A normative sugarcane supply function and optimum land rental plan for a proposed expansion of the Sragi sugar factory in central Java, Indonesia
by Rudolf Solindungan Sinaga

A thesis submitted in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY in Applied Economics
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Abstract:
The Indonesian Agro-Economic Survey was appointed to carry out a survey on the availability of sugarcane supply for the factory to process in each individual working area of the factories proposed by the International Development Association for rehabilitation in Java, Indonesia.

The author took some of the data collected in the survey with him to Montana State University in support of this dissertation.

The main objectives of this study are: (1) to derive a normative land-rent supply schedule faced by the Sragi factory in its working area, and (2) to derive a normative sugarcane supply function and to determine an optimum land-rental plan for the Sragi sugar factory.

The technique of variable price linear programming is employed to generate the relationship between the minimum rental prices paid by the sugar factory and the corresponding maximum amounts of land the farmers would be willing to rent to the sugar factory. The technique of variable resource programming is employed to generate the relationship of various levels of sugarcane produced in the field and their associated marginal and average total costs of producing sugarcane in the field, and the optimum land-rental plan for the Sragi factory for various levels of sugarcane production.

The land-rental supply schedule generated from the solution to the first linear programming model suggests that on the average, the land-rent rate paid by,the factory should be at least twice the land rent paid in the 1972/73 crop season.

The solutions to the second linear programming model suggest that the Sragi sugar factory does not have to expand its current working area to get enough land to grow sugarcane to meet its cane needs for producing up to 70,000 tons of refined sugar.

The total cost of producing sugar at the factory door for the 1972/73 crop season is approximately Rp 65.5/Kg. Under the proposed rental plan total cost could increase to Rp 69.8/Kg., and 22.3 percent or about Rp 15.6/Kg., would be attributed to the cost of renting land from farmers.

If it were the goal to hold down the price of sugar at the factory door, then farming costs to the mill, factory costs, and other mill costs such as management costs could be reduced and the proposed rents could be paid. If these costs could not be reduced, the government could increase the wholesale price of sugar. Either alternative would probably be more desirable than coercing the farmers into accepting rental payments that are less than their opportunity costs.

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by

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ABSTRACT

The Indonesian Agro-Economic Survey was appointed to carry out a survey on the availability of sugarcane supply for the factory to process in each individual working area of the factories proposed by the International Development Association for rehabilitation in Java, Indonesia. The author took some of the data collected in the survey with him to Montana State University in support of this dissertation.

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The technique of variable price linear programming is employed to generate the relationship between the minimum rental prices paid by the sugar factory and the corresponding maximum amounts of land the farmers would be willing to rent to the sugar factory. The technique of variable resource programming is employed to generate the relationship of various levels of sugarcane produced in the field and their associated marginal and average total costs of producing sugarcane in the field, and the optimum land-rental plan for the Sragi factory for various levels of sugarcane production.

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CHAPTER I

INTRODUCTION

In January, 1971, at the request of the Government of Indonesia, the United Nations Development Program (UNDR) commissioned the Indonesian Sugar Study (ISS) to formulate a 10-year program to meet domestic sugar demand, at the least cost to the economy, and prepare a project to increase sugar production for international financing. The study was carried out by a British consortium; Bookers Agricultural and Technical Services, and Tate and Lyle Technical Services in association with the Economist Intelligence Unit. Based on the consortium study, ISS prepared an initial three-year project which proposed construction of two new sugar factories, major expansion of one, and rehabilitation of twelve other sugar factories, with ancillary transportation and agricultural facilities [1,p.1].

In October-November, 1972, an International Development Association (IDA) appraisal mission to Indonesia conducted a further study. Based on the findings of the appraisal mission and on data from ISS, the IDA has established that the construction of new factories would be too expensive and could not be justified at that time. Major rehabilitation of three factories and minor rehabilitation of twelve is recommended by IDA instead. This rehabilitation project will increase the sugar supply substantially and at a lower cost than would be the case if new factories were constructed [1,pp.1-2].

Major rehabilitation was proposed for the Sragi, Gempolkrep, and Pesantren sugar factories [1,Annex 5,p.1]. Sugar factories that belong to the minor rehabilitation project are Jatiwangi, Tersana Baru, Gempol, Bandjaratma, Sumberharjo, Cepiring, Rendeng, Ceper Baru, Mojosragen, Tasikmadu, Lestari, and Cukir [1,Annex 6,p.1]. 1/ The project would markedly increase the milling capacity of the factories ranging from 70 percent for minor rehabilitation to 200 percent for major rehabilitation above their current capacities [1,p.8].

IDA is aware that adequacy of cane supply to meet forecast capacity is critical and depends on many factors such as the value of alternative crops, irrigation availability, and farmers' attitudes [1,p.8]. 2/ Therefore, the IDA recommended in their report that before any rehabilitation is planned, a survey must be carried out to make quite sure that sufficient land would be made available for cane production [1,p.21]. The resulting Draft of Terms of Reference for Cane Supply Survey proposed by IDA is presented in Appendix I [1,Annex 7].

In 1973, the Indonesian Sugar Project on behalf of the Director General of Estates of the Ministry of Agriculture appointed the Indonesian Agro-Economic Survey (AES) to carry out a survey on the

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1/ Underlining indicates these factories are of first priority in the minor rehabilitation project.

2/ Sugarcane or cane refers to sugarcane crop as the raw material for the factory to process. Cane sugar or sugar refers to centrifugal or refined sugar as the final product.

availability of sugarcane supply for factory processing in each of the individual sugar factory working areas belonging to the rehabilitation project. 3/

The objectives of the survey carried out by AES are to determine in each factory working area: [39,p.3]

a) The total area of the factory concession.

b) The area currently in cane grown by the factory and estimated yields.

c) The area currently in cane grown by the farmers and estimated yields.

d) The area available for expansion by the factory within the concession area, divided into area available for planting and area available for factory ratoon, along with estimated yields. 4/

e) The area available for ratooning by farmers within the concession regardless of the factory's capacity and estimated yields.

f) The rents proposed and present prices for sugar and other crops:

3/ The Agro-Economic Survey was created in 1965 as an *ad hoc* inter-ministerial research organization. The Minister of Agriculture is the Chairman of the Policy Board composed of approximately one dozen members including policy makers in the Ministry of Agriculture, Public Works, Land Settlement and Cooperatives, Home Affairs, Ministry of Trade, Central Bank, and Food Supply Authority [2,pp.7-9]. Dr. A. T. Birowo is the current Executive Director of the organization.

4/ Ratoon is the regrowth of sugarcane from the stubble of the previous crop.

1) What area farmers would be willing to lease along with estimated yields.

2) What total area farmers would be willing to ratoon, the number of years that ratooning is desired, and estimated yields.

For the first round of the survey, AES conducted a survey in the working area for all three factories of the major project--Sragi, Gempolkrep, and Pesantren--in December-January, 1974. The author was appointed by the Executive Director of AES to supervise the survey on the preparation of the survey, collecting and editing the data, and tabulating the data for further analysis. In April, 1974, the author took some of the data with him to Montana State University to support this thesis. The AES team will do separate data analysis and report writing in Indonesia. The thesis will complement the AES report.

This thesis, after review of general nature of the information collected from each factory, will only present the specific data for the Sragi sugar factory and its working area. 5/ The thesis is therefore a case study of the Sragi factory, but this case study is used as a means of addressing the more general problems involved. The specific objectives of the study in this thesis are:

1) To calculate the economic opportunity cost for the farmers to rent their land to the Sragi factory, and to derive a normative

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5/ For simplicity the Sragi sugarcane factory will be referred to as Sragi factory or factory in this thesis.

land-rent supply schedule faced by the Sragi factory in its working area; and

2) To derive a normative sugarcane supply function, and to determine an optimum land rental plan for the Sragi factory.

CHAPTER II

INDONESIAN SUGARCANE INDUSTRY

Production and Consumption of Sugar in Indonesia

The sugar industry was one of the most important industries in Indonesia for many years before World War II. In 1928, there were 178 sugar factories operating in Java, harvesting about 200,000 hectares of cane and producing nearly 3 million tons of sugar, almost half of which was exported. At this time, Java was the second largest supplier of sugar in the world market, surpassed only by Cuba [3,p.1].

Indonesian sugar production had already been curtailed before World War II because of the depression and world over-production. The Indonesian sugar industry operations were then severely interrupted by the Japanese invasion and by the postwar Indonesian struggle for independence. Production revived after the war but never again approached the prewar peak.

In recent years, the output of the sugar factories has been something over 700,000 tons per annum produced by 55 factories. However, since 1966 consumption of sugar in Indonesia has overtaken domestic production and instead of a surplus for export as previously, imports of about 100,000 tons per annum have been required to meet domestic demand. Table II-1 indicates the pattern of production, exports,

TABLE II-1. WHITE SUGAR PRODUCTION, EXPORTS, IMPORTS, AND APPARENT CONSUMPTION, 1952-1972.*

1	2	3	4	5
Year	Production	Exports	Imports	Apparent Consumption 1/
	------------------	Tons	------------------	
1952	460,264	1,181	--	395,092
1953	619,829	97,369	--	498,928
1954	717,712	212,200	--	499,851
1955	852,299	199,543	54	642,746
1956	785,723	174,772	--	612,842
1957	828,451	142,864	92	665,870
1958	771,186	87,167	1,695	704,458
1959	855,209	39,000	--	729,993
1960	667,000	34,800	--	707,790
1961	639,000	142,713	--	461,572
1962	583,000	33,279	1,756	591,445
1963	650,284	105,049	70	497,558
1964	647,000	104,627	113	626,018
1965	779,900	75,400	340	672,093
1966	605,000	27,262	23,504	586,063
1967	659,900	--	37,524	739,020
1968	600,595	--	107,757	676,930
1969	732,288	--	77,780	812,298
1970	715,047	--	118,164	833,845
1971	830,000	--	150,000	823,000
1972	889,400	--	90,000	NA

1/ After adjustment for movements in stock levels.

*Source: Bookers Agricultural and Technical Services, Ltd. and Tate and Lyle Technical Services, Ltd. "Indonesian Sugar Study--Final Report." Vol. I (in association with The Economist Intelligence Unit). July, 1972; and Indonesian Food Supply Authority (BULOG).

imports, and consumption of sugar in Indonesia for the last 21 years. 1/

Projections contained in the IDA report indicate that production will increase from 890,000 tons in 1972 to 1,300,000 tons in 1980 including forecasted production from the proposed rehabilitation of the 15 factories. The report also indicates, however, that consumption is expected to double within the same period to approximately 1,600,000 tons. The estimated demand and supply balance of sugar indicates that Indonesia will continue to import sugar until 1980, which on the average, will be about 100,000 tons per year [1,Annex 4,p.3].

General Characteristics of Indonesian and Some Other Countries' Sugarcane Industries

The sugarcane industry in Indonesia has certain characteristics which sharply differentiate it from other sugarcane industries. The differences mainly stem from the unique basis of occupation and use of the land involved in cane production. In other countries, cane is grown either on large estates which are owned and cultivated by the enterprise

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1/ Figures in Table II-1 only include sugar produced by sugarcane factories as "white sugar" or centrifugal cane sugar. In addition to white sugar produced by the factories there is a substantial production of crude, brown sugar (non-centrifugal sugar) made by a simpler method of processing using smallholders' cane or palms. The production and consumption of all types of non-centrifugal sugar in recent years has been about 350,000 tons per annum which is about one-third of the total sugar production in Indonesia [4,p.43].

owning the factory and devoted to sugar for periods of years without interruption or on smaller, privately owned plots ranging in size from tiny smallholdings to medium-size estates, and also continuous growing and selling of cane for processing to a central factory. In many cases the estates in other countries have been developed for sugarcane on land not previously under systematic cultivation with food crops.

Indonesian Sugarcane Industry

In 1957, following the growing tension between Indonesia and the Dutch over the future status of West Irian, the Dutch-owned sugar factories were expropriated by the Indonesian government and run as government enterprises. Today there are 55 sugarcane factories in Indonesia and all are located on Java Island. Only one of these 55 factories belongs to private shareholders, 48 belong to the government enterprise, and 6 to so-called private companies. Five of this latter group are owned by government agencies (two by Ministry of Finance, two by the Bank of Indonesia, and one by an army group), and one is owned by a local interest [4,p.35].

When sugar production began more than 80 years ago in Java, the most suitable lands for growing cane were already occupied by the Javanese peasants and intensively cultivated with food crops, primarily rice. Sugarcane estates could have been established only at the cost of very serious social disturbance and, at least locally, serious reduction of food supplies. A system evolved, therefore, by which land was made available for cane cultivation without passing out of the ownership of the local community and without being permanently withdrawn from rice production. Under this system, the land is leased for a single season to a sugar factory and then reverts back to the farm owners of small plots for two seasons. During this time the land is usually planted to rice with some intermediate crops during the dry part of the year if the water supply is insufficient to grow rice continuously. Each factory is allocated a concession area within which it is entitled to arrange leases via this rotation system. Arrangements are worked out with representatives of the village(s) involved by which one-third of the land is scheduled for leasing in each of three successive years. In practice, since sugarcane takes more than 12 months to mature fully plus the fact that some time must be allowed for soil preparation and for clearing after harvest, the length of leasing period is 16 months.

There are at least six technical consequences resulting from the leasing system on the three-year rotation: [4,p.40]

1) This rotational system results in important differences in agricultural practices from other countries. In the other sugarcane producing countries it is normal to ratoon cane for periods of five years or longer, but ratooning cane is not customary in Java. It is therefore necessary to plant cane afresh each year, which involves additional planting costs for labor and planting material from nurseries.

The nurseries occupy about 12 percent of the available land which could otherwise be used to grow sugarcane or other products.

2) Since the lands cultivated with cane are scattered over an area at least three times the area actually planted at any one time, the cane transportation system has to be proportionately more extensive than would be needed for a more compact layout. The cost is consequently increased as well.

3) There are greater administrative tasks and problems. Since the sugar factories have to make leasing arrangements every year, it is time-consuming and a significant burden on the management.

4) Additional costs are involved after harvesting the cane. The cane roots must be removed and the land boundaries must be restored to prepare the land for reversion to rice crops.

5) There are many individual landholdings grouped in such a way as to leave the factory with several fairly small, fairly widely separated areas of cane. This scattering means that agricultural management is complicated, and introducing new cultivation techniques is often difficult.

6) Irrigation and drainage systems cannot be designed and operated to meet the primary requirements of the cane, but are oriented towards rice, which occupies most of the land most of the time.

Sugar production currently is only a small part of total agricultural activities in Indonesia. In 1970, sugarcane occupied only 135,000 hectares. Total cultivated area in Java is about 8 million hectares, and in Indonesia as a whole is over 50 million hectares [1, Annex 2,p.2].

About 85 percent of the total sugar production is marketed and distributed under the government's direct supervision from the government-owned factories. The remainder is independently marketed and distributed by private and quasi-private factories [1,Annex 4,p.3].

The organization of the sugarcane industry in Indonesia is unique. A brief description of the organization of sugarcane industries in Taiwan, the Philippines, and Hawaii is presented to provide a basis for comparison.

Taiwan Sugarcane Industry 2/

Sugar in Taiwan is produced mainly for export, for example, the production in the 1960's was approximately 800,000 metric tons of which nearly 90 percent was for export. The sugarcane industry in Taiwan is controlled by a monopoly corporation called the Taiwan Sugar Corporation (TSC), which is one of the largest government-owned enterprises. Taiwan

2/ Information on the Taiwan sugar industry is obtained from the following references: [5,pp.1-8] and [6,pp.24-25].

Sugar Corporation owns 25 well-equipped sugar mills and 188 large-scale farms with a total acreage of about 43,000 hectares. Because sugar in Taiwan is a monopolized industry, those farmers who want to grow cane must contract with the Sugar Corporation in advance. There are no acreage restrictions limiting how much farmers may plant, nor any government compulsion on farmers to plant cane. Contract farmers provide about 70 percent of the total annual supply and the remaining 30 percent is supplied by the mill's farms.

Cane growers under contract can obtain chemical fertilizers and a certain amount of production credit from the Corporation, for which payment may be deferred until after the cane is harvested. The mill is also responsible for helping growers improve the technology of production and cultural practices of growing sugarcane. The growers agree to deliver all of their cane harvest to the mill for the manufacture of sugar and agree to sell a given percentage of their share of refined sugar to the mill for the prevailing purchase price.

Growers receive 55 percent of the refined sugar made from the cane they deliver, and the remaining 45 percent is retained by the mills to cover the processing expenses. Under this contract, however, the farmers are forced to sell at least 65 percent of their share of the refined sugar to the mill for the prevailing purchase price. The mill's purchase price is based on the average export sugar price in the preceding twelve months. The Corporation controls about 90 percent of the annual sugar production in Taiwan.

In general, the ratoon are regrown from a planting only once, but some farmers ratoon their sugarcane twice or even three or more times in succession. Nearly one-half of the Taiwan cane acreage is propagated by the ratoon method each year. The average size of farm in Taiwan is only about 3 acres (1.21 hectares) and the average size of cane field of these farms is around 0.5 hectare.

Philippine Sugarcane Industry 3/

There are 27 sugarcane factories in the Philippines, all privately owned by independent companies. These factories produced about 1,764,000 short tons per annum in the 1960's.

A unique feature of the Philippine sugar industry is the relationship between the farmers who grow sugarcane and the millers or processors who manufacture the sugar on a share or toll basis. Unlike the situation in other countries where central sugar processing units control sugar production, in the Philippines the farmers have a hand in controlling the production of sugarcane.

The cooperative arrangement between factory owners and farmers in the sugarcane district contained in the milling contract obliges farmers

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3/ The information was obtained from reference [7,pp.22-35].

to grow sugarcane to be milled while processors agree to transport the cane and to process it into sugar. The sugarcane farmers grant the right-of-way for the railroads of the centrals over their property and agree to plant sugarcane each year on at least one-half of the area of their land during a milling contract period. The processors receive 30 to 40 percent of the sugar produced as compensation for milling and transporting the cane.

The average size of farms is 13.86 hectares, and farms 10 hectares or more and 200 hectares or more are 80 and 43 percent of the total area of sugarcane farms, respectively.

Hawaiian Sugarcane Industry 4/

There are 26 sugarcane factories owned by 23 private companies operating independently of each other, each with its own management. To facilitiate the actual production of sugar, all sugar companies except one are represented by an agency or parent company in Honolulu.

The companies have 238,997 acres devoted to growing sugarcane in Hawaii. More than half the sugar lands are owned by sugar companies. The balance is leased from government or private owners. Irrigated land produces about two-thirds of Hawaii's sugar production. The remaining one-third is produced by unirrigated areas depending solely upon rainfall.

4/ The information was obtained from reference [8,pp.3-7].

