three of the six CRIFC institutes, i.e. SURIF, SARIF, and MARIF. At MARIF the discipline is staffed by only one scientist Postharvest research activities at BORIF, MORIF and BARIF are virtually nonexistent, while those at SARIF have only just begun.

TABLE 2

Available manpower by institute

food crops

Institute	PhD	MSc	Ir.	BSc	High School	Total
BORIF	12	32	73	24	96	237
MARIF	2	2	42	3	13	62
SURIF	7	10	31	8	43	99
SARIF	1	14	45	31	26	117
MORIF	3	9	48	2	41	103
BARIF	1	2	23	4	11	41
Total	26	69	262	72	230	659

Source : ISNAR Palawija Review, 1984.

TABLE 3

Financial resources of the
Central Research Institute for Food Crops
1984/1985

million Rp.

Institute	Routine	Development	Total
1. BORIF	743	650	1393
2. MARIF	355	306	661
3. SURIF	209	660	869
4. SARIF	111	857	968
5. MORIF	262	575	837
6. BARIF	108	279	387
7. Coordinating Center	279	250	529
Total	2067	3577	5644

In contrast, some form of postharvest research has been going on in Karawang and Sukamandi since about 1974.

Original activities at Sukamandi consisted primarily of quality control or quality assessment as a service to the breeding, agronomy and plant protection discipline. With the construction of new laboratories, beginning in 1979, however, the discipline began to stand on its own. Today the chemistry and technology division at SURIF is one of the most active disciplines and routine food and plant analysis, in addition to nutritional evaluation, are carried out on a daily basis.

While the SURIF division has focused more on the chemical and nutritional aspects of postharvest technology research, the Karawang installation has paid attention to the simple steps involved in food harvesting and postharvest handling. Their research activities, for the past ten years, have emphasized the improvement of harvesting, threshing, drying and storing techniques currently utilized at the farm level. The staff has more hands-on, practical experience than the research staff in Sukamandi.

Postharvest research titles for rice and secondary crops at Sukamandi from 1977-1985 are listed in Appendix II, while those at Karawang are listed in Appendices III and IV. Table 4 summarizes these activities by commodity and topic. It is obvious that, while the Sukamandi group has concentrated on the more fundamental aspects of physico-chemical characteristics and quality, the Karawang group has lent itself to the practical problems of drying and storage. In a comprehensive chemistry and postharvest technology program, this whole scope of activities will be included, therefore it is important to continue both aspects. It should be possible,

Table 4

POSTHARVEST RESEARCH ACTIVITIES,

BY NUMBER OF TITLES

Karawang and Sukamandi Institute

1976 - 1985

Research topic	Sukamandi	Karawang	Total
1. Rice			
a. harvest age	1	4	5
b. yield	1	4	5
c. postharvest handling	1	3	4
d. quality	4	5	9
e. harvesting and threshing	0	2	2
f. drying	0	6	6
g. storage	2	12	14
h. physico-chemical characterization	5	0	5
i. flavor/cooking quality	3	0	3
j. seed technology	1	0	1
	18	36	54
2. Corn			
a. survey/inventorization	1	1	2
b. processing	0	1	1
c. drying	0	4	4
d. shelling	0	1	1
e. storage	2	9	9
	3	14	17
3. sorghum			
a. survey	0	0	0
b. processing	2	1	3
c. storage	0	1	1
	2	2	4
4. Wheat			
a. processing	1		1
b. physico-chemical characteristics	1		1
	2	0	2
5. Soybeans			
a. survey	0	1	1
b. harvest time	1	0	1
c. storage	1	2	3
d. seed technology	1	1	2
e. processing	1	2	3
	4	6	10
6. Mungbeans storage	0	2	2

7. Peanuts			
a. survey and aflatoxin	1	0	1
8. Pigeon peas			
a. processing	1		1
b. physico-chemical characterization	1		1
	2	0	2
9. Cassava[1]			
a. survey	1	2	3
b. harvest time	0	1	1
c. drying	0	2	2
d. blanching	0	1	1
e. storage	1	6	7
	2	12	14
10. Sweet potatoes[1]			
a. harvest time	1	2	3
b. storage	0	1	1
c. leaves	1	1	2
	2	4	6
	36	76	112

[1]Cassava and sweet potato research was carried out at Sukamandi only during the 1984/85 year.

however, to better coordinate and inter-relate those two, for the moment, uncoordinated focuses.

C. Resources Available in the Chemistry and Postharvest Technology Division[1]

Resources which are currently available for chemistry and postharvest technology research may be divided into three different types, i.e. physical, manpower and financial. Each will be discussed briefly.

1. Physical resources

a. Buildings

Physical structures, or buildings currently existing for chemistry and postharvest technology research within CRIFC are listed in Table 5. Presently, the largest area exists at SURIF (including Karawang) followed by BORIF, SARIF and MARIF. The postharvest laboratory which has recently been constructed at BORIF by the AARP projection is still under questionable status, as there is no postharvest staff at BORIF. The building is, at the moment, devoid of equipment and office furniture. SARIF's seed processing/quality analysis laboratory is new and unequipped at the present time. MARIF has only a very small seed technology lab, which doubles as a postharvest technology lab for its one staff member in this discipline. Plans for construction at MARIF, however, include allocation of 200-250 m^2 for postharvest technology. Neither MORIF or BORIF have postharvest research facilities at the present time.

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[1] A comprehensive discussion of CRIFC resources may be found in the recent "Postharvest Evaluation of Tuber and Fruit Crops" report.

