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BIOTECHNOLOGY AND DEVELOPING COUNTRY AGRICULTURE: MAIZE IN INDONESIA

by

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RÉSUMÉ

Après le riz, le maïs vient au deuxième rang des produits alimentaires de base en Indonésie. Sa culture s'étage selon des conditions agro-écologiques très diverses. L'alimentation humaine absorbe plus de la moitié de la récolte maïs, au cours des dernières années, la demande pour l'alimentation animale -- en particulier -- l'aviculture, a beaucoup augmenté. Le Plan indonésien de développement fixe des objectifs de production de maïs aux différentes régions, avec des conditions technologiques variables sur le plan des semences et du niveau d'autres intrants. Bien que le recommandations technologiques prévoient une large diffusion de semences améliorées, une faible partie de la surface cultivée totale est ensemencée d'hybrides. L'industrie commerciale de la semence est d'ailleurs à ses débuts.

A la différence du riz et du soja, le maïs n'est pas l'objet d'interventionnisme actif de la part des pouvoirs publics. Cependant, le revenu agricole lié à la culture du maïs a augmenté malgré la croissance des coûts de production à l'hectare. Le prix élevé des hybrides par rapport à celui des variétés à pollinisation libre produites par les exploitants n'incite guère à l'introduction des hybrides. Il semble également que, à court terme, l'introduction des nouvelles biotechnologies ne suscite qu'une faible demande dans le domaine de la production de maïs.

SUMMARY

After rice, maize is the second most important staple food in Indonesia, and is cultivated under a diversity of agro-ecological conditions. While food accounts for more than half total maize utilisation, demand for maize as livestock feed - particularly for poultry - has been growing rapidly in recent years. The Indonesian Development Plan sets production targets for maize for different regions, according to different technological "packages" in terms of the type of seed used and level of other inputs. Although the recommended technology packages imply wider diffusion of improved seed, only a small share of the total area cultivated is sown to hybrids and the commercial seeds industry is only just emerging.

Unlike rice and soybean, maize is not a major focus of policy intervention. Nevertheless, farm revenue in maize production has been increasing despite growing production costs per hectare. Given the high price of hybrids compared to open-pollinated varieties so far obtained under farmers' conditions, there is little incentive to introduce hybrid seed. There would also appear to be little demand for introducing new biotechnology in maize production in the short term.

PREFACE

This case study of Indonesia has been undertaken as part of a research project on "Biotechnology and Developing Country Agriculture: the Case of Maize", carried out in the context of the Development Centre's research programme on "Changing Comparative Advantages in Food and Agriculture". The project, which assesses the prospects for selected developing countries of incorporating new biotechnologies in competitiveness, focuses on the institutional aspects of technological change.

Maize was selected as an eminently suitable subject for examining how new technological developments in industrialised countries "interact" with the situation in developing countries. One of the world's major cereal crops, in many developing countries maize is an important food and/or feed crop for which demand continues to expand, particularly for use as livestock feed. Maize is also a crop on which major biological research effort has been focused. This effort resulted in the innovation of hybridization in the 1930s and shows promise with respect to new biotechnolgies.

Dr Hidajat Nataatmadja and colleagues have contributed this case study of Indonesia. It traces production and consumption trends, examines Indonesia's maize research, technology development and diffusion system and concludes that at present there a few incentives to producers to adopt hybrids rather than open-pollinated varieties. In addition to the case of Indonesia, the project includes case studies of Brazil, Mexico and Thailand. It also analyses trends in research on the emerging maize biotechnologies and in the supply, demand and trade of maize internationally. The country studies together with the analysis of technology trends (entitled "Emerging Maize Biotechnologies and their Potential Impact") are all being published in this Technical Paper Series. The Conclusions and policy implications to be drawn from the project will be published by the OECD in a separate volume by Carliene Brenner.

Louis Emmerij
President
OECD Development Centre
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I. PRODUCTION, UTILISATION AND MARKETING

1. Administration and Population

Indonesia is the world's biggest archipelago nation, comprising 13 677 islands stretching 5 110 km from east to west and 1 888 km from north to south. The total area is 4 497 241 km^2, of which 2 019 380 km^2 are land. This bigness has great potential but lack of thought and planning can make it a great burden.

The population (Table 1.1) is very unevenly distributed. Java, with about seven per cent of total land area, has more than 60 per cent of the population. The country has 27 autonomous provinces.

2. *Land Resources*

Indonesia's agricultural potential depends on several major factors:

- topography, geology, and soils
- climate and water resources
- agricultural enterprise, organisation and technology
- socio-economic conditions and infrastructure.

Topography will determine land use and climate the possibility of developing a crop or farming system. Soil will determine the inputs needed for the growth and continuity of the agricultural system adopted. The level of technology will determine the good utilisation of resources. Socio-economic conditions will influence growth of a farming system. Table 1.2 shows areas of land capability, which have been classified as follows:

I-III: for food or perennial crops
IV: for mixed farming (food, perennial crops, grass/sylvipasture)
V: for perennial and estate crops
VI: for perennial crops and forest farming
VII-VIII: for forest

Areas of swampland and dryland, which have agricultural potential in Sumatra, Kalimantan, Sulawesi and Irian Jaya are shown in Table 1.3. We can see that such dryland in these four major islands totals 37 996 000 ha., while the swampy land is 28 863 000 ha. Of the dryland, only 1 710 000 hectares can be classified as in land capability classes I-III. So the four islands have only very limited dryland suitable for food crop cultivation. The swampy area could be used for food crops but only with major investment. Prospects for new dryland include mixed farming, perennial or estate crop cultivation and animal husbandry.

Table 1.1
POPULATION [1]

Province	Area km^2	Population 1974 (X 1,000)	Population Density 1974 Persons/km^2	Population 1980 (x 1,000) Estimated	Population Density 1980 Persons/km^2 Estimated
D.I. Aceh	55 392	2 210	40	2 633	48
North Sumatra	70 787	7 079	100	8 686	23
West Sumatra	48 778	2 950	59	3 661	74
Riau	94 562	1 769	19	2 152	23
Jambi	44 924	1 118	25	1 318	29
South Sumatra	103 688	3 813	37	4 514	44
Bengkulu	21 168	578	27	680	32
Lampung	33 307	3 163	95	3 640	48
Sumatra	473 606	22 679	48	27 278	58
D.K.I. Jakarta	590	4 712	7 986	7 531	12 764
West Java	46 300	22 525	486	25 762	556
Central Java	34 206	22 879	669	26 052	762
D.I. Jogyakarta	3 169	2 580	814	2 965	936
East Java	47 922	26 309	549	30 399	634
Java and Madura	132 187	79 004	598	92 709	701
Bali	5 561	2 217	398	2 677	481
West Nusa Tenggara	20 177	2 321	115	2 781	138
East Nusa Tenggara	47 876	2 397	50	2 899	61
Bali & Nusa Tenggara	73 614	6 935	94	8 357	114
West Kalimantan	146 760	2 201	15	2 579	18
Central Kalimantan	152 600	772	5	894	6
South Kalimantan	37 660	1 803	48	2 169	58
East Kalimantan	202 440	797	4	936	5
Kalimantan	539 460	5 574	10	6 578	12
North Sulawesi	19 023	1 842	96	2 191	115
Central Sulawesi	69 726	997	14	1 166	16
South Sulawesi	72 781	5 368	74	6 618	91
South East Sulawesi	27 686	757	27	911	33
Sulawesi	189 216	8 964	47	10 886	58
Maluku	74 505	1 187	16	1 375	18
Irian Jaya	421 981	1 007	2	1 167	3
INDONESIA	1 904 569	125 349	66	148 349	78

East Timor is not included.
Source: B.P.S. Statistical Pocket Book 1975, "Social Indicators 1975".
Population density 1974 calculated. From Manfred Woelke, 1978, Statistical Information on Indonesian Agriculture. German Agency for Technical Cooperation.
1 In 1989, the population was some 176 million, growing at 2.1% a year.

Table 1.2

ESTIMATED AREA AND DISTRIBUTION OF LAND CLASSES, BY ISLAND (000 HECTARES)

Land Class	Java/ Madura	Bali	Suma- tra	Kali- manten	Sula- wesi	Irian Java	Nusa Tenggarra	Maluk	Total
I	275	-	-	-	-	-	-	-	275
II	344	19	-	-	275	-	94	-	723
III	969	-	631	-	806	-	138	25	2 569
IV	3 369	144	7 781	1 319	1 869	1 144	2 069	1 113	18 809
V	2 314	125	26 306	23 281	2 106	17 756	2 200	3 425	77 543
VI	3 312	206	5 206	13 263	3 425	6 688	481	1 206	33 787
VII/VIII	2 606	62	7 439	16 137	10 614	16 612	2 056	1 708	51 232
Total	13 219	556	47 363	64 000	19 095	42 200	7 038	7 475	190 946

Source: A. Affandi, Agricultural Development in Indonesia, 1986.

Table 1.3

ESTIMATED POTENTIAL AREA WITH 0-15 per cent SLOPE SUITABLE FOR AGRICULTURE IN THE FOUR MAJOR ISLANDS (000 HA)

Island	Flat- Swampy	Flat- 0-3% 3-8%	Rolling 8-15%	Rolling	Total
Sumatra	8 500	6 679	4 056	2 015	21 250
Aceh	500	412	530	385	1 827
North Sumatra	625	673	660	450	2 408
West Sumatra	625	595	445	210	1 875
Jambi	937	595	915	232	2 679
Riau	1 750	1 265	915	277	4 207
South Sumatra	2 938	2 245	271	296	5 750
Bengkulu	188	69	160	75	492
Lampung	937	825	160	90	2 012
Kalimantan	9 196	4 445	5 944	4 035	23 620
West Kalimantan	3 038	1 260	630	1 107	6 035
Central Kalimantan	2 863	2 110	3 232	1 630	9 835
South Kalimantan	1 100	82	916	537	2 635
East Kalimantan	2 195	993	1 166	761	5 115
South Sulawesi	162	746	551	705	2 164
Southeast Sulawesi	0	221	118	113	452
Central Sulawesi	0	300	133	363	796
North Sulawesi	0	40	39	126	205
Irian Jaya	11 506	4 825	3 026	969	20 326
Total	29 364	16 695	13 577	7 724	66 360

Source: Repelita V, Ministry of Agriculture.

Table 1.4 shows land use for agriculture, where food crops occupy about 11.3 million ha (columns 1, 2, and part of 5), or about 74 per cent of the total land for agriculture. The 15.2 million ha was about 7.5 per cent of the total national land area. Yet when only soil classes I-IV are considered, it was about 47 per cent.

Table 1.4

LAND USE PATTERN FOR AGRICULTURE, AGRICULTURAL CENSUS 1983 (000 HA)

Island	Wet Lands[2]	Dry Lands	Fish Ponds	Estate[1] Crops	Others	Total
	1	2	3	4	5	6
Sumatra	1 247	1 319	231	1 317	58	4 172
Java	2 882	2 361	577	324	40	6 184
Nusa Tenggara	321	572	7	139	15	1 054
Kalimantan	507	548	8	682	60	1 805
Sulawesi	469	654	28	366	22	1 540
Maluku + Irian	6	216	2	225	8	456
Indonesia	5 432	5 670	853	3 053	203	15 211

1 Only for smallholders, large estates excluded.
2 Wet land under various irrigation types.
Source: Agricultural Census 1983, CBS.

3. Climate

In 1975 Oldeman, a Dutch expert, came up with a new climate classification, supposedly better than the Schmidt & Fergusson classification and more suitable for food crops. He defines a dry month as when rainfall is lower than 100 mm and a wet one when it exceeds 200. 200 mm is the minimum for a food crop to grow without irrigation.

Much of the east coast of Sumatra has a drier climate than the western and middle parts of the island it is wetter. Parts of east coast Aceh and North Sumatra are irrigated. Other parts of this zone especially Riau, Jambi, South Sumatra and Lampung are swamp and tidal swamp. Except for the province of West Sumatra itself, the western part of the island is much less developed because of mountains. The high rainfall also seems to produce highly acid soil (pH 4 - 5) and liming is desirable, particularly for soybeans. Aluminium toxicity also limits food crops.

In Java much of the northern coastal area is drier, but these are the best irrigated areas, particularly in West Java. In general, rainfall decreases from west to east. Without irrigation, food production seems to follow rainfall, especially in the drier part of Central Java. East Java is the centre of palawija (secondary crop) production, such as maize, cassava and soybean. West Java produces least palawija, but is both the biggest rice producer and consumer, which makes its rice surplus lower than that of East Java.

The higher palawija production seems linked with East Java's relatively high pH, which is very close to neutral (pH 6-7). Higher rainfall in West Java produces acid soil (pH about 5-6) less suitable for palawija crops. Southern Java is less developed than the north because of mountains and limestone. Large rivers flow to the northern coastal region, generating a vast alluvial soil suitable for agricultural production, hence the saying that "Java is the most fertile land in the world." This is not wrong, because there are so many active volcanoes, suggesting a young and fertile soil.

Kalimantan is wet except in the east and the south-eastern tip. Much of the coast is swamp and tidal swamp. The island is said to have "the poorest soil in the world". Yet East Kalimatan produces much oil and natural gas and the province has a big urea factory.

Sulawesi is wetter in the centre, yet rice production is concentrated in the south, which is known as the rice granary of eastern Indonesia. High rainfall alone does not ensure high yields: mountainous central Sulawesi has poor transport.

In eastern Indonesia, we have Maluku, Irian Jaya, Nusa Tenggara (west and east) and Bali. Bali is not really wet but water conservation is relatively good. Lombok and Sumbawa island of West Nusa Tenggara stand between the drier parts of the east, such as Sumba, Flores and Timor. East Nusa Tenggara is mainly savannah and livestock production is high there.

In many places, maize and cassava are the main staples. Nusa Tenggara is poor with limited agricultural potential and population density is too high in these islands. Their dryness comes from the nearby Australian continent, to which Nura Tenggara belongs climatically. Irian Jaya is wet and swampy, particularly in the south. The government has begun developing this virgin island's infrastructure, but little has been done in the short term.

4. Regional Characteristics of Smallholdings

Food crop farming is usually a combination of many crops, within a region or a single farm. Only in irrigated areas can we see rice planted as monoculture. Mixed cropping is shown in Table 1.5.

Table 1.5

PERCENTAGE DISTRIBUTION OF AGRICULTURAL HOUSEHOLD
by Type of Agricultural Enterprise 1983

	Type of Agricultural Enterprise						
Region/Island	Rice & Palawija	Vegetables Fruit	Small-holder Estate	Fish Culture	Fisher -Man	Live stock/ Poultry	Degree of diversi-fication
Sumatra	80.2	32.3	68.6	3.3	2.6	17.7	204.7
Java	86.4	50.8	63.4	4.5	0.9	22.4	228.4
Bali/NTT/NTB	85.5	52.3	65.4	1.2	3.6	41.8	249.8
Kalimantan	88.0	45.3	54.1	1.6	3.5	18.4	210.9
Sulawesi	82.2	44.9	66.2	1.7	8.5	27.4	230.9
Maluku/Irian	84.4	63.2	66.0	0.6	11.1	25.9	250.2
East Timor	96.3	62.3	79.6	0.9	1.8	28.6	269.5

Source: Agricultural Census, 1983. Book A.2. CBS, 1985.