Only in Hawaii is the average age of the cane two years at the time of harvest. About one-half of Hawaii's sugar lands are harvested each year. From two or four ratoon crops are obtained from each original planting.

Approximately 97 percent of all Hawaiian raw sugar production is shipped to the United States mainland for refining. About 3 percent is processed in a local refinery, largely for Hawaiian consumption. Total sugarcane production in 1970 was about 1,162,071 short tons of raw sugar.

Land Lease System for Sugarcane

The present land lease system for growing sugarcane in Indonesia must be traced back to the Dutch period when the sugar industry was first introduced. In 1830, a compulsory cultivation system ("cultuür-stelsel") was introduced to the Indonesian peasants, mainly in Java. Under this system of the Dutch colonial government, the farmers were compelled to grow government-owned export crops including sugarcane on one-fifth of their fields, or, alternatively, to work 65 days every year on government-owned estates or other projects as a substitute for the farmers' land taxes [9,pp.52-53]. Hence, the sugar factories, which were all owned by the government obtained land from the farmers without paying for it. In addition, the farmers were also required to work some hours every day in the Dutch estates without pay [10,p.2]. Since sugar-cane demands irrigation and a general environment almost identical to that of wet rice crops, nearly all the sugarcane was cultivated on the farmers' paddy land.

In 1870, an Agrarian Law was issued to replace the cultivation system. This law was designed to preserve the local population control of the land they owned, and at the same time to encourage the exploitation of the remaining land by non-indigenous enterprises [11,p.129]. The law enabled private corporations to grow commercial crops on leased land for 75 years, and consequently the plantation system flourished rapidly.

Since all sugarcane was owned by the farmers and used for cultivating rice and other food crops, the sugar companies had to obtain land from the farmers to grow sugarcane. For this purpose the Dutch government issued a land lease law in 1918 which was valid on Java and Madura Islands except for Jokjakarta and Surakarta. Big corporations were allowed by law to lease one-third of the farmers' paddy land for 21.5 years, because seven growing cycles for cane and rice equal 21 years. The farmers were allowed to grow food crops on the land after one season had elapsed [10,p.4].

The appropriation of the land by the sugarcane factory was usually regulated under the "glebakan" system; i.e., paddy land in each village within the factory working area was divided into three sectors. These glebakan were released in succession to the sugarcane factory, no matter which individual owned the land within the sector. Under this glebakan system, the land rent was based on a formula which took into account the opportunity cost to the farmers of releasing their land to the factory. The opportunity cost was computed based on values of two rice crops (one wet-season and one dry-season) and one dry-season cash crop such as corn, soybeans, or peanuts. The value of the land rent paid to the farmers was the calculated opportunity cost minus potential earnings of the farmers working as laborers during the leasing period [11,p.131].

After independence the Indonesian government attempted to provide a more appropriate institutional framework for the sugar industry. New regulations were issued in 1952 to replace the 21.5-year lease agreements with annual or single sugarcane crop agreements. The formula which had been used from 1918 onward to fix the rent locally was then replaced by a procedure in which rent was fixed from year-to-year by the Ministry of Agriculture [11,p.137].

At the present time, the land lease system is only slightly different from the one regulated by the 1910 land lease law. The element of compulsion associated with the renting system in the colonial times has been preserved in order to maintain the level of sugarcane cultivation. For this purpose, a Land Use Law (No. 38 of 1960) was issued to give assurance to the sugar industry that the sugar factories could get enough land to grow sugarcane. 5/

5/ The full text of the Land Use Law No. 38 of 1960 and its official explanations can be found in reference [12,pp.175-188].

Every year the Minister of Home Affairs issues a Letter of Decision or Minister's Regulation. For the 1972/73 sugarcane crop season it contained among others the following decisions: [40]

1) The Form of Payment: The land rent should be paid in the form of money. 6/

2) The Installment: Twice--first when the contract is made, and finally when the farmers hand over their land to the factory. 7/

3) The Amount of Rent: The Minister sets the minimum and maximum amounts of rent for 16-month and 11-month periods. The minimum amount of rent is based on the amount of rent practiced among and by the farmers. The maximum amount is based upon the alternative returns from paddy and second crops, taking into account the financial capacity of the sugar mills to pay the farmers. 8/ For the 1972/73 sugarcane crop season the minimum

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6/ Since 1967/68 the land rent has been paid in the form of money.

7/ If the factory should decide to return the land to the farmers before the rental agreement termination date, the factory has to pay the full rent. The factory should not pay the first installment earlier than six months before the handing over of the land to the factory. And the first installment should not affect the total land rent received by the farmers (no interest charge).

8/ There is no available information on how the data are gathered to determine the maximum and minimum amounts of rent.

and maximum land rents for 16 months was Rp 60,000 and Rp 80,000, respectively. 9/

4) Delivery Premium: If the farmers deliver the land to the factory in March, April, or May, the factory is supposed to pay a premium. In 1972/73, this premium was Rp 4,800 per hectare for March delivery, Rp 3,200 for April, and Rp 2,400 for May delivery.

5) Late Delivery Premium: If the factory is late in returning the land to the farmers as specified in the contract, the factory must pay the farmers another premium. In 1972/73, this was Rp 4,843.75 per hectare for one month late delivery; Rp 9,687.50 for two months; and Rp 14,531.25 for three months late delivery.

6) Production Premium: For any amount of cane above the 800 quintals (80 tons) produced per hectare, the farmers received Rp 32 per quintal in 1972/73.

7) Clearing Costs: At the end of the season when the land is about to be returned to the farmers there is still a lot of cane stalks, stumps, etc., on the field. The factory is supposed to

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9/ How much precisely the rent should be for a certain sugar mill is up to the bupati for the area to decide within the minimum and the maximum limits. In the case of Sragi factory for the 1972/73 crop season, the rent for Class II land was Rp 77,500 and for Class III land, Rp 75,500 per hectare for 16 months.

return it in its original clear state, and for this purpose the factory must pay the farmers a land clearing fee. In 1972/73 this was Rp 960 per hectare. 10/

In practice, the local governments do not follow the above regulations faithfully. 11/ The bupati can decide the amount of rent for his area. There is a committee in each kabupaten for calculating the amount of money to be paid per hectare of land as rent and the amount of land to be rented. This committee consists of the bupati personnel from the Agrarian Office, Agricultural Extension Service, Irrigation Office, Farmers' Organization, Courts, Police, etc. 12/ The bupati submits a land rent proposal to the Governor based on this committee's findings and the Governor makes the final decision. For legalizing the bupati's proposal or recommendation, the Governor also convenes a committee with the same membership as that of the kabupaten.

If the process runs smoothly, after the bupati fixes the rent he orders the camats and lurahs (village heads) to find out and determine

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10/ The rent, all premiums, and the land clearing fee must be paid directly to the farmers in front of and legalized by the village head and camat.

11/ A brief description of the Indonesian Government administrative division of the country is presented in Appendix II.

12/ No information is available on how this committee determines the amount of rent and the amount of land to be rented in each village.

the location of land within the village. The assistant field manager and the village head together determine the location of the land and compile the names of the owners and the size of their holdings. If the land in each village has been divided into three parts (i.e., the glebakan system), one-third of the paddy land is surrendered to the factory for cane each year. 13/ If the glebakan system has been in order, finding the land is a matter of routine work.

After the name and the size of holdings have been fixed and approved by the camat, the contract between the factory and the farmers is then agreed upon and the first installment of the land rent payment is given to the farmers.

Since the local governments permit only a part of the paddy land to be used for cane, fragmentation of the cane growing area is unavoidable. In addition to this, the factory may lease the land for a short period (16 months); i.e., one sugarcane crop growing season. This results in high costs for clearing the land, replanting, and clearing again at the end of the period.

13/ This glebakan system varies from region to region. Even within the factory working area more than one glebakan system can be found. In Sragi factory working area, for example, there are three glebakan systems: 3 years, 4 years, and 5 years of glebakan. The larger the paddy land in a village, the longer the cycle in the village.

Beginning with the 1975/76 crop season, the factories belonging to the rehabiliation project plan to ratoon sugarcane. This means that a new regulation or law should be issued to enable the factories to lease land for more than one crop season.

CHAPTER III

ANALYTICAL MODEL, DATA GENERATION, AND UNIT OF ANALYSIS

Introduction

The purpose of this chapter is to present the basic ideas used in the development of the rest of the thesis. The principal objective of the thesis is to develop a framework for estimating a normative sugarcane supply function and then to use that framework empirically for the Sragi factory working area. Linear programming will be the primary analytical model used.

The first step is to develop a model which will permit the derivation of a normative Land-Rent Response Schedule. The technique of variable price programming is used as a means of estimating the relationship between the rental prices paid by the sugar factory and the corresponding amounts of land the farmers would be willing to rent to the sugar factory. The second step is to develop a model which will be used to generate a normative supply function for sugarcane. The output of the linear programming analysis of step one will be utilized for constructing this second linear programming model. The technique of variable resource programming is used to generate the relationship of various levels of sugarcane output and their associated marginal and average costs. As a by-product of this analysis, an optimum land rental plan is also specified.

Analytical Model

Linear Programming

Linear programming is a widely used tool for empirical analysis of economic problems. It is one of the three types of analytical models used in economics that consist of linear relationships. These three types of analyses are linear programming, input-output analysis, and two-person, zero-sum or elementary game theory. 1/

Multinational groups, individual nations, and even individual firms frequently face normative type problems of determining how factors of production can be best organized. Linear programming is often a useful tool to analyze these problems.

There are three necessary quantitative components of a linear programming problem: linear objective function, resource or other constraints, and alternative methods or activities which affect the objective function and constraints in linear fashion. A problem which has these three components can always be expressed as a linear programming problem.

1/ A brief historical sketch of the development of these three types of analyses can be found in [13,pp.1-5]. Also in the same reference [13,pp.507-512], selected basic works are listed for conveying a reasonably rounded picture of the work which has been done in the three types of analyses up to the late 1950's.

Linear programming problems are set up in terms of matrix algebra. The linear programming maximization problem in general form can be stated as follows: 2/

$$\text{Maximize} \quad CX \quad \text{subject to}$$

$$AX \leq B \quad \text{and}$$

$$X \geq \bar{0} \ . \ \underline{3/}$$

The meaning of the above inequalities will be discussed later in more detail. It may be explained simply as follows.

The first inequality, $AX \leq B$, restricts activities from using more resources than the amounts which are available. For example, the number of hectares of land used for crop production cannot exceed the number of total hectares of land that is available to produce the crops. The second inequality, $X \geq \bar{0}$, prohibits negative values from occurring for any activity. For example, one cannot produce minus 2 hectares of rice crop.

2/ The dual of the maximization problem is a minimization problem. The relationship of these problems is often useful in economic analysis but will not be discussed here. A brief and sufficient economic interpretation of dual problems of a linear programming model can be found in [14,pp.103-121].

3/ The bar sign above 0 refers to zero column vectors.

For purpose of illustration, a simple linear programming problem is used in the following discussion. The example uses the linear programming maximization problem and specific data for a group of farmers in a kecamatan as presented in Table III-1.

Objective Function

The objective function (OBJ) of a profit maximization problem is represented by CX in the above general linear programming problem formulation. This function can also be expressed in equation form as the following:

$$\text{Maximize } CX = c_1x_1 + c_2x_2 + c_3x_3 + c_4x_4 + c_5x_5 + c_6x_6 + 0x_7 + \ldots + 0x_{11}.$$

In matrix notation this is expressed as:

$$\text{Maximize } CX = [c_1,c_2,c_3,c_4,c_5,c_6,0,0,0,0,0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ x_8 \\ x_9 \\ x_{10} \\ x_{11} \end{bmatrix}$$

TABLE III-1. DATA FOR LINEAR PROGRAMMING MAXIMIZATION PROBLEM OF A GROUP OF FARMERS IN A KECAMATAN.*

	Units	Real Activities						Disposal Activities					Available Resources
		(x_1) AR_1	(x_2) ARL	(x_3) BR_2	(x_4) BRL	(x_5) DR_1	(x_6) DRL	(x_7) Labor	(x_8) Cash	(x_9) ALAND	(x_{10}) BLAND	(x_{11}) DLAND	
	1	2	3	4	5	6	7	8	9	10	11	12	13
OBJ = Return to Land and Family Labor	Rp.	266313	90000	54604	90000	212315	90000	0.0	0.0	0.0	0.0	0.0	
ROWS													
Labor	Man Hrs.	3057	7343	1354	7343	2237	7343	1	0.0	0.0	0.0	0.0	55504800
Cash Capital	Rp.	95467	0.0	34619	0.0	65205	0.0	0.0	1	0.0	0.0	0.0	400000000
Land Type:													
ALAND	Ha.	1	1	0.0	0.0	0.0	0.0	0.0	0.0	1	0.0	0.0	1565
BLAND	Ha.	0.0	0.0	1	1	0.0	0.0	0.0	0.0	0.0	1	0.0	745
DLAND	Ha.	0.0	0.0	0.0	0.0	1	1	0.0	0.0	0.0	0.0	1	1255

*Source: Table is developed from Tables 1, 2, and 3 in Appendix III.

From the above expression we can see that C is a matrix which consists of a row vector of prices 4/ and that X is a matrix of a column vector showing the level of output of the activities.

In linear programming problems, there are two general groups of activities, real activities and disposal activities. Real activities are those which produce a product for sale or purchase and use a commodity. Disposal activities are those activities which are included in the program to permit some available resources to go unused and to allow inequalities to be converted into equalities. Using the data in Table III-1 the objective function of that specific linear programming problem is stated as follows:

Maximize CX =

$$[266313, 90000, 54604, 90000, 212315, 90000, 0, 0, 0, 0, 0] \begin{bmatrix} AR_1 \\ ARL \\ BR_2 \\ BRL \\ DR_1 \\ DRL \\ \text{Labor} \\ \text{Cash} \\ \text{ALAND} \\ \text{BLAND} \\ \text{DLAND} \end{bmatrix}.$$

4/ The term prices refers to economic gain from a unit of activity. In the example problem, economic gain is defined as Net Return to Land and Family Labor (NRLFL).

AR_1, ARL, BR_2, BRL, DR_1, and DRL are real activities while Labor, Cash, ALAND, BLAND, and DLAND are disposal activities.

The row vector of prices represents the net return to land and family labor from a hectare of cropping activity or of a hectare of renting land to sugarcane factory. In this particular example, the prices of the real activities or outputs are positive while the prices of the disposal activities are assumed to be zero. To assume zero prices for disposal activities means that there is neither economic reward nor penalty from not using some or all of the resources available. The values of the real and disposal activities (AR_1 through DLAND) represented by the column vector are unknown. The purpose of solving the linear programming problem is to find the optimum level of these activities.

Alternative Activities

The X component of the first inequality, $AX \leq B$, has been discussed briefly, and the B component will be discussed in the next section. The A matrix is an $n \times m$ matrix, where n is the number of rows and m is the number of columns. The general form of the A matrix can be written as:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & & & \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{bmatrix}.$$

In the specific data example in Table III-1, the A matrix is a 6 × 5 matrix:

$$A = \begin{bmatrix} 3057 & 7343 & 1354 & 7343 & 2237 & 7343 \\ 95467 & 0.0 & 34619 & 0.0 & 65205 & 0.0 \\ 1 & 1 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1 & 1 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 1 & 1 \end{bmatrix}.$$

Each element in the A matrix represents an input-output coefficient of an activity; i.e., the amount of certain resources required to operate an activity at the level of one. For example, a_{13} is the third element in the first row of the A matrix and it represents the amount of labor required to operate one hectare of rotation BR_2. The labor required is 1,354 hours.

A bundle of resources is required to farm a hectare of land. For example, to farm a hectare of rice requires other inputs such as labor and cash capital. Therefore, a column vector in the A matrix represents a specific combination of inputs to produce one unit of an output. Thus, the inequality $AX \leq B$ can be written in matrix form by using specific data in Table III-1 as in the following:

$$A = \begin{bmatrix} 3057 & 7343 & 1354 & 7343 & 2237 & 7343 \\ 95467 & 0.0 & 34619 & 0.0 & 65205 & 0.0 \\ 1 & 1 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1 & 1 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \end{bmatrix} \leq \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \\ b_5 \end{bmatrix} .$$

The first column in the A matrix consists of a_{11}, a_{21}, a_{31}, a_{41}, a_{51}, and shows the amount of labor and cash capital required to farm one hectare of land type A using rotation AR_1. The 0.0 coefficients indicate that no land type B and D are required for rotation AR_1. Similarly, the second column represents the amount of resources required if one hectare of land type A is rented to the sugar mill, etc.

The first row of A consists of a_{11}, a_{12}, a_{13}, a_{14}, a_{15}, a_{16}, and shows the amount of resource b_1, labor required to farm one hectare of each AR_1, ARL, BR_2, BRL, DR_1, and DRL, respectively. Similarly, the second row represents the amount of capital required for a hectare of each activity.

Resource Restrictions, Linear Inequality, and Disposal Activities

The column vector $B = [b_1, b_2, b_3, b_4, b_5]'$ represents fixed resources which are available to the farmers in a region. Using data from Table III-1, this column vector becomes:

$$B = \begin{bmatrix} 55504800 \\ 400000000 \\ 1565 \\ 745 \\ 1255 \end{bmatrix}.$$

The linear inequality for labor resource can be found by multiplying the first row vector of matrix A by real activities in column vector X. The result of the multiplication becomes:

$$3057x_1 + 7343x_2 + 1354x_3 + 7343x_4 + 2237x_5 + 7343x_6 \leq 55504800.$$

Similarly linear inequalities for the other resources can be expressed as the above linear inequality. The inequality indicates that not all the resources will necessarily be used in the production activities. In order to simplify the computation in the process of solving the linear programming problem, however, it is necessary to change the inequality into an equation. To facilitate this, disposal activities are introduced into the equation, which obviously allow non-used resources. Generally, one disposal activity is required for each resource restriction. When disposal activities are introduced, the above inequality becomes:

$$3057x_1 + 7343x_2 + 1354x_3 + 7343x_4 + 2237x_5 + 7343x_6 + x_7 = 55504800,$$

where x_7 is the labor disposal activity. Similarly, disposal activities can be introduced for other fixed resources.

Feasible Solution, Basic Solution, and Optimal Solution

A feasible solution is any set of activities which meets the requirements stated in the general form of the linear programming problem, after disposal activities are added. In other words, a feasible solution is any set of activities which meets the requirements that $AX = B$, where A includes the disposal activities and $X \geq \bar{0}$.

A basic solution is a set of activities (real and/or disposal) which satisfies the restraints and is equal to the number of resource restrictions. Consequently, there cannot be more than five activities including real and disposal activities in a basic solution to our specific example problem in Table III-1. One of the basic solutions to any linear programming problem is a set of activities which consists of all disposal activities; i.e., all resources are in disposal activities or remain idle. This particular basic solution is frequently used as an initial set of activities in an iteration procedure for solving linear programming problems.