TABLE 5

Current physical resources for postharvest research

Central research institute for food crops

Institute	Laboratories		Storage/warehouses		Offices etc.	
	Name	m^2	Name	m^2	Name	m^2
1. BORIF						
a) Bogor Institute	-all-	4331	-all-	9750	-all-	9269
b) Postharvest division	1. Visual Lab	60	1) storage			
	2. Analysis Lab	52.5				
	3. Controlled atmosphere rooms	67.5				
	4. Preparation Lab	48				
	5. Processing Lab	20				
	6. Grinding Lab	25				
		273				
2. MARIF						
a) Malang Institute	-all-	185	-all-	768	-all-	1653
b) Postharvest division	Seed Technology Lab.	20	-	0	-	0
3. SURIF						
a) Sukamandi Institute	-all-	3035	-all-	1120	-all-	1899
b) Postharvest division	1. Analysis	178	-	0		52
	2. Instrumention Lab	25				
	3. Physical analysis Lab	22				

4. Karawang Laboratory	1. Physical analysis Lab 2. Chemical analysis Lab	299 200	1). Processing 2). Machinery/ garage 3). Storage	1200 299 598	1). Staff 2). Meeting room	299 200
5. SARIF						
a) Sukarami Institute	- all-	449	-all-	0	-all-	801
b) Postharvest Division	Seed Processing/Quality Lab.	36	-	0	1). Division head 2). Staff	16 30
6. MORIF						
a) Maros Institute	-all-	392	-all-	1240	-all-	1510
b) Postharvest Division	-	0	-	0	-	0
7. BARIF						
a) Banjarmasin Institute	-all-	0	-all-	0	-all-	450
b) Postharvest division	-	0	-	0	-	0

N/A = not available to evaluation team

[1]This facility was completed in 1984, and use for it has not been planned yet.

SURIF's postharvest laboratory is well-equipped and used on a daily basis, and would appear to be the best-functioning CRIFC postharvest research laboratoty. Its Karawang installation, while fairly large, is poorly maintained and underutilized.

b. Equipment

On the basis of laboratory equipment, SURIF and its recently acquired Karawang installation would appear to have the best resources (Table 6). SARIF has ordered a few items (Table 7), but these are still not enough to provide the institute with a fully functioning chemistry and technology laboratory. Recommendations on lab equipment will be made in the final section of this report.

2. Human resources

Currently available postharvest CRIFC staff and projections for 1986/87 are given in Table 8. Most of these staff members split their time between a number of commodities, however priority is still placed on rice. The largest number, again, exists at SURIF. A listing of staff, by institute and degree training, appears in Table 9. Postharvest staff available in other AARD institute are listed in Table 10 - 13., and summarized in Table 14.

3. Financial resources

The postharvest research component of the total CRIFC budget is illustrated in Table 15. As a percentage of the total CRIFC development budget, postharvest research is allocated a mere 0.8%.

TABLE 6

Present large-scale laboraroty equipment available

Central research institute for food crops

Institute	Equipment
BORIF	- None -
MORIF	1. Oven 2. Analytical balance 3. Moisture tester
SURIF	1. Air ovens (4) 2. Vacuum oven 3. Analytical balances (3) 4. Muffle furnace 5. Kjeltec nitrogen detector 6. Ultra-centrifuges(2) 7. Freeze-drier 8. Gas chromatograph 9. High performance liquid chromatograph 10. Microscopes (2) 11. UV/Vis Spectrophotometers(2) 12. Amino acid analyzer 13. Polarimeter 14. Scanning electron microscope 15. Gel electrophoresis apparatus 16. INSTRON texture analyzer 17. IR moisture meter 18. Brabender amylograph 19. Fat analysis equipment 20. Fiber analysis equipment 21. Rice mills (2) 22. Electric moisture meters (3) 23. Shaker 24. Dehuskers (2)
SARIF	- None -
KARAWANG LAB.	1. Air ovens (3) 2. Analytical balance 3. Moisture testers (9) 4. Rice mills (3) 5. Whiteness tester (1) 6. Sieve shakers (2) 7. Miniterm temperature controller 8. Micro-Kjeldahl apparatus

	9. Foos-Lett fat analyzer 10. Muffle furnace 12. Microscopes (2) 13. Nepho-colorimeter 14. Spectrophotometer 15. Centrifuge
MORIF	- none -
BARIF	- none -

TABLE 7

SARIF Equipment Order(s)

Postharvest Technology Division

No.	Quality	Name of equipment
1	1	thresher
2	2	rice thresher
3	4	corn sheller
4	8	mini-thresher
5	20	seed cleaners
6	4	bag triers
7	1	seed processing and storage equipment
8	3	analytical balances
9	1	centrifuge
10	15	grinding and cutting mills
11	2	pH meter
12	2	conductivity meter
13	4	electronic balances
14	4	top-loading balances
15	2	sieve shaker
16	1	muffle furnae
17	12	lab ovens
18	1	micro-mill grinder
19	1	spectrophotometer
20	2	vacuum pump
21	1	atomic absorption spectrophotometer
22	2	fumehoods
23	10	refrigerator
24	4	kjeldahl digestor
25	4	refrigerator/freezer
26	1	micro-kjeldahl unit
27	7	sieves
28	11	deionizers
29	1	seed testing lab equipment
30	1	seed tester-cleaner
31	2	moisture tester
32	1	seed germinator
33	1	boerner divider
34	1	testing dryer
35	2	testing husker
36	1	testing mill polisher
37	1	thickness grader tester
38	1	lab rice grader
39	1	whiteness meter
40	1	cracked grain inspection apparatus
41	1	black light, rodent detection
42	5	threshers. test plot
43	12	hot plates

TABLE 8

Currently available postharvest research staff*

food crops

	Current			Now in Training		Available 1986/87		
	PhD	MS	Ir	PhD	MS	PhD	MS	Ir
BORIF	0	0	0	0	0	0	0	0
MARIF	0	0	2	0	0	0	0	2
SURIF	1	1	13	3	5	4	6	13
SARIF	0	2	3	0	2	0	4	3
MORIF	0	0	1	1	0	1	0	1
BARIF	0	0	2	0	0	0	0	2
TOTAL	1	3	21	4	7	5	10	21

* Includes seed technology scientists as follows:

SURIF - 1 Ir., 1 Ph.D. in training

SARIF - 1 M.S., 1 Ir.

MORIF - 1 Ir., 1 Ph.D. in training

BARIF - 2 Ir.

MARIF - 1 Ir.