Landholding size and distribution is shown in Table 1.6. There are many small farms below 0.5 ha outside Java, in more sparsely-populated areas. Since the farmer relies exclusively on manual labour, for food crop farming the maximum practicable area per household is about 0.7 ha however great the land potential.

So smaller landowners are needed to help bigger farmers. The Agricultural Census of 1983 also showed about 18 per cent of rural households in Sumatra were landless and about 20 per cent in Kalimantan, 15 per cent in Sulawesi and some 30 per cent in Java. Not all the landless are farmers however.

Table 1.6

PERCENTAGE DISTRIBUTION OF AGRICULTURAL HOUSEHOLDS
by Class of Landholding and Region/Island, 1983

Region/Island	0.5 ha	0.5-1 ha	1-2 ha	2-3 ha	3 ha	Total %
Sumatra	28.3	23.3	26.2	12.1	10.1	100
Java	63.1	21.5	10.5	2.7	1.6	100
Nusa Tenggara	34.0	23.1	23.5	10.4	9.0	100
Kalimantan	20.3	15.4	23.8	15.1	25.4	100
Sulawesi	27.1	23.7	26.9	12.3	10.0	100
Maluku/Irian	30.3	17.5	22.3	13.6	16.3	100

Source: Agricultural Census, 1983, Book J1.

Table 1.7 shows the importance of maize farming in relation to other food crops. Maize is second in importance after rice. Rice easily dominates, except in Maluku and Irian Jaya, where sago palm is the main rural staple.

Table 1.7

PERCENTAGE DISTRIBUTION OF AGRICULTURAL HOUSEHOLDS BY FOOD CROP CULTIVATED AND REGION/ISLAND IN 1982/1983[1]

Region/Island	Lowland Rice[2]		Upland	Maize	Cassava	Sweet	Peanut	Soybean
	WS	DS	Rice			Potato		
Sumatra	48.6	30.3	30.7	15.3	27.8	5.5	4.6	2.4
Java	60.3	38.3	18.1	4.3	42.1	9.1	10.0	11.0
Bali & NTT/NTB	42.0	24.5	23.5	46.0	39.4	19.2	8.0	7.0
Kalimantan	39.7	34.5	47.1	23.2	31.8	6.1	4.2	1.4
Sulawesi	30.6	30.2	16.7	46.5	34.9	10.7	8.4	2.8
Maluku/Irian Jaya	1.4	0.4	14.6	30.8	61.7	55.6	11.5	3.3

Source: Agricultural Census, 1983, CBS Jakarta.
1 per centage of total food crop households, animal husbandry and inland fishery.
2 WS = wet season. DS = dry season.

5. Maize Production System

Maize production in Indonesia is exclusively a smallholder activity. Private companies enter only into production and marketing of seed, fertiliser, and pesticide. Stephen D. Mink in *The Corn Economy of Indonesia* mentions the "tremendous diversity" in maize production methods, between farms as well as regions. Often maize is grown as a supplementary crop, occupying less than 10 per cent of the total area. In shifting cultivation, maize and rice are always mixed, with maize harvested first and then rice. Cassava, maize and rice is a common crop mix in much of Indonesia. Cassava may be harvested late in the year, acting as standing food storage in the field.

This diversification and complexity of production is illustrated by the Upland Agriculture and Conservation Project, in East Java. The project was in a "critical area," where erosion was high and the slope above 15 per cent. Crop productivity was particularly low before and during the first project year. The government provided a subsidy for land conservation, plant materials, fertiliser and insecticide. In the first year the subsidy was Rp180 000/ha. In the second, it was Rp 80 000/ha for further improvement.

The project was then evaluated for the four years shown in Table 1.8. The data was collected from five farmers participating in the project (1, 2, 3, 4 and 5). The year 1984/1985 was the start of the project. The second year subsidy was used to buy goats which were given free to farmers. The table shows that:

- farm size ranged from 0.26 - 1.0 ha.

- fertiliser and insecticide use increased beyond the subsidy year.

- there was a shift from rice to maize.

- no farmer grew cotton in the first year, but later all did.

- gross revenue increased from Rp122 200 in 1984/1985 to Rp1 419 900 per hectare in 1987/1988.

- rice was mixed with maize; cassava was planted after the maize/rice harvest, sometimes only at the border; cotton was planted before maize was harvested.

- besides annual crops, farmers also planted citrus, expecting to receive higher income the following year.

- for feed and terrace strengthening they grew elephant grass.

- some farmers experimented with growing soybeans.

So when properly carried out, even on eroded soil, maize production can reach 2.9 tons/ha under mixed cropping. Fertiliser use per hectare reached a high 526 kg/ha in 1987/1988. Within a year, the gross income was comparable to an irrigated rice field. But such results were not achieved in all villages of the project. Infrastructure and leadership were decisive for success.

Table 1.8

PRODUCTION PERFORMANCE IN UPLAND AGRICULTURE AND CONSERVATION PROJECT, BRANTAS WATERSHED, EAST JAVA, 1984/86 (Sumberjo Village, Blitar)

Input & Production	1984/1985						1985/1986					
	1	2	3	4	5	X	1	2	3	4	5	X
Area (ha) of Farm Sample	.26	.54	.35	.32	1.0	0.5	.26	.54	.35	.32	1.0	0.5
Inputs												
Fertiliser (kg)	50	100	75	50	100	152	150	175	220	123	250	375
Manure (qt)	15	15	25	10	30	38	20	25	30	12	45	53
Pesticide (lt)	-	2.5	-	-	-	0.2	1	1	1.5	1	2	2.6
Production (qt)												
Rice	1.3	1.5	-	-	-	1.3	7	21	-	12	38	32
Maize	0.4	1	1.5	3	12	7.2	1	2.3	8	-	10.5	8.8
Cassava	12	11	23	10	22	32	12	6.3	18	4.5	18.8	16.5
Cotton	-	-	-	-	-	-	1.5	4	0.5	1.5	11.8	7.7
Gross Revenue			R =		13 000					R =		320 000
					61 200							96 800
					48 000							66 000
			RP		122 200							308 000
										RP		790 800

Table 1.8 (continued)

PRODUCTION PERFORMANCE IN UPLAND AGRICULTURE AND CONSERVATION PROJECT, BRANTAS WATERSHED, EAST JAVA, 1987/88 (Sumberjo Village, Blitar)

	1986/1987						1987/1988					
Input and Production	1	2	3	4	5	X	1	2	3	4	5	X
Area (ha) of farm sample	.26	.54	.35	.32	1.0	0.5	.26	.54	.35	.32	1.0	0.5
Inputs												
Fertiliser (kg)	200	250	325	175	300	506	200	250	325	225	300	526
Manure (qt)	25	25	30	12	15	55	30	25	30	12	45	57
Pesticide (lt)	1	1	1.5	1	1	2.2	1	1	1.5	1	1	2.2
Production (qt)												
Rice	5.5	24	-	15	-	18	8	24	-	-	-	12.4
Maize	1.1	3.1	8.2	-	42.5	22	1.5	3.6	8.5	15	44.5	29.6
Cassava	13	6.8	19	4.5	19.2	21	13	6.8	19	4.8	19	25
Cotton	1.6	4.5	0.7	1.5	12	8.2	2	5	0.9	2.5	12	9
Gross revenue			R =			360 000				R =		396 700
						275 000						503 200
						84 000						125 000
						369 000						495 000
			Rp			1 088 000				Rp		1 419 900

X = average or per hectare R = average gross revenue/ha (current price)
Source: UACP, Bangdes Tingkat II, Blitar, 1988.

6. National Maize Production

National production of maize is presented in Tables 1.9 and 1.10. Table 1.9 shows aggregate production and Table 1.10 average yield by region. Since 1976, yield has increased significantly everywhere, showing the impact of technology.

Java accounted for about 71 per cent of national maize production in 1986. East Java is the main maize exporting region. Maize surplus also comes from South Sulawesi, Nusa Tenggara and Sumatra (Lampung and North Sumatra).

Table 1.9

MAIZE PRODUCTION IN SELECTED YEARS, 1968-86, BY REGION/ISLAND (000 tons)

Region/Island	1968	1973	1978	1983	1986
Sumatra	120.2	186.1	127.1	288.2	587.7
Java	2 352.7	2 690.8	3 025.1	3 656.2	4 250.9
Bali + Nusa Tenggara	243.2	251.6	304.3	351.8	380.4
Kalimantan	11.5	8.6	13.4	33.0	44.8
Sulawesi	420.7	533.5	536.8	742.7	654.2
Maluku + Irian Jaya	17.6	17.5	21.9	15.5	13.2
Indonesia	3 166.0	3 688.1	4 028.6	5 077.0	5 931.1

Source: Statistical Yearbook of Indonesia.

Table 1.10

MAIZE PRODUCTIVITY IN SELECTED YEARS, 1968-86, BY REGION/ISLAND (tons/ha)

Region/Island	1968	1973	1978	1983	1986
Sumatra	0.86	1.29	1.19	1.58	1.95
Java	1.02	1.14	1.40	1.81	2.15
Bali + Nusa Tenggara	0.89	0.90	1.09	1.32	1.42
Kalimantan	0.69	0.60	0.76	1.11	1.17
Sulawesi	0.89	0.87	1.23	1.52	1.43
Maluku + Irian Jaya	1.05	0.97	1.02	1.12	1.22
Indonesia	0.98	1.07	1.33	1.69	1.94

Source: Statistical Yearbook of Indonesia.

National aggregate production, yield and harvested area are shown in Table 1.11, together with estimated growth rate. Very high growth was achieved by soybean, because the government tried hard to reduce imports of some 400 000 tons a year. Imports were reduced to less than 200 000 tons, but in 1989 the demand for imports rose again.

Maize production grew 2.4 per cent a year from 1983-87, much slower than during Pelita (five-year development plan) III (8.4%). The low growth was due to a drop in harvested area (-1.4%), which was compensated by a yield increase of 3.8 per cent.

Table 1.11

HARVESTED AREA, YIELD AND PRODUCTION OF PALAWIJA CROPS, 1983-87 (PELITA IV)

Crop/Item	Growth Rate Pelita III	1983	1984	1985	1986	1987	Growth rate % Year
Harvested area (000 ha)							
Maize	2.9	3 002	3 086	2 440	3 143	2 626	-1.4
Cassava	2.O	1 221	1 350	1 292	1 170	1 222	0.2
Sweet pot.	0.3	280	264	256	253	229	-4.8
Soybean	0.9	640	859	896	1 254	1 101	16.6
Peanut	0.8	481	538	510	601	551	4.0
Mungbean	4.4	293	289	286	293	227	-5.6
Yield (qt/ha)							
Maize	5.0	16.94	17.13	17.74	18.84	19.63	3.8
Cassava	0.5	99.00	105.00	109.00	114.00	117.00	4.3
Sweet pot.	1.7	79.00	82.00	84.00	83.00	88.00	2.8
Soybean	0.5	8.48	8.96	9.70	9.88	10.55	6.8
Peanut	1.9	9.57	9.95	10.35	10.60	9.68	0.4
Mungbean	3.2	6.01	6.47	6.90	7.26	7.35	5.2
Prod. (000)							
Maize	8.4	5 087	5 288	4 330	5 920	5 155	2.4
Cassava	-1.2	12 103	14 167	14 057	13 312	14 356	4.7
Sweet pot.	2.6	2 213	2 157	2 161	2 091	2 013	-2.3
Soybean	-1.8	536	769	870	1 227	1 161	23.1
Peanut	0.9	460	535	528	642	533	5.6
Mungbean	14.2	176	187	200	213	204	7.5

Source: Pelita V, Ministry of Agriculture, 1989.

7. Maize Consumption and Utilisation

Most maize produced is for human consumption, estimated at 59 per cent in 1984. This was much smaller than the estimated 71 per cent in 1976 (Table 1.12). Yet, in absolute terms, human consumption of maize increased.

Table 1.12

MAIZE PRODUCTION, CONSUMPTION BALANCE, 1976/80/84

Utilization/Suppply	1976	000 Tons 1980	1984	Growth Rate/Year 1980-1984
Total Supply	2 623	3 942	5 289	7.3
Feed Industry	514	899	1 491	12.4
Seed	66	65	76	3.9
Industry	118	259	378	9.3
Losses	52	197	204	0.9
Human Consumption	1 873	2 522	3 140	5.6
		kg/cap/year		
Human Consumption	14.02	17.25	19.63	3.2
Rural	16.69	21.32	24.49	3.5
Urban	2.18	2.70	3.07	3.2

Source: Rosenthal et al., 1987.

Based on the growth of livestock population, Simatupang made a smaller estimate of maize utilisation for feed (Table 1.13), showing also that the feed industry grew 6.6 per cent a year between 1983 and 1988. In 1986, there were 71 feed mills in nine provinces (Table 1.13) registered with the Directorate-General of Livestock. Most are in West Java (33), East Java (10), Central Java (8) and North Sumatra (7). Although there were only three in Jakarta, the province ranked third in production.

Total capacity was 304 280 tons a month. The five largest production capacity regions are East Java, West Java, Jakarta, North Sumatra and Lampung. But capacity utilisation was very low everywhere except Jakarta, where the figure reached 75 per cent in 1986. Elsewhere, it ranged from 10 to 50.5 per cent.

Table 1.13

FEED MILLS DISTRIBUTION, PRODUCTION CAPACITY
AND ACTUAL PRODUCTION, 1986

Capacity			**Production (Tons/Month)**	
Province	Number	Capacity	Actual	Utilization %
Jakarta	3	18 450	13 850	75.0
West Java	33	120 300	46 758	38.8
Central Java	8	9 150	4 538	49 0
Yogyakarta	2	750	190	25.3
East Java	10	126 450	48 580	38.6
North Sumatra	7	16 960	8 580	50.5
West Sumatra	3	1 020	420	42.2
Lampung	4	10 900	3 140	19.6
Riau	1	300	30	10.0
Total	71	304 280	126 148	41.5

Source: Pantjar Simatupang, 1989.

The very low capacity utilisation indicates over-expansion of the feed mill industry and is reflected in the excessive average size of factories (Table 1.14). Smaller factories had a much higher capacity utilisation rate. In North Sumatra, for example, utilisation for a small factory with capacity below 1 000 tons/month was 96.7 per cent, whereas for a large factory with capacity above 3 000 tons/month it was only 57.9 per cent. The same was true in Central and East Java. Capacity utilisation for small factories was more than twice that of the large ones.

Table 1.14

CAPACITY UTILISATION RATES FOR DIFFERENT FACTORY SIZE (%)

	Production Capacity (tons/month)		
Provinces	1000	1000-3000	3000
Central Java	71.6	61.8	27.5
East Java	42.3	24.2	21.6
North Sumatra	96.7	50.0	57.9

Source: ADB consultants' team.

Over-expansion and over-size in the feed mill industry was partly caused by government policies. In the early 1970s, the industry received various incentives, such as low interest rates, an overvalued exchange rate, easy credit, and free import of raw materials. The demand for feed also grew quickly and the industry over-expanded.

Poultry production and demand for feed then slowed down. Yet the price of feed increased as the price of eggs and chicken fell. This probably explains the slower growth of maize production. Estimated growth of livestock and demand for feed are shown in Table 1.15.