The optimum basic solution is the set of activities, or the basic feasible solution, which gives the highest value to the objective function of a linear programming maximization problem.

Solution and Economic Interpretation of a Specific Example

The data from Table III-1 were prepared for computation using a high-speed electronic-digital computer and the results obtained are presented in Table III-2. 5/

Objective Function.--For this particular linear programming problem, the profit of an activity is defined as net return to land and family labor. Thus, the objective function represents a return to land and family labor per unit of activity times the number of units of the activity, summed over all activities.

The optimum solution to this specific example gives a value to the objective function of Rp 750,285,170. This value can be checked by multiplying each real activity in the optimum solution by its corresponding price; i.e., return to land and family labor per hectare, and then summing these products. Using the information in Table III-2, the value of the objective function is verified.

5/ MFORD, a FORTRAN, big-M, double precision based linear programming code was used to solve the problem. The data were processed using the Xerox Sigma 7 computer with the CP-V operating system.

TABLE III-2. OPTIMAL SOLUTION FOR LINEAR PROGRAMMING MAXIMIZATION PROBLEM AS SHOWN BY COMPUTER OUTPUT.

	Unit	Status	Objective Function and Real Activities		Disposal Activities	Resources		Opportunity Cost of Real Activities
			Level	Price	Level	Level of Use	Shadow Price	
	1	2	3	4	5	6	7	8
ROWS								
OBJ	Rp.		750285170					
Labor	Hrs.	BS			42442625	13062175	0.0	
Cash Capital	Rp.	BS			168761870	231238130	0.0	
Land Type:								
ALAND	Ha.	NB				1565	266313	
BLAND	Ha.	NB				745	90000	
DLAND	Ha.	NB				1255	212315	
COLUMNS								
AR_1	Ha.	BS	1565	266313				0.0
ARL	Ha.	NB	0.0	90000				176313
BR_2	Ha.	NB	0.0	54604				35396
BRL	Ha.	BS	745	90000				0.0
DR_1	Ha.	BS	1255	212315				0.0
DRL	Ha.	NB	0.0	90000				122315

Activities in the Solution.--In the previous section it has been mentioned and shown in Table III-1 that there are six real activities represented in the objective function. In addition to these six alternative real activities, there are five disposal activities which can also enter into the basis (the set of non-zero activities in the optimum basic feasible solution). The activities included in the optimal basic feasible solution are those designated BS in column 2 of Table III-2. There are three real activities (AR_1, BRL, and DR_1) and two disposal activities (labor and cash capital) in the optimum basic feasible solution. This optimal solution shows that in order to maximize return to land and family labor for the farmers in the kecamatan under stated conditions, the farmers should rent all land type BLAND to the sugarcane factory and all other land types should be cultivated for food crops. All resources except labor and cash capital are depleted by these activities.

Shadow Prices (Marginal Value Product) and Imputation of Value Product.--The shadow price (col. 7) represents the marginal value product of a resource. Only scarce resources have positive marginal value products. Those resources which are relatively in excess have zero marginal value products. The marginal value product of a resource indicates that the amount of the objective function would be increased by increasing one unit of that resource available for the activities. Land is in limited supply in this example problem. Thus, the shadow prices for all land types are positive. Consequently, acquisition of additional units of any of these land types would increase the value of the objective function. For example, if the farmers in the kecamatan could acquire one additional hectare of land type BLAND, it could be used to increase the value of the objective function by Rp 90,000 (col. 7). However, since labor and cash are surplus, their shadow prices are zero. Acquisition of one unit of any of these two resources would not increase the value of the objective function.

The marginal value product is used to compute the total value product. If all resources are paid their marginal value product, then they will exhaust the total value product (the value of the objective function). This fact can be used to check computation.

With respect to shadow prices, there are two points that need to be emphasized. First, shadow prices represent the marginal value product of the resources. If one of the scarce resources was increased by one unit, a hectare of land type ALAND for example, it will increase the value of the objective function equal to the shadow price (Rp 266,313) of that resource (col. 7). However, if more units of land type ALAND were added, the shadow price of that land type could be driven to zero, so that land type would no longer be a scarce resource in the production process relative to the other resources. Secondly, one must be careful in interpreting imputed prices. In linear programming problems it is assumed that all inputs are variable. 6/ Thus, if all resources were paid their shadow or imputed prices then there would be no payment for fixed non-land costs not included in the calculation of the coefficients of the objective function. Fortunately, addition (or subtraction) of a fixed (i.e., constant) term to the objective function does not alter the composition and level of the activities in the optimum solution.

Assumptions for Linear Programming Model

According to Agrawal and Heady, there are seven basic assumptions encountered in conventional linear programming problems: (1) additivity of resources and activities, (2) linearity of the objective function, (3) non-negativity of the decision variables, (4) divisibility of activities and resources, (5) finiteness of the activities and resource restrictions, (6) proportionality of activity levels and resources, and (7) single-valued expectations [15,pp.31-33].

The assumption of additivity of resources and activities means that the total products produced must be equal to the sum of the product produced by activities individually, and also the total amount of resources used in the production process must be equal to the sum of the resources

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6/ In the next section it will be assumed that all resources are divisible, hence they are all variable in the sense of production process.

used by individual activities. In other words, the total products produced and total resources used resulting from joint performance of the activities must be equal to the respective sums of these quantities resulting from activities being conducted individually. Thus, it is assumed that there is no interaction among activities in the production process. However, activities that interact with one another could be included in the program as a unique separate activity. In fact, this approach is followed in this study since activities can refer to crop rotations rather than a single crop.

The linearity assumption of the objective function simply means that the prices of all products produced and resources used by the activities do not change as the level of either inputs or outputs change.

In the previous section it has been stated that for general linear programming problems, the objective function CX is maximized subject to $AX \leq B$ and $X \geq \bar{0}$. This second condition implies that there will be no negative activity levels allowed. For example, one cannot cultivate negative hectares of rice crop.

The assumption of divisibility of activities and resources requires that products and resources could be produced and used, respectively, as a continuous variable infinitely divisible. However, in many cases when there are a larger number of units involved, rounding up or down to the nearest feasible whole number would not change the solution but would change the value of the objective function slightly.

Linear programming becomes an efficient analytical tool for a problem with large numbers of alternatives and resource restrictions. However, there is a limit for a linear programming model as an operational tool. That is, there must be a finite number of activities and resource restrictions included in linear programming models.

The assumption of the proportionality of activity levels to resources means that at any level of activity the proportions of the resources used by an individual activity will remain constant. In other words, the production function of all activities is linear.

Finally, the assumption of single-valued expectations requires that all product and resource prices, input-output coefficients, and the amount of resources available have unique constant values and are known exactly.

Parametric Programming

Linear programming provides methods for computing the response of an optimal solution to changes in values that were originally assumed to be constant. The general name given to this technique is parametric linear programming.

A linear programming problem has three necessary components: an objective function, alternative activities, and resource restrictions. Programs which change one or more of the prices in the objective function are called variable price programming programs, programs which change one or more of the coefficients in one or more of the activities are called parametric programming programs, and those programs which change one or more of the resource restrictions are called variable resource programming programs [16,p.139].

Variable Price Programming

Variable price programming has been discussed extensively by Heady and Candler [17,Ch.8]. According to these authors, one need which stimulates interest in the results of the effect of price changes on linear programming problems would occur when policy problems are the predominant consideration. Heady and Candler use the United States example of determining the minimum Soil Bank payment that would take a certain acreage out of production and determining what price differential would be required to produce a significant shift from one crop to another; they suggest that in this context, variable price programming may be used to derive a normative supply function [17,p.265].

Variable price programming has been used extensively to derive normative supply functions for agricultural products and to a lesser degree to derive normative demand functions for agricultural resources. In this study, variable price programming is used to derive a normative land-rent supply schedule faced by the Sragi sugarcane factory in its working area.

The variable price programming technique simply varies the price of the output of a commodity of interest and seeks the optimum solutions for the various prices. By plotting the quantities produced and supplied against the corresponding price levels of output, we can obtain a supply schedule.

Variable Resource Programming

Variable resource programming is suggested by Vandermeulen to derive a demand curve for an input and supply curve for an output [41,Ch.5]. In deriving the supply schedule of an output by variable price programming, the conceptual experiment is to vary the price of one product and observe the reactions of the firm. The supply curve of a product derived by the variable resource technique is obtained by varying the level of output parametrically. The computer output will provide the minimum total costs and the shadow prices of the output at various output levels. In this case the shadow price at each level of output is the marginal cost of production. In this study, variable resource programming is employed to derive a normative supply function of sugarcane for the Sragi sugar factory.

Normative Supply Function

In economics the term "positive" is used to describe analysis which explains phenomena as they exist, and the term "normative" is used to explain what they ought to be. However, Johnson indicated that the term normative is used by some to explain supply estimates that are inaccurate, while accurate estimates are labeled predictive or positive [18,p.170].

According to Heady and Candler, generally linear programming is not a tool for positive analysis; it is mainly a procedure for providing normative answers to problems which are so formulated. By normative they refer to the course of action that ought to be taken by a decision unit (individual, business, area, or other economic sector) when (a) the end or objective takes a particular form and (b) the conditions and restrictions surrounding the action or choice are particular in form [17,p.8]. That is, they explain what the decision unit ought to do under stated conditions.

Heady and Candler also argue that supply functions derived by variable price programming are normative supply functions; i.e., it describes the quantities of products which the firm should produce to maximize income at each set of prices [17,p.265]. In deriving the supply function using linear programming, it is assumed that all other products and all input prices remain constant. Thus, a normative supply function for a product derived by using linear programming describes the quantities of a product which the firm should produce at any given price of that product, *ceteris paribus*, to maximize the profit of the firm.

The researcher faces difficulty in empirically defining the actual situations with respect to the nature of the farmers' objectives and the conditions within and surrounding the farms. For example, it may be assumed that the farmers maximize the return to land and their family labor in the linear programming model. In some cases, however, farmers may really maximize utility of self-sufficiency in rice. If these factors are ignored, the results will be of limited value in predicting the future for planning purposes.

Johnson suggests that appropriate handling of the subjective factors in the linear programming model will lead to a more accurate (predictive) supply function than would similar attempts that disregard such considerations [18,p.170]. That is, programming or statistical analysis empirically designed to measure the beliefs, norms, and values of farmers will improve the capability of the model to predict, even though the explanatory variables are by nature normative.

Procedure to Derive a Normative Land-Rent Supply Schedule

Following the procedural requirements for variable price programming discussed by Heady and Candler [17,Ch.8], the land-rent supply schedule may be derived as follows. First, set up the problem which conforms to the variable price programming model. Second, assign a certain uniform value of land rent in the objective function to all renting land activities. Third, determine an optimum solution to the program at the assigned values of land rent; the solution designates which type of land and how much should be rented. And fourth, repeat the second and third steps with other values of land rent. This procedure should be repeated as many times as needed until all land which can be rented has been rented by assigning new values for land rent exogenously.

Data in Table III-1 will be used to illustrate how a land-rent supply schedule is derived by using variable price programming. It will be more convenient for us if the computer also gives information on the total land in addition to the amount of each land type which should be rented at any assigned value for land rent. For this purpose the arrangement of the data in Table III-1 has to be modified as shown in Table III-3. A new real activity called Total Renting Land (TRL) and a new resource restriction for total land rented, called a material balance equation, are introduced. Zero value is assigned in the objective function to TRL activity and the right-hand side of the balance equation for Total Land Rented.

Using data in Table III-3 and assigning various values of the objective function of Renting Land activities (cols. 3, 5, and 7) exogenously, we obtain various optimum solutions as summarized in Table III-4. It is obvious from Table III-4 (cols. 10 and 11) that farmers should not rent any of their land at the value of land rent less than Rp 55,000 per hectare and the farmers should rent all of their land if the value

TABLE III-3. DATA FOR VARIABLE PRICE PROGRAMMING PROBLEM TO DERIVE LAND SUPPLY FUNCTION.

		Real Activities							Disposal Activities					
		(x_1)	(x_2)	(x_3)	(x_4)	(x_5)	(x_6)	(x_7)	(x_8)	(x_9)	(x_{10})	(x_{11})	(x_{12})	
	Units	AR_1	ARL	BR_2	BRL	DR_1	DRL	TRL	Labor	Cash	ALAND	BLAND	DLAND	Available Resources
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
OBJ	Rp.	266313	'rent'	54604	'rent'	212315	'rent'	0.0	0.0	0.0	0.0	0.0	0.0	
Labor	Hrs.	3057	7343	1354	7343	2237	7343	0.0	1	0.0	0.0	0.0	0.0	55504800
Cash Capital	Rp.	95467	0.0	34619	0.0	65205	0.0	0.0	0.0	1	0.0	0.0	0.0	400000000
Land Type: ALAND	Ha.	1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.0	0.0	1565
BLAND	Ha.	0.0	0.0	1	1	0.0	0.0	0.0	0.0	0.0	0.0	1	0.0	745
DLAND	Ha.	0.0	0.0	0.0	0.0	1	1	0.0	0.0	0.0	0.0	0.0	1	1255
Total Land Rented	Ha.	0.0	-1	0.0	-1	0.0	-1	1	0.0	0.0	0.0	0.0	0.0	0

TABLE III-4. SUMMARY OF THE OPTIMAL SOLUTIONS TO VARIABLE PRICE PROGRAMMING PROBLEM IN TABLE III-3.*

Solution Number	Real Activities							Disposal Activities		Land Rent Value Range	
	(x_1) AR_1	(x_2) ARL	(x_3) BR_2	(x_4) BRL	(x_5) DR_1	(x_6) DRL	(x_7) TRL	(x_8) Labor	(x_9) Cash	Min.	Max.
	1	2	3	4	5	6	7	8	9	10	11
1	1,565	0.0	745	0.0	1,255	0.0	0.0	46,454,430	142,970,715	0.0	55,000
2	1,565	0.0	0.0	745	1,255	0.0	745	41,924,830	168,761,870	55,000	213,000
3	1,565	0.0	0.0	745	0.0	1,255	2,000	35,402,595	250,594,145	213,000	267,000
4	0.0	1,565	0.0	745	0.0	1,255	3,565	28,552,590	400,000,000	267,000	Over

*Source: Computer output of the linear programming problem presented in Table III-3.

of the land rent is Rp 267,000 or more per hectare. The information provided in columns 7, 10 and 11 of Table III-4 is the land-rent supply schedule for the example used in this chapter.

Procedure to Derive a Normative Sugarcane Supply Function

A linear programming model of the type presented in Table III-3 and the variable price programming technique can therefore be used to generate a schedule of the rental prices and the corresponding maximum amount of land by type that the farmers might rent to the sugar factory (see Table III-4). In addition to the land rent, the sugar factory must also pay other field costs; farming costs, transportation costs of the cane from the field to the mill. The normative sugarcane supply function can be derived from the linear programming model presented in Table III-5.

For each farming activity on each land type (FLA, FLB, and FLD), there is one land renting activity assigned to it (RLA, RLB, and RLD). Hence, it is required that a material balance equation be given for renting and farming each land type. Rows 2, 4, and 6 are the material balance equations which say that the land cannot be farmed by the sugar factory unless it is rented. It is assumed the total costs of farming plus transportation cost for a hectare of cane are the same for all land types and equal to Rp 360,000. It is also assumed that the factory can

TABLE III-5. FACTORY LINEAR PROGRAMMING PROBLEM OF MINIMIZING FIELD COST FOR PRODUCING SUGARCANE. 1/

			Real Activities						Land Disp. Activities			
	Row #	Units	RLA	FLA	RLB	FLB	RLD	FLD	DLA	DLB	DLD	Constraints
	1	2	3	4	5	6	7	8	9	10	11	12
OBJ	0	Rp.	267,000	360,000	55,000	360,000	213,000	360,000				= C (min.)
Land A	1	Ha.	1						1			= 1,565
	2		1	-1								= 0
Land B	3	Ha.			1					1		= 745
	4				1	-1						= 0
Land D	5	Ha.					1				1	= 1,255
	6						1	-1				= 0
Cane	7	Tons		13		10		11				= K

1/ Field cost = land rent cost + farming cost + transportation cost.

NOTE: RLA, RLB, and RLD are the factory activities on renting land type A, B, and D, respectively.

FLA, FLB, and FLD are the factory activities on farming land type A, B, and D, respectively. Transportation cost is included in the farming activity cost in the objective function.

DLA, DLB, and DLD are disposal activities for land types A, B, and D, respectively.

delineate the land market and pay the owner of each land type a rent equal to each offer price.

Row 7 is the sugarcane (in terms of refined sugar equivalent produced per hectare) output equation. By systematically varying the value of S, the amount of the sugarcane that must be produced, and finding the optimum solution for the model for each value of S, we can generate the sugarcane supply schedule and the optimal land rental plan for the factory. The optimum solution for the linear programming problem in Table III-5 for various values of S is presented in Table III-6 in a summary form.

The information provided in columns 10 and 11 of Table III-6 is the normative sugarcane supply schedule of the sugar factory, given the information on land-rent supply schedule (shown in Table III-4) and the cost of farming and transportation, and the yield of each land type (as shown in Table III-5).

Using the information from the sugarcane supply schedule in Table III-6, a sugarcane supply curve for the sugar factory may be drawn as presented in Figure III-1.

Stepped Supply Function

The traditional neo-classical supply function is "smooth" or "continuous." The supply function derived by using variable price or variable resource programming has a "stairstep" nature as shown in

TABLE III-6. SUMMARY OF THE OPTIMAL SOLUTIONS TO VARIABLE RESOURCE PROGRAMMING PROBLEM OF TABLE III-5.*

Solution Number	Real Activities						Land Disposal Activities			S Value (tons)	MC (Rp/Ton)
	RLA	FLA	RLB	FLB	RLD	FLD	DLA	DLB	DLD		
	1	2	3	4	5	6	7	8	9	10	11
1	0.0	0.0	745	745	0.0	0.0	1,565	0.0	1,255	0 - 7,450	41,500
2	1,565	1,565	745	745	0.0	0.0	0.0	0.0	1,255	7,450 -27,795	48,231
3	1,565	1,565	745	745	1,255	1,255	0.0	0.0	0.0	27,795 -41,600	52,091

*Source: Computer output of the linear programming problem presented in Table III-5.