TABLE 9

Postharvest research staff by location and degree training, food crops

Institute	Staff Name	Degree Training	Currently Training ? Degree and Completion Date
1. BORIF	-	-	-
2. MARIF	1. Ir. Sri Satya Antarlina	Postharvest Technology	-
	2. Ir. Didik Hernowo	Seed Technology	-
3. SURIF	1. Dr. Djoko S. Damardjati	Food Chemistry	-
	2. Dr. Ridwan Thahir	Agricultural Engineering	Ph.D. January 1985
	3. Dr. Agus Setiyono	Food Technology	Ph.D. June 1986
	4. Ir. Robertus Mudjisihono, M.S.	Food Technology	-
	5. Ir. Udin Nugroho M.S.	Seed Technology	Ph.D. June 1986
	6. Ir. Susilo Santoso	Food Technology	M.S. June 1985
	7. Ir. Rumiati Soemardi	Postharvest Physiology	M.S. January 1986
	8. Ir. Eko	Agricultural Engineering	M.S. June 1985
	9. Ir. Sutrisno	Agricultural Engineering	M.S. January 1986
	10. Ir. Soemardi	Chemical Technology	-
	11. Ir. Soeharmadi	Agronomy	-
	12. Ir. Suismono	Agronomy	-
	13. Ir. Yetty Thahir	Food Technology	-
	14. Sugit Nugroho, B.Sc.	Food Technology	-
	15. Ir. Sri Widowati	Food Technology	-
	16. Ir. Joni Munarso	Food Technology	-
	17. Ir. Koswara	Food Technology	-
	18. Ir. Haryono	Agricultural Engineering	-
	19. Ir. Dadang	Agricultural Engineering	-
	20. Ir. Suwadi	Agricultural Engineering	-
	21. Ir. Lubis	Agricultural Engineering	-
	22. Sudaryono BSc.	Food Technology	-
	23. Prihadi	Chemical Analysis	-
4. SARIF	1. Ir. Yulmar Jastra MS.	Seed Technology	-
	2. Ir. Ketut Tastra MS.	Postharvest Technology	-
	3. Ir. Azman	Biochemistry/Nutrition	M.S. January 1986
	4. Ir. Darsono	Food Technology	M.S. June 1986
	5. Ir. Marzempi	Food Technology	-
	6. Ir. Artuti AM	Seed Technology	-
	7. Ir. Afdhal JP. Tamsin	Food Technology	-

5. MORIF	1. Ir. Sania K M.S. 2. Ir. Nur Richarana	Seed Technology Food Technology	Ph.D. January 1986 -
7. BARIF	1. Ir. Ida Herawati 2. Ir. Hidayat	Seed Technology Seed Technology	- -

TABLE 10

Fruit crop postharvest research staff

by location and degree training

Institute	Staff Name	Degree Training	Currently Training? Degree and Completion Date
1. Malang Research Institute for Horticulture	1. Ir. Kamarul Arief	Food Science	M.S. January 1985
	2. Ir. Suhardjo	Food Science	M.S. January 1985
	3. Ir. Anggarwati MS.	Food Science	-
	4. Ir. Yuniarti	Food Science	-
	5. Ir. Djoko Wijadi	Food Science	-
2. Pasar Minggu Sub Research Ins-	1. Dr. Syaifulloh	Horticulture	-
	2. Moh. Sudibyo, Msc.	Postharvest Horticulture	PhD Feb. 1984
	3. Rooswani, Msc.	Postharvest Horticulture	PhD Sept.1984
	4. Iman Muhadjir,Msc.	Postharvest Horticulture	PhD Jan. 1986
	5. Ir. Sabari	Food Science	MS Jan. 1985
	6. Laksmi BSc.	Food Science	-
	7. Ir. Heriyati	Ag.Proc.Technology	-
	8. Ir. Wisnu Broto	Ag.Proc. Technology	-
	9. Ir. Sulusi Prabawati	Ag.Proc.Technology	-
	10. Elizabeth Sitorus Bsc.	Chemical Analysis	-
	11. Ir. Poernomo	Food Science	-
	12. Murtingsih Bsc.	Ag.Proc.Technology	-
	13. Dewi Utama Bsc.	Ag.Proc.Technology	-
	14. Suyanti, Bsc.	Ag.Proc.Technology	-
	15. Ir.Setiyadjit	Ag.Proc.Technology	-
	16. Dudung Muhidin Bsc.	Chemical Analysis	-
	17. Ir. Sunarwati	Ag.Proc.Technology	-
3. Lembang Research Institute for Horticulture			
4. Brastagi Sub-Research Institute for Horticulture.	1. Ir. Maas H. Lubis	Agronomy	
	2. Ir. Bresma Napitupulu	Food Science	

TABLE 12

Postharvest Research personnel

.Central research institute for spices and medicine drugs

1. Ir. Sofyan Rusli
2. Ir. Djayeng Sumangat
3. Ir. Pandji Laksmana Haya
4. Ir. Edi Mulyano
5. Ir. Nanan Nurjanah
6. Dra. Hernani
7. Anggraeni B.Sc.
8. Ma'mun B.Sc.
9. Sufiani B.Sc.
10. Triantoro B.Sc.
11. Ir, Makarani Hasanal M.sc. (currently in PhD program)

TABLE 13

Postharvest research personnel

Central research institute for animal husbandry

1. Ms. Roswita Sunarlim M.S.	Chicken and Rabbit Technology
2. Ir. Abubakar	Meat Technology
3. Ir. Triyantini	Chicken Technology
4. Ir. Celly H. Sirait	Milk Technology

TABLE 14

Postharvest research personnel in various Indonesian institutes

Institute	Current			In Training		Available 1986/87		
	Ph.D.	MSc.	Ir.	Ph.D.	MSc.	Ph.D.	MSc.	Ir.
1. AARD								
a. Food Crops	1	3	23	2	5	3	9	23
b. Fruit Crops	1	0	17.4	3	3	4	3	17.4
c. Industrial crops	0	0	10	0	0	0	0	10
d. Animal Science	0	1	3	N/A			N/A	
e. Fisheries								
2. IPB	19	17	20	8	14	27	31	20
3. UGM	4	4	22	5	0	9	4	22
4. UNIBRAW	1	7	13	3	7	4	14	13
5. UNAND	1	0	10	N/A			N/A	
6. UNISYIAH	1	0	0	N/A			N/A	
7. BBIHP	1	5	32	2	3	3	8	32
8. LKN								
a. Total	4	4	35	4	0	8	4	35
b. Postharvest	0	0	3	1	0	1	0	3
Total	33	40	173	25	34	61	74	173

TABLE 15

Postharvest component of food crop research budget

1984/85

million Rp

Institute	Total AARD Budget			Postharvest Budget			Postharvest Percentage of Development Budget (%)
	Routine	Development	Total	Routine	Development	Total	
1. BORIF	743	650	1393	N/A	6	6	0.9
2. MARIF	355	306	661	-	-	-	-
3. SURIF	209	660	869	65	23	88	3.5
4. SARIF	111	857	968	-	-		
5. MORIF	262	575	837	-	-		
6. BARIF	108	279	387	-	-		
7. Coordinating Center	279	250	529	-	-		
TOTAL	2067	3577	5644	65	29	94	0.8

III. PRINCIPAL ACTIVITIES OF THE CONSULTANT

Detailed explanations of the consultant's activities can be found in her quarterly reports, therefore only a summary appears below.