Table 1.15

DEMAND GROWTH FOR MAIZE BASED ON GROWTH OF LIVESTOCK POPULATION

Livestock	1983	1986	1988	Rate of Growth %
		000 Tons		
Poultry	642	784	878	7.4
Layer	280	358	409	4.6
Pullet	70	89	102	9.1
Broiler	70	89	102	9.1
Local chicken	222	248	265	3.9
Hog	75	67	96	5.1
Dairy cow	16	27	34	22.5
Total	733	898	1,008	7.5

Source: Pantjar Simatupang, 1989.

There is little information on other industrial uses, although the International Food Policy Research Institute (IFPRI) estimated an appreciable 378 000 tons were used in 1984.

8. Farm Income, Production Cost, and Marketing Margin

The farming cost structure for East Java is shown in Table 1.16. Note the big change in cost components such as seed, fertiliser and wages, evidence of increasing adoption of technology.

The data suggests cost changes were reasonably in line with production and productivity. Yield increased by 5.7 per cent a year, prices by 10.8, and costs by 16.8 per cent. The resulting surplus (net farm income) grew 15.4 per cent a year (current price). If inflation was an annual average 10 per cent, it means income growth of 5.4 per cent. Note also that the revenue/cost ratio declined.

There is no serious marketing problem in East Java, which is considered the national maize granary and has a direct link to both the deficit and surplus regions as well as export outlets.

Table 1.16

PRODUCTION AND COST STRUCTURE OF MAIZE FARMING,
EAST JAVA, 1978-86

Production/Cost	1978	1979	1980	1981	1982	1983	1984	1985	1986	Growth % year
Production (kg/ha)	1299	1483	1530	1601	1677	1799	1827	1984	2051	5.7
Price (Rp/kg)	56	82	74	87	117	108	107	124	135	10.8
				- Rp.ha -						
Value of produce	7 2878	12 2057	113 031	138 583	196134	194850	196060	245077	276005	16.4
Cost of production	2 5183	2 0305	41 938	45 219	61971	63903	49422	79662	100392	16.8
Seed	2043	2855	4 176	3 835	4693	4404	4204	5480	6230	14.0
Fertiliser	6539	5950	10 299	12 585	16500	16534	13010	20529	23544	16.0
Pesticide	119	77	158	126	206	274	210	630	485	15.3
Wages	1 4103	1 0075	23 533	24 288	33125	35710	26251	38434	55862	16.5
Others	2379	1348	3 772	4 385	7451	6981	5747	14589	14271	20.9
Surplus(2-3)	4 7695	10 1752	71 093	93 364	134163	130974	146638	165415	175613	15.4
R/C[1] 2/3	2.9	6.0	2.7	3.1	3.2	3.0	4.0	3.1	2.7	8.3[2]
Cost/unit 3/1	19.4	13.7	27.4	28.2	37.0	35.5	27.0	40.1	48.9	11.9

Source: CBS, Struktur Ongkos Usahatani Padi dan Palawija, 1978-1986. 1 Revenue/cost. 2 Negative due to high value in 1979

Table 1.17 shows the cost structure from farm level to wholesale level, as presented in the IFPRI study for selected regions. When net farm profit is considered, hybrid maize was much more profitable, and for the wholesaler too. Yet the IFPRI team found hybrid was not specially profitable as an export. This will be discussed in Chapter II.

Table 1.17

COST STRUCTURE OF MAIZE PRODUCTION AND MARKETING, 1985 (CURRENT PRICES)

Region	Yield	Price of Output Farmgate	Price of Output Wholesale	Production Cost Current Input	Production Cost Labour Cost	Production Cost Land Rent	Production Cost Other Prod Cost	Total
	(kg/ha)	Rp/kg		Rp/ha				
Open-pollinated								
West Java	1725	137.70	158.98	30645	87303	78721	21613218282	
Central Java	1999	137.11	166.73	26240	66786	78721	35437207184	
East Java	1904	128.72	144.31	26171	72968	78721	17636195496	
Bali + N. Tenggara	1382	130.87	182.90	6478	68675	37056	14108126317	
Sumatra	1863	113.83	169.55	22032	90790	37056	19152169030	
Sulawesi	1510	133.19	134.32*	4518	86634	37056	9722137930	
Kalimantan	1147	153.42	197.26	9796	60788	37056	25029132669	
Hybrid								
Central Java	3500	137.11	166.73	47075	128501	132726	11287 319589	
East Java	3500	128.72	144.31	45507	128501	132726	11018317752	
Sulawesi	3500	133.19	134.32	46767	128501	71823	14042261133	

* The very small difference between farm-gate and wholesale price is difficult to understand, particularly since South Sulawesi is a surplus region.

Region	Processing & Marketing Cost	Total Cost	Net Financial Profit Farmgate	Net Financial Profit Wholesale
	Rp/ha			
Open-pollinated				
West Java	26 307	244 589	19 250	29 652
Central Java	37 142	244 326	66 899	88 967
East Java	38 080	233 576	49 587	41 190
Bali & N. Tenggara	35 130	161 447	54 393	91 321
Sumatra	36 925	205 955	43 035	109 917
Sulawesi	42 658	180 588	63 187	22 235
Kalimantan	21 507	154 176	43 304	72 081
Hybrid				
Central Java	65 030	384 619	160 296	198 936
East Java	70 000	387 752	132 768	117 333
Sulawesi	98 875	360 008	205 032	110 112

Source: Rosenthal et al., 1987.

Table 1.18 shows the ratio between farmgate and wholesale financial profit and price, and between wholesale and onfarm cost, based on data in Table 1.17. The marketing cost is reasonable, ranging from 12.1 to 30.9 per cent of onfarm cost. But the farmer's profit margin is really low compared with the wholesaler's, except for open pollinated maize in East Java and Sulawesi, and for hybrid maize in Central and East Java.

Table 1.18

ONFARM AND MARKETING COST RATIO, AND RATIO BETWEEN FARMGATE AND WHOLESALE MARGIN AND PRICE

Region	Wholesale/Onfarm Cost Ratio	Farmgate/Wholesale Profit Ratio	Price Ratio
Open-pollinated			
West Java	12.1	64.9	68.6
Central Java	17.1	75.2	82.2
East Java	19.5	120.4	89.2
Bali & Nusa Tenggara	27.2	59.6	71.6
Sumatra	21.8	39.2	67.1
Sulawesi	30.9	284.2*	99.3*
Kalimantan	16.2	60.1	77.8
Hybrid			
Central Java	20.3	80.1	82.2
East Java	22.0	113.2	89.2
Sulawesi	37.9	186.2*	99.2*

Source: calculated from data in Table 1.17.
* apparent data flaw.

Note also the relatively large profit with hybrid compared with open pollinated maize shown in Table 1.17. This is due to high productivity. But in Table 1.17 we did not distinguish between traditional and open pollinated modern varieties like Arjuna, the productivity of which differed little from hybrid.

II. MAIZE RESEARCH, TECHNOLOGY DEVELOPMENT AND DIFFUSION

1. Research Organisations

As mentioned in Chapter I, food crops (particularly palawija) are produced exclusively by smallholders. Research is mainly carried out by government institutions, mostly within the Ministry of Agriculture.

Before 1974, research was split up between various directorates-general: of Food Crops, of Estate Crops, of Fisheries, of Animal Husbandry and of Forestry (now the Ministry of Forestry). Then the Agency for Agricultural Research and Development (AARD) was founded with national responsibility for research.

AARD has 10 research centres (Fig. 2.1), one of which is the Central Research Institute for Food Crops (CRIFC). This coordinates research on food crops in six institutes, which represent the major agro-climatic conditions and each of which has a special task:

- Bogor Institute for Food Crops (BORIF), at Bogor, West Java (pioneer research).
- Sukamandi Institute for Food Crops (SURIF), at Sukamandi, West Java (irrigated land).
- Malang Institute for Food Crops, in Malang, East Java (palawija crops).
- Maros Institute for Food Crops (MORIF), in Maros, South Sulawesi (dry land in dry climates).
- Banjarbaru Institute for Food Crops (BARIF), at Banjarbaru, South Kalimantan (swamp and tidal swamp eco-system).
- Sukarami Institute for Food Crops (SARIF), at Sukarami, West Sumatra (dry land in wetter climate).

Maize research is chiefly conducted by AARD, particularly the CRIFC. Other centres within AARD also research into maize, such as the centres for Soil, Agro-Economic and Animal Husbandry Research.

Beyond AARD, several government agencies carry out research on maize, including the universities, the Centre for Biotechnological Research (under the Indonesian Institute of Science, LIPI), the Agency for Appropriate Technology Development (under the Ministry of Research), the National Agency for Atomic Energy and the National Agency for Logistics (BULOG).

Some private companies, particularly Cargill, Pioneer, and Bright Indonesia Seed Industry (BISI), also conduct field trials for hybrids developed in Thailand and the Philippines. Pesticide and fertiliser companies carry out trials with CRIFC.

The figure 2.1 (Organization Structure of the Agency for Agricultural Research and Development) is not reproduced due to technical reason. Please consult technical reason.

2. ***Research Coordination***

a. Coordination within CRIFC

CRIFC and its institutes have improved research methods, planning and resource allocation and the central institute organised the first workshop on the National Coordinated Research Program on Corn and Grain Legumes in Bogor attended by 150 people in June 1988. The workshop aimed to:

- update knowledge on maize's status, production systems and cultivation practices.

- agree on main constraints to maize production and on research priorities.

- exchange news about research.

- improve the National Coordinated Corn Research Program (NCCRP) and its organisation.

An annual workshop will review the achievements, constraints and priorities of the NCCRP.

The first workshop produced a booklet, "National Coordinated Research Program: Corn," designed as a guide for institutes, universities and researchers. Research institutes within CRIFC have been asked to draft detailed 3-5-year national and regional research plans. The NCCRP is managed by the National Corn Coordinator (NCC) assisted by the National Inter-disciplinary Corn Team (NICT) within CRIFC and supervises and evaluates maize research. An ICT at each institute does the same work.

b. Coordination with Universities and Institutes Outside AARD

In addition to AARD's core budget, maize research is backed by special projects funded by donor agencies or countries, multilateral aid programmes or international research organisations. An example is the Applied Agricultural Research Project (AARP) funded by USAID, a project with AARD and the directorate-general for Higher Education. It involves three commodity research projects (upland rice, maize, grain legumes) and a special study. For each, a team of researchers from AARD, the university and representatives of the DG of Food Crops evaluates and advises on the projects and their implementation. The teams are chaired by the NCC.

c. Ties with Foreign Institutes

Arrangements for training, research cooperation and exchange of information, technology and germplasm have been made with the International Maize and Wheat Improvement Center (CIMMYT), IRRI Cropping System Network, FAO/UNDP (Project RAS/82/002 TCDC for Research and Development of Food Legumes and Coarse Grains in the Tropics and Sub-Tropics of Asia), the Dutch government and USAID. There is also cooperation between the NCCRP and CIMMYT, which provides germplasm not only from the CIMMYT breeding programme but also from national programmes, particularly in Asian countries. The NCCRP participates in this, especially for testing CIMMYT materials, such as in IPTT, EVT, ELVT, OPTT, and Al tolerant materials.

CIMMYT also puts out useful publications and provides training in Mexico and elsewhere. CIMMYT staff visit the country and tour institutes, on- and out-station trials, on farm research, farmers' fields, seed industries and, in the case of on farm research, also conduct field surveys. Sometimes it provides research equipment, such as pollen testers, ear bags and grain moisture testers, as well as some funding for trials.

The germplasm CIMMYT provides is good, but so far none has been directly released as a variety because it lacks one or more important traits, such as downy mildew resistance and tight husk cover. Potential germplasm needs to be efficiently used in the national programme through critical evaluation, adaptation to local conditions or incorporation in the national gene pools. Some CIMMYT germplasm, along with local collection and materials from national programmes, have been used in development of Indonesian gene pools, from which high-yield varieties were generated and released in 1985. The national programme cannot use CIMMYT germplasm more effectively for lack of cash and facilities.

d. Linkage with Private Sector

National fertiliser factories and foreign companies producing and selling pesticides have cooperated in field trials because without certification no pesticide can be sold. Technology for intensification is often devised with private companies, especially in the case of new chemicals, such as growth-stimulating materials.

Maize seed companies began to operate in Indonesia in the 1980s and made links with CRIFC. They were Cargill, BISI (Bright Indonesia Seed Industry), Pioneer, Ciba-Geigy, Pacific Seeds, and San Miguel. Their breeding research stations are in Thailand and the Philippines. The promising hybrids developed there are further tested in Indonesia for possible release. Cargill, BISI, Pioneer, and Pacific Seeds have released and produced commercially their own hybrids in Indonesia. Ciba-Geigy has recently stopped seed research and concentrates more on pest management research. San Miguel has not so far been active while BISI is now producing seeds of open pollinated varieties released by AARD and is the only private company that produces them in addition to their own hybrid.

3. Research Goals

According to the Master Research Plan (1989-94), CRIFC has the following aims:

- strive for food self-sufficiency and improve nutrition.
- improve the balance of payments through increased agricultural exports and reduction of farm imports.
- improve use of soils, water and forests.
- increase job opportunities and rural income.
- promote regional and rural development.

- give guidance to research through a national research program involving:
  - rice
  - palawija (maize, wheat, sorghum, grain legumes, soybean, mungbean, pigeonpea, cassava and sweet potato)
  - problem soils (low pH, swampy eco-system, deficiency etc)
  - water management
  - post-harvest technology
  - agricultural engineering
  - farming systems
  - seed production and technology
  - socio-economic and environmental impact
  - biotechnology
  - germplasm

As noted, the programmes are supervised and coordinated by the CRIFC and carried out by six research institutes for food crops.

For maize research, the aims are summarized in Figure 2.2, based on the CRIFC Master Research Plan. Special attention is given to the feed industry (especially poultry and aquaculture), which bolsters domestic demand for maize. The feed industry is growing by about 10 per cent a year. Most of its soybean requirements are met by importing soybean cake, a by-product of soybean oil.

Figure 2.2

RESEARCH PROGRAMME FOR MAIZE AND EXPECTED OUTPUT, 1989-94

Main Activities	Principle Research Titles	Justification	Expected Output	Duration	Executing institution
Germplasm Varietal Improvement	Introduction and Collection	Genetic variability is a basis for successful	A wide genetic variability of genetic materials.	5 years	BORIF,SURIF,MARIF MORIF,BARIF, SARIF
	Hybridisation	Hybridisation is very important in combining good ferent parent.	Progeny population consisting of superior plans loped for new variety.	5 years	BORIF,SURIF, MARIF MORIF, SARIF
	Screening & selection for: - yield potential - pests, diseases resistance. - specific environmental stress tolerance. - high quality seed	There is a need to have improved variety showing high yield and resistant to pests and environmental stress.	Improved lines/varieties.	5 years	BORIF,SURIF, MARIF MORIF,BARIF, SARIF
	Multilocation	Selected lines need to be further tested under different environment.	Improved lines ready for varietal release.	5 years	BORIF,SURIF, MARIF MORIF,BARIF, SARIF

Figure 2.2 (contd...)

