CGPRT NO 13

Maize Production in Java

Prospects for Farm-Level Production Technology

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Foreword

This study was carried out in 1985/1986 in the framework of the Regional Project on Food Legumes and Coarse Grains, RAS/82/OO2.

One of the objectives of the regional project was to identify and analyse socio economic constraints to increased production and efficient distribution.

The report is the fourth country report in the RAS/82/OO2 series. It describes constraints and cultivation practices at the farm level and analyses the adoption patterns of improved technology.

The authors, Aman Djauhari, Adimesra Djulin and Irian Soejono indicate that successful production expansion is most likely to take place in areas with sufficient rainfall, while the supply of quality seeds is also crucial. More specifically, when monocropped, high-yielding maize varieties appear to be less- sensitive to rainfall variation. The authors distinguish between growers of traditional varieties who consume a relatively large proportion of their production, and growers of high-yielding varieties (HYV). Different approaches for these two groups are advocated. It is encouraging to learn that the size of landholding is unrelated to the rate of HYV adoption.

I hope that this study will contribute to increased understanding of socio-economic factors in upland agriculture in Indonesia.

Shiro Okabe
Director
CGPRT Centre

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Summary

Increasing imports of secondary crop products and the recent achievement of self-sufficiency in rice have caused the Government of Indonesia to consider ways of raising production of secondary crops, including maize, through the application of improved technology. At the beginning of the 1980s, however, only some of the more progressive farmers were benefiting from improved maize production technology and many were still using traditional methods of production. Hence, information is needed on the characteristics of maize farmers. Who adopt the improved practices and who do not? Under what environmental conditions do they operate successfully? What constraints do they face in their efforts to increase maize production? If more farmers are expected to adopt the new technologies such data would' help both policy makers and extension workers.

The main objectives of the present study are to identify and analyse:

1. the constraints to adoption of new technology for maize production,

2. the conditions needed to improve productivity and farmers' incomes,

3. the characteristics of both the successful and unsuccessful maize farmers.

In 1984, the Stanford University/BULOG Corn Project Study was concerned with the maize economy as a complete system and interested in the various systemic activities, including prediction of maize development in the near future. The present study, on the other hand, aims at analyzing farm level prospects and constraints in the adoption of improved maize production technology.

This study is based on a survey of 149 randomly-selected farmers. They were chosen from IO villages of five districts *(kabupaten)*, which are well-known maize producing centres of Central and East Java. Survey data refer to the 1984/85 crop year.

Certain characteristics of the sample farmers have relevance for the maize development programme.

1. Most (93%) use only their own working capital.

2. Only 6% of the farmers treat their seeds chemically before planting.

3. Only 20% use manure in addition to artificial fertilizers.

4. On average, 70% of the maize produce is sold by the farmers.

5. Sixty-five percent of the farmers sell their maize on one occasion only.

6. With only a few exceptions (such as the Kediri area), more than 85% of the farmers consume both rice and maize.

With the aim of finding ways to alleviate the problem of low maize production, the following factors are pertinent.

1. Survey data from sample farmers tend to reinforce the findings of Oldeman and Suardi (1977) that highest yields of maize are found in areas with total precipitation of 300 to 600 mm during the maize-growing period.

2. The farmers' age, experience and formal education are positively related to the adoption of improved varieties.

3. Maize consumption levels of the farm families are inversely related to the adoption rates of he current high-yielding varieties (HYV such as Arjuna and the hybrids), but are positively related to the adoption rates of local/traditional varieties.

4. The form of tenancies and the size of landholdings appear to be unrelated to the rates of HYV adoption. However in case of share-cropping adoption of HYV remains limited.

5. Limited family labour tends to constrain the adoption of more labour-intensive maize technology, regardless of the availability of hired labour and the prospects of increased profits.

6. Farmers who purchase seeds adopt more HYV than those who use their own seed.

7. Maize product marketing appears to be sufficiently competitive.

Some of the recommendations resulting from the study are:

1. Intensified maize-production programmes should be concentrated in areas with precipitation ranging from 300 to 600 mm during the maize-growing period.

2. Competitive commercial supply of seed should be developed and encouraged to meet the pressing needs for quality seeds. This in turn will provide a stronger basis for the maize-improvement programme in the producing areas.

3. Yield improvement of local varieties, which are mostly of white grain varieties, is an important objective in areas where farmers consume relatively more maize.

4. In areas where maize is grown primarily for commercial purposes, the development of the yellow-grained HYV programme is recommended.

1

Introduction

Background

Among *palawija* crops, maize is an important source of calories for many Indonesians. With a per capita consumption in 1980 of over 90 kg, it is the staple for about 17 million of the 63 million rural people in the four main producing provinces: Central and East Java, South Sulawesi and East Nusa Tenggara (Stanford University/BULOG Corn Project Report 1984). Approximately 70% of the maize produced is used for food by farm families and, except in Madura and East Nusa Tenggara, the white grain is preferred. For market purposes, however, the yellow grain is more acceptable.

More than 50% of the annual maize production in Indonesia originates from upland areas, where most farmers plant local varieties of seed. This results in an estimated low average yield of 1.7 t/ha of grains in 1983 (Table 1.1). Maize is planted as either a monocrop or an intercrop. In drier areas, soil moisture content limits the

production of secondary crops and necessitates the use of local varieties of short- , maturing maize. Low seed viabilities and high shoot fly incidence are common problems in such traditional farming systems and frequently lead to high seeding rates of three or more seeds per hill.

Recent data indicate that increasing quantities of maize have been imported (Table 1.2) mainly for use in feed mills. This demand for maize presumably increases with that for livestock products. Issues of grain quality therefore, especially those relating to moisture content, become more important.

With current low yields and prevailing prices, maize is not competitive with rice, grain legumes or vegetables. Although the net returns of maize have improved in relation to upland rice on Java in the last decade, they are barely competitive with cassava, peanuts and soybeans. Reduction in unit costs of maize production through yield increases have helped maize maintain its position, despite a general decline in relative output prices (Mink 1984). Expansion is not likely in the near future, particularly in areas of established. farming systems (Table 1.3). In such conditions, it is clear that efforts should be made to increase yield levels and reduce costs of production.

After recent successes in rice production the Government of Indonesia is starting to pay more attention to increasing production of secondary crops, including maize, and to promote crop diversification rather than emphasize only rice production. Results of earlier research indicate the technical potential for rapid increase in production is available. Recently, there have been private attempts to encourage the growing of hybrid maize. Some of the more progressive farmers have benefited from the improved technology, but many are still using traditional methods of production.

Table 1.1 Area, yield and production of maize in Indonesia, 1983.

Province	Harvested Area ('000 ha)	Yield (t/ha)	Production ('000 t)
Aceh	4	1.30	5
North Sumatra	42	1.79	75
West Sumatra	3	1.92	15
Riau	27	1.33	35
Jambi	1	1.35	2
South Sumatra	15	1.30	20
Bengku1u	5	1.38	7
Lampung	81	1.56	132
Sumatra	187	1.56	291
Jakarta		1.09	-
West Java	93	1.58	148
Central Java	712	1.85	1,315
Y ogyakarta	56	1.40	79
East Java	1,156	1.79	2,068
Java & Madura	2,018	1.79	3,609
Bali	48	1.51	73
West Nusa Tenggara	28	1.50	42
East Nusa Tenggara	190	1.31	249
Bali & Nusa Tenggara	266	1.37	363
West Kalimantan	9	0.99	9
Central Kalimantan	4	1.26	4
South Kalimantan	7	1.12	8
East Kalimantan	10	1.23	12
Kalimantan	29	1.13	32
North Sulawesi	105	1.88	109
Central Sulawesi	42	1.26	53
South Sulawesi	302	1.52	459
Southeast Sulawesi	57		
Sulawesi	506	1.55	784
Maluku	30	1.03	10
Irian Jaya	3	1.32	4
Maluku & Irian Jaya	33	1.09	14
Total outside Java	1,090	1:49	1,485
Indonesia	3,018	1.69	5,095

Source: Statistical Yearbook of Indonesia 1984.

Table 1.2 Maize exports and imports in Indonesia, 1981 to 1985.

Year	Import		Export	
	Volume (t)	Value (US$ 1000)	Volume (t)	Value (US$ 1000)
1981	2,011	728	8,157	1,468
1982	76,466	13,163	57,240	3,711
1983	28,190	5,250	46,553	3,466
1984	59,386	9,660	21,246	1,745
1985[a]	49,610	6,968	2,948	501

Source: Central Bureau of Statistics. Jakarta. 1985.
[a]From January to October.

Table 1.3 Harvested area and prodnction of maize in Indonesia, 1980 to 1985.

Year	Production ('000 t)	Harvested area ('000 ha)
1980	3,991	2,735
1981	4,507	2,955
1982	3,207	2,064
1983	5,095	3,018
1984	5,359	3,025
1985[a]	5,694	2,223

Source: P.T. Data Consult Inc. 1986.
[a]Provisional data.

Rapid increases in fertilizer use, the spread of higher yielding varieties, and a possible shift from intercrop to monoculture maize help to explain the rise in maize yield from the early 1970s. Average figures hide tremendous regional and seasonal variations. Survey results and field observations suggest that as farmers intensify maize production through use of improved varieties and fertilizer, they move to monoculture production (Mink 1984).
It would be of interest to know who adopts or rejects the new technology, under what environmental conditions they operate and the reasons why they have or have not opted for the improved practices. By comparing such farmers, important information can be gained about production constraints and the potential for maize production if more farmers adopt the new technologies.

In 1984, the Stanford University/BULOG Corn Project conducted an in depth study on the maize economy of Indonesia. The resulting working papers provide analyses of the dynamics of maize development, the current production performance and future prospects. Although various constraints on production and marketing were reported, no specific effort was made to analyses the characteristics or success of maize farmers in applying the improved technologies. The present study complements the Stanford study by identifying these characteristics and by describing both the management of the farmers and their production environments.

Objectives of study

Given that proven technologies with reportedly high yield potentials are presently available in specific environments, and also that the government is committed to engage in development with equity, the following issues appear particularly challenging.

1. What is the potential of the new technologies, including hybrids, for increasing maize production at the farm level?

2. What reduction in production costs may be expected from applying these technologies?

3. Who benefits from the new technologies, and what is the likely impact on other farmers?

4. What are the possibilities of improving the situation of small farmers **in** traditional, low-productivity maize farming systems?

The main objective is to address these issues. More specifically the study will identify:

1. the main constraints to adopting new technologies for maize production,

2. the conditions needed to improve maize productivity and farmers' income,

3. the characteristics of both the successful and the unsuccessful farmers.

In accomplishing these objectives, this study can provide effective guidelines for extension workers involved with increasing maize productivitie.. More appropriate technology may then be devised to meet the different farmers' needs.

2

Methodology

Conceptual framework

The need for expanding agricultural production in Indonesia, especially of food commodities, is widely recognized. It is also true, although not so generally acknowledged, that growth in agricultural production can only be realized if the majority of farmers adopt a more productive technology.

Each new technology has certain biophysical as well as socio-economic requirements and, similarly, each farmer and his farm has specific biophysical and socio-economic attributes. The rate of acceptance of innovation varies from farmer to farmer and from region to region because of different kinds of barriers to change and the intensity of those barriers (Dalrymple 1969). Factors influencing the rate of adoption of technology include the characteristics of the technology; the characteristics of the adopters; and the characteristics of the economy and the society (Dalrymple 1969; Schutjer et al. 1976).

The present study deals with a biological innovation: with improved maize varieties, including'the hybrids. Predicting and understanding the importance of economic and social variables as constraints to adopting this technology requires consideration of its characteristics. Four are important; efficiency, factor intensity, complexity and divisibility. In general, farmers give priority to those technologies which are least complex and most divisible. The advantages of the ,first two characteristics are not felt directly.

. High-yielding variety or hybrid maize technology consists of high-yielding plants and an associated package of inputs and management practices. According to some studies (Schutjer et al. 1976) the technology is fairly divisible, neutral to scale; relatively complex in application and the cost of reversing an adoption decision after one planting season is minimal. Therefore any constraints faced by farmers in adopting the techI1o1ogy probably derive largely from the characteristics of adopters, economy and society, as was found in a study from Colombia (Zandstra et al. 1979).