A. Organizational, planning and directional activities

The consultant spent a great deal of her time assisting in the evaluation and future planning of postharvest research for AARD. In that this is a relatively new and growing discipline, it still requires a great deal of organization and attention. Activities in which the consultant participated are listed below.

1. Design and implemention of a "Postharvest Evaluation of Tuber and Fruit Crops" for AARD. This evaluation focused on two specific commodities, but in essence reviewed resources devoted to general postharvest research within the Central Research Institutes for Food Crops and Horticulture. The two volume report of the evaluation is available to all interested parties.

2. Establishment of new contacts and strengthening of old between Karawang and Sukamandi staff and scientists in other institutes concerned with postharvest technology research.

3. Assistance in planning future research projects for all commodities, with particular emphasis on cassava.

4. Cooperation with the tuber crops group to identify priority topics for future research, to recommend titles and plan budgetary, manpower and facility needs.

5. Aid in joining the Karawang and Sukamandi staffs into a cohesive postharvest research team.

6. Collaboration on preparation of TORs for submittal to foreign funding groups.

7. Formulation of a five year research plan for cassava by-product utilization.

B. Training

Staff training occurred at two levels, i.e.

1. Training scientific staff in research design and methodology food analysis and use of sophisticated instruments, interpretation of research results and report-writing.

2. Training technical staff in analytical methods, instrumentation and basic laboratory practices.

The following topics were taught/discussed with both Karawang and Sukamandi staff during the period of the consultancy:

1. Scientific staff

   a. methods of literature review and sources of postharvest literature

   b. statistics and experimental design

   c. need for assessment of economic feasibility prior to implementing a new or improved technology

   d. scheduling of experiments

   e. assessment of physical and chemical analysis methods

   f. principles of moisture, starch, sugar, fiber, fat, protein, ash, viscosity, physical and sensory analysis

   g. sampling techniques

   h. survey techniques and questionnaire design

i postharvest changes in cassava

1. physiology
2. postharvest handling
3. pests
4. curing
5. storage
6. drying

j. processing of cassava

1. gaplek and traditional products
2. starch and modified starch
3. pellets
4. fermented products (HFS, SCP, ethanol)

k. quality standards for cassava and its products

l. economic potential for cassava utilization, domestically and internationally

m. rice quality factors and use in grading quality and standardization

h. physico-chemical characteristics of pigeon peas and anti-nutritional factors

The consultant spent most of her time working with three scientists : Ir. Soeharmadi
Ir. Suismono
Ir. Sri Widowati

However, time was spent in research discussion with all Karawang and Sukamandi staff. In addition, the consultant coordinated the one-month training program of Ir. Antarlina, the only postharvest staff member located at MARIF, while she was at Sukamandi.

The consultant also gave twice-weekly English conversation lessons to interested scientists in the evenings while based at Sukamandi and assisted in organizing short-term training for SURIF staff through the AARP project.

2. Technical staff

a. sampling methods

b. weighing analytical samples

c. moisture analysis

d. ash analysis

e. starch and sugar analysis

f, fiber analysis

g. filth analysis

h. viscosity analysis

i. HCN analysis

j. acidity analysis

k. physical and subjective analysis

l. installation of new equipment

m. sample preparation

n. use of analytical balance, nepho-colorimeter, Brabender viscoamylograph, spectrophotometer, etc.

o. use of approved analytical methods (AOAC, Department of Trade, etc.)

Technicians with whom the consultant worked included Sdr. Amir and Tri at Karawang and Sdr. Otone, Achmad and Ayi at Sukamandi.

C. Research

During the consultant's two-year contract, she participated primarily in cassava postharvest research, but also took a part in rice and pigeon pea projects. In addition, she was frequently consulted by both Karawang and Sukamandi staff on all on-going projects. The research projects in which she served as advisor/participant are discussed below. It should be noted that research topics for the 1983/84 budget year were determined by Ir. Soemardi, head of the Karawang station, while those for the 1984/85 budget year were determined by Dr. R. Soenarjo, head of the national tuber crops program, following the consultant's recommendations. Research reports are either finished or in progress, but have been written in Indonesian, therefore only a summary follows in English.

1. Cassava research

a. Influence of type of packaging material on storage of crude tapioca starch (Suismono, D.M. Barrett)

Crude tapioca starch is produced by many small scale producer/processors in the West Java area. The crude starch is usually sold immediately after processing to large scale "bolting" operations which grind the crude starch and sell the higher quality, fine starch

Because cassava harvests peak in July August and September, the price received by the farmer and crude starch processor at this time is very low. It was thought that if the processor could safely store the crude starch until prices increased,

he would profit. An interesting note is that crude starch is usually stored at the farmer level in gunny or polypropylene bags, while the "bolting" operation packages its finished, fine starch in a double thickness of polyethulene inner bag and polypropylene outer bag. It was deemed of interest to note the quality differences following storage in various packages. The work plan for this project appears in Appendix V.