RESEARCH PROGRAMME FOR MAIZE AND EXPECTED OUTPUT, 1989-94

Main Activities institution	Principle Research Titles	justification	expected output	duration	executing
Crop and resource management	Soil and nutrient Management: - agronomic aspect - physiological aspect	Efficient use of ferti-lisers and effective soil management is needed.	Appropriate fertilisation and soil management to have high corn yield.	5 years	BORIF,SURIF, MARIF MORIF,BARIF, SARIF
	Crop management: agronomic aspect - physiological aspect Water management	Better cultivation prac-tices are needed for high production of maize. (To be described under MAJOR PROGRAMME: WATER MANAGEMENT	Improved technique in cultural practices.	5 years	BORIF,SURIF, MARIF MORIF,BARIF, SARIF
	Crop protection: - pests and diseases	Pests and diseases very much reduce the yield.	Better pests control for seed fly, stem borer, storage pests, downy mildew.	5 years	BORIF,SURIF, MARIF MORIF,BARIF, SARIF
	On-farm research	Technological package should be formulated not only based on research station but also on farmers field.	Better package of techno-logy which has been tested under farmers' condition.	5 years	BORIF,SURIF, MARIF MORIF,BARIF, SARIF

Source: CRIF Master Research Plan, 1989-94.

dan Palawija, 1978-1986. 1 Revenue/cost. 2 Negative due to high value in 1979.

4. Research Results and Contributions

a. Improved Open-Pollinated Varieties

Twenty-four open-pollinated varieties have been released by the Central Research Institute for Food Crops since the breeding programme started in 1923 (Table 2.1).

Table 2.1

RELEASED MAIZE VARIETIES BEFORE 1945 TO 1985

Variety Released	Base Material	Year	Maturity (days)	Average Yield (t/ha)	Downy[3] Mildew Reaction
Kuning	Landrace	Before 1945	110	1.1[2]	S
Jawa Timur Kuning	Landrace	Before 1945	85	1.0[2]	MR
Maya	Landrace	Before 1945	95	1.1[2]	S
Genjah Warangan	Landrace	Before 1945	80	0.8[2]	S
Bastar Kuning	Landrace	1951-60	130	3.3	S
Kania Putih	Introduced	1951-60	150	3.3	-
Penduduk Ngale	Landrace	1951-60	85	0.8[2]	S
Malin	Introduced	1951-60	100	3.0	S
Perta	Introduced	1956	110	1.7[2]	S
Metro	Introduced	1956	110	3.2	S
Harapan	Introduced	1964	105	3.3	S
Bima[1]	Introduced	1966	140	3.7	S
Pandu[1]	Landrace and Introduced	1966	130	3.7	S
Permadi (Bogor Synthetic 2)	Landrace and Introduced	1966	96	3.3	S
Bogor Composite 2	Introduced	1969	105	3.6	S
Harapan Baru	Introduced	1978	105	3.6	R
Arjuna	Introduced	1980	90	4.3	R
Bromo	Introduced	1980	90	3.8	R
Parikesit	Introduced	1981	105	3.8	R
Sadewa	Landrace and Introduced	1983	86	3.7	MR
Nakula	Landrace and Introduced	1983	85	3.6	R
Abimanyu	Landrace and Introduced	1983	80	3.3	R
Kalingga	Landrace and Introduced	1985	96	5.4	R
Wiyasa	Landrace and Introduced	1985	96	5.3	R

1 Variety for high elevations.
2 Unfertilised/fertilised at very low level.
3 S = susceptible. MR = Moderately resistant. R = resistant.
- = no data from DM nursery, thought to be susceptible.
Source: Subandi et al., 1987.

Several conclusions can be drawn from the table:

- before independence in 1945, the released varieties, derived from landraces, had low yield and were susceptible to downy mildew.

- from 1950-77, most varieties released showed a higher yield (3.0-3.7 tons/ha) but were late maturing and susceptible to downy mildew. Most derived from introduced materials.

- from 1978, the released varieties were derived from both landraces and introduced materials. They vary in maturity, have higher yields (3.3-5.4 tons/ha), and are resistent to downy mildew.

- earliness, high yield potential and resistance to downy mildew can be combined in one variety.

- between 1964-80, yield potential increased by 36 per cent. This was shown by Arjuna, which was derived from introduced materials.

- through development of a gene pool, combining landraces and introduced materials, between 1980-85, yield potential further increased by 24 per cent. This was shown by Kalingga.

- between 1964-85, annual increase in yield potential with open-pollinated varieties was 2.9 per cent. If maturity is considered, this changes to 3.1 per cent.

Comparative performance in yield and downy mildew resistance of varieties released since 1964 is shown in Table 2.2.

Table 2.2

SUPERIOR VARIETIES FOR LOW ELEVATION, AFTER 1960

Period	Variety		Year of release	Maturity (days)					Related yield								Downy mildew infection (%)		
Before PELITA	Harapan	1964	105	100	100	100	100	100	-	-	-	-	88	78	81	70	69	70	65
	Permadi	1966	100	101									66						
PELITA I	Bogor composite 2	1969	100	108										63					
PELITA II	Harapan Baru	1978	105		108	111									18	15	13	15	13
PELITA III	parikesit	1981	105			116										15			
	Arjuna	1980	90			136		136	136	136	136					17			12
	Bromo	1980	90				117	122						14					
	Sadewa	1983	85					118									45		
	Nakula	1983	85					115									26		
	Abimanyu	1983	80						110										
PELITA IV	Wiyasa	1985	96							158									20
	Kalingga	1985	96								160								14
	number of trials			41	33	43	15	11	38	9	7	24	4	5	8	10	10	3	1

Subandi et al., 1987.

b. Hybrid Varieties

Hybrid development was once just a sideline. A more consistent programme was set up in 1982, but so far CRIFC has not released any hybrid. The top crosses and single crosses developed in the 1950s gave high yield but were no higher than the open-pollinated variety Perta, except that the hybrids had harder endosperm and more uniform grain colour and size. The top crosses and single crosses developed in the 1960s yielded 40 per cent more than Harapan, but conditions did not permit work to continue at the time. The hybrids (top crosses and single crosses) of lines developed in 1970s yielded 20 per cent higher than Arjuna, but still lower than hybrid C-1. Some lines when top-crossed to C-1 (F2) and Pool 4 could produce 20-35 per cent more grain than hybrid C-1.

The CRIFC lines were derived from varieties with yield capacity lower than varieties released later, such as Perta, Arjuna or Kalingga. Nevertheless, CRIFC hybrids developed from these lines did show higher yield capacity compared to the base population. Before the lines were yield tested in hybrid combinations, open-pollinated varieties derived from introduction or pool development (Perta, Arjuna, Kalingga with yield capacity higher than the base populations of the lines) had been identified and released. When the CRIFC hybrids reached the preliminary yield test, an introduced high yield hybrid (TC 63.85 from Cargill) was identified and released under the name hybrid C-1.

CRIFC helps in testing hybrids developed by private companies. The first hybrid released and available in the market was Hybrid C-1, which yielded, on average, 5.8 tons/ha at experimental level and 6 tons/ha at demonstration level in various provinces. The release of this hybrid was followed by others from companies and institutes (Table 2.3). All the hybrids are late maturing.

c. Varietal Distribution

Table 2.4 shows varietal distribution in 1985/86 and 1986/87. The released varieties were planted on 30 per cent of the reported area. Twenty per cent was planted to Arjuna. Hybrids, mostly C-1, shared only 2.97 per cent. Because maize is a cross-pollinated species, the germplasm of the released varieties tend to cross with local (traditional) varieties, resulting in impure (and hence increased yield capacity) local varieties.

Among the released varieties, Metro, Harapan, Harapan Baru, and Arjuna are quite popular. Arjuna is most widely grown because it is early, high yielding, resistant to downy mildew and reasonably promoted in the government intensification programme. Two years after their first release and availability in the seed market, the hybrids shared only 10 per cent of the improved varieties used by farmers. The low rate of hybrid adoption by farmers is mainly due to high seed price. Other factors influencing adoption of hybrid varieties are yield potential, stability and maturity of the hybrid itself, seed availability, the risk of growing hybrids, guarantee of selling the product and farmer's profit. The price of hybrid seeds in East Java in 1988 was Rp 2 600/kg compared with Rp 1 300/kg for open-pollinated seeds.

Table 2.3

RELEASED HYBRID MAIZE, 1983-88

Variety	Type of Hybrid	Company/ Institute	Year Released	Maturity (days)	Average Yield (t/ha)	Downy[1] Mildew Relation
Hibrida C-1	TC	Cargill	1983	100	5.8	R
Hibrida Pioneer-1	TWC	Pioneer	1985	100	5.5	R
Hibrida CPI-1	TC	BISI	1985	100	6.2	R
Hibrida Pioneer-2	TWC	Pioneer	1986	100	5.9	R
Hibrida IPB-4	SC	Bogor Agric. University	1985	97	5.4	R
Hibrida C-2	TWC	Cargill	1988	97	6.3	R

R = resistant.
Source: Subandi et al., 1989.

Table 2.4
MAIZE VARIETAL DISTRIBUTION[1], 1985-87

Variety	1985/86	1986/87	Seed[2] Supply (MT) 1986/1987
Bastar Kuning	-	0.12	35
Metro	1.1	0.44	130
Harapan	3.1	2.82	833
Permadi	0.02	-	-
Bogor Composite 2	0.001	-	-
Harapan Baru	2.2	2.53	748
Arjuna	18.0	20.36	6,017
Bromo	0.2	0.28	81
Parikesit	0.1	0.14	41
Sadewa	0.01	0.02	6
Nakula	0.02	0.17	50
Abimany	0.01	0.02	6
Kalingg	-	0.02	6
Wiyasa	-	0.0003	-
C-1 (hybrid)	1.9	2.44	721
CPI-1 (hybrid)	0.00006	0.35	122
Pioneer (hybrid)	-	0.16	47
IPB-4 (hybrid)	-	0.02	6
Local	73.34	70.11	20 719
Total Reported	100 (1 591 900 ha)	100 (1 477 572 ha)	29 551

1 Source: Directorate of Food Crops Production.
2 Estimated, based on 20 kg seed/ha.

d. Varietal Performance at Farm Level

At experimental level, yields of new open-pollinated varieties range from around four tons/ha to more than five, depending on maturity, compared with six for hybrids. Yields are generally less at field level, depending on the land, season, facilities and management. Some examples of yields at farmer's field level, which could be considered as potentials, are:

- a special project on maize cropping in 1981 in East Nusa Tenggara, covering 40- 50 000 ha of land planted to Arjuna (90 days), was reported to yield an average 3 tons/ha, or 71 per cent of the experimental yield level.

  - the Bright Indonesia Seed Industry at Kediri, East Java, produced seeds in cooperation with farmers.It was reported in 1984/85 that 760 ha of Arjuna (involving 2 265 farmers) gave an average yield of 4.29 tons/ha, or 100 per cent of the experimental yield level (Banjerd Bonsue, personal communication).

  - one private company at Sukabumi, West Java, produced seeds of Arjuna and Wiyasa in 1988. From 150 ha, the yield ranged from 3.9-5.4 tons/ha.

  (Iskandar S., personal communication).

- a survey on the government intensification program in Central Java (Banjarnegara, Blora) and East Java Bojonegoro, Lumajang, Kediri) in the dry and wet seasons of 1984/85 indicated that on dryland, rainfed wetland and irrigated wetland, Arjuna yielded 3.55, 3.50 and 4.40 tons/ha compared to hybrid C-1's 3.55, 3.85 and 4.70 tons/ha.

- the hybrid out-yielded open-pollinated only by less than 400 kg/ha (about 10 per cent) and it was shown only on wetland where the moisture problem is generally less severe than on dry land.

This data shows that 70-100 per cent of yield potential at experimental level could be realised by farmers for open-pollinated varieties, but only 60-80 per cent for hybrids. Thus more effort is needed to grow hybrids. So truly superior hybrids should be further developed and planted in highly-productive land with proper management to compete with existing open-pollinated varieties.

e. Increase in National Production and Productivity

Through the government intensification programme, production technology (including use of superior varieties) has been increasingly adopted by farmers. So research has helped boost national production and productivity. Annual maize production grew from 2.73 million tons in Pelita I to 5.10 million in Pelita IV (Table 2.5), while the national average yield increased from 1.08 tons/ha in 1973 to 1.94 in 1986.

Table 2.5

HARVESTED AREA AND PRODUCTION PER YEAR OF MAIZE
PELITA I - IV

Pelita	Area (ha)	Harvested Production (tons)	Yield (t/ha)
I	2 723 629	2 734 354	1.00
II	2 559 582	3 131 532	1.22
III	2 672 529	4 086 000	1.53
IV	2 859 442	5 182 000	1 81

Central Bureau of Statistics (CBS) and Directorate- General of Food Crops.

5. Support Facilities, Manpower and Budget

a. Research Facilities

Breeding facilities are mostly at Bogor and Sukamandi, mainly for rice. Bogor Research Institute (BORIF), which is supposed to handle pioneer research, needs more modern equipment and facilities. Because most equipment cannot be produced domestically, foreign grants or loans are important.

Recently, the Japanese International Cooperation Agency (JICA) provided a new building for biotechnology research within CRIFC, but the equipment and manpower are insufficient, especially where modern biotechnological instruments are concerned.

The six research institutions within CRIFC also have 45 experimental stations with enough facilities for field experiments. The experimental farms total over 2,000 ha.

b. Manpower Resources

Most maize research is done within CRIFC's institutes by about 76 of its own researchers. Of these, only 27 are full-time, and of these, five have Ph.Ds, nine MSc degrees and the other 13 Ir degrees (equivalent to BS).

The 49 part-time workers usually spend less than half their time on maize research. In this group, seven have Ph.Ds, 12 MS degrees and 30 Ir degrees.

Indonesia's maize area fluctuates around 2.7 million ha and production systems vary. Most is planted in low productivity areas by small farmers. If maize is to be promoted to meet increasing domestic demand for food and to supply the feed industry and increase exports, the number of researchers is inadequate, apart from the question of quality and support facilities.

In addition to AARD's researchers, scientists from other institutions (such as universities) also spend time on maize, but only temporarily. Only a few researchers from private companies are working on maize.

c. Financial Resources

AARD draws its budget from both domestic and external sources. The domestic component comprises routine and development budgets. Before 1985/86, the external funding was not used for research and it was hard to break it down into commodity components. CRIFC's 1984/85 external financing was 3 million US dollars. The domestic budget was analysed to determine the share of the palawija crop research program. An estimate was made for maize and sorghum research components (sorghum had only a small portion), shown in Table 2.6.

Of $962,000 allocated to maize and sorghum, only 12 per cent was really used for research. The rest went for salaries (54 per cent), maintenance of facilities (3 per cent), capital (19 per cent) and other items (12 per cent). So the 1984/85 budget for maize and sorghum that went to research was only $115,440.

Table 2.6

MAIZE AND SORGHUM SHARE IN CRIFC'S AND AARD'S DOMESTIC BUDGET, 1984/85

Budget Source, Commodity/Institute	Amount of Budget US$000	%
<u>Routine</u>		
Maize & Sorghum	358	4.5
Non-Rice Food Crops	919	11.7
CRIFC Budget	2 131	27.2
AARD Budget	7 833	100.0
<u>Development</u>		
Maize & Sorghum	604	4.2
Non-Rice Food Crops	1 548	10.7
CRIFC Budget	3 687	25.4
AARD Budget	14 493	100.0
<u>Routine and Development</u>		
Maize & Sorghum	962	4.3
Non-Rice Food Crops	2 467	11.0
CRIFC Budget	5 818	26.0
AARD Budget	22 326*	100.0

* excluding $10,798 for estate crops and sugarcane.
Source: AARD, 1984.