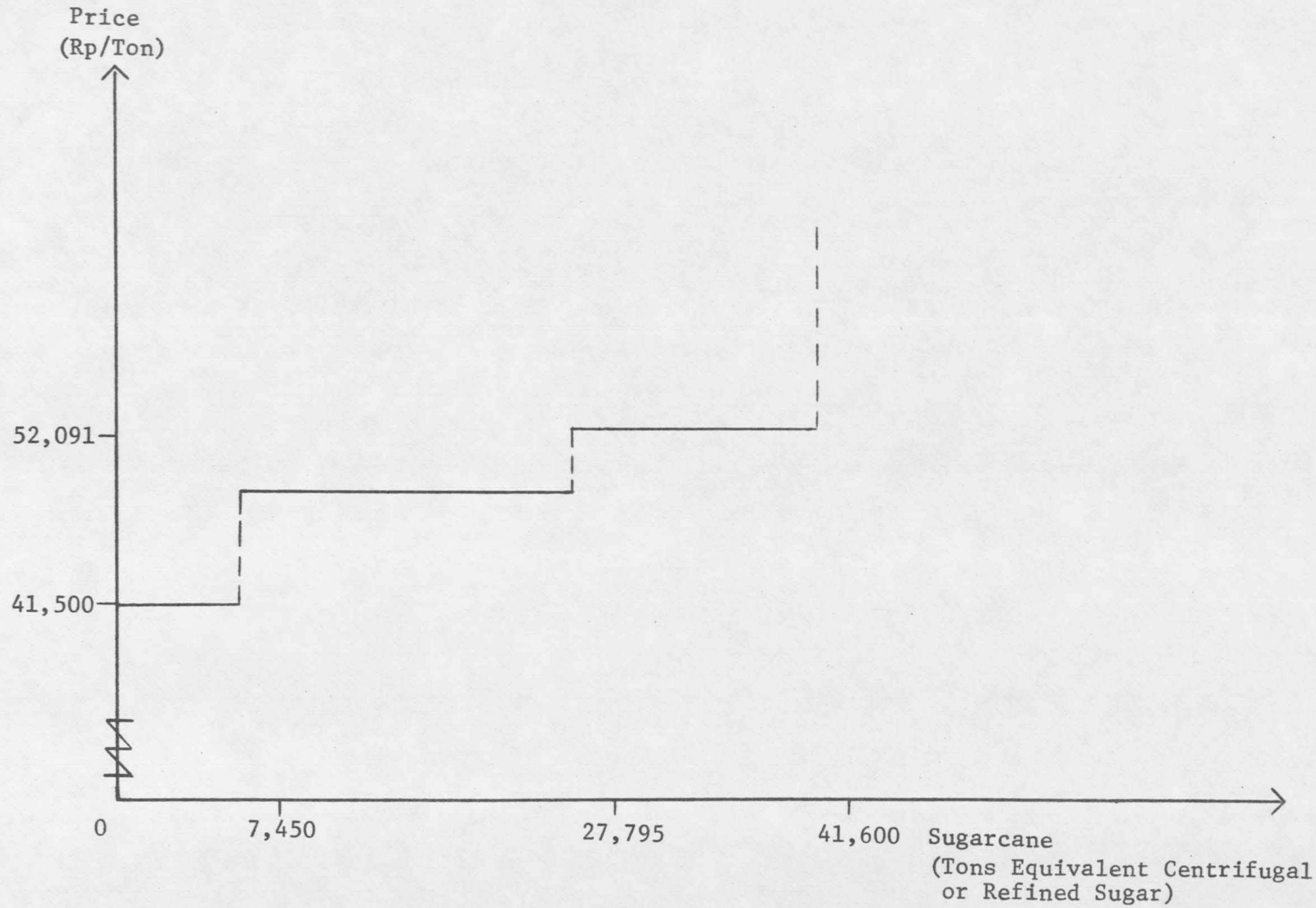

Figure III-1. Normative Sugarcane Supply Curve.

Figure III-1. This means that a given optimal basic feasible solution and the associated marginal cost will be stable over a range of "supply" (i.e., output). Steps in the function are established at points indicating a change in the activities in the optimum basic feasible solution. When this occurs, the marginal cost (or Price (Rp/Ton) in Figure III-1) changes to a new level, *ceteris paribus*.

The stairstep characteristics of the normative supply function derived by using variable price programming results from a finite number of alternative activities and rigid resource restrictions. The number of steps and corners in the stepped supply function are a function of the number of alternative activities and restricting resources. By including more competitive alternatives and more effective restrictions, variable price programming will give a normative supply function with more and smaller steps [19,p.17].

Kottke in his article, "The Anatomy of a Step Supply Function," questioned whether or not a stepped supply function has the same conceptual basis as a smooth supply function and took the position that the interpretation of the stepped supply position follows the conventional explanation of a smooth supply function [20]. Kottke concluded that the anatomy of a stepped supply function consists of two basic parts: (1) the marginal cost function, which forms the horizontal segment, and (2) the profit-maximization function, which forms the vertical segments [20,p.112].

Burt has developed a technique for curve fitting to step functions [21]. This technique can be used to convert a stepped supply function to a smooth supply function and retain its original interpretation of supply behavior.

Why Linear Programming Was Used In This Study

Nerlove and Bachmann suggest two general approaches for deriving supply functions empirically: (1) constructive methods and (2) statistical analysis of time series data [22,pp.541-547].

The constructive methods involve the derivation of supply functions from data and information relating to production functions and individual behavior. The estimation of supply functions through the use of classical production functions, farm budgeting, and linear programming are the constructive methods or synthetic approaches. The statistical analysis of time series data uses regression techniques in deriving a supply function.

Each of these methods has advantages and disadvantages relative to other methods as an empirical tool for deriving supply fucntions. However, despite any advantages or disadvantages attached to the statistical time series analysis used in other studies, it is not an operational analytical technique for this study for the following reasons:

1) Supply functions derived by using statistical time series data analysis for regression analysis are considered to be positive

supply functions. By positive the author refers to what has happened. In this particular case, data on what has happened, does not represent a quantity-price relationship. The participation of the farmers in supplying land to the factory for sugarcane growing has never been based on the free will of the farmers because the rate of land rent paid to the farmers has always been too low. 7/

2) There is no time series data available for important independent variables which might be postulated to affect the quantity of land supplied by the farmers to the sugarcane factory for growing sugarcane.

To derive a supply function through classical production function analysis requires data which are not available, and it is very time- and cost-consuming to collect enough data to construct such production functions in the sugarcane areas. Hence, there are only two alternatives remaining to choose from, farm budgeting and linear programming.

Looking at the number of alternative activities and the resource restrictions faced by the farmers in a region in this study, it is very

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7/ This statement may be clarified by quoting Mubyarto's statement: ". . . daptlah disimpulkan bahwa pokok persoalan dalam hal areal tanah ini bukan terletak pada ketidak mampuan pabrik gula untuk mendapatkan areal jang tukup bagi tanaman tebunya, akan tetapi terletak pada persoalan bagaimana areal tanah tersebut dapat diperoleh tanpa kesukaran dan tanpa disertai perasaan terpaksa dari pihak para petani/pemilik tanah" [23,p.20]. What Mubyarto really means is that sugar factories in Java have been able to meet their demand for land at any level of land rent that has been paid to the farmers. However, the farmers gave up their land under a feeling of "pressure."

hard to decide *a priori* whether farm budgeting or linear programming is a more efficient tool to derive a normative supply function in this study. However, since linear programming is more flexible than budgeting for analyzing the problem, provided a high-speed computer is available, linear programming was chosen as a tool of analysis in this study.

Data Generation and Unit of Analysis

Area Under Study and Method of Data Collection

Each sugar factory in the major project has made plans for obtaining its raw sugarcane supply for the expanded future milling capacity. The factories have chosen a combination of the following methods of obtaining its additional requirement of raw material:

1) renting additional land within the current factory working area;
2) renting land outside the current working area (expansion of the working area); and
3) growing ratoon sugarcane either managed by the factory or by the farmers (landowners).

All three factories in the major project have to expand their current working areas to meet their expanded raw material requirements for the future.

The Sragi factory and its working area (current and expansion) covers twelve kecamatans (sub-districts) in the northern coastal plain of Central Java. These twelve kecamatans are located in the administrative boundary of two adjacent kabupatens (districts), Pemalang and Pekalongan. Six of these kecamatans (Petarukan, Taman, Ampelgading, Bodeh, Comal, and Ulujami) belong to kabupaten Pemalang; and the other six (Sragi, Wirodesa, Bojong, Wonopringgo, Kedungwuni, and Kesesi) belong to kabupaten Pekalongan.

The opportunity cost to the farmers of leasing land to a sugar mill for a given leasing period will be determined by: (1) type and number of crops that can be grown on the land, (2) yields of the crops, and (3) input and output prices paid and received by the farmers. According to the field managers of Sragi sugarcane factory, variation in the first two factors from one plot of land to another depends mainly upon the variation in the availability of water for the land during the rental period. Hence, for determining an appropriate opportunity cost of leasing land to the factory for the farmers, the land in the factory working area is stratified according to availability of water for the land.

There are three main categories of availability and source of water for paddy land in the Sragi factory working area:

1) Water available year-round for the land. The source is mainly from public irrigation systems.
2) Water available only during the rainy season. The source is mainly from public irrigation systems.

3) Water available during the rainy season, depending on the rainfall.

The land in the working area is stratified into three land types based on the above three categories of availability of water as the following:

No.	Working Area	Irrigation	Code for Land Type
1	Current	Year-round	A
2	Current	Rainy season	B
3	Current	Rainfed	C
4	Expansion	Year-round	D
5	Expansion	Rainy season	E
6	Expansion	Rainfed	F

There was no homogeneous land type (based on the availability of water) map available to the AES survey team, and even a desa (village) might have more than one land type. For the purpose of land stratification, a majority of a land type in a desa is used to represent the land type in that desa. Desas with the same type of land in a kecamatan are grouped together and the majority of land types in the kecamatan is used to represent the land type in that particular kecamatan for purposes of sampling.

One kecamatan in both current and expansion areas is selected as sample areas to represent each land type in both areas. The kecamatans selected as samples in the current working area are those which have the largest amount of land grown with sugarcane in the past five years. Kecamatans selected as samples in the expansion working area are those which have the largest land area that could be grown with sugarcane in the future.

One desa is selected in each sample kecamatan to represent the sample kecamatan previously chosen. The criteria used to select the kecamatan sample were also used to select the desa sample. In other words, two-stage purposive sampling procedure was followed in selecting desas to represent each land type in both current and expansion working areas.

In each selected village, ten farmers who grew rice were selected using a systematic random sampling procedure. The farmers had to meet the requirement that they grew more than 0.10 hectare of rice. For other crops--corn, soybeans, peanuts, mungbeans, and other cash crops--the sample was selected from the ten selected rice farmers. Five samples were required for each other crop. If among the ten selected rice farmers, five samples were not available, then additional samples were arbitrarily taken in the village.

To conduct an interview with the farmers more efficiently, a questionnaire was prepared. All data needed for estimating yields, input-output coefficients, prices of inputs, and output for each crop were collected from the sampled farmers by use of the questionnaire. Questionnaires were also designed to interview government officials and to collect secondary data.

The stratification mentioned above was only for the purpose of collecting data needed for identifying alternative crop rotations and estimating input-output coefficients for each crop in each land type.

Representative Farm and Regional Farm Models

Linear programming was chosen as the analytical method in this study. However, a basic unit of analysis in estimating an aggregate supply function still has to be chosen once linear programming is chosen as the analytical tool.

To avoid aggregation bias in estimating an aggregate supply function for a region, each individual farm in the region of interest should be a separate unit of analysis and for which the supply function of each individual farm is determined. 8/ The aggregate supply function of the region will be the summation of the linear programming solutions for each individual farm in the region. However, programming each individual farm is impractical in a real-world situation. Other practical alternative methods have to be chosen. There are two farm models that have been used as the basic unit of analysis using linear programming

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8/ Aggregation bias as defined by Frick and Andrews states that "Aggregation bias . . . is the difference between the area supply function as developed from the summation of linear programming solutions for each individual farm in the area, and summations for a smaller number of 'typical' or 'benchmark' farms" [24,p.696].

as an analytical method: (1) representative farm model and (2) regional farm model. 9/

Representative Farm Model

This model used the representative or typical farm as the basic unit of analysis. This concept follows closely Marshall's concept of a representative farm. The farms in the region or area of study are stratified based on the typical characteristics of representative farms such as land type, size of farm, alternative enterprises, type of restrictions and input-output coefficients, and other characteristics of a farm. Previous studies suggest that the estimation of an aggregate supply function through the representative farm, linear programming method, may be accomplished in the following general procedure: 10/

1) Stratify the farms in the region into somewhat homogeneous groups of farms.

2) A representative (typical or benchmark) farm is selected for each group of farms.

9/ For example Goodwin, Plaxico, and Lagrone [25]; Krenz, Heady, and Baumann [26]; and Anderson and Heady [27] have used representative or typical farm models. Egbert, Heady, and Brokken [28]; Heady and Whittlesey [29]; and Egbert and Heady [30] have used regional farm models.

10/ See, for example, Miller and Heady [31,p.685], Anderson [32,p.97], and Barker and Stanton [33,p.704].

3) A linear programming model is developed for each representative farm, and its supply function is estimated by variable pricing (parametric) techniques.

4) The supply functions of the representative farms are expanded to estimates of the supply functions for each group of the sample farms.

5) The supply functions of these groups are summed horizontally to obtain supply functions for the overall population presented by the sample.

Regional Farm Model

This model uses a farming region as the basic unit of analysis; the aggregate supply for the region is determined directly in this model. Unlike the representative farm model, using a regional farm model, a supply function for a region is determined dependent upon (1) the farming practices within the region, (2) the resources available in the region, (3) input-output estimates for the region, and (4) the prices received and paid by the farmers within the region. Thus, the linear programming calculation is carried out so as to maximize the regional objective function subject to regional constraints.

The regional farm model appears to simplify the estimation technique because the aggregate resource levels and other restrictions can be obtained easily and the number of farms, their size distribution, and other characteristics within the region do not have to be known. However, the representative farm as the basic unit of analysis has the following advantages: [31,p.685]

1) It permits analysis of the impact of aggregate changes at the individual farm level, thus relating macro- and micro-variables and conditions.
2) It simulates the response decision made by the managerial units actually involved.
3) Compared with area or regional models, it allows restrictions on resource mobility among farms.

The regional farm model is used in this study as the unit of analysis for the following reasons: (1) there is no sampling frame readily available to carry out meaningful stratification of the farms in the region with respect to typical characteristics of a representative farm, and (2) the study is directed mainly toward the aggregate sense of the supply function and no attempt is made to explore the exogenous effects such as variable price of output on the organization or production plans for an individual or a group of typical farms.

CHAPTER IV

DERIVATION OF A NORMATIVE LAND-RENT SUPPLY SCHEDULE FACED BY SRAGI FACTORY IN ITS WORKING AREA

Introduction

The objective of this chapter is to determine the opportunity cost for different types of land controlled by the farmers in the Sragi factory working area. The opportunity cost determines the normative minimum amount the sugar factory must pay the farmers if the farmers are to make a free choice to rent their land to the Sragi factory. The resulting schedule of prices for rental land should provide the factory with the information on minimum rate of land rent for various land types and locations in its working area for a specified length of land lease. With the information on the land-rent supply schedule, cane yield of the land, and cost of farming sugarcane, the factory will be able to develop an optimum land-rental plan. The factory optimum land-rental plan will be discussed in the next chapter.

A land-rent supply schedule faced by Sragi sugarcane factory in its working area is derived by using the various price linear programming technique discussed in the previous chapter. A linear programming model for Sragi working area should be developed and the various components of the Sragi working area linear programming model must be specified explicitly.

The factory working area consists of twelve kecamatans. Each kecamatan will be treated as a regional farm or basic unit of analysis.

It is necessary to break down the factory working area into smaller units because of the limited mobility of some of the resources, such as human and animal labor. The working area of the factory is too large for the labor and draft animals to be employed anywhere in the working area. The labor has to walk to the field; hence, the fields have to be within walking distance of their homes. It is assumed that labor can do the work within the kecamatan boundary without reducing its working efficiency. It is also assumed that each kecamatan should strive to be self-sufficient in rice production. If there should be a rice deficit, then the people in the kecamatan have to buy rice from other kecamatans at a price which is higher than production costs for the deficit kecamatan.

Some resources such as credit for cash capital and fertilizers are mobile and can be made available anywhere in the working area. These types of resources become a binding or common constraint for all kecamatans in the working area. Thus, the objective function of each kecamatan will be maximized subject to specific restrictions applied to each kecamatan and the common restriction for cash capital and fertilizer applied to all kecamatans in the working area.

Linear Programming Model to Derive A Normative Land-Rent Supply Response

The objective of the farmers in the working area is to

$$\text{maximize} \quad OBJ = \sum_{k=1}^{12} C^k X^k$$

subject to

$$A^k X^k \leq B^k \qquad \text{for} \qquad k = 1, 2, \ldots, 12$$

$$\sum_{k=1}^{12} A^{kw} X^k \leq B^w \qquad \text{for} \qquad w = 1, 2, \ldots, 4$$

where: C^k = a subvector of per unit prices, containing n^k elements to represent a net return to land and family labor from a unit activity in the k-th kecamatan.

X^k = a subvector of activities, with n^k elements, representing activity levels in the k-th kecamatan.

A^k = a submatrix for input-output coefficients, containing $n^k \times i^k$ elements to represent the amount of each resource required by one unit of activity or the amount of output produced by one unit of activity in the k-th kecamatan. 1/

B^k = a subvector of restrictions, containing i^k elements, to represent the amount of resources available and output that should be produced in the k-th kecamatan.

1/ One of the restrictions in all kecamatans is that each kecamatan should provide a certain minimum quantity of rice for the population in the kecamatan; hence, the inequality signs are not strictly less than, but one of them is greater than, for the rice restriction in each kecamatan.

A^{kw} = a submatrix of input-output coefficients with respect to common resources, containing $n^k \times w$ elements to represent the amount of working area resources required by each unit of activity in the k-th kecamatan.

B^w = a subvector of working area or common resource restrictions, with w elements representing the amount of resources available in the working area for any kecamatan's use.

The above mathematical linear programming model may be stated in a matrix form called an "angular structure;" i.e., one or more independent blocks linked by coupling equations as presented in Figure IV-1. This kind of linear programming structure consists of a set of almost separable sub-problems linked together by several common resource constraints.

The first row of Figure IV-1 contains the objective function for each region. The working area objective functions are the summation of the twelve sub-objective functions. The superscripts 1-12 represent the identity of the kecamatan. The subscript j denotes the activity, i the resource constraints unique to each kecamatan, and w the working area common resource constraints. The B vectors are resource limitations for each kecamatan and working area.

In structuring the linear programming model to derive a normative land-rent supply schedule faced by Sragi sugarcane factory in its working area, the following assumptions are made:

1) The standard assumptions of linear programming are assumed to be valid.