Crude tapioca starch was stored in gunny sacks, polypropylene bags, polyethylene bags and polyethylene+ polypropylene bags. As far as quality, starch stored in the airtight bags, i.e. polyethylene and polyethylene+ polypropylene, was of much higher quality. Moisture and filth contents remaind low and deterioration due to pest attack and/or chemical reactions was limited. The limiting factor would appear to be cost and length of practical usage for each type of package. The prices of the various packaging materials at the moment is as follows:

gunny sacks	525 Rp/sack
plastic (polypropylene) sacks	250 Rp/sack
plastic (polypropylene) bags	200 Rp/sack
double thickness bags (polyethylene+polypropylene)	450 Rp/bag+sack

The price of the double thickness bag is the second highest, however its airtight nature and the sturdy outer polypropylene bag result in the highest quality

of crude tapioca starch. Crude starch stored in the airtight bags, during this experiment, maintained Grade 1 quality, while that in the gunny and polypropylene sacks fell to Grade 2 or Grade 3 quality. Differences in prices, as of November 1984 at P.T. Setia in Bogor, were as follows :

Grade 1 crude tapioca starch	Rp. 200/kg
Grade 2 crude tapioca starch	Rp. 170/kg
Grade 3 crude tapioca starch	Rp. 150/kg

Based on the results of this experiment use of airtight bags resulted in better quality starch. Although a gunny sack will last longer than a plastic bag, the plastic bag + sack combination should be able to used almost as long. Therefore, the best packaging material, in the long run, would appear to be the double thickness of polyethylene and polypropylene.

b. Storage of fresh cassava tubers in moist rice huks (Soeharmadi, Suismono, D.M. Barrett)

Fresh cassava tubers are used for both fresh consumption and are also processed into various dry products. Cassava is extremely perishable and must be utilized within 2-3 days or physiogical and microbiological deterioration with render it unusable. Methods for storing fresh cassava have been sought for many years. Fresh storage could be aimed at one of two objectoves :

1. short-term storage (1-2 weeks) to aid in transportation from field to market or factory and to temporarily preserve tubers at times of peak harvest

2. long-term storage (2 months or more) for the farmer's consumption or in order to await a better market price.

The Department of Agriculture is interested in the second objective, i.e. long-term storage.

A review of the literature revealed that storage of cassava tubers in high temperature, high humidity conditions was conducive to "curing" of the cassava tuber, and thereby limiting deterioration. A modification of earlier research was made with storage of tubers in bamboo boxes, using wet rice husks as a packaging material (See Appendix VI). This method was compared to storage in plastic bags without moist rice husks.

In addition, a pre-survey of deterioration rates of 12 different varieties in the open air was peformed in order to identify the best variety for storage.

Although the experiment was completed in December, chemical analysis of all the samples has not been completed yet. Preliminary results, however, indicate that storage of tubers in the moist environment provided by the rice husks greatly prolonged the initiation of deterioration. Some changes in chemical composition did take place, i.e. moisture and starch contents

decreased while sugar and fiber contents increased, but to a much lesser extent in the tubers stored in moist husks.

It was noted that tubers with a fibrous neck of 5 cm or so in length stored better than those which had been cut too close to the flesh. Wounds incurred during harvesting and transportation provide sites for microbial attack, therefore tubers meant for storage should be selected carefully. In addition, round or long, cylindrical tubers seemed to store better than irregularly shaped ones. Some varieties deteriorate at a slower rate than others, and varietal selection would be beneficial. This experiment was the first step in what should be a series of small experiments. The method which was tested can be refined, in the future, to further improve storability.

b. Survey and chemical analysis of traditional processed products (Suismono, S. Widowati, D.M. Barrett)

The work plan for this project, which was carried out in February, 1984, appears as Appendix VII. In Indonesia cassava is either consumed fresh (boiled, baked, fried etc) or processed into gaplek or another dried form and stored until further processed and consumed. Processed cassava products, such as "gaplek" "tiwul", "gogik", "oyek" and "gatot" are commonly consumed on Java and have been brought to the other islands also by the transmigrating Javanese. Little is known about traditional processing methods and resultant quality. Kabupaten Gunung Kidul (D.I.Y.) is one of the poorest economic areas in Indonesia and also one of the highest cassava-consuming areas,

therefore this region was chosen for survey and sample collection.

The results of this survey and chemical analysis are put forth in a paper by the consultant entitled "Traditional Cassava Processing in Indonesia" (Appendix XXVI). It was found that farmers generally consumed a small portion of their harvest fresh and processed the rest as gaplek. The moisture, acidity and ash contents of stored gaplek and other cassava products was fairly high, and in addition mold and insect attack were common. These factors would indicate poor storage conditions. Starch content was fairly low, suggesting the possibility of hydrolysis or degradation due to exposure to microbial enzymes, acid or heat. The filth content of almost all of the products was high and sensory analysis results indicated that products were unacceptable as far as odor, color and physical condition. In conclusion, the quality of the stored cassava products sampled in Kabupaten Gunung Kidul was low, due to improper drying and storage conditions. Improved storage conditions would greatly improve nutrional quality and therefore health of the Gunung Kidul residents.

d. Analysis of sweet potato leaf quality (Suismono, Yetty Thahir, D.M. Barrett)

Although the protein content and overall nutritional composition of sweet potato leaves is high, they are rarely used as a vegetable for human consumption. Cassava leaves, in contrast, are often consumed. There is some opinion that removal of the leaves will greatly decrease sweet potato root yield. In order to test this hypothesis, and also to analyze the physico-chemical characteristics of leaves of

various sweet potato varieties, the above-mentioned experiment was carried out. The work plan appears in Appendix VIII.

This experiment was begun in October, 1984 and was completed in February, 1985. Samples are undergoing analysis at SURIF and, until results are available, no conclusions can be drawn. Possible results have been discussed with the scientists and they will write the final report.

e. Determination of optimal harvest time for various promising sweet potato lines (Suismono, Yetty Thahir, D.M. Barrett)

The postharvest group was requested to assist the breeding division in determination of optimal harvest time for various new lines. This project was begun in October 1984 and was completed in February 1985. A work plan is given in Appendix IX. Sample analysis is still on-going, therefore results are not available at the present time. Possible alternatives, however, have been discussed with the scientists and the meaning of physical and chemical changes is understood.

f. Priorities for cassava by-product research

The consultant was asked to design a 5-year program for cassava by-product research, to be submitted to AARD for possible funding through a collaborative project. The paper enclosed as Appendix X formed the basis for the Terms of Reference. This project has been approved by the AARD review committee and is not awaiting submittal to various outside funding sources.

g. Ideas for future postharvest cassava research

For the benefit of scientists who will carry on cassava postharvest research in the future, the consultant prepared a brief description of research priorities (Appendix XI). In addition, a work plan for the most needed project, classification of existing cassava lines/ varieties was prepared (Appendix XII).