6. Technology Capability and Infrastructure

Technological capability in the research centre, where maize is concerned, is adequate for transfer to the ultimate users, the smallholders. But when policy is more geared to exports, greater research manpower and capability will be vital. Let us limit ourselves to economic infrastructure, particularly transport, farm supplies distribution and the seed industry.

a. Economic Infrastructure

Adequate roads and transport are prerequisites for economic development. But investment in roads is expensive and long-term, and cannot depend on narrow economic interests such as maize production.

Infrastructure varies greatly between regions. The highest fertiliser distribution cost margin is about twice the lowest one (Table 2.7).

Table 2.7

UREA DISTRIBUTION COST AND FACTORY PRICE, 1988

Factory	Volume (MT)	Distribution Cost (Rp/MT)	Factory Price (Rp/MT)	Subdsidized[1] Farm Price (Rp/kg)	Ratio 2/4
PT PUSRI	1 108 941	86 354	342 279	135 000	0.64
PT KUJANG	450 000	44 812	300 737	135 000	0.33
PT KALTIM	650 000	99 688	355 612	135 000	0.74
PT PIM	440 000	92 203	348 014	135 000	0.68

1 From October 1988, the subsidised price was Rp 165/kg and since October 1989 Rp 185/kg.
Source: Studi/Analisa Penghapusan Subsidi Pupuk dalam Pelita V, Center for Agro-Economic Research, 1988.

The low distribution cost for Kujang Factory is due to it's being in West Java where most of its customers are. Distribution costs are about double outside Java. Note also the high distribution cost relative to the retail (subsidised) price. Such high costs are reflected as well in the high margin between farm-gate, wholesale and export prices (f.o.b) shown in Table 2.8. International comparisons of margins are shown in Table 2.9.

Table 2.8

MAIZE MARKETING MARGINS (RELATIVE)

Market Point	South Sulawesi 1970[1]	1971[2]	East Java	1966[3]	South Sulawesi 1968[4]	South Sulawesi Lampung East Java 1972[5]	East Java 1971[6]
Farm Price	100	100	100	100	100	100	
Middlemen Price	160	131	133	-	151	-	
Export Price	189	188	250	180	206	189	

1 Karim; 2 Harsono et al.; 3 Atje; 4 Abdul Karim Hamid;
5 Mubyarto et al.; 6 Moh. IksanSemaoen.
Source: Proceeding, Indonesian Corn Commodity System, First Agribusiness Seminar-Workshop, SEARCA-HARVARD Project, 1975.

Table 2.9

MAIZE MARKETING MARGINS (RELATIVE) IN SELECTED COUNTRIES, 1974

Market Point	Thailand[1]	Philippines[2]	United States[3]
Farm price	100	100	100
Wholesale price	139	119	108
Export price	149	(143)[4]	122

1 SEARCA; 2 SEARCA; 3 USDA; 4 Retail price.
Source: Proceeding, SEARCA-HARVARD Workshop, 1976.

The situation seems to improve when we compare the data in Table 1.18, where the ratio between farm-gate and wholesale price was 113 percent for East Java in 1986.

Note the very efficient market margin in the United States. Middleman prices in East Java in 1971 and 1966 were comparable with Thailand (an exporter), but export prices were very much higher. It suggests the need to reduce port-entry. [1] The government has begun deregulation in trade, investment and banking, which greatly helps export capability. This will also help when the maize export phase is reached. The high marketing margin alone probably justifies the high fertiliser subsidy to Indonesian farmers.

b. The Seed Industry

The seed industry is developing fast in Indonesia, particularly in connection with the rice intensification programme. Without seed availability, it is hard to talk about agricultural development.

For rice, the government has created a firm, Perum Sang Hyang Seri, in West Java, with a 2,000 ha irrigated seed production farm, part of it shared with local farmers. Sang Hyang Seri has a large and modern seed processing unit, combine harvesters and large tractors for land preparation.

Indonesia has also set up a National Seed Board chaired by the Director-General of Food Crops and supported by the food crop research institutes under CRIFC.

More and more private firms are entering the flourishing seed industry, apart from government agencies and cooperatives such as PT Pertani, KUD, Patra Tani Ltd., PT Cargill, farmers as seed growers, and the increasing number of seed shops and seed dealers.

Perum Sang Hyang Seri has contracted with PT Cargill to produce hybrid seeds, while Pioneer and BISI have begun hybrid seed production in East Java for maize. But the seed industry for maize is just beginning.

In Table 2.4, which shows the estimated volume of seeds supply for maize, the share of traditional varieties was dominant (70 percent) in 1986/87. C-1 hybrid had the highest share among hybrids, while Arjuna had 20 per cent. Farmers generally use Arjuna seed from their own farm, especially when they plant maize in wet and dry seasons, or get them from their neighbours. So seed sales may be far below the estimated 6,000 tons a year. Some seed companies push sales in East Java, with incentives to extension workers, seed credit to be paid after the harvest, sponsorship of budgets for field verification trials, and cooperation with local agricultural agencies and with research institutions.

More about the seed industry in Indonesia has been written by Sihombing in the Proceedings of the First FAO/DANIDA Seminar on the Design and Implementation of Seed Programmes, Islamabad, 1985.

7. Diffusion of Technology to Producers

For developing countries in general, diffusion of technology is always a great problem - huge production areas, the large number of smallholders to communicate with and poor infrastructure. Yet the problem is not insurmountable, as Indonesia's successful rice production programme shows. Since independence, Indonesia has been striving for rice self-sufficiency, starting with a massive intensification programme in 1959. The programme worked with small pilot projects, but problems came with large-scale implementation.

The first success was in the late 1970s after introduction of IR varieties and better extension and technological capability of researchers and programme workers. Then brown planthopper disease broke out and threatened the "miracle" rice varieties. But it spurred rapid development of research into pest management and plant breeding. By 1984, Indonesia was self-sufficient in rice and could boast leadership in rice technology among developing nations. The success of the rice intensification programme cannot be judged on production alone. Much more important is research and management capability, together with a viable extension infrastructure. The Bimas ("mass guidance") programme has been a great lesson on how to develop small farming.

a. Extension Infrastructure

In the early 1960s, there was only one agricultural officer in each kecamatan, or sub-district, that might consist of 10 to 20 villages covering some 10 000 ha of farmland. He had to deal with all agricultural activities, including extension, administration, programme operation and data collection.

By now, the extension infrastructure has become much better. In 1974, along with creation of AARD, the government founded the Agency for Agricultural Education, Training, and Extension (AAETE). Agriculture Extension Centers (BPP) were set up in the regions, now serving two or three kecamatans. BPPs are home bases for field extension officers working in the villages (PPL). One PPL serves an area of about 600-1000 ha, or about one PPL per village in Java for rice villages. For a non-rice area, the number of PPLs is much less, sometimes only one for three villages. The situation is worse outside Java.

A BPP is run by an extension manager and several extension programmers (PPUP). He is a specialist in food and estate crops, fisheries and animal husbandry and a resource specialist.

At the Kabupaten (district) and province levels are Extension Specialists (PPS), supporting the BPPs. This extension structure is separate from but linked with the Agency (Fig. 2.3).

Figure 2.3 Extension infrastructure

```
 (1)          (2)          (3)
BIMAS       AAETE        D.G.S        ......    National Level
|           |            |
BIMAS        PPS        DINASES       ......    Prov. Level
|           |            |
BIMAS        PPS        DINASES       ......    Kab. Level
|           |            |
|                        |
             BPP                      ......    Kec. Level
|                        |
|- - - - - - - - |- - -  - - - - - |
          extension                   ......    Vill. Level
           workers
```

The organisational structure in Figure 2.3 is not well-defined in practice. But in principle:

- Channel 1 is the administration channel. Extension workers are employees of the Bimas organisation.

- Channel 2 is the technical channel, through which extension materials and training programmes are developed.

- Channel 3 is the operational channel, as field operation of the Bimas is also in the hand of the Dinases.

One channel not in Fig. 2.3 is the Agricultural Regional Office (Kanwil), which is supposed to represent the minister of agriculture in the provinces. Kanwil is a cross-commodity agency at provincial level.   A major reorganisation of the Ministry of Agriculture should be complete by the end of Pelita V.

The field extension worker, serving 600-1 000 ha and in Java some 3 000 farmers, is obliged to divide farmers into groups, each with about 50 ha of farmland.

The service area of a PPL is called a WKPP and the service area of a farmer group is called a Wilkel. Every PPL is supposed to set up about 16 Wilkels in his service area, each headed by a Kontak Tani, the key farmer for the PPL to contact. The LAKU system (extension visit programme) means communicating with the 16 farmer groups and is monitored by the BPP manager.

The FIGURE 2.4 (CORN PRICE TRENDS 1974 - 1984) is not reproduced due to technical reasons. Please consult printed version.

Intensification programmes use the extension grouping of farmers, especially in the INSUS programme (special intensification). Growth of extension infrastructure is shown in Table 2.10, including village cooperatives and banking (BRI village unit).

Table 2.10

GROWTH OF EXTENSION INFRASTRUCTURE IN PELITA III AND IV

Extension Infra-Structure	Growth Rate in Pelita III	1983	1984	1985	1986	1987[a]	Growth Rate 1983-1987
WKPP	11.0	15 840	16 597	17 243	17 594	17 843	3.0
PPL	7.1	14 904	18 659	18 874	22 162	27 747	17.2
PPS	8.9	592	595	1 034	1 398	1 501	29.5
BRI vill.unit	2.0	3 617	3 626	3 646	3 646	3 645	0.2
KUD (coop)	7.9	6 141	6 455	6 945	7 126	7 429	4.9
Kiosk	9.7	18 322	18 730	20 303	20 303	21 326	3.9

a: provisional figures
Source: Repelita V, Ministry of Agriculture, Jakarta.

b. Incentives and Disincentives to Producers

The success of the rice intensification programme and the enthusiasm of rice farmers for technology -- even without the Bimas programme -- is the token of profitability. See also the growing profitability of maize production in Table 1.16 and the maize price trend in Figure 2.4.

Profitability of intensification for rice and maize farmers presents no serious problems, as market forces are reasonable in intensification areas. For soybean, intensification may bring serious problems in areas of low pH and aluminium toxicity. But this can be solved by proper liming and soybean production has the highest rate of increase in recent years. Soybean intensification failed in irrigated areas where drainage was a problem.

c. Private Versus Public Roles

As noted, food crops are largely a smallholder activity and commercial firms are involved only outside production, in trade and processing.

With success of intensification programmes and establishment of technology, extension and greater farmer skills, private companies are cooperating with researchers and extension workers in field trials for fertiliser, pesticide, growth-stimulating chemicals and high quality seeds. In East Java, they virtually hired the PPL to market their seeds by giving incentives to extension workers.

Companies may also produce seeds in cooperation with farmers, paying all expenses and getting the seeds from farmers at an agreed price or offering seeds on credit, for payment after the harvest.

Since 1985, the government has invited private firms to "adopt" smallholders and rural industry. It has also set up an estate system for industrial crops, called PIR. The government estates open up a new area, 20 per cent fully managed by the estate and 80 per cent managed cooperatively with farmers as smallholders. Much of the system is supported by a World Bank loan.

8. Competition and Comparative Advantage

a. Competition Between Crops

There is no sharp competition between crops at farm level. The cropping system of farmers is necessarily complementary because of the small area managed by each farmer.

IRRI's scientists have long seen the need to promote the cropping system rather than rice culture and talk of a rice-base-cropping system. Prices may cause some competition between crops but crops are interrelated as is the consumption pattern of rural households.

b. Comparative Advantage in World Markets

Comparative advantage, particularly between developed and developing nations, is the theme of this study. The main hypothesis is that rapidly-advancing biotechnology seems to reduce the comparative advantage of developing nations in production of some major farm items such as maize and soybean. This is sharply reflected in the average food balance of developing nations and their decreasing world market share.

The Center for Agro-Economic Research worked with IFPRI in 1986 to study the comparative advantage of Indonesia in production of various food items, especially rice, maize, soybean and cassava. Six regions were studied - West Java, Central Java, East Java, Sumatra, Bali & Nusa Tenggara, and Kalimantan - using mainly secondary data from the Central Bureau of Statistics (BPS).

The model distinguishes between potential production and potential deficit, showing potential trade direction. Each province has the potential for an importing, exporting and interregional surplus or deficit situation. Three trade regimes were then defined: Interregional Trade (IR), Import Substitution (IS) and Export Promotion (EP).

Domestic Resources Cost (DRC) measures how many rupiahs need to be spent on maize production to earn one dollar. The ratio between DRC and Shadow Exchange Rate (SER) is called Resource Cost Ratio (RCR), with the following features:

$<$ advantage
RCR = 1 neutral
$>$ disadvantage

Thus the RCR can be used to evaluate whether a region belongs to an Export Promotion regime (EP).

IS measures how many rupiahs need to be invested in maize production to substitute for one dollar's worth of maize imported.

IR is how many rupiahs need to be invested in maize production within the region to substitute for one rupiah of maize brought in from another region.

So:
$<$ advantage
IS = 1 neutral
$>$ disadvantage
$<$ advantage
IR = 1 neutral
$>$ disadvantage

Results of the calculation are shown in Table 2.11.

Table 2.11

SUMMARY OF ECONOMIC COMPARATIVE ADVANTAGE OF MAIZE
BY REGION AND TRADE REGIME

Region	Trade Regime	RCR	DRC	NEB (Rp/kg)	NFP (Rp/kg)
West Java	IS	0.85641	1408	20.64	18.43
	EP	1.52588	2509	-49.47	-56.56
Central Java	IR	0.64226	1056	50.18	77.07
	IS	0.53806	885	67.85	98.88
	EP	0.93058	1530	7.08	7.52
East Java	IR	0.79586	1308	21.71	14.64
	IS	0.69801	1148	40.85	55.59
	EP	1.23166	2025	-20.87	-20.46
Sumatra	IR	0.55306	909	59.72	56.94
	IS	0.46642	767	73.96	96.37
	EP	0.98264	1615	1.62	17.33
Bali & Nusa Tenggara	IR	0.44179	726	78.70	93.70
	IS	0.41974	690	89.11	107.28
	EP	0.72184	1187	27.39	16.71
South Sulawesi	IR	0.47879	787	75.38	48.55
	IS	0.84540	1390	91.25	43.01
	EP	0.75442	1240	24.88	17.21
Kalimantan	IS	0.47165	775	81.82	110.91
	EP	0.82205	1351	17.67	6.56

RCR = Resource Cost Ratio; DRC = Domestic Resource Cost; NEB = Net Economic Benefit; NFP = Net Financial Profitability. Based on exchange rate of Rp 1,126 per dollar.
Source: Rosegrant et al., 1987.

From Table 2.11 we can conclude:

- it is profitable to produce maize in all regions because all values of IR and IS are smaller than one.

- maize exports are cost probihitive in West Java and East Java, but reasonably profitable for Bali & Nusa Tenggara, and very close to neutral for Sumatra.

In 1986, the rupiah was devalued from 1 126 to 1 644/dollar (in October 1989, it was 1 780). It is hard to make an instant adjustment, because domestic prices are changing. Assuming all other things constant, we arrive at the adjusted values shown in Table 2.12.