Characteristics of the adopters include their attitudes in farm decision making, their general knowledge and perception of their economic environment, their personal status, past behaviour and otlter social and farm firm variables. Characteristics of the economy include the nature of its infrastructure, the demand for agricultural products, off-farm employment and government policies. Infrastructure includes the availability of input necessary for change, the availability of credit and the nature of marketing systems, communication and transportation.

Area and farmer sampling

The provinces of Central and East Java, representing the two major production centres of maize, were selected as the study areas (Figure 1.1). Together, the provinces contributed 67% of the national maize production in 1984, although an intensive introductory programme of hybrid maize expansion started in those provinces only with the planting season of 1984.

In each of these provinces, district *(kabupaten)*, subdistrict *(kecamatan)* and village *(desa)* samples were selected on the following criteria:

1. each had the largest (or second largest, etc.) maize crop harvested area;
2. more than half the crop lay in either uplands or dry season irrigated field;
3. the gap between the average farmer's current yields and adjacent trial plot yields is large;
4. the maize development programmes of hybrid and Arjuna variety crop production were being implemented before the wet season cropping of 1985/1986.

In the selected villages maize farmers were grouped into three categories:

1. Those who participated in the special intensification programme INSUS, where participating farmers apply the recommended inputs obtained through BIMAS credit. This programme uses the national yellow high-yielding varieties (HYV), including C-l hybriq and Arjuna varieties.
2. Those who joined the general intensification scheme INMUM, where they purchase the recommended inpyts themselves.
3. Traditional farmer not involved in any programme.

Five farmers were randomly selected from each category, giving a total of 15 sample farmers in each village. Some deviation occurred between planned and realized sample. The final representation of farmers is presented in Table 2.1.

Table 2.1 Farm household samples, East and Central Java Provinces, 1985.

District	Subdistrict	Village	Maize development programme (1984)	Type of Farm		
				INSUS	INMUM	Traditional
Central Java						
Banjarnegara	Bawang	Kutayasa	Arjuna	5	6	4
	Karang Kobar	Laksana	Hybrid	4	5	6
Blora	Tunjungan	Sambongrejo	Arjuna	5	5	5
	Tunjungan	Adirejo	Arjuna	5	3	7
East Java						
Bojonegoro	Kapas	Sidodadi	Hybrid	5	5	5
	Purwasari	Tlatah	Arjuna	5	5	5
Lumajang	Klakah	Kudus	Hybrid	6	4	5
	Kunir	Sukorejo	Arjuna	5	4	6
Kediri	Gurah	Kerkep	Arjuna	5	5	5
	Gurah	Bangkok	Hybrid	5	5	4

Data Collection

When sample farm households were interviewed (see list of required information, Appendix), certain problems emerged. The number of man-days of labour reguired for

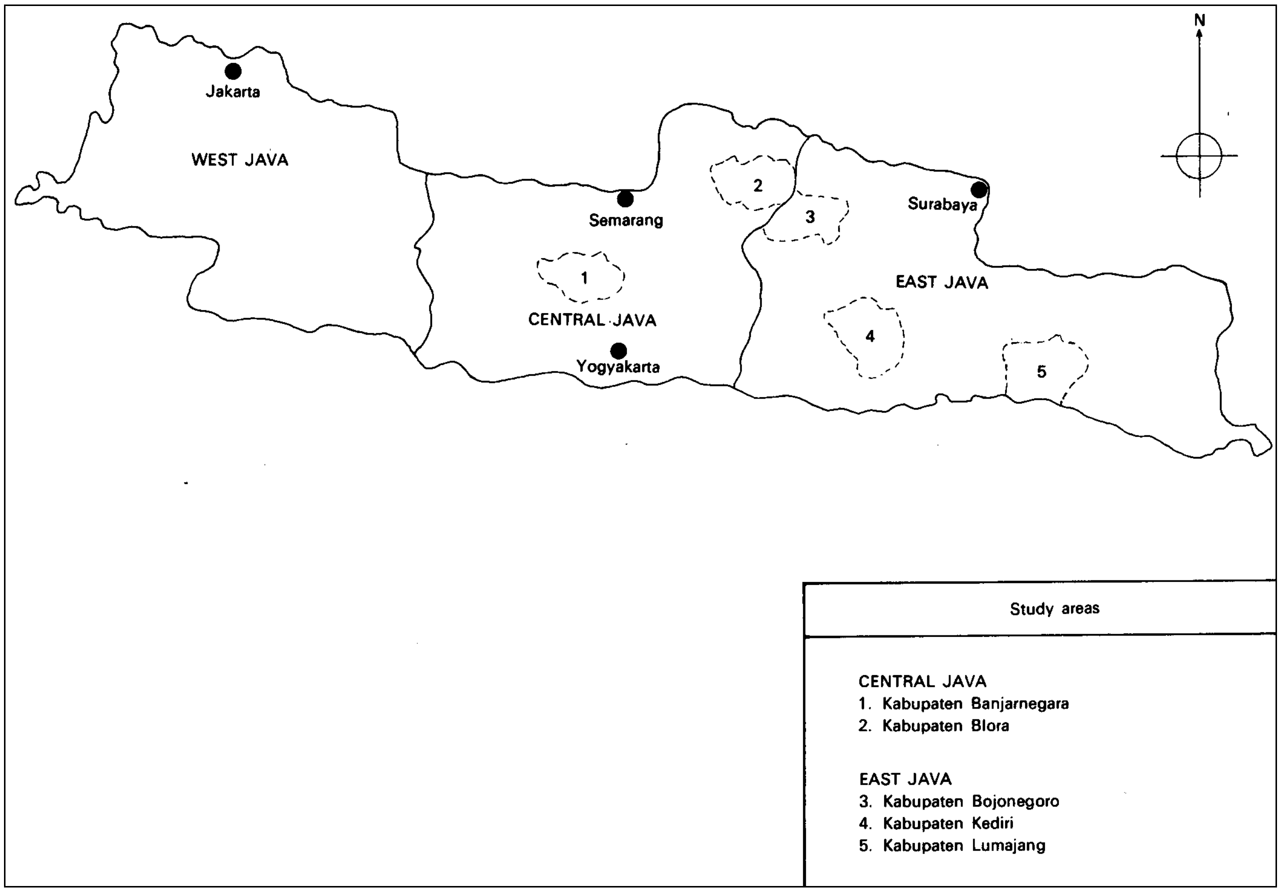

Figure 1.1 Study area, Central and East Java.

each activity was hard to obtain because many farmers employ a unique working arrangement, known as the *kedokan* system. Labour for all crop management is contracted out and remunerated only after harvest when a share of the harvest (ranging from 16 to 20%) is paid to the contractor *(pengedok).* Difficulties arise when a farmer employs different contractors for each of his scattered plots. The problems are compounded when a farmer rents other land.

Data on input and output were collected from all separate enterprises. Factors taken into consideration were season, variety and land type. Duplication of information on crops, cultural practices, variety and land type was avoided although this also led to problems of selection. Each farm consists of several plots. If season, variety or land type differed in the plots of one sample farm, all sets of corresponding data was collected from each plot. This led to the creation of several cases from some sample farms.

Data on maize production in Kediri was hard to obtain. This was because many of the farmers had sold the standing crop five to seven days before harvest, with a down-payment of as much as 10 to 25%.

The completed questionnaires were edited for data processing and 149 questionnaires were satisfactory for further analysis.

Data analysis

The collected data was organized and grouped for testing of certain hypotheses and relationships. The extent of adoption of the recommended technology is evident from the percentage of adopters, the extent of application in hectares, the intensity and effectiveness of adoption. It may be influenced by many independent variables: the farmer's education, experience exposure to extension services, size of farm and family income. Depending on the actual indication or direction of relationship, the existence of adoption constraints could be confirmed and analysed further. Similar processing of data may also be applied in the case of production constraints identification and analysis.

Another method of identifying the existence of production constraints is to compare estimates of current resource marginal productivities with their relative prices. Both a higher or lower marginal value of productivity relative to price indicates the existence of constraints to increased production. They may suggest excessive or deficient use of input. Results from the quantitative approach are checked with the available qualitative data.

In the effort to present averages of certain variables or percentages of certain occurrences out of their totals, the number of cases was considered, regardless of the number of sample farms. These were done especially with information pertaining to growing season, crop variety and land type. As a result, the stated number of cases may exceed the number of sample farms, since a sample farm may produce more than one case of specific data sets.

Information on certain variables was lacking from some of the survey questionnaires, because either it was not relevant or it was inadvertently omitted. As a result, the numbers of farms and of cases used in the analyses varies, as indicated in the footnotes of the tables in this report.

3

Area Description and Farm Characteristics

Description of study area

Kabupaten Banjarnegara

The district of Banjarnegara covers a total area of 100,069 ha. Dominant soil types in the area are Latosols, Alluvials, Andosols and a small proportion of Organosols. Upland farming (63%) is the main form of land use, followed by-wet fields or *sawah* (18%), public forests (16%), perennial crop estates (0.15%) and other uses (3%). Altitudes above sea level range from 44 to 1,630 m. Low plains cover 62% of the area and the rest are hill or mountainous areas. Annual rainfall averages 3,000 mm with 180 days of rain. According to Oldeman (1976), in general the area has seven to nine wet months (more than 200 mm/month) and only two dry months, July and August, which each have less than 100 mm.

Based on the harvested areas, maize is the most important commodity in Banjarnegara. In 1984, the area under maize was 51,600 ha, whereas .paddy covered only 25,600 ha. Most of the maize was grown in upland and rainfed *sawah*, while only 16% was planted in irrigated *sawah*, where paddy is preferred.

Observations from the two sample subdistricts give the following cropping patterns. Maize is at least one of the components. The (-) symbol indicates a relay cropping ana (+) an intercropping.

Irrigated *sawah*
Paddy - paddy - maize (78%)
Paddy - paddy - maize + soybeans (8%) Paddy - maize + tobacco (5%)
Maize + vegetables - paddy - maize (3%) Other patterns (6%)

Rainfed *sawah*
Paddy - maize (41 %)
Maize - maize (23 %)
Paddy - maize - maize (10%)
Other patterns (26%)

Uplands
Maize + cassava - maize (59%)
Maize + maize (10%)
Upland paddy + cassava - maize (10%)
Maize + cassava - long beans (8%)
Maize + cassava - cowpeas (5%)
Other patterns (8%)

During the period 1980 to 1984, the harvested areas of maize experienced an annual growth rate of 2.4%, while annual productivity increased at the rate of 1.9%. The average yield in 1984 was 2.35 t/ha, which was above the average of the 'province of Central Java as a whole (1.90 t/ha). Nonetheless, effort's to increase yields further are continuing through intensification programmes and the introduction of new high yielding varieties.

In the 1984/1985 rainy season, C1-hybrid maize and the high-yielding variety Arjuna were introduced for the first time with initial planting areas of] 90 and 320 ha respectively. The C1-hybrid demonstration plot in rain fed *sawah* resulted in a yield of 6.0 t/ha while that in an upland area of],000 m elevation produced 5.2] t/ha. This suggests that C]-hybrid may be the means of raising maize yields in Banjarnegara, especially in areas more than 800 m above sea level.

Meanwhile, the yield potential] of Arjuna maize in an upland demonstration plot of 300 m elevation was only 4.2 t/ha. This suggests that it does not grow well at high altitude and may explain why, particularly in Banjarnegara, the use of Arjuna maize variety has increased in the lower plains rather than in higher areas.

Kabupaten Blora

In a total area of 182,058 ha, soil types are predominantly *Grumosols* (56%), Mediterraneans (37%) and Alluvials (5%). Altitudes vary from 30 to 250 m above sea level. Annual rainfall ranges from 1,700 to 2,000 mm, with 80 to 100 days of rain. The wet season includes the months from November to March, while the dry season runs from May to September. Data on district land use indicate that 24% of the total area are wet fields *(sawah)*, 30% are uplands, 44% are public forests and 2% have other uses. As irrigated water is scarce, 87% of the 44,328 ha of *sawah* are rain fed

In the last five years, the harvested area of maize has decreased from 71,972 ha in 1980 to 52,351 ha in 1984, an average annual decrease of 7.5%. In the same period, maize productivity has increased from 0.9 to 1.12 t/ha, an annual increase of 4.6%. These rates are still below the provincial] average yields. Most farmers in the district grow a low-yielding local white variety of maize, with very limited application of fertilizer. .