2. Pigeon pea research (S. Widowati, D.M. Barrett M.S.)

In addition to the consultant's main activities in cassava research, she assisted in advising Ir. Sri Widowati on two pigeon pea postharvest research projects :

a. Utilization of pigeon peas as a high protein food source

b. Characterization of the physico-chemical and nutritional features of selected pigeon pea varieties.

Results of these two projects have not been completed yet, however preliminary results were summarized by Ir. Sri Widowati in a paper entitled "Cajanus Cajan, salah satu alternatif bahan pangan bergizi tinggi" (Cajanas, Cajan, one alternative high-protein food source) (Appendix XIII).

Preliminary results indicate that the protein, Vitamin A, phosphorous and calcium contents of pigeon peas are indeed high. Problems, now, lie in teaching the populous new methods of utilizing a crop which is not well known.

In addition to the above two projects, the consultant wrote a TOR for pigeon pea research, to be submitted to external funding sources (Appendix XIV).

3. Rice research

The consultant assisted in rice research on an informal basis and, in addition, helped to prepare various TORs for possible collaborative projects (Appendices XV-XXI). Various farmer, trader and industry surveys were conducted during the period of consultancy and the consultant assisted in survey and questionnaire design and implementation also.

4. Routine research improvement

The consultant worked closely with scientists and technicians in the SURIF chemistry and technology laboratory in order to implement better organization of sample analysis. This activity included the following :

a. calculation of time, manpower and material requirements for each type of analysis performed by the SURIF lab

b. allocation of responsibility for each type of analysis to a specific technician or technicians

c. assessment of samples to be analyzed, i.e. those already taken and stored and those to be taken in the near future

d. designation of priorities to specific samples and analyses

e. scheduling of technicnian's activities on a monthly basis.

D. Publications

During the course of the consultant's term, a number of papers have been written, both alone and in collaboration with Indonesian couterparts. The papers and locations of presentation are listed below :

No.	Paper title	Location
1	Quality characteristics, standards analysis of cassava and its products	Department Ag./ BULOG Cassava training Tambun Sept.20-29, 1983
2.	Highlights of postharvest tuber crop research, Pelita III (Appendix XXII)	AARD Highlights Karawang November, 1983
3.	Peningkatan Mutu Hasil Ubi Kayu di Indonesia(Improvements of cassava quality in Indonesia) (Appendix XXIII)	Jurnal Penelitian dan Pengembangan Pertanian Januari 1984
4.	Improving the awareness and maintenance of rice quality in Indonesia(Appendix XXIV)	Jurnal Penelitian dan Pengembangan Pertanian(still in progress)
5.	Cassava Reader (still in progress with Ir. Wargiono, Agronomy department, BORIF)	Yayasan Obor (IDRC funding)
6.	Cassava processing in Gunung Kidul	Sukamandi weekly seminar April, 1984

7. Tofu waste utilization for animal feed (in progress)	Sukamandi May, 1984
8. Postharvest research priorities for cassava in Asia (Appendix XXV)	ESCAP/CIAT workshop Bangkok, June 4-8, 1984
9. Traditional cassava processing in Indonesia (Appendix XXVI)	Institute of Food Technologists Conference, Anaheim, California June 10-14, 1984
10. Rice harvesting, threshing and drying in Indonesia (Appendix XXVII)	ASEAN training Tambun Sept. 15, 1984
11. Report of "Postharvest Evalution of Tuber and Fruit Crops"[2]	Bogor January, 1985
12. Postharvest handling of cassava in Indonesia and propective cassava products for the future	Seminar on Cassava Potential in East Java Malang. Jan.15-16, 1985

E. Seminars/Conferences

Seminars, conferences and workshop in which the consultant participated during her two-year position are listed below:

No.	Name	Dates	Location
1	International Workshop promoting Research on Tropical Fruits	May 29-June 6, 1983	Jakarta
2	Workshop on Cassava Processing and Storage	Sept.20-29, 1983	Tambun

[2] Available on request.

3	Solar Drying Workshop	Oct.24-29, 1983	Yogyakarta
4	Workshop on Future Potential of Cassava in Asia	June 4-8, 1984	Bangkok
5	Annual Institute of Food Technologists Conference	June 10-14, 1984	Anaheim, California
6	International Symposium on Agricultural Product Processing and Technology	July 30-August 2, 1984	Bogor
7	Workshop on Potential of Cassava in East Java	Jan.15-16, 1985	Malang

F. Miscellaneous

A few miscellaneous job were performed, in addition to routine organizational, research and training activities. These were as follows :

1. Acted as rapporteur for the "International Workshop on Promoting Research on Tropical Fruits" held in Jakarta from May 29-June 6, 1983. Following the workshop, the consultant compiled workshop discussion notes and assisted in editing of all papers presented.
2. Assisted in short-term consultancies and meetings with foreign consultants to AARD, in particular:
   a. Dr. Ron Edwards — Head, Institute of Food Techology, University of New South Wales, Australia

b. Ir. Franz Altes — Agricultural Engineer
Royal Tropical Institute
Amsterdam

c. Ir. Kees Hartveld — Economist
Royal Tropical Institute
Amsterdam

3. Submitted an application, in collaboration with SURIF, for a VSO to teach English at Karawang and SURIF.
4. Translation and editing of numerous articles for BORIF and SURIF staff
5. Preparation of Indonesian-language questionnaires for postharvest technology related questions aimed at farmers, traders, industry personnel and research institutes
6. Acquisition of books and journal articles related to postharvest technology and placement in SURIF and Karawang libraries.
7. Preparation of a master list of chemical costs for routine food analyses
8. Gave comments on a proposed method of paddy grading developed by a Swiss aid project.

IV. RECOMMENDATIONS

The recommendations detailed below take the form of comments, suggestions and ideas put forth by the consultant. They should not be taken as requirements, but rather as the opinion of an outsider who has had the privelidge of working

closely with the chemistry and postharvest technology division of the Agency for Agricultural Research and Development.