Table 2.12
DOMESTIC RESOURCES COST RATIO OF MAIZE
ADJUSTED FOR DEVALUATION IN 1985

Region	IR	IS	EP
West Java	-	0.74	1.02
Central Java	0.71	0.63	0.84
East Java	0.75	0.65	0.86
Bali & Nusa Tenggara	0.57	0.49	0.76
Sumatra	0.65	0.58	0.80
Sulawesi	0.62	0.60	0.75
Kalimantan	-	0.60	0.88

Rosegrant et al., 1987.

From these adjusted values, we conclude that maize exports are feasible for all regions except West Java. What does that mean? Unfortunately, the research team stopped work abruptly. Tables 2.11 and 2.12 do not indicate whether Indonesia should export maize.

Kalimantan produces little maize. The island produced no more than 33 000 metric tons equivalent in 1983, probably enough for its seven million people. Producing, say, 200 000 tons of maize would change the whole cost structure.

9. International Technology Transfer Versus Domestic Generation

Technology must be related to income generation, because technological know-how is an investment, an asset we have to buy, in terms of hard cash or shadow prices. We must be selective and cost and benefit conscious. We already have a lot of idle technological resources, expensive assets we have bought without being able to use profitably or transfer to the ultimate users. One of the most precious and expensive assets is trained research professionals.

At this stage, domestic generation of technology means the ability of developing countries to explore and adapt the full potential of technology from abroad. International transfer and domestic generation of technology is not an alternative, but complementary. Japan is a unique example of success in importing, adopting, mastering and generating technology.

III. INTELLECTUAL PROPERTY RIGHTS

1. Seed Classification and Certification

Seeds are generally classified as breeder, foundation, stock or extension seed.

Extension seed is the seed sold to farmers. Stock seed is given to extension seed growers by certified seed firms such as Sang Hyang Seri. Breeder seed is only produced by breeders in research institutions. Production of foundation seed from breeder seed is tightly controlled. The national seed system and seed institutions have been set up by government decisions as follows:

- foundation of the National Seed Board (1971).
- organisation and function of the National Seed Board (1971).
- establishment of the Agency (Sub-directorate) of Seed Production and Development (1971).
- establishment of PERUM Sang Hyang Seri (1971).
- development, market control and seed certification (1971).
- guidelines for varietal certification (1974).
- import permits for plant materials (1977).
- procedure for requesting plant material imports (1980).
- requirements and procedure for varietal release (1977).

The National Seed Board is appointed by the government and by experts. Seed certification and procedures are vital for development of a seed industry.

Here are some examples of how the system works:

- certification is done by the Sub-directorate of Seed Production and Development and its branches in the regions.
- certification will only be considered if it has been approved by the minister of agriculture on recommendation of the National Seed Board.

- certification is based on classification into breeder, foundation, stock and extension seed.
- the area used for certification should be approved by the Sub-directorate.

- field tests should be carried out by staff of the Sub-directorate.

- the seed grower should endorse the request for field control one week before seeding.

- a field test is done at the vegetative, flowering and ripening phases.

- no laboratory test will be conducted if the field test fails.

- storage will also be supervised and the seed grower should endorse the request one month before seed storage.

- sampling for seed certification should be done by Sub-directorate staff.

- laboratory tests should be done in the Sub-directorate's seed laboratory.

- results of field, laboratory and storage tests should be written up in the proper format one week after the test.

- when all quality requirements have been met, a certificate will be issued to the seed grower.

- tags will be provided for the bags of seed produced. On the tag, the seed classification (breeder, foundation, stock or extension seed) will be written, with a specific colour (white for breeder and foundation seed, violet for stock seed and blue for extension seed).

- standard quality for extension seed is determined as follows:

Rice:	-	purity, minimum 95%
	-	germination rate, minimum 60%
	-	seed of weeds, maximum 2%
	-	moisture, maximum 13% (lab)
Maize:	-	purity, minimum 95%
	-	germination rate, minimum 60%
	-	seed of weeds, maximum 2%
	-	moisture, maximum 12% (lab)

2. Preference and Promotion of Open-Pollinated Versus Hybrid

Table 2.4 shows the farmer's great preference for local varieties, especially open-pollinated varieties and particularly Arjuna, released by Bogor Food Crops Research Institute. Preference for hybrid is only beginning.

Farmers seem to be guided by the following factors:

- where home consumption is high, farmers prefer local varieties because they are hardier. In Nusa Tenggara, farmers reported new varieties were easily attacked by *calandra* right after harvest.

- when selling is a problem and farmers have to wait indefinitely to sell, perishability is important.

- field tests at experimental stations show hybrid requires good soil, rainfall distribution and cultivation practices, so the gap between realised and potential yield is greater than with open-pollinated varieties.

- the price of hybrid seed was Rp 2600/kg in East Java (1988), while Arjuna Super was only Rp 1300/kg.

- farmers can use open-pollinated seed from neighbours or their own fields for several generations, without seriously reducing yields.

- hybrid seed is generally long maturing compared with open pollinated varieties and therefore less suited to existing cropping patterns, especially in a semi-arid climate.

So it is easy to understand why hybrid maize is mostly concentrated in irrigated fields. Where irrigation is good, maize cannot compete with rice. But where irrigation is not so good, maize may have a comparative advantage over rice. In Kediri, East Java, many maize farmers use pump irrigation for maize production.

The situation can be changed but it will take time. The production potential of hybrid varieties is much greater than open-pollinated varieties despite the higher seed price, so there will eventually have a stronger footing in Indonesian agriculture.

3. Policies and Attitudes Towards Property Rights and Patent Protection

Virtually all breeding research is done in government institutions and there is little talk about patent and intellectual property for breeders in Indonesia. A patent law is still in draft stage. It is being discussed by parliament and a law will probably be passed in 1990.

Trade marks are protected. But for hybrid seed, this is no problem because the technology is not reproducible. No-one will want to produce hybrid commercially however. It is expensive and government institutions would be better off staying out of it if it means cost and competition with commercial companies.

Also, no breeder would be rash enough to try producing hybrid maize unless he could sell it -- on the black market -- to a commercial seed company. So lack of breeder's rights means no incentive for the breeder to produce hybrid and means farmers must depend solely on private seed suppliers, who may charge a monopolistic price.

The problem has already been experienced by maize breeders inventing Arjuna open-pollinated seed. Because it is "public property," everybody can produce Arjuna seed as long as it meets seed requirements. The seed company BISI saw the opportunity and began producing Arjuna Super seed as a trade mark.

A breeders' patent right should be given to government seed producers like Sang Hyang Seri. The firm can produce seed as demanded but can sell it to a commercial seed company and offer the breeder some incentive share.

We must distinguish between "patent right" and "copyright law," which was established in Indonesia in 1982 and improved in 1986.

IV. POLICIES AFFECTING MAIZE PRODUCTION AND CONSUMPTION

1. Production Policy

Agricultural policy in general is directly linked with production, particularly through intensification (higher technology), irrigation (rehabilitation and new projects to expand agricultural land) and transmigration. This is confirmed in the National Guidelines for Development concerning the Five-Year Plan for agricultural development. Development has four aspects: intensification, extension[2], rehabilitation and diversification.

Since independence, increased production of rice, the major staple, has been a priority. Maize is only a secondary staple. Large-scale rice production began in 1959 and included intensification and mechanisation to open up new farmland outside Java. The intensification programme was first called Padi Sentra and became the Bimas Programme in 1964. Farm mechanisation was discontinued.

a. Intensification and the Bimas Programme

Under the Bimas programme, the government provides comprehensive credit, including farm input costs, cost of living allowance and an extension service. Bimas enabled Indonesia to develop the extension institutions discussed in Chapter II.

From 1972, maize was included in the intensification programme shown in Table 4.1. Arjuna, the new open-pollinated variety, appeared in 1980, followed by hybrid in 1983.

In Table 4.2, yield per hectare is presented for intensification and non-intensification areas, showing that increasing use of high-yield varieties must be the basis for higher productivity. But high-yield varieties were not used in all intensification areas.

We must beware of yield differences between programme and non-programme areas. Look at the decreasing tendency of the non-intensification areas. This was not due to falling yield but to improved soil in the intensification areas. It means soil became poorer in non-intensification areas, hence its apparent smaller yield.

The intensification areas have generally better soil and infrastructure and so better yields. The rapid increase of maize intensification areas partly reflects the spread of technology. Increased yields between 1969 and 1973 of about 3.8 per cent a year (Table 4.1) cannot be attributed to intensification.

Rice intensification must indirectly affect maize production. Fertiliser for rice can be used for other crops as well. So maize intensification in the farmer's field must have begun before the formal intensification programme.

TABLE 4.1

AREA AND YIELD OF MAIZE 1969 -1986

Year	Area of Maize under Intensification (000ha)	Percent. Of Total	Total area Harvested (000Ha)	Yield Ton/Ha	Production (000t)
1969	-	-	2.435	0.94	2 289
1970	-	-	2.938	0.96	2 820
1971	-	-	2.651	0.98	2 598
1972	6	-	2.160	1.04	3 708
1973	116	3.4	3.433	1.08	
Average Pelita I	-	-	2.723	1.00	2 723
1974	196	7.3	2.667	1.13	3 014
1975	312	12.8	2.445	1.19	2 910
1976	443	21.1	2.095	1.23	3 136
1977	767	30.1	2.550	1.23	4 023
1978	904	29.9	3.025	1.33	.....
Average Pelita II	524	20.5	2.556	1.22	3 118
1979	979	37.7	2.594	1.39	3 606
1980	1 194	43.6	2.735	1.46	3 829
1981	1 561	52.8	2.955	1.53	4 521
1982	1 387	67.3	2.061	1.57	3 267
1983	1 720	57.3	3.002	1.69	5 087
Average Pelita III	1 368	51.2	2.669	1.53	4 084
1984	1 960	63.5	3.085	1.71	5 288
1985	1 863	76.4	2.440	1.77	4 330
1986	2 597	82.6	3.143	1.88	5 920

Source: Bimas Secretariat, Jakarta.

Table 4.2.
YIELD OF MAIZE (QT/HA) IN INTENSIFICATION
AND NON-INTENSIFICATION AREAS, 1980-85

Province	1980	1982	1983	1984	1985
DKI Jakarta:					
-Intensification	11/81	-	-	-	15/48
-Non-intensification	10/29	11/07	11/22	10/61	10/00
-Aggregate	10/33	11/07	11/22	10/61	11/11
West Java:					
-Intensification	15/22	16/22	15/87	16/54	17/36
-Non-intensification	14/03	13/11	14/62	13/61	15/49
-Aggregate	14/77	15/73	15/72	16/19	17/25
Central Java:					
-Intensification	16/71	18/73	19/34	19/31	20/23
-Non-intensification	15/01	15/90	16/80	16/24	16/40
-Aggregate	16/12	18/14	18/81	18/99	19/99
DI Yogyakarta:					
-Intensification	15/41	15/91	16/06	15/74	15/70
-Non-intensification	14/74	12/80	13/73	11/38	12/66
-Aggregate	15/00	14/71	15/41	14/60	15/35
East Java:					
-Intensification	16/77	17/24	18/28	18/90	19/40
-Non-intensification	13/08	15/02	16/70	15/17	16/82
-Aggregate	15/30	16/77	17/99	18/27	19/04
Java aggregate:					
-Intensification	16/65	17/54	18/47	18/78	19/55
-Non-intensification	13/77	15/09	16/55	15/06	16/66
-Aggregate	15/54	17/02	18/10	18/22	19/23

Source: Bimas Secretariat, Jakarta.

In Pelita V (1989-93), the government will continue the intensification programme. Production is heavily geared to intensification, which for rice is strongly supported by irrigation expansion and rehabilitation. For dryland food crop farming, land development is rare and intensification is therefore slower. Poor land development for dryland farming also leads to serious erosion and declining land productivity.

Until 1986, the price of certified seed for maize was subsidised by the government at the rate of Rp 750/kg for hybrid and Rp 500/kg for non-hybrid. Now it depends on market price, and varies depending on the company. For hybrid, the price ranges from Rp 2 300 to Rp 2 600/kg, and for non-hybrid between Rp 1 000/kg and Rp 1 300/kg.

2. Extension Programme

Extension means area expansion for agriculture, particularly:

- expansion of irrigation area through rehabilitation and new construction.

- transmigration.

In Java, new irrigation schemes are usually through large water reservoirs which also produce hydroelectric power. Construction is usually closely associated with reforestation. A large area of Java is in critical condition in this respect and a huge conservation programme is under way there. It is in such critical areas that priority is given to transmigration.

In the rest of the island, there are small irrigation schemes (below 1,000 ha), which are believed to be more efficient in supporting rural development in line with limited government funds. But the programme seems to have no big impact on production and productivity, especially outside Java.

The transmigration programme consists of a general scheme, fully government-financed, and the "swadaya" scheme, in which migrants are supported only after arrival in the transmigration site, where they get land from the government.

The number of swadaya transmigrants is growing rapidly (Table 4.3).

Table 4.3

TRANSMIGRATION PROGRAMME, 1983-88, NUMBER OF PEOPLE

Type	1983/84	1984/85	1985/86	1986/87	1987/88
General Scheme	61 431	51 558	79 685	46 351	23 134
Swadaya	14 867	50 330	86 665	126 508	140 813
Total	76 298	101 888	166 347	172 859	163 937

Each family is given an area of 2 ha, with the following specification:

- 0.25 ha for homeyard
- 0.75 ha for food crop
- 1.00 ha for perennial crop

The homeyard and food crop area is ready for cultivation. But the transmigrants face many problems, including:

- improper land opening and development, where fertile topsoil is destroyed by tractors.

- poor soil fertility, due to low pH and aluminium toxicity for food crops in much of the dryland opened for transmigration (Red Yellow Podsolic soil).

- shortage of labour on one hand, and better job opportunities for the transmigrant outside their farms in the short term.

- in tidal swamp areas, water control, salinity, peat, sulphur toxicity and clean water availability are the main problems faced by transmigrants, making their effective cultivated area much less than their farm size.

The transmigration programme has failed to create food surpluses in the new areas but it does help the poor to recover. However in about 20 per cent of transmigration sites, it is hard for farmers even to reach self-sufficiency in production of cereals and grain legumes. In the transmigration area in Lampung and South Sumatra, a lot of transmigrants work in the new plantations, especially sugar cane, which is considered preferable to developing their own farms.

Other, smaller kinds of transmigration besides the general and swadaya schemes, are:

- fisherman transmigration

- nucleus estate transmigration

- local transmigration

Nucleus estate transmigration concerns large estates (rubber, palm oil, sugar) in the new area. The working area is subdivided into the nucleus and plasma areas, in the proportion of about 20 to 80 per cent. The plasma area is distributed to farmers, 2 ha per household, along with the homeyard and additional area for food crops.

Development of the plantation is carried out by the commercial estate, with a soft government loan (with or without foreign participation). Farmers act as labourers on their own farms and are paid by the estate. Once the standing crops reach production, field management is then transferred to farmers and the repayment schedule begins.

The transmigration programme in Pelita IV (1983-88) was slower than in Pelita III and the swadaya programme was emphasised. In Pelita III, about 300 000 farm families were moved, involving about a million ha of farm area. Assuming a family size of four, about 170 000 families joined the programme in Pelita IV, which was equivalent to about 340 000 ha.