The sample sub district of Tunjungan showed that maize is grown only on rain fed *sawah* and upland areas, since irrigated *sawah* is used only for paddy cropping. About 85% of the maize was intercropped with secondary crops or vegetables. The various cropping patterns found in the sample area are as follows:

Rain fed *sawah:*
Paddy - maize (3] %)

Paddy - maize + cowpeas (22%)
Paddy - maize + groundnuts (18%)
Paddy - maize + mungbeans (15%)
Maize - maize +, soybeans (8%)
Other patterns (6%)

Uplands:
Maize + soybeans - maize + chillis (35%)

Maize + soybeans - chillis (24%)
Maize + soybeans - soybeans (16%)
Soybeans + maize + mungbeans - chillis (9%)
Maize + soybeans - maize + cowpea (6%)
Maize - maize (6%)
Other patterns (4%)

Efforts to increase maize production in Blora district were started in the rainy season of 1984/1985, through the implementation of an intensification programme. In that season, and also in the dry season of 1985, the programme's targets were never fully realized because of problems of seed procurement. Serving as one of the sites for multi location trials in rainfed *sawah* during the dry season, Blora district showed that the yield potential of Arjuna maize varied between 2.62 and 2.82 t/ha. Although not high when compared with those in Banjarnegara district, these potential yields were actually twice as high as the farmers' current yield averages.

Kabupaten Bojonegoro

Bojonegoro district has a total area of 224,867 ha, much of which consists of low plains along the river Bengawan Solo. Hilly areas are confined to the south of the district. Soil types are Alluvials, Grumosols, Latosols and Mediterraneans.

The two sample subdistricts of Purwosari and Kapas are 24 to 40 m above sea level, with annual rainfall ranging from 1,500 to 1,800 mm. Wet months are December to March, and dry months are June to September, with an annual average of 50 to 65 rainy days. Data on land use indicate that wet fields *(sawah)* occupy 31 %, uplands 22%, forest 33%, and other uses, 14%. It should be noted that most (92%) of the existing *sawah* are rainfed.

After paddy maize is the second important food crop in the district. In 1984, the area of maize harvested reached 67,056 ha with yields ranging from 1 to 1.28 t/ha. Compared with that for paddy and soybeans, however, the intensification programme for maize has lagged far behind. This is evident from the faster rates of increase in paddy and soybean yields as well as their higher economic values.

Most (95%) of the maize is grown in upland and rainfed *sawah.* In irrigated *sawah* maize is planted as an intercrop in the third planting season. The following are the common, traditional cropping patterns:

Irrigated *sawah*
Paddy - paddy - maize + tobacco (43%)
Paddy - paddy - maize + cowpeas (28%)
Paddy - paddy - maize (14%)
Paddy - paddy - maize + groundnuts (10%)
Others patterns (5%)

Rain fed *sawah*
Maize - paddy - tobacco (48%)
Paddy - maize - cowpeas (28 %)
Paddy - maize - tobacco (12%)
Paddy - maize - soybeans (12%)

Uplands
Maize - cassava - tobacco (40%)
Maize + soybeans - maize + soybeans (35%)
Maize - soybeans (10%)
Maize + cassava - groundnuts (10%)
Other. patterns (5%)

Besides aiming to increase yields, development programmes of yellow Arjuna and hybrid maize are also attempting to replace tobacco, which recently has decreased in quality and price. Dry season demonstration plots in the sample subdistricts yielded from 3.5 to 4.3 t/ha for the hybrids, and from 2.8 to 3.7 t/ha for Arjuna. Relatively high prices of commercial seed have led some farmers to use their own seed for the 'subsequent cropping.

Kabupaten Lumajang

The district of Lumajang has a total area of 179,090 ha, of which 178,186 ha are used for agricultural purposes. This consists of irrigated *sawah* (40%), rainfed *sawah* (10%) and uplands (50%). Annual rainfall is high, ranging from 5,000 to 6,500 mm, with 140 to 170 rainy days. Wet months are from October until June and dry months from July to September.

The three important food crops in this district are paddy, maize and soybean. The harvested area of maize in 1984 was 62,713 ha, an area relatively unchanged from the previous five years. Through efforts at intensification, yields were raised from 1.38 t/ha in 1981 to 2.15 t/ha in 1984, an average annual increase of 14%. This high increase in yield is mainly the result of improved seed and increased fertilizer application.

In two sample subdistricts, 59% of the maize crops were planted in rainfed *sawah* and uplands, while the rest was in irrigated *sawah.* Maize was usually planted as a single crop in irrigated *sawah*, whereas in rainfed *sawah* and uplands both mono- and intercropping were common. The main cropping patterns are as follows:

Irrigated *sawah:*
Paddy - soybeans - maize (32%)
Paddy - paddy - maize (24%)
Paddy - maize + chilies (22%) .
Paddy - maize - maize (16%)
Paddy - maize + soybeans - maize (6%)

Rain fed *sawah:*
Paddy - maize + chill is (35%)
Paddy - soybeans + maize (32%)
Paddy - maize + groundnuts (15%)
Other patterns (4%)

Uplands
Maize - soybeans - maize (41 %)
Maize - soybeans - maize + cowpeas (20%)
Soybeans - cowpeas - maize (20%)

Upland paddy - maize + ground nuts (15%)
Other patterns (4%)

Farmers in the district of Lumajang have responded favourably to the introduction of yellow maize, in particular the Arjuna variety. In the dry season of 1984, the area planted with Arjuna maize exceeded the projected target, although the seeds used were of doubtful purity. Hybrid maize cropping in this area only started in the dry season of 1984 and the wet season of 1984/1985, with respective cropping areas of 390 and 650 ha. Yields from the 1984 dry season demonstration plot in rainfed *sawah* were 3.2 t/ha for Arjuna maize and 4.4 t/ha for hybrid maize.

It was predicted that in the dry season of 1985 the cropping areas of hybrid maize would be more than doubled, because of the low subsidized seed price of Rp 1,000/kg. Behind this prediction, however, there was also a fear that due to limited seed supply farmers might use seeds of their own production, which would lead to lower yields.

Kabupaten Kediri

The district of Kediri covers a total area of 138,605 ha, comprising *sawah* (35%), uplands (27%) and forests (25%). The remaining 13% includes estate used for perennial cropping. Almost all *sawah* are irrigated and only 4% are rainfed. Topographically, the district consists of low plains (35%) with Alluvial and Grumosol soil types, hilly areas (56%) with Mediterranean, Latosol and Regosols soils, and mountainous areas (9%). The average annual rainfall is 2,000 mm with 118 rainy days. The wet season is from November until April, and the dry months from July to September.

From 1980 to 1984, consistent development of food crops, particularly paddy, maize and soybeans, was observed in the district of Kediri. The harvested area of maize increased from 43,267 ha to 47,852 ha, an annual average of 2.2%. At the same time, maize productivity experienced remarkable growth from 1.9 to 3.48 t/ha, an annual growth of 16%. This compares favourably with the potential yields of Arjuna in Kediri which ranged from 4.8 to 6.7 t/ha, and those of the hybrid variety of 5.6 to 7.0 t/ha. In the wet season of 1984/1985 Cargill Company organized a yield contest of hybrid maize demonstration plots in East Java province. The district of Kediri won, achieving an outstanding yield of 14 t/ha. Kediri became both the third largest maize producer and the highest average yield achiever in the province. It also supplies seeds to other districts and provinces, particularly 'because PT. Bright Indonesia Seed Industry is located at Kediri.

Data on maize-planted areas from the sample sub district show that in the 1984 dry season and the 1984/1985 wet season, Arjuna variety occupied 74%, hybrids 9% and other (local) varieties 17%. This could mean either that the Arjuna variety was preferred to hybrids, or that insufficient hybrid seed was available, or that hybrid maize was not considered profitable by farmers. Generally planted as a monoculture, most maize crops (61 %) are in rain fed *sawah* and uplands, while 39% are in irrigated *sawah* as a third crop in the cropping pattern. The common cropping patterns in the area are as follows:

Irrigated *sawah*
Paddy - paddy - maize (59%)
Paddy - maize - maize (30%)

Paddy - paddy - maize + groundnuts (7%)
Paddy - paddy - maize + chilies (4%) .

Rain fed *sawah*
Paddy - maize - maize (45%)
Paddy - soybeans - maize (35%)
Paddy - maize - .groundnuts (20%)

Uplands
Maize - maize (40%)
Maize - soybeans (32%)
Maize + cassava - groundnuts (15%)
Maize - cowpeas (13 %)

Sample farmer characteristics

Most sample farmers (79%) had either not attended or not completed primary school, while only 13% had a primary school diploma. Only 7% had attended high school for varying lengths of time. Experience in maize cropping ranged from 6 to 41 years. Only 14% of the sample farmers had 6 to 14 years, while most (58%) had from 15 to 24 years, 22% had from 25 to 34 years and 7% had 35 years or mote experience.

Available family labour depends on the size and ages of household members. For practical purposes, any household member who is 10 years old or more is assumed to join the family labour force. Table 3.1 shows that the average farm family size is 4.5, of which 1.8 are male and 0.9 are female labourers. On average, 0.6 draft animal units are available to each family to help with soil preparation. If farmers are grouped according to those who join the government intensification programmes and those who do not (and hence practice traditional methods), the availability of family labour is similar but the first group has slightly more draft animal units.

In addition to their own farm work, some farmers (38%) engage in various other jobs (Table 3.1). On average, non-agricultural (non-farm) work is a more common alternative source of income (19%) than labouring (off-farm) work (12%). It is apparent that more farmers joining intensification programmes engage in non-farming jobs than do the more traditional farmers.

Table 3.1 Household size, family labour and income

Items	Farmer's group applying		All Farmers (n = 149)
	Intensification practices (n = 97)	Traditional practices (n = 52)	
Household size (person)	4.49	4.55	4.52
Family labour (> 10 years old)	2.69	2.80	2.73
Male (persons)	1.74	1.89	1.79
Female (persons)	0.95	0.91	0.94
Family draft animal (units)	0.67	0.48	0.61
Other Sources of income			
Off-farm only (%)	8	20	12
Non-farm only (%)	20	17	19
Both off-and non-farm (%)	8	6	7
Total sample involved (%)	36	43	38

Source : 149 sample farmers, Central and East Java, 1985.

The number of plots of farm land owned by sample farmers ranged from one to six. Most farmers (41 %) own two plots of land with an average size of 0.39 ha per plot or a total ownership of 0.78 ha. Overall, the average plot size is 0.38 ha, 'which gives an average total ownership of 0.88 ha (Table 3.2).

Table 3.2 Relationship of farm size and number of plots.

Number of Plots	A verage size per plot (ha)	A verage total owned land (ha)
I (n = 24%)	0.43	0.43
2 (n = 41%)	0.39	0.78
> 3 (n = 35%)	0.32	1.44
Average	0.38	0.88

Source: 147 sample farms, Central and East Java 1985.

Table 3.3 shows the distribution of plots according to land-types based on water availability. Upland plots (43%) are predominant, followed by irrigated *sawah* (33%) and rainfed *sawah* (24%). Sample farm plots in the districts of Banjamegara and Blora particularly are concentrated in the uplands, while those in Kediri and Lumajang districts are mainly irrigated *sawah.*

Table 3.3 Distribution of farm plots according to water availability.

Districs	% total plots of sample farm land		
	Irrigated *sawah*	Rainfed *sawah*	Uplands
Banjarnegara	18	22	60
Blora	10	34	56
Bojonegoro	32	39	29
Lumajang	43	18	39
Kediri	58	7	35
All districts	33	24	43

Source: 147 sample farms, Central and East Java 1985.