A. Organizational

1. General

a. Recognition of the importance of proper postharvest handling of food crops (and all crops, for that matter) and the degree of losses which result without such care is just beginning to take place in Indonesia. The government must take a firmer position in the monitoring of not only food quanty but food quality. Only through the implementation of such top-down policies as floor prices, quality standards and credit or subsidies for the farmer and other individuals participating in the post-harvest food chain will major improvements in food quantity and quality take place.

b. Marketing activities greatly influence the postharvest handling and subsequent quality of food crops and the price received by the farmer. This vital but elusive area falls under the Department of Trade but is, at the present time, not adequately monitored or controlled. In order to insure food quality, as safety and fair marketing practices, the government must take a definite role in the control of traders and middlemen currently functioning in the food marketing system.

c. In many cases, the successful upgrading of a raw material into a higher value product is only possible through some degree of processing at a fairly large scale. Home industries and activities which take place at a farmer group level, while beneficial in that they provide employment, are oftentimes not economic in the long run. In the same respect, labor intensive activities which are not "allowed" to become mechanized due to the wish to provide employment often go bankruptand/or cannot complete on the international market. Therefore, in order for postharvest technology, and many other fields, to progress, some degree of scale increase and mechanization is required. This fact must be realized, and must be considered in terms of economics of scale and possible reallocation of the labor force.

2. Specific

a. Postharvest technology is a vital component of food research and, as such should be incorporated into the national research programs of each food crop commodity to form an all-encompassing multi-disciplinary research program.

b. In order to facilitate the above suggestion the postharvest technology divisions of AARD should be allocated a greater portion of the budget. According to the recent "Postharvest Evaluation of Tuber and Fruit Crops" report, the postharvest technology division is given a mere 0.8% of the total CRIFC budget. It was determined that, based on currently available manpower, this amount should be increased at least three times.

c. As far as physical presence, each of the six CRIFC research institutes should eventually house a postharvest technology division which both supports the other disciplines and carrie out research on "primary processing" activities. Two stages of postharvest technology, i.e. "primary" and "secondary" processing are typically referred to. Primary processing involves direct handling of the original agricultural product i.e. immediate activities such as harvesting, sortation or grading, threshing, drying, storage, packaging, transportation, preservation and initial processing. Secondary processing, on the other hand, involves chemical and physical manipulations which are implemented to produce new products having higher value.

In that primary processing steps are geared more to the specific commodity and are put into action immediately after harvest, it is necessary that research on these activities be carried out near the production site, i.e. the individual research institute. Development priority should be given to SURIF, BORIF, MARIF and SARIF, with preparatory activities taking place at MORIF and BARIF.

d. In secondary processing activities, the product is visualized not as that specific commodity, but rather, more as its component parts. For example, secondary processing might involve the conversion of tofu waste, cassava starch waste or coconut husks into single cell protein. The product would be seen as a source of cabohydrates rather than a specific food or industrial commodity. In addition, secondary processing research usually requires more sophisticated equipment and a higher

level of technology. For these reasons, it is best to centralize secondary processing research for all related institutes under AARD, i.e. food crops, industrial and estate crops, fisheries and animal husbandry.

It is recommended that a new Central Research Institute be created to handle secondary processing activities. Preparations should begin withinthe next 3-5 years. This central institute would be best located in Bogor or Jakarta in that this is where the greatest concentration of food technology manpower, facilities and industry currently exists. It is recommended that, for the moment, priority be given the primary processing of food crops (at the individual institute level) but that secondary processing research be initiated also.

e. National research coordinators, who have been appointed for most of the priority food commodities, should remain located in their individual research institutes, but should also be given a position at the central institute level in order to better coordinate their activities. In addition, they should be allocated a budget with which to visit researchers and experimental sites under their commodity group.

B. PHYSICAL RESOURCES

Equipment and laboratory facilities for postharvest research exist, at the moment, only at SURIF. SARIF and BORIF have physical structures which have been allocated to postharvest research, but lack the basic equipment required to carry out research. Within 3-4 years, MARIF's postharvest laboratory will have been constructed

but equipment has not been ordered yet. BARIF's plans show plans for approximately 50 m^2 of laboratory space, but this will not exist for a few years. MORIF has not yet planned for such facilities. With these facts in mind, the following recommendations can be made.

1. As far as physical structure, concentration should be placed on construction at MARIF and BARIF and utilization of the existing structure at BORIF. Secondary emphasis should be given to construction of postharvest facilities at MORIF and expansion of existing lab space at SARIF.

2. Minimum requirements for postharvest laboratories were established by the postharvest tuber and fruit crop team, i.e. :

a. chemistry and nutrition	75 m^2
b. microbiology	75 m^2
c. quality control and organoleptic analysis	50 m^2
d. processing	100 m^2
	300 m^2

This means that, eventually, each of the six CRIFC institutes should allocate at least 300 m^2 of lab space to postharvest technology research.

3. Support facilities such as drying floors, storage godowns and could storage facilities should also be designed for each institutes.

4. In that the location and environment at the Karawang installation are no longer conducive to the effective conductance of research activities, it is recommended that this installation be closed. The existing research personnel and equipment could be transferred to institutes lacking in such resources, i.e. BORIF and MARIF. Granted, this relocation of staff and equipment may take some time and cause some discomfort, but in the long run it will be advantageous.

5. A recommended list of equipment for postharvest research appears as Appendix XXIX. This list denotes only large scale, fairly sophisticated equipment and does not attempt to cover glassware and small scale equipment, however it will hopefully provide a useful guideline. Most of the items have been taken from the Fisher Scientific catalog, but comparable items may be substituted. Not all of the items are "priority", therefore the list will have to be reviewed prior to procurement.

C. MANPOWER RESOURCES

The current status of postharvest research manpower in AARD and other institutions appears in Table 14. It is clear that the greatest pool of postharvest technologists exists in the universities. Within AARD, CRIFC boasts the largest number, with the concentration based at SURIF. With these facts in mind the following recommendations may be made.

1. Staff recruitment and upgrading of existing staff are the primary needs in strengthening AARD's postharvest research

program. Although buildings and equipment may take a long time to procure, and increases budget allocations may be slow in coming, it is the lack of skilled manpower which will be the greatest drawback to a functioning research program. Therefore, major efforts must be made to improve existing manpower.