For the whole period of the Pelitas (I to IV), about 800 000 families have been moved to the new areas, equivalent to expanding agricultural land by about two million ha.

The new irrigated area is shown in Table 4.4.

Table 4.4

NEW IRRIGATED AREA DEVELOPED IN PELITA III AND IV

Irrigated Area	Pelita III	1984/85	1985/86	PelitaIV 1986/87	1987/88
Developed	170 184	43 399	55 492	31 493	26 496
Cultivated	146 068	49 518	54 758	32 227	26 492

Source: Ministry of Agriculture, Pelita V.

Besides area expansion, major irrigation rehabilitation schemes have been conducted, covering millions of hectares in Pelitas I to V. The growth of new irrigated areas was less than 50 000ha a year, which is believed to be the conversion rate of land area for industrial use and real estate in Java and outside.

Farmers outside Java, in areas where land is abundant, have no strong reason to maximise rice production because it does not maximise their income. A team leader in a transmigration research programme in East Kalimantan noted that:

- for people in rice-producing villages, more income can be earned in other jobs,with rice farm income only about 12 per cent of the total despite abundant land.

- rice farming is very labour intensive and there is a shortage of labour.

- for transmigrants, job opportunities outside agriculture appear more promising, at least in the short term, while food crop cultivation is quite risky due to poor soil and pests.

- in the long term, farmers need to diversify from food crops to perennial crops, but much capital is needed.

- cassava could be easily grown, but marketing is poor. So despite the massive extension programme, rice production still heavily relies on large-scale irrigation schemes in Java, where significant surpluses are generated.

3. Current Priority Perception

At a seminar to mark International Food Day in September 1989, participants did not talk seriously about the extension programme. The option of intensification was considered the best, because a large area of food crops had not been touched on by Insus or Supra-Insus (high level intensification). On the other hand, food diversification, when properly implemented, will significantly affect people's consumption patterns[3].

The lack of enthusiasm of technocrats in the Ministry of Agriculture for extension is probably due to the fact that the budget is allocated among a number of ministries. The extension program is also the job of the public works and transmigration ministries. When serious extension is implemented, much of its budget will not flow through the agriculture ministry but through the other two. It may result in anti-national policies. The little interest of the agriculture ministry in the programme has led to over-emphasis on the intensification programme.

Over-reliance on the small and crowded island of Java for food surpluses is dangerous because:

- Java will become more and more industrialised. Some 30 000 ha of land is being converted annually to industrial use and real estate, including productive rice areas.

- high population pressure in Java has led to over-exploitation of the soil and serious erosion in the upper part of watershed areas.

- sugar cane was planted by the Dutch in irrigated rice areas in Java, but because of serious competition from other crops it has been shifted increasingly to dryland and new areas have been developed outside Java. Yet a significant part of the irrigated area has to be reserved for cane or the feasibility of the sugar industry will suffer. When cane is shifted to dryland, pressure on land increases and with it problems of soil and water quality.

- industrial development will also increase demand for water, both for factories and the urban population. By the year 2000 much more irrigation water in Java will be used for industry and fresh water for the urban population. Industrial pollution will be aggravated by lack of water. Already lack of water in Jakarta is causing deep wells to be dug, creating a problem of sea water intrusion.

The agro-ecosystem outside Java is quite different, and attempts to open the area for transmigration have been inconsistent. Poor support seems the main reason and sectoral or ministerial budget separation is probably another. The transmigration programme was started by the public works ministry. The ministry of transmigration was formerly a directorate-general under the ministry of labour and transmigration, with a weak technical staff and organisation to deal with either land and agriculture development, and acted mainly as a contract holder for the transmigration projects. Even now, land development expertise is in the hands of the public works ministry, while agricultural development expertise is under the ministry of agriculture. An interministerial organisation has been set up.

4. Competition with Other Crops

When the food crop extension program is considered, the main issue is not rice versus other crops, but rice and the so-called palawija crops, such as maize, cassava and grain legumes, the main staple mix of the population.

Rice has a high comparative advantage in irrigated areas and the government encourages farmers to grow rice there and use the land all year round. In well-irrigated areas, farmers can apply a rice-rice-rice cropping system or rice-rice-palawija. In less favourable conditions, rice-palawija-palawija may be best. Under the three-crop system, a theoretical cropping index of 300 per cent can be reached.

But this is difficult to achieve when aggregate area is concerned. In Java, where labour is plentiful, it is not hard to reach a cropping intensity of 200 or slightly above. But outside Java, where labour is scarce, cropping intensity may not reach 120 per cent. In regions where non-agricultural job opportunities are numerous and the perennial crop alternative is strong, cropping intensity in small-scale irrigation schemes may be less than 100 per cent. It means some areas are abandoned or left fallow.

In Jatiluhur irrigation scheme in West Java, the best and largest irrigation project so far, drainage is a problem, making palawija production as second or third crop difficult.

In the best-irrigated area, maize has no comparative advantage over rice, while in the dryland eco-system it depends on local consumption preferences and rainfall. In West Java, rice preference is high in family diet and little maize is produced there. This is also supported by high rainfall in West Java. In East Java, maize is more popular, a choice affected by the lower rainfall.

With rapid development of high-yield maize varieties, its comparative advantage over other crops seems to increase, especially supported by the fast-growing feed industry discussed in Chapter I.

Based on performance in Pelita IV and the expected need in Pelita V, the government plans to promote maize production as much as rice, which is shown in Table 4.5. The growth target in Pelita V suggests the government is satisfied with its low profile policy of maintaining self sufficiency rather than expanding maize production for export.

Diversification through cropping system improvement is considered the best bet. There is no serious problem of competition between crops at farm level when aggregate area is concerned. See also the cropping system discussed in Chapter I, Tables 1.11 and 1.8.

5. Consumption and Related Policy

Over-reliance on rice in Indonesia's diet is the weak point of the economy and efforts have been made to diversify. Yet because marketing support for food crops is focused on rice, it is hard to see how this can be done. One way is through product diversification using innovation in food technology, such as processing cassava into meal as a partial substitute for wheat. But the well-developed marketing structure for rice encourages townspeople to eat more rice, even in provinces where maize and other food are staples among the rural population.

Protein and calorie consumption per capita from various food sources are shown in Table 4.6. Note that even for protein consumption, cereals come first, reflecting a strong bias towards a carbohydrate diet, which also indicates a low income level.

In absolute terms, calorie intake per capita per day is about 2 500 (about 600 gr carbohydrate equivalent) and protein intake about 50 grams. Calorie intake is considered sufficient, but protein intake is very low. About 80 per cent of protein intake is plant protein and 20 per cent animal protein. Fish is by far the most important animal protein source in the diet.

Where diet quality is concerned, maize is better than with cassava and a shift from cassava to maize or rice is recommended in poor areas where cassava is the major staple, usually in the dry season. Grain legumes are rich in protein, the development of which will improve rural diet.

A large soybean deficit in national production compared with domestic consumption is one of the most important policy issues in food production. Import needs may soar beyond a million tons a year by the end of Pelita V if production growth cannot be improved. The Pelita V target growth of 3.4 per cent a year seems too low. Soybean is the major protein source in the diet of the people, in the form of *toufu* and *tempe*. Income growth seems to boost demand for these food items much above other protein sources. Note the high protein contribution of fatty grains in Table 4.6.

So far, maize has never been a serious policy issue in Indonesian agriculture, except for its strong link with the feed industry. The major policy issue in food production is rice and soybean. The self-sufficiency in rice since 1984 is considered a challenge to maintain.

Table 4.5

TARGET FOR HARVESTED AREA, YIELD, AND PRODUCTION FOR FOOD CROPS IN PELITA V

Commodity	1988	1989	1990	1991	1992	1993	Growth rate %
Harvested area (000 ha)							
Rice	9 943	10 089	10 164	10 253	10 352	10 461	1.0
Maize	3 178	3 182	3 207	3 228	3 261	3 337	1.0
Cassava	1 200	1 208	1 210	1 220	1 224	1 232	0.5
Sweet Potato	262	263	264	266	268	270	0.7
Soybean	1 230	1 256	1 269	1 281	1 295	1 309	1.2
Peanut	606	608	610	612	615	617	0.4
Mungbean	333	333	334	335	337	338	0.4
Vegetables	1 089	1 098	1 108	1 118	1 126	1 131	0.7
Fruit	640	642	643	651	653	657	0.6
Yield (q/ha)							
Rice	41.83	44.01	44.63	45.48	45.95	46.56	2.2
Maize	19.60	20.16	20.60	21.08	21.49	21.63	2.0
Cassava	128.49	129.53	131.23	132.08	133.59	134.68	0.9
Sweet Potato	86.72	87.60	88.48	89.06	89.63	90.22	0.7
Soybean	10.70	10.83	11.08	11.34	11.60	11.86	2.1
Peanut	9.65	9.76	9.88	9.99	10.06	10.21	1.1
Mungbean	9 65	7.91	7.96	8.01	8.03	8.08	0.5
Production (000 t)							
Rice	41 596	44 399	45 362	46 633	47 566	48 707	3.2
Maize	6 229	6 415	6 607	6 805	7 008	7 218	3.0
Cassava	15 419	15 647	15 879	16 114	16 352	16 593	1.5
Sweet Potato	2 272	2 304	2 336	2 369	2 402	2 436	1.4
Soybean	1 316	1 360	1 406	1 453	1 502	1 552	3.4
Peanut	584	593	602	611	620	630	1.5
Mungbean	261	263	266	268	271	273	0.9
Vegetables	4 215	4 255	4 295	4 336	4 377	4 419	0.9
Fruit	5 182	5 233	5 284	5 336	5 388	5 441	1.0

Source: Ministry of Agriculture, Pelita V.

Table 4.6

PROTEIN AND CALORIE INTAKE PER CAPITA FROM VARIOUS FOOD SOURCES, 1983-86

Food Item	1983 Cal.	Prot.	1984 Cal.	Prot.	1985 Cal.	Prot.	1986 Cal.	Prot.
						%		
Cereals	67.3	66.6	66.1	63.1	65.9	62.7	68.1	61.9
Fatty Foods	9.3	5.5	9.3	3.8	9.3	3.8	8.0	3.1
Sugar	4.4	0.1	4.4	0.1	5.1	0.1	4.3	0.1
Fatty Grains/Nuts	8.6	13.6	8.6	19.2	8.9	19.2	7.9	21.8
Fruits	1.4	1.4	1.4	0.9	1.2	0.7	1.5	0.9
Vegetables	0.6	1.5	0.6	1.5	0.7	1.7	0.8	1.8
Meat	0.8	3.0	0.8	2.7	0.9	3.1	1.0	3.2
Egg	0.3	1.0	0.3	1.1	0.3	1.1	0.3	1.1
Milk	0.3	0.8	0.3	0.6	0.2	0.5	0.2	0.6
Fish	0.7	6.8	0.8	6.7	0.8	7.0	0.7	5.6
Fat and Oil	7.4	0.2	7.4	0.1	6.6	0.2	7.2	0.2

Source: Indonesia Food Balance, Central Bureau of Statistics.

Table 4.7

FOOD CONSUMPTION PER CAPITA PROJECTION, 1984-2010

Year	Population (000)	Rice	Maize	Soybean	Cassava	Sweet Potatoes	Peanut	Mungbean
1989	176 770	137.845	26.316	8.096	59.273	11.639	2.549	1.129
1990	180 160	138.318	26.394	8.159	58.414	11.398	2.567	1.163
1991	183 616	138.770	26.472	8.217	57.578	11.167	2.585	1.197
1992	187 138	139.204	26.549	8.270	56.762	10.944	2.603	1.230
1993	190 728	139.620	26.626	8.317	55.966	10.730	2.619	1.263
1994	194 386	140.019	26.703	8.358	55.188	10.524	2.642	0.619
1995	198 115	140.401	26.780	8.394	54.430	10.324	2.651	1.327
1996	201 915	140.766	26.856	8.425	53.688	10.132	2.667	1.359
1997	205 788	141.117	26.933	8.451	52.964	9.947	2.682	1.390
1998	209 736	141.452	27.009	8.473	52.255	9.767	2.696	1.420
1999	213 759	141.772	27.085	8.490	51.562	9.594	2.710	1.451
2000	217 859	142.079	27.161	8.502	50.884	9.426	2.723	1.480
2001	222 038	142.372	27.237	8.510	50.220	9.263	2.736	1.509
2002	226 297	142.653	27.313	8.515	49.569	9.105	2.749	1.538
2003	230 638	152.921	27.389	8.515	48.932	8.952	2.761	1.566
2004	235 062	143.177	27.464	8.511	48.308	8.804	2.773	1.594
2005	239 571	143.422	27.540	8.504	47.695	8.804	2.773	1.594
2006	244 166	143.656	27.615	8.494	47.095	8.519	2.795	1.647
2007	248 849	143.879	27.691	8.480	46.505	8.383	2.806	1.673
2008	253 623	144.093	27.766	8.463	45.927	8.251	2.816	1.699
2009	258 488	144.296	27.842	8.433	45.360	8.122	2.827	1.723
2010	263 446	144.490	27.917	8.421	44.802	7.996	2.836	1.748

Source: Center for Agro Economic Research, 1989.

Table 4.7 shows food consumption per capita projected for 1984-2010. Only consumption of cassava and sweet potato is declining. Note steadily increasing rice consumption.

6. Employment and Farm Mechanisation

Unemployment is probably Indonesia's gravest economic problem. In Pelita V about 11 million new workers will come onto the market, four million of them for agriculture. Yet in Table 4.8 we see that jobs in agriculture were shrinking in Java (except East Java). So this new employment should be directed outside Java.

Table 4.8

STRUCTURE OF HOUSEHOLD INCOME AND GROWTH OF AGRICULTURAL EMPLOYMENT BY PROVINCE

Province	Agr. Income %	Food Crop Income Share Total Income %	Household Income/Year Rp.000	Growth of Employment 1978-1985
D.I. Aceh	44.6	26.9	791	0.1
North Sumatra	52.5	29.9	735	0.5
West Sumatra	58.8	30.5	735	0.2
Riau	17.4	9.9	1 086	3.8
Jambi	40.5	28.0	724	8.5
South Sumatra	33.8	22.5	878	5.9
Bengkulu	37.7	26.1	821	7.0
Lampung	39.7	25.1	590	6.5
West Java	68.0	28.3	640	-0.8
Central Java	61.6	31.0	609	-1.0
Yogyakarta	57.1	24.3	750	-2.0
East Java	58.4	33.9	593	0.1
Bali	39.1	23.0	847	2.1
West N. Tenggara	63.4	39.8	523	-1.1
East N. Tenggara	45.9	33.3	621	1.6
West Kalimantan	42.7	27.2	655	3.8
C. Kalimantan	36.9	22.3	853	1.5
S. Kalimantan	58.9	29.4	574	0.4
E. Kalimantan	35.3	21.6	702	0.1
North Sulawesi	43.2	24.4	907	4.4
Central Sulawesi	44.1	33.4	836	6.6
South Sulawesi	55.8	36.4	634	0.6
SE. Sulawesi	42.9	26.1	659	9.2
Maluku	29.5	19.7	909	5.5
Irian Jaya	30.8	22.7	770	8.6

Source: ILO/UNDP study, 1989. Quoted from Kasryno & Swenson, 1989.