Since in rainfed *sawah* and upland conditions there is not always sufficient water for maize growing, this is a potential constraint for 67% of all sample farm lands.

Most farmers use their own working capital to defray the operational costs of maize growing (Table 3.4). Only 7% found additional sources of funding and a mere 2% depended solely on borrowed capital. The latter were all farmers who participated in the maize intensification programmes.

Table 3.4 Source of working capital for maize growing

Source of capital	Farmers employing		
	Intensification practices (n = 97)	Traditional practices (n = 52)	All farmers (n = 149)
Own	87.6%	96.0%	90.6%
Own plus borrowed	9.3%	4.0%	7.4%
Borrowed only	3.1%	-	2.0%

Source: 149 Sample farmers, Central and East Java, 1985.

Maize farming

Soil preparation

In the rainy season soil preparation is commonly done two or three times for both rainfed *sawah* and uplands (Table 3.5). First preparations are made before the rain, and the second and third after the first rain. Sometimes manure is spread and mixed with the soil during the last preparation. From the first soil preparation until wet season planting takes between 17 and 35 days.

In the dry season, most farmers practice only minimal soil preparation o_ even none at all because of the tight planting schedule and consequent possible labour shortages. Without soil preparation, maize seed is usually planted seven to 10 days before the previous crop is harvested, after which intensive weeding follows. Since less than 15 days are needed to prepare the soil in the dry season, only 25% of the farmers repeat the work in the upland, and no one did so three times. It appears that differing soil preparations are not related to maize variety and whether it is monocropped or intercropped.

Table 3.5 The relationship of soil preparation frequency to maize cropping.

Frequency	Percentage of cases of sample farms			
	Rainfed *sawah*		Uplands	
	wet season (n = 23)	dry season (n = 38)	wet season (n = 52)	dry season (n = 28)
0	0	2]	0	39
]	13	45	8	36
2	48	26	62	25
3	30	8	30	0
4	9	0	0	0

Source: 141 cases of sample farms, Central and East Java, 1985.

Planting distance and seed use

The recommended distances for monocrop maize planting are 75 cm between and 25 cm within rows. For intercropping, the recommended distance between rows varies from 150 to 200 cm and within rows from 25 to 50 cm, depending upon the type of intercrops.

In monocropping, the sample farmers space their maize close to these recommended distances. Distance between rows varies from 66 to 79 cm and within rows from 27 to 40 cm (Table 3.6). These distances result in an estimated 47,580 to 84,200 plants per hectare figures, derived by multiplying the estimated number of hills with the seeding rate per hill. Intercropped maize plants are relatively closer within the row, indicating the importance of maize among the other crops.

In the wet season, maize is planted in holes between 2 and 3 cm deep, while in the dry season deeper holes, from 4 to 5 cm, were more common. The average seed growth rate is over 90%, except for those local varieties grown in the dry season in the uplands of Blora and Bojonegoro districts. The rate of these was only 80%. Seed treatments were not known to most farmers, and applications were reported by only 6% of the sample farmers, particularly those joining the special intensification programmes.

Table 3.6 Planting distances and estimated maize plant populations per hectare.

Crop	No. of cases (n)	Average planting distance (em)		Estimated plant population/ha
		between row	within row	
Monocropping				
Hybrids	33	71	33	64,000
Arjuna	64	79	40	47,500
Local	35	66	27	84,200
Intercropping				
Hybrids	22	123	30	40,650
Arjuna	34	136	28	39,400
Local	41	95	26	60,700

Source: 229 cases of sample farms, Central and East Java, 1985.

Generally farmers plant up to three seeds per hole to ensure cultivation. Thinning to one to two plants per hole is done during the first weeding and the surplus is given to livestock. Consequently, the rate of seedjha is higher than the recommended rate of 20 kg. The averages for hybrid, Arjuna and local varieties are 22.1, 28.3 and 33.6 kg/ha respectively.

Use of fertilizer

Data on the number of farmers applying various kinds of fertilizer are presented in Table 3.7. In general, the success of the intensified extension efforts is indicated by the high percentages of farmers' using fertilizer. The nitrogenous fertilizer (urea) was used by all farmers who joined the intensification programmes while it was used by only 73% of the traditional farmers growing local varieties. Phosphorus fertilizer (TSP) was used by all farmers in the intensification programmes but by only 25% of the farmers following traditional methods. Since the effect of urea is visible shortly after application, it appears to be more commonly used. Potash-based fertilizer (KCl) is still employed only by a few farmers in intensification programmes. Manure application is limited to the few farmers who own livestock.

Table 3.7 The use of fertilizers in maize cropping.

Fertilizer	Farm method (%)			% of all farmers
	INSUS	INMUM	traditional	
	(n = 50)	(n = 47)	(n = 52)	(n= 149)
Urea	100	100	73	91
TSP	100	68	25	64
KCI	38	19	0	19
Manure	20	28	13	20

Source: 149 Sample farmers. Central and East Java 1985.

The average levels of fertilizer applications used by sample farmers in maize cropping are given in Table 3.8. The current recommended applications per hectare are around 25 to 300 kg urea, 100 to 150 kg TSP and 50 kg KCI. Actual urea applications are approximately the same as recommended, except with local maize varieties, while those of TSP and KCl are below the recommended levels for all maize varieties. Since the majority (72%) of sample farmers said that fertilizers are always available to them, this suggests that either farmers lack information about fertilizers or that, under current prices, the use of fertilizers is unremunerative.

Table 3.8 Extent of fertilizer application in maize production.

	Hybrid		Arjuna		Local	
Fertilizer	rainfed	uplands	rain fed	uplands	rainfed	uplands
(kgfha)	*sawah*		*sawah*		*sawah*	
Urea	316	282	248	260	153	137
TSP	89	114	73	65	36	44
KCI	34	27	II	14	0	0
Manure	415	298	382	670	580	420

Source: Sample farmer-users, Central and East Java 1985.

Weeding and plant protection

From the time of planting until about a third of its life, maize is very susceptible to weed competition. Failure to weed during this critical period may reduce the yield by 20% (Bangun 1985). The recommended practice is to weed twice or more depending on the extent of weed infestation.

The pattern of weeding by sample farmers, according to the maize varieties grown, is shown in Table 3.9. Most farmers who grow high-yielding varieties weeded twice, while those with local varieties usually weeded only once.

Table 3.9 Frequency of weeding by maize variety.

Frequency of weeding	Percentage of fanners		
	Hybrid varieties (n = 55)	Arjuna varieties (n = 98)	Local varieties (n = 76)
0	12	13	23
I	9	17	51
2	69	67	2]
3	10	3	5

Source: 229 cases from 149 sample farmers, Central and East Java 1985.

To protect plants against pests and diseases, farmers use only liquid pesticides with an average level of application of 0.7 l/ha. This figure ranges from an average 0.9 l/ha with high-yielding maize varieties (hybrids and Arjuna) to 0.4 lJha with local varieties. Most farmers (77%) stated that pests and diseases were not a serious problem and there was no need to spray more than once.

Labour

Requirements for labour vary according to variety, type of land, previous crop in sequence, cropping method, moisture availability and the source of labour. Table 3.10 summarizes data on labour in maize production. Detailed analyses of labour use in the production of each maize variety by specific land type are given in Tables 3.11, 3.12 and 3.13. It appears that both male and female labourers work interchangeably for most of the various cropping operations, except for:

1. soil preparation, where male labour is used in combination with draft cattle, and

2. spraying, where male labour is used exclusively

Table 3.10 Average use of labour/ha in maize cropping.

Maize variety	Type of land and number of cases	Days of labour by		
		Cattle a	Men b	Women c
Hybrid	Irrigated *sawah* (n = 7)	8	73	55
	Rainfed *sawah* (n = 17)	4	66	59
	Uplands (n = 21)	2	87	64
Arjuna	Irrigated *sawah* (n = II)	3	94	30
	Rainfed *sawah* (n = 28)	5	85	46
	Uplands (n = 42)	9	83	56
Locals	Irrigated *sawah* (n = 4)	3	55	49
	Rainfed *sawah* (n = 18)	1	66	43
	Uplands (n = 25)	5	60	39

Source: 173 cases from 146 sample farms, Central and East Java,1984/1985.
a A pair of cattle work five hours per day.
bMale labourers work seven hours per day.
cFemale labourers work four hours per day.

On all land types, hybrids and Arjuna varieties of maize generally require more human labour than local varieties. This is particularly so in upland areas. Most human labour, totalling 151 days, is needed by hybrid maize in the uplands while the least, 99 days, is needed to crop local varieties. There is a particular demand for labour in weeding upland crops.

Harvesting age

Different ages of harvest in maize cropping are the result differences in variety, season and type of planting (Table 3.14).

On average, hybrid maize is harvested after 114 to 1l7 days in the wet season, and after 106 to 110 days in the dry season, later than the anticipated harvesting age of 100 days. At higher altitudes, such as the district of Banjarnegara, Central Java, hybrid maize reaches a later harvesting age of 135 days. The Arjuna variety shows a harvesting age of 95 to 96 days in the wet season, and 93 to 94 days in the dry season, which are earlier than the hybrids.

Table 3.11 Average use of labour/ha in hybrid maize cropping by land type.

Cropping operation and source of labour	Number of labour days		
	irrigated *sawah* (n = 7)	rainfed *sawah* (n = 17)	uplands (n = 21)
Soil preparation			
Cattle	8	4	2
Men'	17	28	29
Planting			
Men	9	7	6
Women	13	17	13
Weeding			
Men	25	14	32
Women	4	4	0
Fertilizing			
Men	9	6	10
Women	4	4	0
Spraying			
Men	9	6	10
Women			
Harvesting			
Men	10	6	8
Women	18	10	19
Total number of days			
Cattle	8	4	2
Men	73	66	87
Women	55	59	64

Source: 45 cases of 146 sample farms, Central and East Jav;4 1984/1985.

Table 3.12 Average use of labour/ha in Arjuna maize cropping by land type.

Cropping operation and source of labour	Number of labour days		
	irrigated *sawah* (n = 11)	rainfed *sawah* (n = 28)	uplands (n = 42)
Soil preparation			
Cattle	3	5	9
Men	28	18	10
Planting			
Men	IS	10	6
Women	6	IS	1l
Weeding			
Men	29	24	38
Women	8	16	22
Fertilizing			
Men	8	21	10
Women	4		4
Spraying			
Men	7	3	4
Women			
Harvesting			
Men	8	9	IS
Women	12	IS	19
Total number of days			
Cattle	3	5	9
Men	94	85	83
Women	30	46	56

Source: 81 cases of 146 sample farms, Central and East Java, 1984/1985.

Table 3.13 Average use of labour/ha in local variety maize cropping by land type.

Cropping operation And source of labour	Number of labour days		
	irrigated *sawah* (n =4)	rainfed *sawah* (n = 18)	uplands (n = 25)
Soil preparation			
Cattle	3	I	5
Men	15	22	18
Planting			
Men	8	13	7
Women	16	9	12
Weeding			
Men	16	15	21
Women	15	19	16
Fertilizing			
Men	6	9	6
Women	3	5	3
Spraying			
Men	2	3	2
Women			
Harvesting			
Men	8	4	6
Women	15	10	8
Total number of days			
Cattle	3	I	5
Men	55	66	60
Women	49	43	39

Source: 47 cases of 146 sample farms, Central and East Java, 1984/1985.

Data in Table 3.14 shows that local maize varieties exhibit the widest range of harvesting ages between the two planting seasons. In the dry season, it is only 86 days, the shortest season for all varieties of maize cropping. It is interesting to note the average age of local varieties planted in the wet season equals that of the Arjuna variety planted in the dry season.

Table 3.14 Average harvesting age of maize varieties by season and type of planting.

		Harvesting age (days)	
Variety	Season	Monocrop	Intercrop
Hybrid	Wet	114 (n = 4)	117(n=10)
	Dry	110 (n = 21)	106 (n = 15)
Arjuna	Wet	96 (n = 11)	95 (n = 15)
	Dry	94 (n = 36)	93 (n = 23)
Locals	Wet	93 (n = 14)	93 (n = 31)
	Dry	88 (n = 25)	86 (n = 36)

Source: 241 Cases of 146 Sample farms, Central and East Java, 1984/1985.