Working Area Objective Function	OBJ^1	OBJ^2	OBJ^3	OBJ^4	OBJ^5	OBJ^6	OBJ^7	OBJ^8	OBJ^9	OBJ^{10}	OBJ^{11}	OBJ^{12}	
Input-Output Matrix for Each Kecmatan	A^1_{ij}	0	0	0	0	0	0	0	0	0	0	0	$\leq B^1$
	0	A^2_{ij}	0	0	0	0	0	0	0	0	0	0	$\leq B^2$
	0	0	A^3_{ij}	0	0	0	0	0	0	0	0	0	$\leq B^3$
	0	0	0	A^4_{ij}	0	0	0	0	0	0	0	0	$\leq B^4$
	0	0	0	0	A^5_{ij}	0	0	0	0	0	0	0	$\leq B^5$
	0	0	0	0	0	A^6_{ij}	0	0	0	0	0	0	$\leq B^6$
	0	0	0	0	0	0	A^7_{ij}	0	0	0	0	0	$\leq B^7$
	0	0	0	0	0	0	0	A^8_{ij}	0	0	0	0	$\leq B^8$
	0	0	0	0	0	0	0	0	A^9_{ij}	0	0	0	$\leq B^9$
	0	0	0	0	0	0	0	0	0	A^{10}_{ij}	0	0	$\leq B^{10}$
	0	0	0	0	0	0	0	0	0	0	A^{11}_{ij}	0	$\leq B^{11}$
	0	0	0	0	0	0	0	0	0	0	0	A^{12}_{ij}	$\leq B^{12}$
Working Area Constraints	A^1_{wj}	A^2_{wj}	A^3_{wj}	A^4_{wj}	A^5_{wj}	A^6_{wj}	A^7_{wj}	A^8_{wj}	A^9_{wj}	A^{10}_{wj}	A^{11}_{wj}	A^{12}_{wj}	$\leq B^W$

Figure IV-1. Linear Programming Model in Angular Matrix Form.

2) The working area objective function is the summation of the twelve separable regional objective functions.

3) All farmers in the factory working area have the same knowledge of the prices of inputs and outputs.

4) Any shift in product outputs as suggested by the solution to the linear programming problem will not change the price of inputs and outputs.

Under these assumptions, the various parts of the linear programming model are developed in the following chapter, including (1) objective functions, (2) activities and their input-output coefficients, and (3) restrictions.

Model Specification

The relevant components of the linear programming problem should be discussed here: (1) the objective of the farmers in the use of their farm land and other resources, (2) the alternative activities or uses of the farmers' land and other resources, and (3) the availability of land and other farm resources.

Objective Function

If the farmers lease their land to the sugar factories, the farmers have to forego the opportunity of raising crops on their land for the length of the land-lease contract. The economic opportunity cost of leasing land for the farmers for a given length of land-lease contract will be determined by many factors, such as number and type of crops that could be grown during a leasing time (crop rotation), input-output coefficients, and prices of inputs and outputs for each crop in the rotation.

There are many factors influencing the farmers' choice of crops and crop rotations suitable for their land. These factors are rather complex as they are interrelated, mutually augmentative, or counter-balancing with each other in the farmers' decision making. These factors include: (1) self-sufficiency of food for their family's consumption, (2) high employment for the family labor, (3) money-income for farming and family living, and (4) even flow and quick turnover of income.

The degrees of importance of these various influencing factors may vary from farm to farm with different quantities of land, family labor, and capital resources available for crop production. Four alternative economic decision criteria could be used independently in the linear programming model and an optimal crop rotation or combination of crops determined for these four alternative decision criteria in each kecamatan. The four are: (1) gross returns, (2) return to land and family and hired labor, (3) return to land and family labor, and (4) return to land. The above decision criteria are defined in the following way:

Gross Returns (GR) = (Yield - Harvesting Cost in Kind) × (Selling Price)

Return to Land, Family, and Hired Labor (RLFHL) = GR - (Cost of Seed, Fertilizer, Animal Labor, and Other Purchased Inputs)

Return to Land and Family Labor (RLFL) = RLFHL - Hired Labor Costs

Return to Land (RLAN) = RLFL - (Family Labor Costs).

However, it is assumed in this study that in the aggregate, one proper way to compare relative profitableness among competitive crops or crop rotations is their relative return to land and family labor per unit of time. In other words, the farmers' objective in farming is to maximize return to their land and family labor for any given length of time. The method used for calculating return to land and family labor is given in Appendix IV-1.

Human Labor

The study area is located in one of the most densely populated provinces in Indonesia where the man-land ratio is very high. The farmers surveyed in the study area used less than 20 percent of the available family labor in the cropping activities of any of the major crops grown in the area.

Dependent upon which of the four decision criteria mentioned earlier is used in the objective function of the linear programming model, the family and hired labor expenditures could be included or excluded from the total cost expenditures. But family labor expenditures are excluded from the cash expenditures, since family labor is not paid. Hired labor usually is paid in cash and in kind.

Since wages for men, women, and children are not the same per unit of time for the same job, it is assumed that their performances are not the same per unit of time. Wages for a man are higher than for a woman and wages for a woman are higher than for a child. In this study, all human labor is stated in man-hours; hence, all labor by men, women, and children is converted into man-hours.

Wage ratios for women and men and for children and men are used as the conversion coefficients in calculating the labor input in each crop activity. Usually hired or family labor works from 8 to 12 in the morning and from 2 to 5 in the afternoon with several short break times within the working hours.

Animal Labor

Animal labor is mainly used for plowing and harrowing the land. Animals are usually used in teams with one man as an operator. Sometimes a child is needed to lead the animals for better performance in plowing and harrowing the land. In the input-output coefficients of the linear programming model, an hour of animal labor means an hour of two animals plus an hour of man labor. Both owned and hired animals are included in the cost expenditures but only hired animals are included in the cash expenditures.

Seeds

Buying seeds for food crop production is not a common practice in Indonesia. Most of the farmers presumably take aside the best quality of their harvest for seed. Some farmers harvest part of their crop for seed before they harvest the whole crop for their family's consumption or for sale. Therefore, seed is included in the cost expenditures but excluded from the cash expenditures.

Fertilizers

In the study area, all farmers interviewed have been using chemical fertilizers in their rice crop production. Some farmers now fertilize their corn crops using fertilizers bought mainly from the government agencies, some from the local market. 2/ Government agencies usually supply fertilizers on a credit basis, while local market supplies them on a cash and carry basis. However, in this study fertilizer is included in the cost expenditures as well as in the cash expenditures.

Other Purchased Inputs

Inputs such as insecticides, pesticides, and other fertilizers besides nitrogen fertilizers which are used in very small amounts are

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2/ Fertilizers are sold to the farmers at a subsidized price; hence, the fertilizers in the rice farming areas are mainly supplied by the government agencies. In January, 1964, the price of urea sold by the government was Rp 40/kg., while the import price was Rp 120/kg.

included in the other purchased inputs group. These inputs are included in both cost and cash expenditures. There might be a disagreement about including animal and green manures in the cash expenditures, but in the available data, manures have been aggregated into the other purchased inputs group.

Prices of Inputs and Outputs

The prices of inputs and outputs used in this study were the prices paid and received at the farm level for each crop season during 1973. There is some variation of prices of inputs and outputs from one sample village to the other in the factory working area; however, average prices received and paid by the farmers in the factory working area are used in this study.

Alternative Activities or Paddy Land Uses

Like in all other sugarcane factory working areas in Java, the Sragi factory working area is located in a rice-producing area. Since rice is the main staple food of the Indonesian people, rice becomes the major competing crop for sugarcane in the sugar factory working area. Other competing crops for sugarcane in Sragi factory working area are "palawija" crops such as corn, soybeans, mungbeans, and peanuts. 3/ These

3/ Palawija is a secondary crop to rice, e.g., corn, soybeans, mungbeans, peanuts, potatoes, sweet potatoes, onions, etc.

crops are grown on paddy land only when water supplies are not adequate for growing rice. Farmers always grow rice on their land whenever water supplies permit them to do so. However, in Sragi factory working area, palawija crops cannot be grown during the rainy season because these crops are very susceptible to disease due to excessive rainfall and resulting low yields or crop failure. 4/ Hence, if rice cannot be grown on paddy land during the rainy season, then the land must be kept fallow.

Rice crops are considered subsistence crops because the farmers' motivation for growing rice is primarily to supply food for their families' daily consumption. On the other hand, palawija crops are considered cash crops because the farmers grow these crops mainly for sale. The majority of farmers sell their ripe palawija crops to the traders in the field before the crops are harvested. This method of selling crops is common all over Java and is called "tebasan." 5/

Sugarcane in Java is grown by the factories on the land rented from the farmers in the factory working area. It is grown with the Reynoso

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4/ This information is obtained from the farmers in the study area.

5/ "Tebasan" is a Javanese word which means to buy almost mature crops which the buyer must harvest at his own expense. Tebasan as a marketing method for rice crops is also becoming more popular in Java as a method of avoiding a relatively high harvesting cost for the rice crops [34,p.39].

cultural techniques which require fertile soil and good irrigation facilities; i.e., enough water supply and good drainage systems. The common practice in Java is to grow sugarcane for one harvest only--a new crop must be planted for the following harvest. Ratooning is not a common practice in Java and in Sragi working area. However, the Sragi factory intends to grow sugar with ratooning whenever conditions in its working area encourage it to do so in the future. 6/ The factory plans to have only one ratooning from each sugarcane crop.

Sugarcane takes 16 months until the first harvest; each ratoon will take 12 months, and all other competing crops take 5 months or less from soil preparation to harvest. If the factory should adopt one or two ratoonings in its sugarcane growing practices, then the factory must make a land-lease arrangement with the farmers for a period longer than 16 months. The length of land lease for one crop, one crop plus one ratoon, and one crop plus two ratoons will be 16 months, 28 months, and 40 months, respectively.

6/ A ratoon crop managed by the farmers themselves is not considered here as an alternative land use for the farmers because there is no data available to assess its economic profitability. Nevertheless, the Sragi factory also plans to buy sugarcane from the farmers in the future who are willing to ratoon factory sugarcane.

The number and combination of crops that can be grown on the land within a given length of land-lease time vary from one land type to another. These variations are mainly due to variations in water availability among various land types. The land with better irrigation can grow more alternative crops and more crops in a given length of time. Hence, it can be expected that sugarcane crops will face keener competition in well-irrigated land than in poorly-irrigated land. On the other hand, with the current Reynoso cultural techniques for sugarcane in Sragi and elsewhere in Java, the factory people think that they have to look for land with better irrigation and better sugarcane yields for the factories to rent.

Common crop rotations are those that have been practiced for various lengths of time on each land type as represented by land in the sampled villages in the Sragi factory working area; these are shown in Table IV-1. Except in the sampled village Kalipancur, two main crop rotations are practiced in each sampled village. Although partial budgeting indicates that more rice crops can be grown on a unit of land in a given length of time with higher return to the farmers, the figures in column 7 of Table IV-1 indicate that only a certain portion of the land in the villages is grown with certain crop rotations. 7/ Hence, the existence

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7/ For example, in Pesucen only 10 percent of the land is cultivated with four rice crops in 16 months; however, all land in Pesucen can be cultivated with at least three rice crops in 16 months.

TABLE IV-1. COMMON CROP ROTATIONS THAT CAN BE GROWN ON EACH LAND TYPE AND RENTING LAND TO THE FACTORY AS AN ALTERNATIVE PADDY LAND USE FOR VARIOUS LENGTHS OF LAND LEASE.*

Village Sampled to Represent Land Type	Land Type Represented by Sampled Village	Code	Crop Rotation for Various Lengths of Land Lease: 16 months	28 months	40 months	Percent Land in the Village
1	2	3	4	5	6	7
1. Pesucen (Petarukan)	A	ARI	R,R,R	R,R,R,R,R,R	R,R,R,R,R,R,R	100
		ARII	R,R,R,R	R,R,R,R,R,R	R,R,R,R,R,R,R,R,R,R	10
		ARL	RL16	RL28	RL40	
2. Purworejo (Sragi)	B	BRI	R,R,R	R,R,R,R,R	R,R,R,R,R,R,R	90
		BRII	P,R,P	P,R,P,R,P	P,R,P,R,P,R,P	100
		BRL	RL16	RL28	RL40	
3. Sukorejo (Ulujami)	C	CRI	P,R,P	P,R,P,R,P	P,R,P,R,P,R,P	70
		CRII	P,-,P	P,-,P,-,P	P,-,P,-,P,-,P	100
		CRL	RL16	RL28	RL40	
4. Kalipancur (Bojong)	D	DRI	R,R,R	R,R,R,R,R	R,R,R,R,R,R,R	100
		DRL	RL16	RL28	RL40	
5. Babakan	E	ERI	P,R,P	P,R,P,R,P	P,R,P,R,P,R,P	80
		ERII	P,-,P	P,-,P,-,P	P,-,P,-,P,-,P	100
		ERL	RL16	RL28	RL40	
6. Pamutih (Ulujami)	F	FRI	P,R,P	P,R,P,R,P	P,R,P,R,P,R,P	70
		FRII	P,-,P	P,-,P,-,P	P,-,P,-,P,-,P	100
		FRL	RL16	RL28	RL40	

R = rice. P = palawijo (either one of corn, soybeans, mungbeans, peanuts). - = fallow (no crop). RI, RII, and RL are Rotation I, Rotation II, and Renting Land, respectively. RL16, RL38, and RL40 are Renting Land activity for 16, 28, and 40 months, respectively.

*Source: AES Sugar Survey in the sampled villages, Jan.-Dec., 1974.

of more than one main crop rotation in a sampled village is mainly due to non-homogeneity of the land in that village. This should be obvious, since all land in a village is grouped into a single type of land represented by the majority of land types in that village. 8/

Growing rice four times in 16 months is possible due to the year-round availability of water, short maturing time for high-yielding rice varieties, and the adoption of the "petukan" cultural practice. 9/ Although the petukan cultural practice has become more and more popular among the farmers in paddy areas where water supply is available all year, in this study this cultural practice will not be considered as an alternative rotation for the following reasons: (1) The sample village of Pesucen is not representative for land type A. Pesucen happened to be the one village with the best irrigation facilities in the Sragi working area. Hence, the fact that 10 percent of the land in Pesucen can be grown with four rice crops in 16 months may be a very high percentage compared to other lands with the same class or type in the Sragi factory

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8/ See section on data generation and unit of analysis, Chapter III. It should also be noted that this procedure might contribute some bias to land supply function and total crop production estimates in each kecamatan and in the whole sugar factory working area.

9/ "Petukan" cultural practice may be described as follows: The farmers use a small part of the rice field as a seedbed for the next crop. Immediately after every harvest, the land is prepared for the next crop. The seed grown in the seedbed should be old enough to be transplanted by the time the land preparation for the next crop has been completed.

working area. (2) There is no information as to the average percentage on land type A in each village or kecamatan that can be grown with four rice crops in 16 months. However, it should be obvious that the competitive position of the sugar growing area will be weaker as the irrigation facilities in the sugarcane area become improved.

The input-output coefficients for each crop commonly grown in the Sragi working area on each land type and the average prices of inputs bought and outputs sold by the farmers in the working area are presented in Table IV-2.

There is no available data on peanuts from the AES survey. However, it seems safe to say that the result of the analysis in this study will not be affected by excluding peanuts as an alternative crop in the crop rotation.

Resource Constraints and Output Requirements

Available Land

It is assumed in this study that Sragi factory will grow sugarcane only on paddy land. The total amount of each type of paddy land in each of the twelve kecamatans in the Sragi factory working area is presented in Table IV-3, column 5. Some villages in a kecamatan are not included in the factory's tentative land-rental plan for two reasons: (1) the land in those villages is not suitable for growing sugarcane, and (2)

TABLE IV-2. INPUT-OUTPUT COEFFICIENTS AND PRICES OF THE FARMERS' CROPS IN SRAGI WORKING AREA.*

Type of Land	Yield: Gross Yield	Yield: Harvest Cost	Yield: Net Yield	Yield: Price	Pre-Harvest Labor: Labor: Family	Pre-Harvest Labor: Labor: Hired	Pre-Harvest Labor: Labor: Total	Pre-Harvest Labor: Labor: Wage	Pre-Harvest Labor: Draft: Hired	Pre-Harvest Labor: Draft: Price	Harvest Labor: Human: Family	Harvest Labor: Human: Hired	Harvest Labor: Total	Total Human Labor	Seed: Quantity	Seed: Price	Urea: Quantity	Urea: Price	Other Purchased Inputs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Kg.	Kg.	Kg.	Rp/Kg	Hrs.	Hrs.	Hrs.	Rp/Hr	Hrs.	Rp/Hr	Pct.	Pct.	Hrs.	Hrs.	Kg.	Rp/Kg	Kg.	Rp/Kg	Rp.
RICE: RAINY SEASON																			
A	5,296	521	4,775	29	61	825	886	20	51	78	--	—	355	1,272	17	60	110	32	3,538
B	4,148	356	3,792	29	230	1,124	1,354	20	83	78	—	—	278	1,715	35	60	140	32	329
C	2,952	245	2,708	29	131	584	715	20	33	78	—	--	348	1,096	28	60	101	32	566
D	3,424	308	3,116	29	47	590	637	18	75	78	--	--	229	943	17	60	101	32	923
E	2,855	255	2,600	29	80	1,047	1,127	17	73	78	—	—	191	1,391	40	60	57	32	115
F	1,942	161	1,781	29	134	529	663	20	71	78	--	—	61	765	30	60	95	32	238
RICE: DRY SEASON																			
A	4,594	366	4,228	28	109	976	1,085	21	51	78	—	—	308	1,444	19	62	106	34	1,490
B	5,283	421	4,862	28	413	1,261	1,674	19	106	78	—	—	354	2,134	33	62	114	34	2,477
D	3,649	311	3,338	28	59	741	800	18	64	78	—	—	244	1,108	22	62	87	34	1,156
E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
F	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CORN																			
A	1,752	—	1,752	32	183	741	924	22	—	—	—	—	227	1,151	22	46	107	33	538
B	1,565	—	1,565	32	160	677	837	22	—	—	—	—	203	1,040	20	46	64	33	344
C	1,378	—	1,378	32	137	612	749	22	—	—	—	—	179	928	17	46	20	33	149
D	880	—	880	32	228	622	850	22	—	—	—	—	114	964	23	46	30	33	—
E	901	—	901	32	100	895	995	22	—	—	—	—	117	1,112	17	46	29	33	—
F	718	—	718	32	160	450	610	22	—	—	--	—	80	690	10	46	29	33	—
SOYBEANS																			
A	796	--	796	105	187	1,153	1,340	23	—	—	—	--	199	1,539	26	122	--	—	2,052
B 1/	760	--	760	105	122	784	906	23	--	--	—	—	190	1,096	30	122	--	--	1,565
C	725	—	725	105	56	415	471	23	—	--	—	—	181	652	33	122	—	—	1,077
D 1/	760	--	760	105	122	784	906	23	—	--	—	—	190	1,096	30	122	—	—	1,565
E 1/	760	--	760	105	122	784	906	23	--	--	—	—	190	1,096	30	122	—	--	1,565
F 1/	760	—	760	105	122	784	906	23	—	--	—	—	190	1,096	30	122	—	—	1,565
MUNGBEANS																			
A 1/	449	—	449	100	96	412	527	20	—	--	—	—	112	639	10	108	—	—	974
B	428	—	428	100	61	470	531	20	--	—	—	—	107	638	12	108	--	—	1,369
C	469	--	469	100	130	373	503	20	—	--	—	—	117	620	7	108	—	—	578
D 1/	449	—	449	100	96	412	527	20	—	—	—	--	112	639	10	108	—	--	974
E 1/	449	—	449	100	96	412	527	20	--	--	—	--	112	639	10	108	—	--	974
F 1/	449	—	449	100	96	412	527	20	--	—	—	—	112	639	10	108	—	—	974

1/ No farmers recently grew the crop in the village sampled to represent the corresponding type of land. Input-output coefficients are calculated for these land types as the average coefficients in the other land types.