The pressure of the labour force is the main reason for Indonesia to pursue labour intensive policies, whenever feasible. It means cautiously - and meticulously - to introduce farm mechanisation, since such mechanisation will sharply reduce jobs in agriculture. This is why agro-economists protested strongly about introduction of rice mills and the shift from ani-ani (a traditional knife in rice harvesting carried by women) to sickle harvesting in the 1970s.

Yet current problems seem to work against a labour intensive policy. They include:

- low labour productivity in agriculture compared with the industrial sector (Table 4.9).

- inability to promote agricultural development in transmigration and other areas of scarce labour.

- power tillers are concentrated in Java and are needed to support the Supra-Insus programme, especially to ensure timely programme implementation.

- the number of tractors and power tillers in Indonesia is among the lowest in Asia (Table 4.10), suggesting the need to encourage more mechanisation. This is also shown in Fig. 4.1.

- reluctance of a better-educated new rural labour force to work on farms and preference for urban jobs.

Labour intensive policy, when carried out beyond its economic desirability, will not achieve its goal and may even prevent high productivity and full employment.

Table 4.9

DEVELOPMENT OF LABOUR PRODUCTIVITY, EMPLOYMENT AND GDP IN AGRICULTURE, 1971-87

Year	Employment (%)	Agriculture GDP (%)	Relative Productivity[1]
1971	66.3	44.0	0.40
1976	61.6	36.1	0.35
1977	61.5	33.7	0.32
1978	60.9	32.8	0.31
1980	55.9	30.7	0.35
1982	54.7	29.8	0.35
1985	54.7	24.0	0.20
1986	55.1	23.7	0.25
1987	55.0	23.4	0.25

1 Ratio of labour productivity in agriculture and in non-agriculture.
Source: Faisal Kasryno and C.G. Swenson, Prospek Penyerapan Tenaga Kerja, Policy Workshop, 1989.

Table 4.10
ESTIMATED INVENTORY OF AGRICULTURAL TRACTORS PER 1000 HA OF ARABLE AND PERMANENT LAND, ASIAN COUNTRIES 1984-85

Country	Tractors (1984)	Tractors (1985)	Power Tillers
East Asia			
Japan	345.2	389.6	594.5
Rep. of Korea	4.5	6.0	248.5
Southeast Asia			
Burma	1.0	1.0	-
Indonesia	0.5	0.6	1.2
Malaysia	2.4	2.6	-
Philippines	1.7	2.5	6.5
Thailand	6.2	6.4	16.8
Vietnam	5.9	5.9	-
South Asia			
Bangladesh	0.5	0.5	-
India	3.3	3.6	0.2
Nepal	1.2	-	-
Pakistan	7.3	7.6	-
Sri Lanka	12.1	12.4	9.1

FAO Production Yearbook 1985 and 1986;
Japan Agricultural Machinery Association 1987;
Korean Agricultural Machinery Association 1985;
Bernas 1986; Reyes 1985.
Quoted from Bart Duff et al., Agricultural Modernization, Mechanisation and Rural-Based Industrial Development in Asia, AESSEA Biennial Meeting, Manila, 1988.

The FIGURE 4.1 (TRENDS IN AGRICULTURAL INPUTS, SOUTHEAST ASIA) is not reproduced due to technical reasons. Please consult printed version.

If mechanical power is needed in the labour surplus economy of Java, it is needed much more where labour is scarce. It is wrong though to regard mechanical power as an alternative to manual power. It is really a tool to increase productivity and capacity of labour. Introducing mechanical power also means creating jobs in related sectors or sub-sectors. Jobs are increasing rapidly in towns, where mechanisation is unrestricted, opening the way for country people to work there. The risk that farm mechanisation will reduce jobs is real, but if done carefully, it can boost rural employment.

Oil is the cheapest form of energy known so far - 2 000 times cheaper than carbohydrate energy used in manual activity. This is the main reason the poor are poor, because they have no opportunity to use cheap mechanical power.

Thailand's ability to introduce greater farm mechanisation is probably the reason it is a significant exporter of rice, maize and cassava - all of them labour intensive commodities.

7. Marketing and Related Policy

a. An Overview

Rice and maize are key items in the national economy and the government has to exert strong market control with a floor and ceiling price policy. Theoretically, when the farm-gate price drops below floor price, the government steps in to buy the commodity at the floor price, protecting the producer. When the price goes above the ceiling price at the consumer's market, the government steps in by selling some of its stock of the commodity in the market below the ceiling price, thus protecting consumers.

To speed up adoption of new technology, the government also controls farm inputs, such as fertiliser, pesticide and seed. A large subsidy encourages adoption of these inputs.

Table 4.11 shows the subsidised price of fertiliser, the floor price for maize and rice, the consumer index and dollar exchange rate for 1979-90. Note the favourable floor price over time in relation to fertiliser price, reflecting real support for increased production. Note also the rate of change in floor prices for maize and rice was higher than the rate of change of the consumer index, reflecting the favourable price incentive over time.

Table 4.11
Selected prices, consumer index and exchange rate, 1979-90

Year	Fertiliser Rp/kg	Floor Price Rp/kg[1] Rice	Maize	Consumer Index	Rp/US$
1979	70	75	-	132.00	632
1980	70	95	42.5	156.32	634
1981	70	105	67	176.46	643
1982	70	120	95	192.09	692
1983	90	135	105	214.74	996
1984	90	145	105	237.19	1076
1985	100	175	105	248.40	1131
1986	100	175	110	262.88	1655
1987	120	190	110	287.27	1652
1988	130	220	125	310.37	1680 x
1989	165 xx	250	140	-	1740 x
1990	185 xx	270	155	-	-
Rate of Change xxx (% per year)	8.8	12.3	15.1	10.0	11.00

x = approximate.
xx = from 1989, the price of triple super-phosphate is different, Rp 185 for 1989 and Rp 210 for 1990. The levels of subsidised price and floor price for 1990 were determined in October 1989.
xxx = calculated using simple arithmetic: $\left| \frac{(x_i - x_{i-1})}{n - 1} - 1 \right| 100\ \%$
Note 1: for rice, it is in the form of "gabah" or unhusked rice.
Source: Statistical Yearbooks, CBS.

This simple exposé is far from sufficient, because the consumer index is based on urban consumption in 17 cities. The index in rural areas may be quite different.

The terms of trade of rice relative to various commodities needed by farmers appeared to decline by 27 per cent between 1976-86, an annual rate of -2.5 per cent. Farmers have to sell rice at the low (producer's) price, but have to pay more for urban commodities than urban consumers because of the rural market's higher costs of transport, storage and distribution. So the rural market consumer index appeared to grow faster[4].

Table 4.12 shows the price of maize relative to selected agricultural commodities. With regard to cassava and sugar, the price of maize is stable, while relative to peanut, soybean, and mungbean it is falling.

Table 4.12

MAIZE PRICE RELATIVE TO SELECTED FOOD ITEMS,
1969-85, WHOLESALE PRICE

Year	Rice	Cassava	Peanut	Mungbean	Soybean	Sugar
1970	0.58	3.78	0.31	0.43	0.53	0.37
1971	0.60	3.34	0.29	0.36	0.43	0.36
1972	0.68	2.73	0.25	0.27	0.46	0.32
1973	0.60	2.51	0.28	0.37	0.42	0.35
1974	0.77	3.80	0.25	0.37	0.46	0.41
1975	0.61	3.12	0.29	0.36	0.47	0.42
1976	0.66	3.68	0.31	0.37	0.56	0.48
1977	0.60	3.06	0.30	0.33	0.43	0.38
1978	0.48	4.12	0.20	0.30	0.40	0.34
1979	0.64	5.40	0.22	0.31	0.46	0.48
1980	0.53	3.25	0.18	0.33	0.38	0.27
1981	0.54	3.59	0.17	0.31	0.38	0.27
1982	0.65	3.61	0.25	0.36	0.50	0.32
1983	0.56	2.21	0.21	0.32	0.44	0.33
1964	0.55	2.74	0.19	0.31	0.38	0.31
1985	0.55	3.48	0.18	0.33	0.41	0.34

Source: calculated from the data of the Directorate of Farm Economics, D.G. of Food Crops, 1987.

In Chapter I, we showed that farm revenue in maize production was increasing despite growing cost per hectare. Adoption of high-yield varieties and the associated intensification programme seemed to be what enables Indonesia to produce enough maize to meet expanding domestic demand.

b. Exports and Comparative Advantage

The ability of the country to meet increasing domestic demand for maize does not imply ability to sell maize on the world market as an exporter. In Table 4.13, we see that:

- until 1975, Indonesia was a net exporter with volume of about 200 000 tons. Since then it has become a net importing country, except in 1981 and 1984.

- since 1976, the ratio between world market price and domestic price (represented by FOB New York and Jakarta wholesale respectively) has been between 0.87 to 0.43, suggesting commodity flow must be from New York to Jakarta, making Indonesia a net importer.

Table 4.13.

DOMESTIC PRODUCTION, EXPORT, IMPORT & PRICE OF MAIZE (1970-86)

Year	Domestic Production (Ton)	Total Export (Ton)	Total Import (Ton)	World Price (Rp/Ton)	World Price Real (Rp/Ton)	Domestic Price (Rp/Ton)	Domestic Price Real (Rp/Ton)	World Price/ Dom Price
1970	2 824 593	282 196	-	-	-	26.100	71.584	-
1971	2 605 975	227 979	-	21 840	57 154	25 580	66 941	0 85
1972	2 254 222	160 723	-	26 040	64 426	33 220	82 190	0 78
1973	3 989 685	180 271	-	39 480	87 918	45 910	102 237	0 86
1974	3 010 710	195 492	-	52 452	101 987	60 060	116 780	0 87
1975	2 902 833	50 723	-	52 204	97 996	74 540	139 924	0 70
1976	2 572 009	3 900	68 773	47 152	81 968	90 370	157 098	0 52
1977	3 142 582	13 392	14 401	40 065	66 971	76 710	128 226	0 52
1978	4 028 986	21 076	46 109	63 823	99 241	75 780	117 833	0 84
1979	3 605 277	6 830	69 945	72 891	99 134	126 410	171 921	0 58
1980	4 011 857	14 890	24 628	78 789	95 059	116 900	141 039	0 67
1981	4 509 065	13 448	35	84 179	87 010	131 910	136 345	0 64
1982	3 234 618	-	72 934	76 246	76 246	177 340	177 340	0 43
1983	5 087 106	16 733	21 654	135 267	125 821	183 000	170 221	0 74
1984	5 287 755	160 264	58 751	146 426	129 931	191 930	170 309	0 76
1985	4 099 023	3 541	50 542	130 105	116 582	208 340	186 685	0 62
1986	5 931 157	-	59 932	113 197	93 918	206 540	171 363	0 55
G Rate	4.75%	-25.3%	-1 4%	11 59%	3 37%	13 80%	5.61%	-2.91%

Source:

- Domestic production: DG of Food Crops
- Total export & import: CBS and Bulog
- World price: FAO
- Domestic price: Jakarta Wholesale Price, CBS

Growth rate:

- in columns 2, 3, 7 and 8 from 1970-86.
- in column 4 from 1975-86.
- in column 5, 6 and 9 from 1977-86.

Real price using a private consumption inflation index, 1982 base.

- World price = USA no.2 yellow FOB Gulf.
- Quantity import = Maize + Other Maize (CCCN 10.05.900).
- Quantity export = Maize + Other Maize.

Yet Jakarta is not a reasonable market point to compare, because it is a deficit region, and Indonesian maize exports are not from Jakarta but Surabaya, capital of the maize surplus province. In chapter I, table 1.17, the wholesale price in East Java was Rp 144/kg, compared with Rp 208/kg for Jakarta wholesale and Rp 116/kg FOB New York.

Peter C. Timmer has suggested maize exports are possible when done not long after the harvest to reduce storage cost (Fig. 4.2). So to evaluate Indonesia's comparative advantage in maize production, we have to analyse prices in the producing regions.

In Chapter II, using the devaluated rupiah in 1986, it was shown that maize exports were feasible, except for West Java. Thus rupiah devaluation changed Indonesia's comparative advantage in maize production (Table 2.14). But (Chapter II), mere low EP value does not necessarily mean export ability, because it only shows "price feasibility" for export. If Indonesia has maize surplus, then within the existing price relationship, exports are feasible. But if there is no surplus, if surplus should be first created, then we have to calculate anew whether the surplus can be produced at the current cost structure or whether we have to change the cost structure to generate surplus.

If we have to open new land to create the surplus, we have to insert the new component of cost related to new investment. Probably we have to improve port facilities to make exports possible or build new roads and other infrastructure to double maize production for export.

The Figure 4.2 (Role of Storage Cost and Government Trade Policy on Maize Price Formation and Potential for Imports and Exports in Same Crop Year) is not reproduced due to technical reasons. Please consult printed version.

The IFPRI study calculated EP for Kalimantan, and Kalimantan produced only 33 000 tons of maize in 1985. The EP value calculated by the IFPRI team says nothing about how Kalimantan should realize its "comparative advantage" in maize production for export.

Government policy for maize and other food crop production is oriented towards self-sufficiency. This contrasts with production of export-oriented commercial crops like rubber, oil palm and coffee, whose production level is far in excess of domestic demand.

This attitude is suported by Leon A. Mears for rice and by Peter C. Timmer for maize. Mears' argument is that it is much harder to manage a large surplus than a small deficit. Small net surplus or small net deficit is the easiest situation to manage and so is the low-risk policy they recommend.

Indonesia is facing serious unemployment, with the problem of how agriculture can absorb four milion new workers in Pelita V, the saturated market for many industrial crops, the problem of involution in Java and land under-utilization outside Java. In the long run, industrial development is expected to resolve most problems, but a more immediate solution is needed.

In this longer view, the precarious rice self-sufficiency will be maintained because of over-reliance on Java for its cultivation, but efforts to expand land area for agriculture through transmigration and small-scale irrigation appear doomed when food surplus in a new area is an important aim. Local surplus for the local market may be achieved, but it has little impact on aggregate supply.

The transmigration programme should really be tied to the long-term aim of shifting food production out of Java and made part of regional development.

Pelita I - V should be considered a rehabilitation phase followed by intensification. In Pelita VI and beyond - the take-off phase of Indonesia's economy - the stress should be on diversification and extension.

Diversification should be seen as widening and deepening agricultural development, involving diversification by region, in resources, crops and products. Farm mechanisation should become a priority. Pelita V should also be considered a transition, a time to draft a long-term agricultural plan for Pelita VI and beyond.

A food surplus strategy for export is desirable to provide jobs in the countryside, for which proper land preparation technology should be applied in the new expansion areas (transmigration). After the take-off stage, agriculture will be hit by a labour shortage and so move to farm mechanisation.

NOTES

1 ROSEGRANT *et al.* used a standardised method to evaluate export potential. See the very high difference between the IR and EP regime in Table 2.12.

2 Extenstion refers to extending the area under cultivation.

3 Directorate-General of Food Crops, Kebijaksanaan Ketahanan Pangan Berwawasan Lingkungan, Seminar, International Food Day, Jakarta, 1989.

4 See Kompas (daily), Harga Jual Gabah dan Dilema Penyediaan Pangan, October 7, 1989, editorial.

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