Maize yield

Marked differences in maize yields have been observed, which are the result of crop varieties, planting seasons and types of land (Table 3.15). It should be noted that no maize was planted in irrigated *sawah* during the wet season as it would compete unfavourably with *sawah* paddy. Presumably for a similar reason, no local maize variety was grown during the wet season in the rain fed *sawah.*

The average yields reported here are often higher than the averages reported in provincial statistics. One should be aware, however, that the averages in Table 3.15 originate from monocropping cases only, while those of the statistical reports derive from both mono_ and intercropping of maize.

It is clear that, on average, yields of improved maize varieties are almost double that of local varieties. It is also interesting to note that little difference in yield was observed between the hybrid and Arjuna varieties. Since Arjuna seeds are cheaper than hybrids, the former may be a more profitable variety.

Table 3.15 Average yields of maize varieties by planting season and type of land.

		Average yields (t/ha)		
Type of land	Season	Hybrid	Arjuna	Local
Irrigated *sawah*	Wet			
	Dry	4.7 (n = 11)	4.4 (n = 11)	4.7 (n = 4)
Rainfed *sawah*	Wet	4.5 (n = 3)	3.8 (n = 5)	
	Dry	3.4 (n = 14)	3.2 (n = 23)	1.2 (n = 3)
Uplands	Wet	4.1 (n = 22)	4.3 (n = 34)	2.2 (n = 25)
	Dry	3.0 (n = 8)	2.8 (n = 18)	1.6 (n = 20)

Source: 197 cases from 146 sample fanns, Central and East Java, 1984{1985.

Maize farm income

Table 3.16 presents estimates of income/ha of maize farms by maize variety and land type, irrespective of input values of land and family labour. Although production costs of improved varieties of maize are higher than those of local varieties, incomes from improved varieties are more than double those of the latter from the same type of land. Based on current prices of hybrids relative to the Arjuna variety, little difference is apparent in incomes derived from them. The highest maize income (Rp 434,275jha) came from Arjuna grown on irrigated *sawah* during the dry season, while .the lowest (Rp 87,280jha) from local varieties planted on rainfed *sawah.*

Although maize cultivation has had consistently low yields in the last decade, often less than half the returns of other *palawija* crops, stability in yields over a wide range of soils has made it more popular than others. The relatively low net returns for maize have not been a powerful force in reducing the area under maize cultivation (Mink 1984).

On the other hand, although local varieties (Kretek) still predominate in Kediri (East Java), farmers have demonstrated that Arjuna can fit into cropping rotations on both *sawah* and uplands, giving high yields and increased economic returns (Dorosh 1984). Similar conclusions on the potential of improved varieties are also drawn from observations of sample maize farms in Central Java (Mink and Irianto 1984).

Table 3.16 Income/ha of maize farms by variety and land type.

	Types of land and Rp/ha		
Items	Irrigated	Rainfed	Uplands
Hybrids	(n = 7)	(n = 17)	(n = 18)
Value of production a	596,900	510,650	440,200
Wage labour	99,200	82,960	93,155
Other inputs c	84,160	76,120	64,500
Income d	413,540	342,570	282,545
Arjuna	(n = II)	(n = 23)	(n = 35)
Value of production	580,800	462,000	468,600
Wage labour	83,955	85,265	109,045
Other inputs	434,275	320,755	300,575
Income	434,275	320,755	300,575
Local	(n = 4)	(n = 15)	(n = 19)
Value of production	297,600	188,000	235,000
Wage labour	62,185	62,500	66,605
Other inputs	39,280	35,220	31,460
Income	196,135	87,280	136,935

Source: Cases of 146 sample farms, Central and East Java, 1984/1985.
aGrain price of hybrids = Rp 127/kg, Arjuna = Rp I 32jkg, local = Rp 124jkg. Hybrid price was lower than that of Arjuna because the latter was preferred for direct human consumption.
bDaily wages paid for draft animal = Rp 3,210, for men = Rp 1,390 and for women = Rp 785.
cSeed price of hybrids = Rp *1,280/kg,* Arjuna = Rp 51O/kg, local = Rp 240/kg; Urea fertilizer price =3.100/1.
The values of land use and family labour are not included.

Unit cost of maize production

For production planning purposes, it is important to know the current unit cost of maize production in order that a proposed production level may be related directly to the estimated costs involved. Table 3.17 presents the unit costs of maize production (in Rpjt) by variety and land type. The data from Table 3.16 was used for this table.

Based on current prices, the lowest unit cost was realized for each maize variety on irrigated *sawah* rather than other types of land. On the other hand, the highest costs are incurred when growing improved varieties of maize on uplands. Nevertheless, lower costs on uplands are incurred by growing high-yielding varieties rather than local varieties.

Table 3.17 Unit cost of maize production by variety and land type.

Maize variety And types of land	Cost/ha (Rp/ha)	Yield (t/ha)	Unit Cost (Rp/t)a
Hybrids			
irrigated *sawah*	183,360	4.70	3,901
rainfed *sawah*	159,080	3.85	4,027
uplands	157,655	3.55	4,440
Arjuna			
irrigated *sawall*	146,525	4.40	3,330
rainfed *sawah*	141,245	3.50	4,035
uplands	168,025	3.55	4,733
Local			
irrigated *sawall*	101,465	2.40	4,228
rainfed *sawah*	100,720	1.20	8,393
Uplands	98,065	1.90	5,161

Source: Cases of 146 sample farms, Central and East Java, 1984/1985.
aNot including the values of land use and family labour.

Product utilization

Most of the maize produced, 70% in Central Java and 74% in East Java, is for sale (Table 3.18). Of the five districts, Kediri has the largest percentage of maize sold by farmers, a factor related to the local practice of *tebasan*, whereby the standing crop is sold in the field just before harvest. Domestic consumption and seed use range from 5% to 40% of the maize product, depending upon location.

A closer look at maize consumption (Table 3.19) shows that in most districts other than Kediri, more than 85% of the families consume a mixture of rice and maize. These two staple foods may be consumed simultaneously or one after another. Lumajang farmers eat rice and maize together throughout the year. Surprisingly, even in maize producing areas, it was found that the average annual per capita consumption of maize was 84 kg. In 1982 the official national annual per capita consumption of maize was only 18 kg (National Food Balance Sheet 1982).

Table 3.18 Maize utilization in five sample producing districts.

District and Province	No. of sample farms	Product utilization (% weight)	
		Home consumption and seed	Sale
Central Java			
Banjamegara	30	19.4	80.6
B1ora	29	39.6	69.4
Total	59	29.5	70.5
East Java			
Bojonegoro	30	41.8	58.2
Lumajang	30	30.9	69.1
Kediri	28	5.7	94:3
Total	88	26.1	73.9
All samples	147	27.5	72.5

Source: 147 s(lmple farms, Central and East Java, 1984/1985.

Table 3.19 Consumption pattern of maize in five sample producing districts.

District and Province	No. of sample farms	Consumption pattern (%)		Annual maize consumption per capita a (kg)
		Rice only	Rice and maize	
Central Java				
Banjarnegara	30	0	100	85
B1ora	29	7	93	124
Total	59	4	96	104
East Java				
Bojonegoro	30	13	87	99
Lumajang	30	10	90	77
Kediri	28	82	18	36
Total	88	35	65	71
All samples	147	22.4	77.6	84.2

Source: 147 sample farms. Central and East Java. 1984/1985.
aincluding seeds. chicken feed. etc.

Table 3.20 Frequency of sales of maize produce by farmers in five sample producing districts.

District and Province	No. of sample farms	Frequency of sales (% of farmers)				
		1a	2	3	4	5+
Central Java						
Banjamegara	30	73	10	7	3	7
Blora	30	53	23	7	13	3
Total	60	63	17	7	8	5
East Java						
Bojonegoro	29	52	10	31	0	7
Lumajang	30	63	30	0	7	0
Kediri	28	82	14	4	0	0
Total	87	65	18	12	2	3
All samples	147	65	18	9	5	3

Source: 147 sample farms, Central and East Java, 1984/1985.
aIncluding sales by *tebasan* methods.

Frequency and time of sales

Most farmers (65%) sell their maize product at one time. They may need a large sum of money or their produce may be too small in quantity to be divided and sold. Approximately one-third of the farmers sell in several transactions. There is little difference between the two provinces in the pattern of sale frequency, although in each province rather different behaviour was observed between farmers of more fertile and of less fertile districts. Farmers in Blora (Central Java) and Bojonegoro (East Java) tend to sell their maize on various occasions more often than those from the more fertile districts of Banjarnegara (Central Java), Lumajang and Kediri (East Java). This may be because farmers in marginal areas like to store their produce until they are sure that rice is available. They sell maize only after they have bought rice at a reasonable pnce.

4

Factors Affecting Maize Production

In this chapter attempts are made to identify the various constraints or incentives to increased production and productivities of maize. Possible contributory factors are analysed to find solutions to the problems of low yields and production. In our analysis the dependent variable of yields, indicating the success of production, is often represented by the variable of adoption of improved maize varieties. This correlation is based on the belief that adoption of improved varieties generally results in higher yields. On the other hand, high yields are not only the results of planting improved varieties. Physical and natural factors, as well as social and economic factors, all play a part.

Climatic factors

According to Oldeman and Suardi (1977), maize crops need an average monthly precipitation of 100 to 140 mm. For a crop to reach optimal growth it takes from 3 to 3.5 months and it would therefore need between 300 and 500 mm of rainfall. Hence the distribution of maize cropping throughout the wet (1984/1985) and dry (1985) seasons is discussed in relation to the rate of precipitation during the growth period, maize productivities, the varieties grown and the type of planting, whether mono- or intercropping (Table 4.1). The level of precipitation during the 3 to 3.5 month growing period was calculated from figures collected at the nearby weather station.

For a maize crop to produce well it is evident from Table 4.1 that total precipitation of 301 to 600 mm is needed during its life cycle, particularly in mono cropping. This corresponds with the figures cited by Oldeman and Suardi (1977). When maize, regardless of variety, is intercropped, more precipitation is necessary if higher average yields are to be realised. Thus, at the farm level, maize mono cropping needs less rainfall than maize intercropping. This is particularly apparent when high yielding varieties are compared to local varieties. More ever, when mono cropped, high yielding maize varieties are less sensitive to rainfall variation.

Exposure to extension service

The extension service is generally expected to encourage farmers to adopt new technologies in place of traditional methods. The more intensively a farmer is exposed to its activities, the more prepared and willing he should be to adopt new practices. At the time of survey, 10 extension-related activities were identified, each of which was assigned a specific score according to the degree of exposure it offered. The scores for each sample farmer were then combined, indicating the intensity of exposure to which he had been subjected. Table 4.2 presents the types of activities and the scoring method used. The maximum possible score is 16.

Table 4.1 Relationship between precipitation and maize productivity.

	Maize variety	Productivities (q/ha) by precipitation									
		< 100 mm (ave. 56 mm)		101-300 mm (ave. 181 mm)		301-600 mm (ave. 452 mm)		601-900 mm (ave. 704 mm)		> 900 mm (ave. 1646 mm)	
Intercropping	Hybrids	11.5	(6)[a]	8.6	(4)	80.0	(I)	28.1	(3)	19.9	(7)
	Arjuna	11.8	(10)	14.2	(8)	12.4	(10)	24.7	(8)	30.2	(12)
	Local	6.2	(3)	4.0	(3)	8.2	(II)	26.8	(9)	29.3	(15)
	Average	10.7		11.7		12.0				23.6	
Monocropping	Hybrids	41.4	(8)	36.5	(7)	86.5	(4)	57.9	(5)	41.0	(II)
	Arjuna	43.9	(13)	45.5	(12)	55.3	(23)	28.1	(7)	27.4	(7)
	Local	8.8	(7)	19.1	(2)	43.5	(8)	19.9	(5)	26.9	(15)
	Average	35.0		44.4		51.2		39.4		32.3	

Source: 244 cases of 149 sample farmers; Central and East Java, 1984/85 wet and 1985 dry season.
[a]numbers in brackets refer to specific cases.