2. While staff number is still low, AARD should draw on the skilled pool of postharvest technologists existing in the universities, in particular IPB and UGM. Collaborative projects in which AARD's wealth of physical facilities is combined with the university's wealth of manpower, are highly recommended.

3. Recommendations on staff requirements were made by the recent postharvest evaluation. The minimum staff required for a research institute involved in research on chemistry, nutrition, microbiology, quality control and processing was deemed to be 1 PhD, 4 M.S. and 8 Ir. degree staff. These staff members should be either from the field of food technology or one of the four specialized fields noted above. Once the division of postharvest technology in each institute has developed, this requirement should be increased to 2 PhD, 6 M.S. and 8 Ir. degree staff. Targets for postharvest manpower, which were calculated by the postharvest evaluation team, appear in Table 16.

4. Both short-term and long-term training opportunitinies should be sought for existing staff imporvement. These opportunities are available through both domestic universities and the NAR III and AARP projects. Some excellent universities and/or training centers are the following :

TABLE 16

Targets for rese. ch manpower for Postharvest research in food and fruit crops in 1988 and 1993

Qualification	1988		1993	
	Food Crops	Fruit Crops	Food Crops	Fruit Crops
Ph.D	8	4	16	8
M.S.	16	10	34	20
Ir.	28	18	40	20
	52	32	90	48

a. Institut Pertanian Bogor (Bogor)	Food Science and Technology Agricultural Product Processing Industrial Technology Agricultural Engineering.
b. Universitas Gadjah Mada (Yogyakarta)	Agricultural Product Processing Agricultural Engineering
c. Asian Institute of Technology(Bangkok, Thailand)	Food Science and Technology Agricultural Engineering
. University of the Philippines (Los Banos, Philippines)	Food Science and Technology Ac icultural Product Processing
e. IRRI (Los Banos, Philippines)	Rice Chemistry
f. Tropical Development Research Institute (Londong, England)	Food Science and Technology Storage Technology
g. Royal Tropical Institute (Amsterdam, Netherlands)	Food Science and Technology
h. Central Food Technology Institute (Hyderabad, India)	Food Science and Technology Agricultural Product Processing
i. Kansas State University University(Manhattan, Kansas USA)	Grain Science Storage Technology Food Science and Technology
j. Cornell University (Ithaca, New York USA)	Food Science and Technology Agricultural Engineering.

Other U.S. universities that the consultant knows to have good Departments of Food Science include : Univ. of California-Davis, Washington State University, Univ. of Wisconsin-Madison, Univ. of Illinois-Urbana, Univ. of Florida-Gainesville, Univ. of Massachusetts- Amherst, Texas A and M and MIT.

5. While postharvest research staff remains minimal, foreign experts may be used to fill in the gaps. These experts should have experience abroad and should gear their research and training emphasis, for the meantime, to practical problems.

6. Existing postharvest staff lack adequate background in chemistry, microbiology and statistics. Oftentimes what is taught in Indonesian food science programs emphasizes only technology which, while needed, must be supplemented with the above-mentioned disciplines.

7. CRIFC postharvest staff, for the moment, are not working on particular commodities but rather must act as "jacks of all trades" and handle <u>all</u> food crop commodities. It is suggested that, if possible, staff be classified into commodity groups i.e. cereals, tubers, legumes, etc. This will provide more coherence to the program.

8. There is presently a relative abudance of staff at SURIF (including Karawang) while other priority institutes (BORIF, MARIF and SARIF) are lacking. A better distribution of staff should be attempted.

D. FINANCIAL RESOURCES

It has been stated that financial allocation to postharvest research must be increased. In the case of CRIFC, the budget could be justifiably increased three times. In addition, the following comments are made :

1. The rationale for allocation of funds for research differs from institute to institute within CRIC. It should be possible to make this more uniform at least in CRIFC, and to make it more flexible. The system of basing funds on the number of locations and/or seasons during which the project runs is not always applicable. It may happen that one project, which takes a mere 3 weeks to carry out but is of great importance, will require a great deal of money. In addition, it is not always true that a two unit project in agronomy will require the same amount of funds as a two unit project in postharvest technology. It would be advantageous to review the current system of research fund alocation and imporve it.
2. Additional funds for postharvest research may be sought through collaboration with :
   a. domestic industries
   b. international institutes
   c. domestic universities and other institutes

3. Regarding allocation of funds to primary and secondary processing researc primary processing research should take precedence at the moment. The recent postharvest evaluation recommended only a 15-20% allocation to secondary processing research for the next 3-4 years.

E. RESEARCH ACTIVITIES

As seen in Table 4, past postharvest research activities at Karawang have been of an applied nature while those at Sukamandi have been more fundamental. A few comments may be made on current research activities and functioning of the labs at Karawang and Sukamandi.

1. Research priority, as stated earlier, should be given to primary processing activities. These include the harvesting, threshing, sortation and grading, drying, storage, transportation and simple processing steps in the postharvest chain. In addition, postharvest research should aim at supporting the other CRIFC pre-harvest disciplines, i.e. breeding, agronomy, plant protection and social-economics.

2. CRIFC institutes lacking physical resources may still begin work in the postharvest technology area by conducting surveys and making inventories of farmer level postharvest activities. This work should be done prior to laboratory research anyway and may be conducted in conjunction with the social-economics division.

3. Overall coordination of postharvest research within AARD is virtually nonexistent, and even projects conducted at different CRIFC institutes may overlap. This coordination must be improved in the future.

4. Organization and planning of research projects is not begun far enough in advance and therefore work plans are often not well thought-out. In addition, long-term goals are somewhat hazy and must be better delineated. While postharvest technology is still a relatively new field, greater efforts should be made to direct research activities.

5. It would be beneficial to plan research projects within an institute's postharvest research division on at least a seasonal (if not month-to-month) basis so that an overload of samples at any one time will not take place.

6. Laboratory analysis could be better scheduled to provide more efficient functioning and give technicians more directions in their work.

7. Publication of research results takes the form of either brief yearly reports or seminar papers. A more standard form of publication should be developed.

8. Specific recommendations for future cassava postharvest research have been made in the recent postharvest evaluation and in the paper which appears as Appendix XI.