*Source: Sample farmers interviewed by AES Sugar survey team, Dec., 1973-Jan., 1974.

TABLE IV-3. AVAILABLE LAND IN THE SRAGI FACTORY WORKING AREA.

Kecamatan	Status	Location No.	Land Type	Total Available Paddy Land in All Villages 1/	Total Paddy Land in the Assigned Villages for Sugarcane 1/	Maximum Land Available for Sugarcane (Institutional constraint)	Sugarcane Yield Per Hectare 1/	Maximum Land Available for Crop Rotations Other Than Sugarcane	
1	2	3	4	5	6	7	8	9	
				Ha.					
1. Petarukan	C	1	A	1,567.650	1,567.650	1ARL = 522.00	11.56	1ARI=1,567.650	
			D	2,297.505	2,297.505	1DRL = 765.00	12.38	1DRI=2,297.505	
			E	1,547.198	—	--	--	1ERI=1,238.001	1ERII=1,547.198
2. Taman	C	2	A	786.021	786.021	2ARL = 262.00	12.77	2ARI= 786.021	
			D	2,577.096	2,577.096	2DRL = 859.00	12.10	2DRI=2,577.096	
			E	823.537	—	—	—	2ERI= 659.000	2ERII= 823.537
3. Kesesi	C	3	A	646.693	646.693	3ARL = 215.00	11.71	3ARI= 646.693	
			B	515.370	515.370	3BRL = 171.00	10.60	3BRI= 464.000	3BRII= 515.370
			D	307.845	307.845	3DRL = 102.00	12.57	3DRI= 307.845	
			D	2,006.574	—	—	—	3DRI=2,006.574	
4. Sragi	C	4	A	1,796.788	1,796.788	4ARL = 598.00	12.20	4ARI=1,796.788	
			B	1,385.020	1,385.020	4BRL = 461.00	12.11	4BRI=1,385.020	4BRII=1,385.020
			E	699.623	—	—	—	4ERI= 560.000	4ERII= 699.623
5. Ampelgading	C	5	A	1,377.625	1,377.625	5ARL = 459.00	13.03	5ARI=1,377.625	
			D	776.660	776.660	5DRL = 258.00	12.00	5DRI= 776.660	
			D	200.545	—	—	—	5DRI= 200.545	
			F	1,306.640	—	—	—	5FRI= 915.000	5FRII=1,306.640
6. Bojong	E	6	D	1,867.462	1,867.462	6DRL = 622.00	11.50	6DRI=1,867.462	
			F	682.970	682.970	6FRL = 227.00	9.60	6FRI= 478.000	6FRII= 682.970
7. Wirodesa	E	7	D	931.731	931.731	7DRL = 310.00	11.30	7DRI= 931.71	
8. Kedungwuni	E	8	D	2,175.970	2,175.970	8DRL = 725.00	11.00	8DRI=2,175.970	
			E	369.750	—	—	—	8ERI= 296.000	8ERII= 369.750
9. Wonopringgo	E	9	D	759.891	759.891	9DRL = 253.00	11.00	9DRI= 759.891	
			D	9.645	—	--	—	9DRI= 9.645	
10. Comal	C	10	B	1,873.186	1,873.186	10BRL = 624.00	12.44	10BRI=1,685.000	10BRII=1,873.186
			E	247.430	—	—	—	10ERI= 198.000	10ERII= 247.430
11. Bodeh	C	11	B	820.474	820.474	11BRL = 273.00	11.96	11BRI= 738.000	11BRII= 820.474
			E	552.126	552.126	11ERL = 184.00	11.00	11ERI= 442.000	11ERII= 552.126
			E	1,247.054	—	—	—	11ERI= 998.000	11ERLL=1,247.054
12. Ulujami	C	12	B	74.270	74.270	12BRL = 24.00	12.18	12BRI= 67.000	12BRII= 74.270
			C	334.324	334.324	12CRL = 111.00	12.57	12CRI= 234.000	12CRII= 334.324
			E	173.689	173.689	12ERL = 57.00	12.50	12ERI= 139.000	12ERII= 173.689
			F	565.325	565.325	12FRL = 188.00	12.10	12FRI= 396.000	12FRII= 565.325
			F	1,733.345	—	—	—	12FRI=1,213.000	12FRII=1,733.345

1/ Calculated from Tables 1-12, Appendix V-3.

the villages are too far from the factory. 10/ Total land available in the villages assigned for sugarcane by the factory are presented in Table IV-3, column 6.

An institutional constraint stipulates that the factory cannot rent more than one-third of the paddy land in any village each year. 11/ Hence, maximum land available for growing sugarcane will be one-third of the total land available in the assigned villages. The maximum land available for growing sugarcane under this constraint in each kecamatan is presented in Table IV-3, column 7. This institutional constraint will set the upper limit of land available for the factory to rent in each village. The purpose of imposing this constraint is to avoid the occurrence of a rice deficiency in the sugarcane area due to growing sugarcane in that area.

Using the information in Table IV-1 on the common non-sugar crop rotations on each land type and the total amount of each land type available in each kecamatan in column 5 of Table IV-3, maximum land available

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10/ A detailed section on how the factory decides which village will be included in its land-rental plan is presented in Appendix IV-3.

11/ However, since sugarcane will take 16 months to mature, there is a possibility that two-thirds of the paddy land in some of the villages will be occupied by sugarcane crops for a short period of time (about 4 months).

for each crop rotation is calculated for each kecamatan and presented in Table IV-3, column 8.

Available Labor

All farmers in Sragi working area as well as in all other rice producing areas in Java use only manual labor with some animal aid in all farming activities. Although the farmers in the study use more than 80 percent hired labor in their farming activities, there is no indication of a labor shortage in the area. 12/ Some laborers are hired by the factory from outside the village where sugarcane is grown. Sometimes laborers are in fact hired from outside the factory working area, but there is no reliable information as to the motivation on the part of the factory to hire labor from different villages or kecamatans or from outside the factory working area. 13/ There are no available data on the seasonal (monthly) labor requirements for farming activities and

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12/ Previous studies in the same area (Pemalang and Kendal districts) indicate that rice farmers used about 85 percent hired labor [35, p.3]. Neither current nor previous studies have any information on the motivation of the farmers to use a higher percentage of hired labor.

13/ One of the reasons the farmers are reluctant to rent their land to the factory is that the factory does not guarantee the farmer a job opportunity in the factory mill or the factory field. On the other hand, the factory has to hire labor from outside the village or working area because there is no labor available in some peak seasons in the village or working area; farmers in the working area are busy with their rice crops.

data on seasonal farm labor supply in each region. Therefore, it is not possible to check more closely whether there is any labor shortage in some peak months in the farming activities in each kecamatan or factory working area.

Monthly farm labor availability and total labor available in 16 months in each kecamatan in Sragi factory working area are presented in Table IV-4. In calculating the figures for Table IV-4, the following definitions and assumptions are made:

1) Labor force is defined as the population of the age 15 to 65 years. 14/
2) Labor requirements or demand for farming activities are uniformly distributed with respect to time in each kecamatan.
3) Number of hours in a working day is assumed to be 6 hours.
4) Number of working days in a month is 25 days.

Total monthly hours of farm labor available in each kecamatan in Sragi factory working area is calculated following the formula below:

$$TMHFL = TNLF \times PFLTLF \times NWHD \times NWDM$$

14/ Hsieh in his study on "Rice and Sugarcane Competition on Paddy Land in Central Taiwan" defined farm laborers as the population of age 16 to 55 years [36,p.20]. It might be that the definition of labor force in this study will lead to some over-estimation of the total farm labor supply in each region.

TABLE IV-4. AVAILABLE FARM LABOR IN EACH KECAMATAN.

Kecamatan	Labor Force 1/ Male	Labor Force 1/ Female	Labor Force 1/ Total	Total Labor Force 2/	Farm Labor Force as % of All Labor Force 3/	Total Farm Labor Force	Total Available Farm Labor in 1 Mo. 4/	Total Available Farm Labor in 16 Mos. 5/
1	2	3	4	5	6	7	8	9
				Men	Pct.	Men	---------Hrs.	.---------
1. Petarukan	28,632	31,120	59,752	49,482	80	39,586	5,937,900	95,006,400
2. Taman	22,593	25,129	47,722	39,429	NA (75) 6/	29,572	4,435,800	70,972,800
3. Kesesi	11,141	14,438	25,579	20,814	68	14,154	2,123,100	33,969,600
4. Sragi	19,983	21,685	41,667	34,511	67	23,122	3,468,300	55,492,800
5. Ampelgading	12,318	13,314	26,532	21,238	75	15,929	2,389,350	38,229,600
6. Bojong	10,104	11,147	21,251	17,572	NA (75) 6/	13,179	1,976,850	31,629,600
7. Wirodesa	17,391	19,513	36,904	30,465	NA (75) 6/	22,849	3,427,350	54,837,600
8. Kedungwuni	22,708	23,593	46,301	38,515	NA (75) 6/	28,886	4,332,900	69,326,400
9. Wonopringgo	6,939	7,646	14,585	12,062	NA (75) 6/	9,047	1,357,050	21,712,800
10. Comal	12,493	13,636	26,129	21,629	NA (75) 6/	16,222	2,433,300	38,932,800
11. Bodeh	9,279	10,383	19,662	16,236	96	15,587	2,338,050	37,408,800
12. Ulujami	14,710	17,131	31,841	26,188	68	17,808	2,671,200	42,739,200

1/ Defined as population of 15 years to 65 years of age in Table 1 of Appendix IV-2.

2/ Total labor force in man units where female converted into man with conversion factor of 0.67 (average female/male wage ratios).

3/ These figures taken from column 11 of Table 2, Appendix IV-2.

4/ Total farm labor (col. 7) × 6 × 25.

5/ Total farm labor (col. 7) × 6 × 25 . 16.

6/ Where data is not available, average percent of the other kecamatans is used as shown between parentheses.

where: TMHFL = Total Monthly Hours Farm Labor available;

TNLF = Total Number of Labor Force, which is defined as population of age 15 to 65 years;

PFLTLF = Percentage of Farm Labor in Total Working People; see Table 2 of Appendix IV-2;

NWHD = Number of Working Hours in a Day, which is assumed to be 6;

NWDM = Number of Working Days in a Month, which is assumed to be 25.

TMHFL in kecamatan Petarukan, for example, is 49,482 × 0.80 × 6 × 25 = 5,937,900 hours. TMHFL for each kecamatan is shown in column 8 of Table IV-4. Total hours of farm labor available in 16 months is presented in column 9 of the same table.

Available Draft Animals

In Java, most farmers use water buffalo and some use cows as draft animals in paddy land. The animals are mainly used for plowing and harrowing the soil. The animals work as a team, with two head of animals and one man as the operator.

Since work efficiency of the animals is affected by the weather temperature, usually plowing and harrowing are performed in the morning while the sun's heat is not too great, between about 6:00 a.m. and about 11:00 a.m. Only a few farmers plow and harrow their land in the evening. The animals are put to work only once in a day, either in the morning or evening, and work only four to five hours a day with several short breaks within this time period.

Cows are raised by the farmers mainly as draft animals for hauling carts, water buffalo as draft animals for plowing and harrowing in paddy or irrigated land. However, these types of animals are technically substitutable in plowing and harrowing jobs. There is no information available on the technical substitution rates between these animals. Nevertheless, since the hiring cost per hour of these two animals is the same, it can be assumed that these two animals are "perfectly substitutable."

The farmers raise and keep the animals only as long as they are fit as draft animals. These animals can be used as draft animals in the age bracket of 3 to 18 years. 15/ There are no data available on the age distribution of these animals in any kecamatan in the study area.

Total numbers of hours of draft animal labor available in each kecamatan monthly and for 16 months are presented in Table IV-5, columns 7 and 8, respectively. In calculating the available total hours of draft animal labor in a kecamatan, the following assumptions were made:

1) Water buffalo and cows have the same quality and the same rate of performance for the same job regardless of the sex or the age of the animal.

15/ These are the average ages calculated from the data collected by Sragi factory field managers in group interviews in the kecamatan in August, 1974.

TABLE IV-5. AVAILABLE DRAFT ANIMALS IN EACH KECAMATAN, 1973.

Kecamatan	Water Buffalo*		Cows*		Total Draft Animals	Total Animal Hours Available in		Draft Animals/ Ha. of Paddy Land
	Male	Female	Male	Female		1 Month	16 Months 1/	
1	2	3	4	5	6	7	8	9
								Head
1. Petarukan	NA	NA	NA	NA	2,691	114,367	1,829,872	0.50
2. Taman	729	1,690	2	35	2,456	104,380	1,670,080	0.59
3. Kesesi	509	1,501	20	80	2,110	89,675	1,434,800	0.61
4. Sragi	625	880	--	--	1,505	63,962	1,023,392	0.39
5. Ampelgading	343	793	--	--	1,316	55,930	894,880	0.36
6. Bojong	203	487	--	--	873	37,102	593,632	0.34
7. Wirodesa	142	445	23	71	681	28,942	463,072	0.73
8. Kedungwuni	800	126	20	48	994	42,245	675,920	0.39
9. Wonopringgo	387	265	--	--	652	27,710	443,360	0.85
10. Comal	120	429	2	20	571	24,267	388,272	0.27
11. Bodeh	336	1,054	105	356	1,851	78,667	1,258,672	0.71
12. Ulujami	203	1,024	--	--	1,227	52,147	834,352	0.43

1/ (col. 7) × 16.

*Sources: Collected by AES Sugar survey team from 1973 office records in each kecamatan, Dec., 1973-Jan., 1974.

2) The animals are used as draft animals only during the ages of 3 and 18 years.

3) The animals are kept by the farmers only up to the age of 18 and the age distribution of these animals in each kecamatan is assumed to be uniform.

4) The animals are always used in pairs, two animals for one man operator.

5) The animals cannot be used for more than 4 hours a day and 25 days a month, but are available all year.

6) Plowing and harrowing season is not a limiting factor to the "effective" supply of the animal labor in each kecamatan; i.e., demand for draft animals is uniformly distributed with respect to time.

Assumptions (2) and (3) imply that only 83.3 percent of the water buffalo and cows in each kecamatan are technically available as draft animals. However, it is further assumed that 85 percent of the animals in each kecamatan are technically available for plowing and harrowing of paddy land.

The monthly available animal labor in each kecamatan is calculated following the formula below:

$$TMHAL = 0.85 \times (THDA)/2 \times (NAWHD) \times (NWDM)$$

where: TMHAL = Total Monthly Hours of Animal Labor available;

THDA = Total Head of Draft Animals;

NAWHD = Number of Animal Working Hours per Day;

NWDM = Number of Working Days in a Month.

Following the above formula, TMHAL in kecamatan Petarukan, for example, is $0.85 \times 2{,}691/2 \times 4 \times 25 = 114{,}367$ hours.

Rice Requirements for Local Consumption

Rice is the main staple food for the people in Indonesia. On the average, rural people in Central Java consume 213.5 grams of rice per capita per day, the figure for Java as a whole is 259 grams. 16/ Rural people in Java consume 1,718 calories and 39.7 grams of protein per capita per day, and rice contributes 55 percent and 27.8 percent of the total daily caloric and protein intake, respectively [37,Table II-10]. 17/ Total consumption of cereal per person per day in Central Java is 370 grams (consisting of 213.5 grams of rice and 111 grams of corn) [37,

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16/ These figures are calculated as the average level of consumption per day in two different seasons in Table II-10 of Sajogyo [37]. He used data from 1969/70 National Social Economic Survey on Household Expenditures for Consumption to calculate figures in his tables II-6 and II-10.

17/ Rice consumption in Java is very low compared to rice consumption in Thailand. In 1962, people in Thailand consumed 459 grams of rice (consisting of 271 and 188 grams of non- and glutinous rice, respectively) per capita per day, and rice contributes 85.3 percent to the total daily caloric intake of 1,986 calories [38,Table 13].

Table II-6]. 18/ There is no specific information available on the level of cereal consumption in the Sragi working area; however, since this area is the rice-producing area, it is reasonable to assume that the people in Sragi working area consume the same level of cereal as the average people in Java--mainly rice.

One of the main motivations of the farmers for farming in Java as well as in Sragi working area is to produce food crops, especially rice, to meet their family's daily food-consumption needs. Needless to say, rice farming is the main source of the farmers' income in a rice-producing area like Sragi working area. Since sugarcane competes with rice and other food crops for land in the sugarcane working area, as a matter of policy, growing sugarcane should not create a deficit or worsen an existing deficit of rice supply in this area.

Rice consumption per month, total rice requirements for 16 months, and its equivalent of paddy (unhusked rice) requirements for 16 months for each kecamatan in Sragi factory working area are presented in Table IV-6. In calculating the figures in Table IV-6, the following assumptions are made:

18/ Sajogyo assumed that corn has the same calories as rice per unit of weight [37,Table II-6,note].

TABLE IV-6. POPULATION, RICE CONSUMPTION, AND PADDY REQUIREMENTS IN EACH KECAMATAN.

Kecamatan	Total Population All Ages and Sex 1/	Rice Consumption per Month (30 Days) 2/	Rice Requirement for 16 Months 3/	Paddy Equivalent Requirement for 16 Months 4/
1	2	3	4	5
		Kg.		
1. Petarukan	99,127	1,100,309	17,604,944	29,341,573
2. Taman	94,860	1,052,946	16,847,136	28,078,560
3. Kesesi	47,697	529,436	8,470,976	14,118,293
4. Sragi	68,484	760,172	12,162,752	20,271,253
5. Ampelgading	39,824	442,046	7,072,736	11,787,893
6. Bojong	40,016	444,177	7,106,832	11,844,720
7. Wirodesa	55,700	618,270	9,892,320	16,487,200
8. Kedungwuni	68,408	759,328	12,149,248	20,248,746
9. Wonopringgo	26,891	298,490	4,775,840	7,949,733
10. Comal	49,287	547,085	8,753,360	14,588,933
11. Bodeh	36,408	404,128	6,466,048	10,776,746
12. Ulujami	60,954	676,589	10,825,424	18,042,373

1/ From column 14, Table 1 of Appendix IV-2.
2/ (col. 2) × 30 × 0.37.
3/ (col. 3) × 16.
4/ (col. 4)/0.6.