Table 4.2 Scoring method of extension-related activities.

Activities	Score
Read news paper: yes/no	1/0
Read agricultural magazine: yes/no	1/0
Observe maize demonstration plot: yes/no	1/0
Own TV set and watch: yes/no	2/0
No TV set but watch other's: yes/no	1/0
Watch TV program: vil1age to village/others Owned radio and listen: yes/no	1/0
Owned radio and listen :yes/no	2/0
No radio but listen to other's: yes/no	1/0
Listen to radio programme,s – agriculture	2
- rural broadcasting	1
- others	0
Participate in training programme: yes/no	1/0
Participate in group action - farmer's association	2
- co-operative agency	1
- none/others	0
Attendance at extension meeting:	
- once every I to 15 days	3
- once every 15 to 30 days	2
- once every 30 days or longer	1
Possible maximum score	16

Table 4.3 Relationship between exposure to extension services and frequency of adoption of certain maize varieties.

Maize variety adopted	Frequency (%) of sample cases belonging to classess Of extension-exposure score		
	low (0-5)	medium (6-10)	high (11-16)
High-yielding varieties (Hybrid and Arjuna)	58%	74%	90%
Local/traditional varieties	42%	26%	10%
Percentage of cases (n = 173)	29%	54%	17%

Source: 173 cases from 149 sample fanners, Central and East Java, 1984/1985 wet and 1985 dry seasons.

The relationship between intensity of extension exposure and adoption of certain maize varieties is presented in Table 4.3. This indicates that extension-related activities and/or media, as listed in Table 4.2, function reasonably well. Those farmers subjected to greater extension exposure have adopted the high-yielding varieties of maize. Since only 28% of the sample plant traditional varieties, it appears the extension service has played a significant role in maize crop development programmes.

Farmers' age and maize farming experience

Older farmers are believed to be more conservative than their younger colleagues. It might be expected that the farmer's age would therefore constrain the adoption of high-yielding maize varieties. Table 4.4 presents the relationship between age and frequency of high-yielding variety adoption by sample farmers.

Table 4.4 Relationship between age of farmer and frequency of adoption of certain maize varieties.

	Age of farmer (%)		
Maize variety	under 30 years	31 to 50 years	over 50 years
High-yielding varieties (Hybrids and Arjuna)	55	70	82
Local/traditional	45	30	18
Percentage of cases	17%	66%	17%

Source: 168 cases of 149 sample farmers, Central and East Java, 1984/1985 wet and 1985 dry seasons.

Table 4.4 shows that older farmers frequently adopt high-yielding varieties of maize. This contradicts the above hypothesis on their conservatism. More mature farmers are prepared to adopt improved varieties. This statement is supported by a comparison of the relationship between maize farming experience and adoption rates of high-yielding varieties (Table 4.5).

Table 4.5 Relationship between age of farmer and frequency of adoption of certain maize varieties.

	Experience of farmer (%)	
Maize variety	under 15 years	over 50 years
High-yielding varieties (Hybrids and Arjuna)	68	77
Local/traditional	32	23
Percentage of cases	44%	56%

Source: 172 cases of 149 sample farmers, Central and East Java, 1984/1985 wet and 1985 dry seasons.

The rate of adoption is correlated with the age and experience of farmers and this suggest that the high-yielding technology is more than just a simple method to learn. If its adoption is to be more widespread, the farmers age and experience need to be taken into account.

Formal education

The behaviour and decisions of the farmer depend partly on his level of formal education. When farming is his main source of income, higher education should enable the farmer to appreciate the advantages of a new technology. Table 4.6 shows the relationship between formal education and adoption rates of high-yielding maize varieties.

Table 4.6 Relationship between age of farmer and frequency of adoption of certain maize varieties.

	Level of education among farmers		
Maize variety	under 5 years	6 years (diploma)	over 7 years
High-yielding varieties (Hybrids and Arjuna)	66%	77%	88%
Local/traditional	34%	30%	12%
Percentage of cases	39%	41%	20%

Source: 172 cases of 149 sample farmers, Central and East Java, 1984/1985 wet and 1985 dry seasons

Data from Table 4.6 indicate that farmers with more years of education are more ready to adopt the new technology. Increasing farmers' education would certainly contribute to higher rates of adoption of new practices.

Maize consumption

From a sample of three villages in a maize-producing area in 1973, it was found that about 90% of farm families consume maize in various ways. On the other hand statistical data of 1967 showed the aVt:rage weekly maize consumption in rural East Java was 0.552 kg per capita or annually about 29 kg per capita (Sinaga 1973). In the present study, data from the province of East Java indicates that only 62% of the sample farmers consume maize, with an average annual consumption of about 63 kg per capita.

The successful rice intensification programme of the 1970s has inluenced some low-level maize consumers to change to rice as their staple food. Its impact was ,generally to reduce the number of maize-consuming farm families. This also means, however, that those who continue to grow maize are its main consumers, who are unable to change because of limited resources and/or inaccessibility to the inexpensive rice market. This pattern was confirmed by farmers from Central and East Java in the 1984/1985 planting seasons (Table 4.7). In these provinces, 74% of the sample farmers consume maize at an annual average of III kg per capita.

Table 4.7 also presents the relationship between levels of maize consumption and frequency of adoption of improved maize varieties. It is clear that for both hybrids and Arjuna maize varieties, frequency of adoption declines with the increased level of maize consumption. The reverse is true for local/traditional varieties, where high frequencies of cropping are related to high levels of consumption. This implies that maize is produced not simply for profit, even in areas where the planting of high-yielding varieties is more remunerative. Many people still prefer local varieties for direct consumption.

Table 4.7 Relationship between maize consumption and frequency of adoption of certain maize variety.

Maize variety adopted (%)	No maize consumed	Maize consumption level (kg/capita/yr)			
		Low [a]	Medium [b]	High [c]	All [d]
Hybrid	34	22	17	8	19
Arjuna	55	50	48	34	47
Local/traditional	11	28	35	58	34
Percentage of cases	26	37	30	7	74

Source: 172 cases of 149 sample farmers, Central and East Java, 1984/1985 wet and 1985 dry seasons.
[a]Low consumption refers to an annual average of 51 kg/capita.
[b]Medium consumption refers to an annual average of 144 kg/capita.
[c]Highigh consumption refers to an annual average of 288 kg/capita.
[d]All consumer average is III kg/capita.

Size of landholding

The issue of the size of farm as a possible constraint to maize crop production comes about because of the concern that nC?w technological improvements should not be biased against small farmers. The technology of the high-yielding variety itself is highly divisible, so that the size of landholding should not be a barrier to its adoption. In reviewing past research, Schutjer and Van der Veen (1976) could not identify any consistent pattern of size of landholding which hindered the adoption of improved technology.

As a form of wealth, land is usually related positively to the farmers' access to credit. In many cases this further determines their accessibility to the input and product market. It is hypothesised that the latter would have a positive influence on the rate of farmers' adoption of new technology. Table 4.8 presents the empirical relationship between size of landholding and the adoption of a high-yielding variety. The rates of maize intercropping and cropping intensity are also provided.

Table 4.8 Relationship between size of fann and intensity of adoption of high-yielding varieties (HYV) and other practices.

	Size of farm (ha)						
	<0.25 (ave. .09)	.25-.49 (ave. .30)	.50-.74 (ave. .55)	.75-.99 (ave. .82)	1. 00-1.24 (ave. 1.03)	1.25-1.50 (ave. 1.32)	> 1.50 (ave. 2.16)
% Maize HYV grower	92	' 62	60	58	70	94	87
% Maize area intercropped	30	40	49	57	51	47	43
% Maize crop intensity /yr	288	135	133	100	96	95	79
% HYV to total Maize area/yr	98	69	66	60	70	87	84
% of sample farmers	9	20	25	16	14	8	8

Source: 146 sample farmers,Central and East Java, 1984/1985 wet and 1985drys seasonss.

As data from Table 4.8 show, the above hypothesis is applicable, except to farmers of the first and possibly the second categories of landholding. As a group, farmers with larger holdings of land are more motivated to grow HYV. A similar trend is also seen in the relationship between percentages of HYV to total maize area and size of holding. Since maize HYV should not be intercropped, a corresponding inverse relationship may also be observed between sizes of holding and percentages of maize intercropped. Apart from the first and second categories, the area of maize intercropped decreases with the size of landholding. Similarly, maize cropping intensity decreases as the size of landholding increases.

The exceptions to HYV adoption found in the first and second categories of landholding need explanation. Small farmers apparently do not pay attention to maximum profit other than to exploiting the maize HYV technology to the best of their knowledge. They even risk mono cropping maize, as shown by the low percentage of intercropped maize. In this connection, it is worth noting that their lands were used the most intensively, with the highest possible cropping intensity of 288%. This amounts to an average of almost three cropping per year.

Tenancy of land

Depending on the local form of tenure, land tenancy may be a constraint to the maize improvement programme. Adoption of maize HYV varies according to credit access, purchased inputs, product markets and technical information. Yet of the 149 sample farmers only 14 were tenants and all of them had planted maize HYV during the period of research. Based on this observation, therefore, land tenancy does not seem to pose any constraints to the maize improvement programme.

Nevertheless, in Lumajang District (East Java) a local form of tenancy called *kedokan* is a possible constraint to the adoption of maize HYV. In the *kedokan* system, the tenant is responsible only for specific field operations, including planting, weeding and irrigating the crop, in return for an agreed upon share of the harvest. In 12 *kedokan* cases, only two (17%) were growing maize HYV, while in 48 owner-operated examples, 34 (71 %) were HYV growers. Further research is needed to determine the causes of non-adoption of the HYV in the *kedokan* system.

Labour availability

Limited evidence from previous research suggests that too much farm family labour encourages the adoption of labour-intensive technology, while the lack of it discourages both the adoption and efficient use of the technology (Schutjer and Van der Veen 1976). Compared to traditional varieties, maize HYV technology requires a relatively high labour input. The present survey data indicates that hybrid varieties require 23 man-days or 14% more than that required by traditional varieties. In the absence of labour-saving technology, therefore, limited family labour may hamper the adoption of HYV. Tables 4.9 and 4.10 correlate the labour size of sample farm families with the frequency of adoption and with the percentage of cropped area, both mono cropped and intercropped, by varieties.

Data from Table 4.9, show that the 'availability of family labour is positively related to the frequency of adoption in hybrid maize variety, the relationship being stronger in cases of mono cropping than of intercropping. Rather surprisingly, however, the adoption of Arjuna variety, like those of local or traditional varieties, is inversely related to family labour availability. On average, no significant difference in labour input needs was observed between traditional and Arjuna varieties. Limited family labour therefore appears to constrain the adoption of more labour-intensive technology such as the hybrids. A similar conclusion is drawn, though less forcefully, from Table 4. 10 where labour availability is related to the percentage of total area planted.

Table 4.9 Relationship between family labour size and frequency of adoption of maize variety by type of cropping.

Family labour	M onocroppi ng				Intcrcropping			
(male equivalents.	No. of	Frequeny (%) of adoption			No. of	Frcqucncy (%) of adoption		
including farmer)	cases	Hybrid	Arjuna	Local	cases	Hybrid	Arjuna	Local
Small (1-2 males) n = 63	48	19	56	25	41	15	41	44
Medium (3-4 males) n = 47	29	34	41	24	29	17	45	38
Large (= 5 males) n = 36	24	42	42	16	18	17	35	28

Source: 146 sample farms, Central and East Java.,1984/1985 wet_ and 1985 dry seasons.

Table 4.10 Relationship between family size and percentage of area planted with maize varieties by type of cropping.

Family labour	Monocropping				Intercropping			
(malc equivalents.	Total	(%) of area planted			Total	(%) of area planted		
induding fanner)	area (ha)	Hybrid	Arjuna	Local	area (ha)	Hybrid	Arjuna	Local
Small (1-2 males) n = 63	25.0	30	50	20	26.8	20	46	34
Medium (3-4 males) n = 47	12.0	30	43	27	16.6	18	49'	33
Large (= 5 males) n = 36	15.3	40	50	10	12.6	14	63	23

Source: 146 sample farms. Ccntral and East Java, I 984/ 19S5 wct and 1985 dry seasons.

Working capital availability

No conclusive information about the effect of differential access to capital on the adoption of new technology is available (Schutjer and Van der Veen 1976). In this case, capital means working capital which is readily available to pay for urgent farm requirements. With relatively small landholdings and limited income from their farms, the existence of alternative sources of income provides farmers with the means and flexibility to meet the expenses of farm operations. It can be hypothesized, therefore, that farmers with alternative sources of non- and off-farm incomes have more working capital to enable them to purchase the additional inputs required by the HYV technology.

Table 4.11 presents the relationship between the frequency of adoption of new varieties and the size of annual non- and off-farm income. Adoption of hybrid maize increases with the size of non- and off-farm incomes while the trend is less evident in the case of Arjuna variety. A small income from other sources leads only a few Arjuna adopters to change to growing hybrids, and makes no difference to those growing traditional varieties. Only large additional incomes of Rp 132,000 to Rp 783,000 seem to motivate traditional maize growers to become hybrid maize producers. Although the results are tentative, they indicate that the provision of additional (off- and non-farm) employment may lead to increased adoption of new technology in maize production.

Table 4.11 Relationship between frequency of adoption of maize varieties and the size of annual off- and non-farm incomes.

Maize variety	Frequency (%) of adoption by size of Additional off and non-farm income		
	No income n = 84	Small income n = 21	Large income n = 17
		Ave. Rp 132,000	Ave. Rp 783,000
Hybrids	16	7	58
Arjuna	54	43	42
Local	30	30	0

Source: 122 sample farms, Central and East Java, 1984/1985 wet and 1985 dry seasons

Market and prices

The importance of well-functioning product and input markets for agricultural dtwelopment is generally recognized. Three development aspects are related to this important market condition: 1) agricultural price policy and foreign exchange, 2) farmers' access to market, and 3) production and distribution of high-quality HYV seed. .

Data show that in order to expand maize production, 61 % of the farmers felt seed production and distribution systems should be improved. On the other hand, only about 26% stated that the improvement of maize marketing and price policy was urgently needed. These views reflect the fact that more improved seed is still required to support the programme of production increase. Only about 57% of the farmers use seed originating outside their farm, while the remaining 43% use seeds from their own farms (Table 4.12). It is clear that those who purchased seeds also showed a much higher adoption of HYV. This confirms that seed production and distribution systems must be improved if maize production is to expand. Increased access to HYV seed markets will enhance HYV adoption by maize farmers.

In Table 4.12, Category I includes government programmes and extension service, Category II refers to farmers' associations and village unit co-operatives and Category III refers to private commercial sources, such as shops, traders and market places.

Table 4.12 Relationship between frequency of adoption of maize varieties and source of seed.

Maize variety	Frequency (%) of adoption by different source of maize seeds				
	Purchased seed				Farmer's own seed
	I	II	III	All sources	
	(n = 79)	(n = 40)	(n = 26)	(n = 145)	(n = 10)
Hybrids	29.	37	31	32	5
Arjuna	61	50	27	52	39
Locals	10	13	42	16	56

Source: 255 cases of 146 sample farmers, Central and East Java, 1984/1985 wet and 1985 dry seasons.

Table 4.13 presents information on the types of product markets and the prices received by maize farmers. Village markets are obviously the primary outlet, followed by middlemen facilities and co-operatives. At these three important outlets, the average price received is the determining factor in the farmer's choice of market.

Furthermore, each of these outlets shows a preference for a specific grain. More middlemen (almost 75%) prefer buying yellow maize, than do traders in village markets (about 50%).

Table 4.13 Maize prices received by fanners.

Type of Market	Hybrid		Arjuna		Local		Percentage Of cases
	No. of cases	Price (Rp/t)	No.of cases	Price (Rp/t)	No. of cases	Price (Rp/t)	
Farmers associations/ KUD	2	1,300	10	1,339	-		10
Middlemen buying at farms	10	1,243	16	1,361	9	1,203	28
Village market	9	1,365	24	1,389	30	1,269	50
Subdistrict market	3	n.a.	1	n.a	-	-	3
District market	1	n.a.	4	1,475	1	1,275	5
Other	2	n.a.	7	1,443	2	1,063	9

Source: 125 cases from 146 sample farmers. Central and East Java; 1984/1985 wet and 1985 dry seasons.

5

Input-Output Relationship

In the previous chapter discussion was concerned mainly with production constraints as they relate to the farmers' background, farm organization and environmental factors which may affect the yield and production of maize. Many of these constraints could be altered by the appropriate policy and a more effective extension service, both of which are largely outside the farmers' control.

The present chapter considers constraints 'which may arise from misallocation of resources at the farm level. Estimates of marginal productivities of resources currently used by the sample farmers are evaluated. For this purpose, a. multiple regression analysis is made to estimate specified equations reflecting the hypothesized input-output relationships. To understand this analysis more fully the average resource use by seasonal growth and maize varieties are each considered in turn.

Average use of resources in maize production

The present survey covered a range of locations and large variations were evident in the data. Coefficients of variation of the means of resource use ranged from 45% for the size of plot area harvested to 50% for the level of pesticide use. By enumerating data from farm plots individually, rather than by taking the average data of all sample farmland, variations within farms were also taken into account.

Resource use by location/district

Individual plots of land and man-days of labour do not vary significantly between sample districts while other variables, especially those of yields, seed use and fertilizer levels showed greater range (Table 5.1). Although pesticide usage varies significantly, this has no visible influence on yields, and is therefore not relevant here.

From Table 5.1 it can be seen that Lumajang and Kediri districts show relatively high yields, particularly Kediri, with an average of 8.1 t/ha. Comparing the input levels of the districts, it is clear that large applications of both seed and fertilizer account for the high yields. Use of seed, at the rate of 40 kg/ha, is particularly high since the recommended level is around only 25 to 30 kg/ha. This may be the result of various factors, such as: I) shorter planting distances, 2) heavier thinning of young plants, and 3) low germination rates, though both Lumajang and Kediri grow a large percentage of HYV. According to Dorosh (1984), the maize system in Kediri represents a dynamic area where new technology and high levels of purchased inputs are already widely used.

Low seed rates in Blora and Bojonegoro may be because both areas are well-known risks for agricultural production. Low precipitation and frequent floods are major hazards and intercropping maize with other crops is' common. Consequently fewer maize seeds are needed.

Table 5.1 Average farm plot areas, yields and input levels of use in the sample districts.

Items	Central Java		East Java			All
	Banjarnegara	Blora	Bojonegoro	Lumajang	Kediri	districts
Plot area (ha)	0.41	0.53	0.44	0047	0040	0.47
Yield (t/ha)	2.60	2.40	2.17	5.38	8.12	3.83
Seed yield a	0.118	0.20	0.174	0.135	0.193	0.16
Labour (man-day/ha)	180	158	145	198	169	171
Other inputs/ha)						
Seed (kg)	22.0	12.0	12.5	40.0	42.0	25.0
Fertilizer (kg)	336	192	320	451	822	392
Pesticidesjl	3.1	2.8	1.0	1.7	2.2	2.3
Number of plot cases	63	59	40	51	35	248

Source: 248 farm plots from 147 sample farms, Central and East Java, 1984/1985.
[a]Yield t/kg seed.

Resource use by land type

The type of land does not result in significant differences in size of farm plots or amount of labour needed in maize production (Table 5.2). The dry season maize yield of 6.8 t/ha in irrigated land, however, is more than double those in either rain fed lowland or upland. It is clear that fewer application of fertilizer and pesticide contribute to lower yields in both types of land. Lower seed rates, although not significantly different from average, may also account for the low yields.

Table 5.2 The effects of land type and cropping method on maize production.

	Types of land			Methods of cropping	
	Irrigated lowland	Rainfed lowland	Upland	Monocropping	Intercropping
Number of plot cases	68	41	138	125	122
Plot area (ha)	0.46	0.47	0.44	0.42	0.48
Yield (t/ha)	6.85	3.06	2.56	4.86	3.28
Seed yield (t/ha)	0.214	0.133	0.116	0.152	0.193
Labour man-day/ha	167	193	168	160	183
Other inputs/ha					
Seed/kg	32	23.0	22.0	32.0	17.0
Fertilizer/kg	637	436	260.0	461.0	323.0
Pesticides/l	4.1	2.0	1.5	2.3	2.3

Source: 247 farm plots from 147 sample farms, Central and East Java, 1984/1985.

Resource use by cropping method

Maize yield and consequently seed rate and fertilizer applications are higher in mono cropping than intercropping (Table 5.2). Yet monocropping constitutes only 51 % of the survey sample while 49% is intercropped. Maize is "generally intercropped with soybean (30%), cassava (20%), cowpea (15%), tobacco (10%), peanuts (9%), pepper (8%) and others (8%).

Resource use by cropping season

Maize may be planted in three cropping seasons:

1. at the beginning of the wet season *(labuhan)*, in September/October (Season 1),

2. at the beginning of the dry season *(marenggn),* AprH and May (Season 2),

3. in the later part of the dry season *(ketigo),* around JulyjAugust(Season 3).

Of the 247 plots from 147 sample farms, 30.5% were planted in *labuhan,* 38,5% in *marengan* and 31 % in *ketigo.*

Data from Table 5.3 show the highest yield (4.9 tjha) resulted from maize cropping in the *ketigo* season. High seed rate and fertilizer applications may account for the higher yield in this dry season maize crop. Wet season *(labuhan)* maize is usually found only in the uplands since no maize is planted in the irrigated lowland at that period, while *marengan* maize occurs in rainfed *sawah* and *ketigo* maize in irrigated sawah. The present result is therefore anticipated in the discussion on resource use by type of land.

Table 5.3 The effects of cropping season and maize variety on farm production.

	Cropping season			Maize variety		
	1	2	3	Hybrids	Arjuna	Local
Number of plot cases	75	95	77	50	160	37
Plot area (ha)	0.45	0.45	0.45	0.51	0.46	0.34
Yield (t/ha)	2.95	3.61	4.94	5.89	3.57	2.11
Seed yield (t/kg)	0.123	0.172	0.165	0.268	0.155	0.057
Labour (man-day/ha)	]82	164	]71	189	168	166
Other inputs/ha						
Seed (kg)	24.0	21.0	30.0	22.0	23.0	37.0
Fertilizer (kg)	270	388	520.0	602	353	285
Pesticide (I)	2.25	6.90	3.50	1.5	2.9	0.7

Source: 247 farm plots from 147 sample farms. Central and East Java. 1984/1985.

Resource use by maize variety

Table 5.3 reinforces the fact that improved varieties (Arjuna and the hybrids) are considered a risk by small farmers with limited capital. Small farmers with an average plot area of 0.34 ha grow local maize varieties. Their average yield (2.1 tjha) is the lowest and their application of fertilizer and pesticide is also low. Their seed use (37 kgjha), on the other hand, is greater than those of all the improved varieties, reflecting their expectation of a low germination rate.

Regression analysis

A multiple regression analysis was employed to estimate the input-output relationship as represented by a Cobb-Douglas production function. The estimating equation has basic quantiative variables, comprising current production inputs of seed amounts, labour uses, fertilizer and pesticide applications. The model also includes several dummy variables to capture qualitative variations in factors believed to be affecting the maize yield: the sample district, maize variety, type of land, season and type of cropping. Transforming this into logarithmic form, the model takes in a linear relationship as follows:

Ln PRODHA	=	LnA + a)Ln KGSOHA + a2Ln TOLABHA + a_3Ln TOPESHA + a_4Ln KGFERTHA + a_5Ln ODISI + a_6Ln ODIS2 + a_7Ln DDIS3 + a_8Ln OOIS4 + a9Ln DLTI + alOLn OLT2 + a_{11}Ln OWS + a_{l2}Ln OOSI + a_{l3}Ln OHBR + a_{l4}Ln OARJ + e

PRODHA	=	production (yield)q/ha
KGSDHA	=	seed (kg/ha)
TOLABHA	=	labour of man-days/ha
TOPESHA	=	pesticides kg/ha or 1/ha
KGFERTHA	=	fertilizer (urea/TSP) kg/ha
DDIS1 4	=	dummy variables for sample districts
DLT1 2	=	dummy variables for land types
DWS	=	dummy variable for wet season
DDS1	=	dummy variable for first dry season
DHBR	=	dummy variable for hybrid variety
DARJ	=	dummy variable for Arjuna variety

In this particular model, the rainfed lowland district of Bojonegoro, the late dry season (Season 3) and local variety of maize are used as bases in constructing the dummy variables.