1) People in Sragi factory working area eat only rice in their cereal consumption.
2) People consume 370 grams of rice per person per day, regardless of their age. 19/
3) Conversion factor of paddy (unhusked rice) to rice is 0.6. For example, 100 kilograms paddy will produce 60 kilograms rice (husked). 20/

In the linear programming model, total rice requirements for each kecamatan will be treated as a minimum constraint that should be met in each kecamatan. However, buying rice as an augmenting activity is added into the linear programming model to facilitate renting of land to sugarcane factories in case there is a deficit of rice in any kecamatan due to renting land to the factory. The deficiency in rice must be made up by purchasing rice from a rice-surplus area at a higher price than is charged for locally grown rice.

19/ The food consumption figures calculated by Sajogyo [37,Table II-6, Table II-10], cited in this thesis are based on average consumption per person in a household.

20/ This is the average conversion factor of main rice varieties grown in the Sragi factory working area obtained from Dinas Pertanian Rakyat Kabupaten Pemalang (Agr. Ext. Serv. in Pemalang District), August, 1974.

Adjustment of Land Rent for Differences In Yields

It has been discussed in Chapter III in the section on data generation and unit of analysis that although there is more than one type of land in a village, all land in that village is classified as being one land type. The land in the village is classified as a land type which constitutes the largest portion of the total land in that village. Hence, it is implicitly assumed that there will be only a single land-rent rate for paddy land paid by the factory to the farmers in any village. This simplification might under- or over-estimate the true opportunity cost of some land in the village.

The above land classification is mainly for the purpose of calculating the economic opportunity cost for the farmers to rent a particular land type to the factory. On the other hand, the factory as the demander for the land is primarily concerned with the cost of land-rent required to produce a ton of sugarcane.

Sragi factory will be indifferent between renting any land type if the net cost per ton of sugarcane produced is the same. For the following discussion, let us assume that production and transportation costs per ton of sugarcane produced are the same across various land classes. Then the sugar factory would value one class of land more than another only on the basis of physical yield.

For example, land type A and land type B yield 10 tons and 5 tons of sugarcane, respectively, and the yield ratio between land A and land B is 10/5 = 2. If the rent for land B is set at Rp 100,000 per hectare, the factory will be indifferent between renting land A and land B if the rent for land A is set equal to 2 × Rp 100,000 = Rp 200,000. In this case, the cost of the land rent to produce one ton of sugarcane will be the same for either land type.

In order that the factory will be indifferent toward renting any land type at a given land-rent rate, the land-rent values in the objective function of the linear programming model must be varied at a fixed proportion such that net costs per ton of sugarcane delivered at the factory are the same over all land types. In this study the proportion coefficients will be based on the yield ratios of sugarcane on each land type and location because data are inadequate to use a more precise criterion. Since the yield of sugarcane on land type F in kecamatan Bojong is the lowest (9.6 tons per hectare), the yield of this land is taken as the basis with the value of 1. By varying the land rent in the linear programming model at a fixed proportion, the land type as defined above will be immaterial for the factory any longer. However, for identification purposes, the land type identification is still maintained in the rest of this thesis.

By employing the variable price programming technique to the above linear programming model, the following information can be obtained from the solutions for the model:

1) the quantity of each land type in each kecamatan that should be offered by the farmers to the factory for rent, and their associated rent or offer prices; and

2) the surplus and deficit of rice, labor, and draft animals in each kecamatan under two different situations: first, when the factory is allowed to rent no rice land, and second, when the factory rents paddy land up to the maximum allowed by the institutional constraint.

Normative Land-Rent Supply Schedule Faced by Sragi Factory in Its Working Area

The solution for the linear programming model at various land rents assigned to the renting land activities give the quantity of each land type that should be offered by the farmers to the factory for rent in each kecamatan, and their associated rent values. The paired values of land quantity and land rent in each kecamatan are presented in Table IV-7. 21/

Surplus and Deficit on Rice, Labor, and Draft Animals

When the factory is allowed to rent no land for growing sugarcane, the farmers in each kecamatan will grow food crops on all the paddy land

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21/ A more detailed section on the quantity of land offered at a given land rent with the land type identification and yield (sugar) are presented in Appendix IV-3.

TABLE IV-7. NORMATIVE LAND-RENT SUPPLY SCHEDULE IN EACH KECAMATAN IN SRAGI FACTORY WORKING AREA.*

Location		Normative Land-Rent Supply Schedule	
Kecamatan	Number	Rent Values 1/	Size of Land Offered
1	2	3	4
		Rp./Ha.	Ha.
1. Petarukan	1	168,000	765.00
		229,000	1,287.00
2. Taman	2	164,000	262.00
		239,000	1,121.00
3. Kesesi	3	157,000	51.54
		166,000	153.27
		209,000	263.00
		232,000	478.00
4. Sragi	4	151,000	138.50
		214,000	460.00
		229,000	1,058.00
5. Ampelgading	5	162,000	258.00
		228,000	717.00
6. Bojong	6	100,000	204.09
		120,000	227.00
		168,000	849.00
7. Wirodesa	7	565,000	310.00
8. Kedungwuni	8	172,000	385.90
		562,000	725.00
9. Wonopringgo	9	172,000	26.52
		562,000	253.00
10. Comal	10	156,000	187.32
		194,000	605.99
		220,000	624.00
11. Bodeh	11	92,000	110.43
		126,000	184.00
		162,000	266.05
		212,000	457.00
12. Ulujami	12	151,000	169.60
		189,000	180.00
		195,000	222.74
		223,000	323.04
		234,000	345.30
		262,000	356.00
		305,000	363.43
		761,000	380.00

1/ Rounded up to the nearest Rp 1,000.

*Based on information given in Table 1, Appendix IV-3.

which maximizes Total Return to Land and Family Labor involved in crop production. The solution for the model gives the information on surplus and deficit of rice, labor, and draft animals in each kecamatan as presented in Table IV-8.

In the case where no sugarcane is grown, figures in column 5 show that in all kecamatans in the factory working area, there would be labor surpluses ranging from 47 percent in kecamatan Sragi to 95 percent in kecamatan Wirodesa. On the average, there would be an 84 percent labor surplus in Sragi working area. Draft animals would be in surplus in all kecamatans except in kecamatan Comal, 26 percent. On the average, draft animals would be in a 51 percent surplus in Sragi factory working area. Rice would be in surplus in all kecamatans but two, kecamatan Wirodesa and kecamatan Ulujami. In these kecamatans, there would be a rice deficiency of 39 percent and 61 percent, respectively. On the average, the Sragi factory working area would have a rice surplus of 40 percent.

When land is allowed to be rented by the factory to grow sugarcane up to the limit permitted by the institutional constraint, the labor surplus decreases, draft animal surplus increases, and the rice deficit becomes worse, as presented in Table IV-9.

There would be a 74 percent labor surplus in the whole working area. About 10 percent more labor would be employed if land could be rented and grown with sugarcane up to the limit. However, draft animals would be in surplus in all kecamatans. On the average, there would be a 64

TABLE IV-8. FARM LABOR, ANIMAL AND RICE SURPLUS OR DEFICIT WHEN NO LAND IS USED FOR SUGARCANE.

		Farm Labor			Animals			Rice		
Kecamatan	Status	Available Man Hours	Surplus/Deficit Man Hours	Pct.	Available Hours	Surplus/Deficit Hours	Pct.	Required Kilograms	Surplus/Deficit Kilograms	Pct.
1	2	3	4	5	6	7	8	9	10	11
1. Petarukan	C	95,006,400	76,113,978	80	1,829,872	1,033,271	56	29,341,573	21,531,917	42
2. Taman	C	70,972,800	56,840,280	80	1,670,080	978,573	59	19,730,800	21,166,431	52
3. Kesesi	C	33,969,600	20,991,639	62	1,434,800	724,920	51	14,118,293	27,102,223	66
4. Sragi	C	55,492,800	25,847,824	47	1,023,392	328,407	32	20,271,253	26,267,134	56
5. Ampelgading	C	38,229,600	25,847,828	68	894,880	420,790	47	11,787,893	20,419,465	63
6. Bojong	E	31,629,600	23,866,874	75	593,632	180,536	30	11,844,720	9,108,190	43
7. Wirodesa	E	54,837,600	51,894,261	95	463,072	273,930	59	16,487,200	-6,497,180	-39
8. Kedungwuni	E	69,326,400	61,230,560	88	675,920	212,604	31	20,248,746	3,926,513	16
9. Wonopringgo	E	21,712,800	19,283,873	89	443,360	287,275	65	7,959,733	284,316	3
10. Comal	C	38,932,800	27,296,695	70	388,272	-139,056	-26	14,588,933	11,559,043	44
11. Bodeh	C	37,408,800	26,724,303	71	1,258,672	928,954	74	10,776,746	4,538,126	30
12. Ulujami	C	42,739,200	34,756,852	81	834,352	627,099	75	18,042,373	-11,081,214	-61
Average for the Factory Working Area				84			51			40

NOTE: C = current working area, E = expansion working area.

TABLE IV-9. FARM LABOR, ANIMAL AND RICE SURPLUS OR DEFICIT WHEN LAND IS USED FOR SUGARCANE UP TO THE LIMIT ALLOWED BY INSTITUTIONAL CONSTRAINT.

		Farm Labor			Animals			Rice		
Kecamatan	Status	Available Man Hours	Surplus/Deficit Man Hours	Pct.	Available Hours	Surplus/Deficit Hours	Pct.	Required Kilograms	Surplus/Deficit Kilograms	Pct.
1	2	3	4	5	6	7	8	9	10	11
1. Petarukan	C	95,006,400	71,251,672	75	1,829,872	1,268,432	69	29,341,573	5,768,939	16
2. Taman	C	70,972,800	52,412,278	74	978,573	1,193,036	71	19,730,800	8,161,425	29
3. Kesesi	C	33,969,600	19,540,975	58	724,920	818,040	57	14,118,293	20,922,965	60
4. Sragi	C	55,492,800	34,889,079	45	328,407	526,533	51	20,271,253	12,285,960	38
5. Ampelgading	C	38,229,600	23,307,359	61	420,790	543,391	61	11,787,893	11,005,033	48
6. Bojong	E	31,629,600	20,112,675	64	180,536	308,429	52	11,844,720	2,394,617	17
7. Wirodesa	E	54,837,600	50,597,221	92	273,930	336,860	73	16,487,200	-9,821,000	-60
8. Kedungwuni	E	69,326,400	58,161,886	84	212,604	354,381	52	20,248,746	-3,635,809	-18
9. Wonopringgo	E	21,712,800	18,225,321	84	287,275	338,634	76	7,959,733	-2,428,349	-31
10. Comal	C	38,932,800	26,059,181	67	-139,056	5,312	1	14,588,933	4,356,719	23
11. Bodeh	C	37,408,800	25,337,252	68	928,954	997,466	79	10,776,746	1,178,056	10
12. Ulujami	C	42,739,200	32,928,051	77	627,099	653,776	78	18,042,373	-12,211,379	-68
Average for the Factory Working Area				74			64			16

NOTE: C = current working area, E = expansion working area.

percent draft animal surplus. More labor would be employed and fewer animals would be employed when sugarcane is grown at the maximum because sugarcane crops require more labor per hectare and require no animals at all. Rice surplus for the whole working area would decrease to 16 percent, and three out of four kecamatans in the expansion working area would have a rice deficit ranging from 18 percent in kecamatan Kedungwuni to 60 percent in kecamatan Wirodesa. In kecamatan Ulujami, in the current working area, there would be a 68 percent rice deficit.

Apparently the traditional institutional constraint which prohibits the factory from renting no more than one-third of the available paddy land is not effective enough to protect the people in some kecamatans from a rice deficit. Some of the kecamatans have been in a rice-deficit position without sugarcane grown in those kecamatans (see Table IV-9, col. 1). However, the institutional constraint is effective in protecting the whole working area of the Sragi factory from experiencing a rice deficit. If one-third of the paddy land in the assigned villages for sugarcane in the Sragi factory were rented for sugarcane, there would still be a rice surplus for the whole working area of about 16 percent (Table IV-9, col. 11). These lands can supply about 97,000 tons equivalent centrifugal sugar of cane for the factory to process. This amount is about 30 percent above the new milling capacity of the Sragi factory.

CHAPTER V

DERIVATION OF A NORMATIVE SUGARCANE SUPPLY FUNCTION FOR THE SRAGI FACTORY

Introduction

The Sragi sugar factory's current milling capacity is about 20,000 tons equivalent centrifugal sugar of cane per milling season each year. To increase the efficiency and the milling capacity of the Sragi factory, it needs rehabilitation.

Rehabilitation of Sragi factory's milling capacity will take place gradually to avoid a complete shutdown of the mill during the rehabilitation process. The rehabilitation will be completed in the 1978/79 crop season. From then on, the factory will be operating with its new maximum technical capacity of about 70,000 tons equivalent centrifugal sugar of cane, more than triple the current capacity. This new milling capacity is presumably an optimum capacity provided that there will be enough raw material (sugarcane) to fully utilize the new capacity.

Since the Sragi factory does not have land of its own on which to grow sugarcane for processing, it has to rent land from the farmers in its working area. In addition to growing a new crop of sugarcane every year, the factory is planning to ratoon the sugarcane crop in the future; some of this ratoon crop will be managed by the factory itself and some by the farmers who own the land. The Sragi factory's future plans with respect to its milling capacity, hectares of land that will be cultivated by the factory and the farmers, and yield and total output estimates of sugar are presented in Appendix V-1.

To meet factory demand for the raw material required to fully utilize the factory's future milling capacity, the factory has developed a physical land-rental plan for each kecamatan in its working area beginning with the 1978/79 crop season as presented in Appendix V-2. The details of Sragi factory rental plan at the village level are presented in Tables 1-12 of Appendix IV-3. However, since there are no data available on ratooning either by the factory or by the farmers, it is assumed in this study that the factory has to supply its cane by renting land and growing cane every year.

The main objective of this chapter is to derive a normative supply function of sugarcane for the Sragi factory to process, and an optimum land-rental plan for the Sragi factory to produce sugarcane in the field for the factory to process. A linear programming model of minimizing total costs of producing sugarcane in the field for the Sragi factory is developed. And the variable resource programming technique will be used to derive the relationship of the marginal and average total costs for various levels of sugarcane output. The solution for this model also will provide necessary information to determine the optimal land-rental plan for the Sragi factory.

Sragi Factory Model of Minimizing Cost of Producing Sugarcane in the Field

Given the land-rent supply schedule faced by Sragi factory in its working area and given the cost of farming sugarcane for the factory, the factory has to make a decision as to which type of land, how much, and in what location the land should be rented to grow a given amount of sugarcane for the factory to process. The land rented for growing sugarcane should be able to supply the factory a given amount of sugarcane at a minimum cost; i.e., minimum cost includes renting and farming costs of the land. This factory problem of choice can be formulated in the following mathematical linear programming model:

$$\text{minimize} \quad C = \sum_{k=1}^{12} \sum_{j=1}^{n^k} [(RC_j^k)(RL_j^k) + (FC_j^k)(FL_j^k)] \tag{1}$$

subject to

$$S = \sum_{k=1}^{12} \sum_{j=1}^{n^k} (FL_j^k)(Y_j^k) \tag{2}$$

$$RL_j^k \leq L_j^k \tag{3}$$

$$RL_j^k - FL_j^k = 0 \tag{4}$$

$$RL_j^k \geq 0 \tag{5}$$

$$FL_j^k \geq 0 \tag{6}$$

where: C = total cost of producing sugarcane in the field for the factory to process;

RC_j^k = cost of renting a hectare of land type j in location k;

RC_j^k = cost of farming a hectare of sugarcane on land type j in location k, and transporting the cane to the mill; 1/

RL_j^k = hectares of land type j in location k that should be rented;

FL_j^k = hectares of land type j in location k that should be cultivated with sugarcane;

S = the amount of sugarcane that should be produced in the field for the factory to process;

L_j^k = the amount of land type j in location k available for the factory to rent at a given price RC_j^k;

Y_j^k = the yield of sugar from farming a hectare of land type j in location k.

The objective function of this model, equation (1), specifies the cost of renting and farming a hectare of each land type in the twelve locations in the factory working area. The factory's objective is to minimize total costs in the field (renting plus farming costs) to produce a given amount (S tons) of sugar for the factory to process. Inequality (3) specifies that the amount of any land type rented in any location should not exceed the amount of that land type in that location available at a specified rent RC_j^k. Equality (4) specifies that

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1/ Cost of transporting cane from the field to the mill is included in farming costs.

any land rented must be cultivated for growing sugarcane and vice versa. The last two inequalities, (5) and (6), specify that there are no negative values allowed for any renting and farming land activities.

The above linear programming problem can also be presented in a linear programming tableau (as shown earlier in Table III-5) (see Figure V-1).

Specification of the Model

For purposes of the analysis presented in this chapter, ratooning sugarcane either by the sugar factory or by the farmers and buying sugar from the farmers are not considered as alternatives for supplying raw materials for the factory to process. Hence, renting land every year for 16 months to grow sugarcane and harvesting every year is the only way in this analysis to supply raw materials for the factory to process during each milling season in the year. A more complete model would consider ratooning.

In addition to the general assumptions of the linear programming problem, the following assumptions are applied to the factory's linear programming model:

1) There are no labor, capital, or other resource constraints except land availability faced by the factory in renting land and farming land with sugarcane.

RL_1^1	FL_1^1	. . .	RL_j^1	FL_j^1	. . .	RL_1^{12}	FL_1^{12}	. . .	RL_j^{12}	FL_j^{12}		Renting and Farming Land Activities
1											$\leq L_1^1$	
1	-1										= 0	
											$\vdots$	
			1								$\leq L_j^1$	Constraints
			1	-1							= 0	and
											$\vdots$	Material
						1					$\leq L_1^{12}$	Balance
						1	-1				= 0	
											$\vdots$	
									1		$\leq L_j^{12}$	
									1	-1	= 0	
	Y_1^1	. . .		Y_n^1	. . .		Y_1^{12}	. . .		Y_j^{12}	= S	
RC_1^1	FC_1^1	. . .	RC_j^1	FC_j^1	. . .	RC_1^{12}	FC_1^{12}	. . .	RC_j^{12}	FC_j^{12}	= C	Factory Objective Function

Figure V-1. Sragi Factory Linear Programming Model for Minimizing Field Cost of Producing Sugarcane in Tableau Form.

2) The factory is able to "delineate" land types in its working area; i.e., the factory will pay a specific land-rent rate to a specific land type equal to its offer price in any location.