Table 5.4 Estimated regression coefficients of a Cobb-Douglas production function model.

Variable	Coefficient	t-value	Level of significance (one tailed)
LnA	2.912	-	-
LnKGSDHA	0.152	1.210	0.885
LnTOLABHA	0.174	1.504	0.932 [a]
LnTOPESHA	0.002	0.983	0.533
LnKGFERTHA	-0.271	-2.271	0.987 [b]
LnDDIS I	-0.113	-0.352	0.637
LnDDlS2	-0.287	-0:819	0.792
LnDDlS3	0.139	0.450	0.673
LnDDlS4	0.584	1.913	0.970 [b]
LnDLT1	0.216	1.002	0.840
LnDL T2	-0.033	-0.148	0.559
LnDWS	0.237	0.964	0.831
LnDDS 1	0.113	0.621	0.732
LnDHBR	0.601	2.836	0.997 [c]
LnDARJ	0.581	3.253	0.999 [c]
R2	0.603b	-	-
SEE	0.666	-	-
F-test	3.510	-	0.994 [c]

Source: 101 farm plots of 147 sample maize farms. Central and East Java. 1994/1985.

Notes: a c = significant at 1%.

[b] = significant at 5%.

a = significant at 10%.

[b] F_r a simple linear multiple regression model. the estimated R - = 0.399.

The regression results are shown in Table 5.4. The model demonstrates a reasonable approximation which is confirmed by the R:2 ,value of 0.603. It should be noted that fitting input-output data from different environments rarely yields a high value' of R_2. Attempts to add other independent variables, such as the frequency of weeding and the interaction of maize variety and fertilizer use, failed to increase the R^2 value. Attempts to fit multi linear regression models met with similar results.

To reflect the general condition of maize production (the farm model), the estimated coefficients of regression are related to the average use of all the variable inputs included in the equation model. Since maize prices also fluctuate with season, the average price is included in the analysis of optimal resource use in the farm model.

The principle of equality of marginal value products per Rupiah value of each resource used is employed to evaluate whether the average maize farmer receives the maximum profit from maize cropping. This approach is based on the assumption that the farmer is a profit-maximizer. It is acknowledged that this is not necessarily so, but such simplication does show the direction of change required for a more efficient use of resources. Table 5.5 estimates and compares marginal value productivity of inputs used and their unit prices. It appears that, on average, maize farmers use more than sufficient fertilizer. The negative sign of the marginal value product means that, at the current level of use, an average reduction of one kilogram of fertilizer would result in a gain of approximately seven kilograms in maize production. Subsequent reductions would inevitably result in less gain in production. It is therefore apparent that the average farmers over-use fertilizers. A slight reduction, especially by those using average amounts, would yield only a modest gain in production. Those who use more than average should further reduce input to yield larger' gains.

Table 5.5 Estimated marginal value products of inputs and their unit prices.

	Marginal product (100 kg)	Marginal value product (Rp)[a]	A verage unit price of input (Rp)
Seed	+ 0.101	+ 1,289	677 /kg
Pesticides	+ 0.0014	+ 18	2.5/cc
Fertilizers (Urea + TSP)	- 0.069	-881	98/kg
Labour	+ 0.066	+843	I,O87/man-day

Source: 101 farm plots from 147 sample maize farms. Central East Java. 1984/1985.
[a]The average price of maize is Rp 12.767/100 kg.

In this connection it is interesting to note the result of the marginal productivity analysis by the Stanford University/BULOG Corn Project, 1982/1983. In Kediri (East Java), where rapid development in the use of improved varieties was reported, the marginal physical product of urea (expressed in kilograms of shelled maize per kilogram of urea used), was estimated to be 2.8, with the average level of use at 464 kg (Mink 1984). In the interim, the average rate of fertilizer use has increased to 822 kg/ha and the estimated marginal product decreased to minus seven. Although there are differences in the method of data collecting, the drastic reduction of the marginal product confirms the present conclusion about overuse of fertilizers.

If a 10% statistically significant regression coefficient is acceptable, it may then be concluded that there was also a slight over-use of labour input by the average maize farmers. This is confirmed by the marginal value product of labour, which is less than its unit. price or wage level. In comparison with the problem of the over-use of fertilizer, however, labour over-use is a minor problem and should be treated accordingly.

Although levels of seed and pesticide use are less than optimal, as indicated by their larger marginal value products relative to their respective prices, their corresponding regression coefficients are not statistically significant to recommend changes in input use. Nonetheless, accepting a significant 15% level, there is some indication that increased seed may result in increased production. In practice, this may point to a need for improved quality of seed.

6

Conclusions and Recommendations

Data from the survey on farm production show that, on average, the highest yields of mono cropped maize are found in areas with precipitation of 300 to 600 mm during the crop life. Heavier or lighter rainfall decreases average yields appreciably, although mono cropped maize is less affected by rainfall variation than intercropped.

Factors contributing positively to the adoption rates of new maize technology include intensive contact with extension services and the farmers' age, farming experience and formal education.

The empirical data on the relationship between size of landholdings and the rates of adoption of HYV showed some peculiar trends. Farmers with less than 0.5 ha were interested in adopting maize HYV, with adoption rates of 65 to 92%. Similarly those with holdings of more than 1.0 ha had adoption rates between 70 and 94%. Farmers with holdings between 0.5 and 1.0 ha, however, were the least motivated and had adoption rates of only 58 to 60%. This suggests that size of landholding is unrelated to the rate of HYV adoption.

Land tenancy does not pose an immediate constraint to the maize development programme. All tenants (10% of the sample) planted maize HYV during the period of survey, although more information, is necessary on the extent of their adoption of the technology. In the *kedokan* system, where the tenant is responsible for specific field operations, farmers of only 17% of the plots grew maize HYV. Further research is needed to evaluate possible constraints from local land tenancy arrangements.

On average, maize farmers rely heavily on family labour in maize production. Limited family labour constrains the adoption of the more labour-intensive maize technology, regardless of hired labour available or potential profit. Family labour is a crucial factor in the farmers' decision to adopt a new, more labour-intensive technology in maize production.

Concerning the marketing of maize, farmers who felt that, if production is to expand, seed production and distribution should be improved outnumbered those who urged the improvement of marketing facilities and price policy. This suggests that competitive commercial seed supplies should be encouraged and developed to meet the pressing need for quality seed and to extend the maize improvement programme. The same conclusion was reached by the BULOG/Stanford University Team (Mink 1984).

Based on available information, village markets are the main outlets for primary marketing of maize by local producers, suggesting that a farmer brings his produce to sell at the nearest market. A few farmers may go further to sub district and district markets in an effort to get higher prices for their products. Other popular outlets are through farm gate middlemen and the village unit co-operative (KUD). Price is the determining factor in the choice of outlet, which means that product markets are sufficiently competitive. This confirms the previous point that most farmers do. not regard produce marketing and price policy as their main concern.

Since many farmers (65%) sell their maize at one time, the prices received depend on the structure of the market and timing of the sale. Further study is necessary to ascertain whether prices tend to be lower because of monopsonistic practices and/or the need for immediate cash by the farmers. Such a marketing study could result in specific recommendations to increase prices received by maize farmers.

Although more than 70% of maize production is sold, it was also found that more than 70% of the maize producers consume maize in various amounts with rice as a staple food. These two staples may be consumed either in combination or alternately within a certain period. Maize farmers in marginal (upland) areas tend to store the product longer and to sell, it in several transactions more often than farmers in more fertile areas. A possible explanation for this is that in the marginal, upland areas rice is more difficult and expensive to obtain so that farmers have to wait and see if rice is available at reasonable prices, or to consume more maize.

It is interesting to note that 78% of the sample farmers' from 'maize-producing centres of Central and East Java consume mixtures' of rice and maize in various proportions, but none eat only pure maize. This fact should be taken into consideration by the Governmen_ (BULOG) when deciding on rice market operations in maize producing areas, so that in future maize need not be an inferior substitute for rice. If this combination is promoted, it may provide a stronger basis for the maize development programmes iri the areas concerned.

The successful rice intensification programme of the 1970s has made many low-level maize consumers change to consuming only rice. This means that ultimately there will be fewer maize consumers, but with increased annual maize consumption per capita. Meanwhile, maize consumption levels of farm families are negatively related to the adoption rates of current high-yielding varieties (Arjuna and the hybrids) while the opposite is true for the adoption rates of local/traditional varieties. The implications are such that for areas where farmers consume relatively more maize, the yield im,provement of local white-colored varieties is an important development objective. On the other hand, for areas where maize is grown primarily for commercial purposes, the yellow-colored HYV programme development is recommended. Similar conclusions were reached by the BULOG/Stanford University Team (Mink 1984).

Two types of seed use were observed, which relate to the method of cropping:

1. the high seed rate of 32 kg/ha for mono cropping, and

2. the low rate of 17 kg/ha used for intercropping with soybean, cassava or cowpea.

The empirical data showed that seed use varies greatly from one district to another, reflecting differences in method of planting and seed quality. Evaluation of the marginal productivity of seed input indicates a need for increasing the effectiveness of seed use and for improving seed quality.

The marginal productivity analysis of fertilizer input in maize production suggests some over-use. A slight reduction in the level of use, especially by those using more than recommended amounts, would result in some gain in production. A similar conclusion, though less decisive, applies to the level of labour input.

Appendix

Information collected in the study on constraints and potentials to corn production development.

1. Farmer background and characteristics: age, education, farming experience, household member, labour force, farm labour, non-farm income sources.

2. Farm assets and farming activities: equipment, landholding (days, type, plots, size, status and use) crop calendar, management, input and output, product use and sales.

3. Input and output: labour (amount by type, gender, kind of wage rate), seed (amount, source, variety, price), fertilizer (amount by kind, source, time of application, frequency, method, price), pesticide (amount, kind, source, time, frequency, method), produce (kind, amount, consumption, farm gate, price), sale (frequency, time and price).

4. Marketing: knowledge on floor and marked prices, selling (when, kind of commodity, sold, buyers, where, cost), processing (equipment, product ration, cost, where, by product).

5. Farmers' appreciation and knowledge of corn farming technology: varieties ever known and planted, identified high productive line, source of information, seed availability, methods of cultivation, best time of planting, aspect to be improved, source and availability of capital, fertilizer, pesticide, frequency of maize crop year, knowledge about hybrid and other HYV.

6. Farmers' participation in corn intensification programme: participate or not and reason, source of first information, advantage and disadvantage, anyone to be followed.

7. Farmers' contact with extension and non-formal agricultural" education: daily magazine reading and reason, view maize demonstration plot, TV and radio programmes, farmers' organization and meetings, agricultural training course.

8. Perceived constraints by farmers: constraints in land preparation/planting period, vegetative stage, harvesting stage and marketing.

9. Consumption: amount and kind of staple food per month, special characteristics of corn consumed, amount of maize bought per year, time and form of buying.

Glossary

Acronym

INMUM	General intensification programe where farmers apply recommended input, purchased themselves
INSUS	Special intensification programme where participating farmers apply the recommended inputs obtained through BIMAS credit
KUD	Village unit co-operatives

Local terms

Desa	Village
Kabupaten	District
Kecamatan	Sub district
Kedokan harvest	System of contracting labour, remunerated after harvest with share of
Ketigo	The later part of the dry season
Kretek	Local maize variety
Labuhan	Beginning of the wet season
Marengan	Beginning of the dry season
Pengedok	Contractor in kedokan system
Rupiah (Rp)	Indonesian currency Rp 1000 = US$ I
Tebasan	System whereby the standing crop is sold in the field before harvest

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