3) The factory's farming cost for a hectare of land is assumed to be the same regardless of the type, yield, and location of the land. The farming cost of a hectare of sugarcane is Rp 360,000. 2/

There are thirty-six different land groups in the whole Sragi factory working area (as shown in Table V-1), each having its specific offer price (or rent) for the factory to rent. For each land group, a renting, a farming, and a disposal activity are assigned in the above linear programming model. One hectare of renting activity will facilitate one hectare of farming sugar activity, and in return farming activity will supply sugarcane for the factory to process. The yield of farming a hectare of various land in the twelve locations in the factory working area is presented in Table V-1, column 5.

The purpose of the model is to seek a minimum total cost of producing a given amount of sugarcane for the factory to process, and to discover which land should be rented with respect to the minimum cost.

2/ This farming cost includes Rp 4,000 for land clearing costs, which should be paid by the factory to the farmers for each hectare rented for sugarcane in addition to the land rent. See Appendix V-4 for further explanation.

TABLE V-1. AVAILABLE LAND FOR THE FACTORY TO RENT AND ITS ASSOCIATED YIELD AND COST OF RENTING PER HECTARE.*

Location			Available Land			
Kecamatan	Status 1/	Code No.	Type	Size	Yield 2/	Rent
1	2	3	4	5	6	7
				Ha.	Tons/Ha.	Rp/Ha.
1. Petarukan	C	1	A	522.00	11.56	228,760
		1	D	765.00	12.38	167,700
2. Taman	C	2	A	262.00	12.77	239,400
		2	D	859.00	12.10	163,800
3. Kesesi	C	3	A	215.00	11.71	231,800
		3	B B1	51.54	12.57	157,080
		3	B2	119.46	12.57	209,440
		3	D	102.00	10.60	165,600
4. Sragi	C	4	A	598.00	12.20	228,780
		4	B B1	138.50	12.11	151,320
			B2	322.50	12.11	214,370
5. Ampelgading	C	5	A	459.00	13.03	228,135
		5	D	258.00	12.00	161,784
6. Bojong	E	6	D	622.00	11.50	167,720
		6	F F1	204.09	9.60	100,000
			F2	22.91	9.60	120,000
7. Wirodesa	E	7	D	310.00	11.30	564,960
8. Kedungwuni	E	8	D D1	385.90	11.00	171,900
			D2	339.10	11.00	561,540
9. Wonopringgo	E	9	D D1	26.52	11.00	171,900
			D2	226.48	11.00	561,540
10. Comal	C	10	B B1	187.32	12.44	155,520
			B2	418.67	12.44	194,400
			B3	18.01	12.44	220,320
11. Bodeh	C	11	B B1	82.05	11.96	161,980
			B2	190.95	11.96	211,820
		11	E E1	110.43	11.00	91,680
			E2	73.57	11.00	126,060
12. Ulujami	C	12	B B1	7.43	12.18	304,560
			B2	16.57	12.18	761,400
		12	C C1	100.30	12.57	222,530
			C2	10.70	12.57	261,800
		12	E E1	34.74	12.50	195,300
			E2	22.26	12.50	234,360
		12	F F1	169.60	12.10	189,000
			F2	18.40	12.10	151,200

1/ C = current working area, E = expansion working area.
2/ Yield is in tons equivalent centrifugal sugar of cane.

*Source: Appendix IV-3.

Model Variations

It has been mentioned in the previous chapter that the factory can expand its sugarcane cropping area in the future in three ways: (1) by renting more land in the villages where the factory is currently renting land, (2) by renting land in the villages within the current factory working area where the factory has never rented land before, and (3) by renting land in the villages of the kecamatans in the factory expansion working area.

Two variations of the factory optimizing model will be used in this study. The difference in the two models is solely due to different assumptions about the land availability for the factory to rent. In the first model (Model I), it is assumed that the factory can rent land in both the current and expansion factory working areas. In the second model (Model II) it is assumed that the factory can rent land only in the current factory working area; i.e., the factory can expand its sugarcane cropping area only by the first two ways mentioned above.

The reasons for holding two different assumptions on the availability of land for the factory to rent are the following: (1) it is implicitly assumed that the factory will possibly get better cooperation from the farmers on renting-land arrangements in areas where farmers have experience in renting land to the factory, provided the factory pays a land rent at least equal to the farmers' opportunity cost; and (2) it is also implicitly assumed that the local authority (bupati) prefers that the factory rents land in the kecamatan where the rice supplies are in surplus. 3/

The optimum land-rental plan will be determined for the Sragi factory under the two different assumptions above and a comparative evaluation made of the two land-rent plans. This will provide information that can be used in reaching policy decisions about how to define the working area of the factory.

Optimum Land-Rental Plan for Sragi Factory

Optimum solutions to Model I for various levels of sugarcane that must be produced in the field for the factory to process are presented in Table V-2. In the optimum solution, to supply the new milling capacity of the factory with 70,000 tons of sugarcane, the Sragi factory should rely mainly on renting land and growing sugarcane in the current working area. Expansion of the current working area is needed only with one kecamatan--Bojong. The solution also suggests that the factory should not rent land type A in kecamatan Petarukan and kecamatan Kesesi,

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3/ One of the four kecamatans in the factory expansion area is in a rice deficit (39 percent) if no land is allowed for sugarcane in those kecamatans; see Table IV-8. If one-third of the land in the villages (where the factory plans to rent land) in the expansion area is rented for sugarcane, three out of four kecamatans will be in a rice deficit ranging from 18 to 60 percent; see Table IV-9.

TABLE V-2. SRAGI SUGARCANE FACTORY OPTIMUM LAND RENTAL PLAN TO PRODUCE VARIOUS AMOUNTS OF SUGARCANE FOR THE FACTORY TO PROCESS, SUGGESTED BY MODEL I.

Production Level	Average Total Cost	Land that should be Rented: Location No.	Type	Size	Total	Average Yield Per Hectare 1/
1	2	3	4	5	6	7
Tons	Rp.			----Ha.----		Tons
20,000	42,375	1	D	765.00	1,637.84	12.21
		2	D	216.84		
		3	B1	51.00		
		4	B1	138.00		
		10	B1	187.00		
		11	E1	110.00		
		12	F1	170.00		
30,000	42,700	1	D	765.00	2,465.82	12.17
		2	D	859.00		
		3	B1	51.00		
		4	B1	138.00		
		5	D	185.82		
		10	B1	187.00		
		11	E1	110.00		
		12	F1	170.00		
40,000	43,131	1	D	765.00	3,277.64	12.20
		2	D	859.00		
		3	B1	51.00		
		4	B1	138.00		
		5	A	129.64		
		5	D	258.00		
		10	B1	187.00		
		10	B2	419.00		
		11	B1	82.00		
		11	E1	110.00		
		11	E2	74.00		
		12	E1	35.00		
		12	F1	170.00		

(table continued)

TABLE V-2. CONTINUED.

Production Level	Average Total Cost	Land that should be Rented: Location No.	Type	Size	Total	Average Yield Per Hectare 1/
1	2	3	4	5	6	7
Tons	Rp.			----Ha.----		Tons
50,000	43,611	1	D	765.00	4,091.28	12.22
		2	D	859.00		
		3	B1	51.00		
		3	B2	120.00		
		4	B1	138.00		
		5	A	459.00		
		5	D	258.00		
		6	D	346.28		
		10	B1	187.00		
		10	B2	419.00		
		11	B1	82.00		
		11	E1	110.00		
		11	E2	74.00		
		12	E1	35.00		
		12	F1	170.00		
		12	F2	18.00		
60,000	44,646	1	D	765.00	4,912.37	12.21
		2	A	262.00		
		2	D	859.00		
		3	B1	51.00		
		3	B2	120.00		
		4	B1	138.00		
		4	B2	165.37		
		5	A	459.00		
		5	D	258.00		
		6	D	622.00		
		10	B1	187.00		
		10	B2	419.00		
		10	B3	18.00		
		11	B1	82.00		
		11	E1	110.00		
		11	E2	74.00		

(table continued)

TABLE V-2. CONTINUED.

Production Level	Average Total Cost	Land that should be Rented: Location No.	Type	Size	Total	Average Yield Per Hectare 1/
1	2	3	4	5	6	7
Tons	Rp.			-----Ha.-----		Tons
		12	C1	100.00		
		12	E1	35.00		
		12	F1	170.00		
		12	F2	18.00		
70,000	44,646	1	D	765.00	5,779.89	12.11
		2	A	262.00		
		2	D	859.00		
		3	B1	51.00		
		3	B2	120.00		
		4	A	292.89		
		4	B1	138.00		
		4	B2	323.00		
		5	A	459.00		
		5	D	258.00		
		6	D	622.00		
		6	F1	204.00		
		10	B1	82.00		
		10	B2	419.00		
		10	B3	18.00		
		11	B1	82.00		
		11	B2	191.00		
		11	E1	110.00		
		11	E2	74.00		
		12	C1	100.00		
		12	E1	35.00		
		12	E2	22.00		
		12	F1	170.00		
		12	F2	18.00		
80,000	45,146	1	D	765.00	6,657.51	12.02
		2	A	262.00		
		2	D	859.00		
		3	A	50.51		
		3	B1	51.00		

(table continued)

TABLE V-2. CONTINUED.

Production Level	Average Total Cost	Location No.	Type	Size	Total	Average Yield Per Hectare 1/
1	2	3	4	5	6	7
Tons	Rp.			----Ha.----		Tons
		3	B2	120.00		
		3	D	102.00		
		4	A	598.00		
		4	B1	138.00		
		4	B2	323.00		
		5	A	459.00		
		5	D	258.00		
		6	D	622.00		
		6	F1	204.00		
		6	F2	23.00		
		8	D1	386.00		
		10	B1	187.00		
		10	B2	419.00		
		10	B3	18.00		
		11	B1	82.00		
		11	B2	191.00		
		11	E1	110.00		
		11	E2	74.00		
		12	C1	100.00		
		12	C2	11.00		
		12	E1	35.00		
		12	E2	22.00		
		12	F1	170.00		
		12	F2	18.00		
90,000	46,458	1	A	522.00	7,523.94	11.96
		1	D	765.00		
		2	A	262.00		
		2	D	859.00		
		3	A	215.00		
		3	B1	51.00		
		3	B2	120.00		
		3	D	102.00		
		4	A	598.00		

(table continued)

TABLE V-2. CONTINUED.

Produc- tion Level	Average Total Cost	Land that should be Rented				
		Location No.	Type	Size	Total	Average Yield Per Hectare 1/
1	2	3	4	5	6	7
Tons	Rp.			----Ha.----		Tons
		4	B1	138.00		
		4	B2	323.00		
		5	A	459.00		
		5	D	258.00		
		6	D	622.00		
		6	F1	204.00		
		6	F2	23.00		
		7	D	172.94		
		8	D1	386.00		
		10	B1	187.00		
		10	B2	419.00		
		10	B3	18.00		
		11	B1	82.00		
		11	B2	191.00		
		11	E1	110.00		
		11	E2	74.00		
		12	B1	7.00		
		12	C1	100.00		
		12	C2	11.00		
		12	E1	35.00		
		12	E2	22.00		
		12	F1	170.00		
		12	F2	18.00		

1/ Yield equivalent centrifugal sugar of cane.

but should instead rent land type D. The Average Total Cost (ATC) for producing sugarcane in the field at 70,000 tons is Rp 44,646 per ton equivalent centrifugal sugar of cane (see Table V-2, col. 2).

To supply raw material to meet the current milling capacity of the factory, which is about 20,000 tons, the factory should grow cane only on land types D, B1, E1, and F1. Since land types D, B1, E1, and F1 are of the lowest land quality in the corresponding kecamatans in the current working area from the viewpoint of the farmers, the solution suggests that the factory should rent only the lowest quality of rice land which is still suitable for sugarcane production to meet the current factory demand for raw material. The ATC of producing sugarcane at 20,000 tons is Rp 42,375 per ton equivalent centrifugal sugar of cane (see Table V-2, col. 2).

Up to a level of 30,000 tons of sugarcane production, the factory should not rent any land type A at all in the current working area. From 40,000 to 50,000 tons of production, only in kecamatan Ampelgading will land type A be rented.

Optimum solutions in Model II for various levels of sugarcane that must be produced for the factory to process are presented in Table V-3. Solutions to Model II suggest that to supply 70,000 tons of sugarcane for the factory to process, the factory has to rent all land types up to their limit except land type A in kecamatan Petarukan and land type B in kecamatan Ulujami. The factory can depend on renting land in the

TABLE V-3. SRAGI SUGARCANE FACTORY OPTIMUM LAND RENTAL PLAN TO PRODUCE VARIOUS AMOUNTS OF SUGARCANE FOR THE FACTORY TO PROCESS, SUGGESTED BY MODEL II.

Production Level 1/	Average Total Cost	Land that should be Rented: Location No.	Type	Size	Total	Ave. Yield/ Hectare 1/	Ave. Rent/ Hectare
1	2	3	4	5	6	7	8
Tons	Rp.			----Ha.----		Tons	Rp.
20,000	42,375	1	D	765.00	1,637.84	12.21	157,457
		2	D	216.84			
		3	B1	51.00			
		4	B1	138.00			
		10	B1	187.00			
		11	E1	110.00			
		12	F1	170.00			
30,000	42,700	1	D	765.00	2,465.82	12.17	159,504
		2	D	859.00			
		3	B1	51.00			
		4	B1	138.00			
		5	D	185.82			
		10	B1	187.00			
		11	E1	110.00			
		12	F1	170.00			
40,000	43,131	1	D	765.00	3,277.64	12.20	166,363
		2	D	859.00			
		3	B1	51.00			
		4	B1	138.00			
		5	A	129.64			
		5	D	258.00			
		10	B1	187.00			
		10	B2	419.00			
		11	B1	82.00			
		11	E1	110.00			
		11	E2	74.00			
		12	E1	35.00			
		12	F1	170.00			
50,000	43,625	1	D	765.00	4,058.88	12.32	177,864
		2	A	195.88			
		2	D	859.00			
		3	B1	51.00			
		3	B2	120.00			
		4	B1	138.00			
		5	A	459.00			
		5	D	258.00			
		10	B1	187.00			
		10	B2	419.00			
		10	B3	18.00			
		11	B1	82.00			
		11	E1	110.00			
		11	E2	74.00			
		12	C1	100.00			
		12	E1	35.00			
		12	F1	170.00			
		12	F2	18.00			
60,000	44,334	1	D	765.00	4,881.06	12.29	184,978
		2	A	262.00			
		2	D	859.00			

(table continued)

TABLE V-3. CONTINUED.

Production Level 1/	Average Total Cost	Land that should be Rented					
		Location No.	Type	Size	Total	Ave. Yield/ Hectare 1/	Ave. Rent/ Hectare
1	2	3	4	5	6	7	8
Tons	Rp.			----Ha.----		Tons	Rp.
		3	B1	51.00			
		3	B2	120.00			
		4	A	220.06			
		4	B1	138.00			
		4	B2	323.00			
		5	A	459.00			
		5	D	258.00			
		10	B1	187.00			
		10	B2	419.00			
		10	B3	18.00			
		11	B1	82.00			
		11	B2	191.00			
		11	E1	110.00			
		11	E2	74.00			
		12	C1	100.00			
		12	E1	35.00			
		12	F1	170.00			
		12	F2	18.00			
70,000	45,066	1	A	142.91	5,729.91	12.22	190,554
		1	D	765.00			
		2	A	262.00			
		2	D	859.00			
		3	A	215.00			
		3	B1	51.00			
		3	B2	120.00			
		3	D	102.00			
		4	A	598.00			
		4	B1	138.00			
		4	B2	323.00			
		5	A	459.00			
		5	D	258.00			
		10	B1	187.00			
		10	B2	419.00			
		10	B3	18.00			
		11	B1	82.00			
		11	B2	191.00			
		11	E1	110.00			
		11	E2	74.00			
		12	C1	100.00			
		12	C2	11.00			
		12	E1	35.00			
		12	E2	22.00			
		12	F1	170.00			
		12	F2	18.00			

1/ Equivalent centrifugal sugar of cane.

current working area only with a slight increase in ATC per ton compared to the solution in Model I. However, the optimal solutions up to 40,000 tons of cane production are the same for both Models I and II. The solution to Model II shows that the ATC at the level of output of 70,000 tons is Rp 45,066 per ton (see Table V-3, col. 2).

The solution for Model II confirms the conclusion drawn from the solution for Model I that the Sragi sugarcane factory can rely on renting land and growing cane in the current working area to supply adequate raw materials up to 70,000 tons. If the factory concentrates its land renting and cane growing in the current working area (Model II), to produce 70,000 tons of cane the ATC will be Rp 420 per ton higher than if the factory is allowed to rent land and to grow cane in the expansion area (Model I). The difference of the ATC is less than 1 percent.

Normative Sugarcane Supply Function for the Sragi Sugar Factory

The optimum solutions to Models I and II discussed in the previous section suggest that the Sragi sugar factory should concentrate its renting and growing activities in the current working area to produce sugarcane for the factory to process up to 70,000 tons. In other words, the Sragi sugar factory can rely on the current working area to supply sugarcane for the factory to process. If this is the case, the normative sugarcane supply function for the Sragi factory should be derived from the optimal solution to the linear programming Model II.

The variable resource programming technique is employed in Model II by varying the value of the sugarcane output exogenously. The optimum solutions to the model at various levels of sugarcane output provide marginal cost (MC) for each level of output. Hence, the relationship of the various levels of output and the MC or output marginal cost schedule for the Sragi sugar factory can be established as presented in Table V-4.

In the traditional theory of the firm, the supply curve of a firm is identified as the marginal cost curve everywhere above the point of the minimum average variable cost. Using the information in Table V-4, the normative sugarcane supply curve for the Sragi sugar factory can be drawn as shown in Figure V-2. By inspection, we can conclude from this figure that the sugarcane supply function for the Sragi sugar factory is very elastic with respect to cost within the range of 0 to 74,000 tons of output. The high elasticity of the sugarcane supply function for the Sragi sugar factory is mainly due to two factors: (1) it is assumed that farming costs, including transportation costs of one hectare of sugarcane on any land type and location in the factory working area, are the same; (2) farming costs, including transportation costs, represent the larger proportion of the total field cost for producing sugarcane in the field. The land-rent cost represents only between 20 and 40 percent of the total field cost to produce sugarcane on most land types in any location in the working area.

TABLE V-4. NORMATIVE SUGARCANE SUPPLY SCHEDULE FOR THE SRAGI SUGAR FACTORY IN ITS CURRENT WORKING AREA.

Output of Sugarcane	Marginal Cost
1	2
1,000 Tons 1/	1,000 Rp/Ton 2/
0 - 10	42
10 - 30	43
30 - 40	44
40 - 50	46
50 - 60	48
60 - 70	49
70 - 74	51
74 and over	∞

1/ Tons equivalent centrifugal sugar of cane.

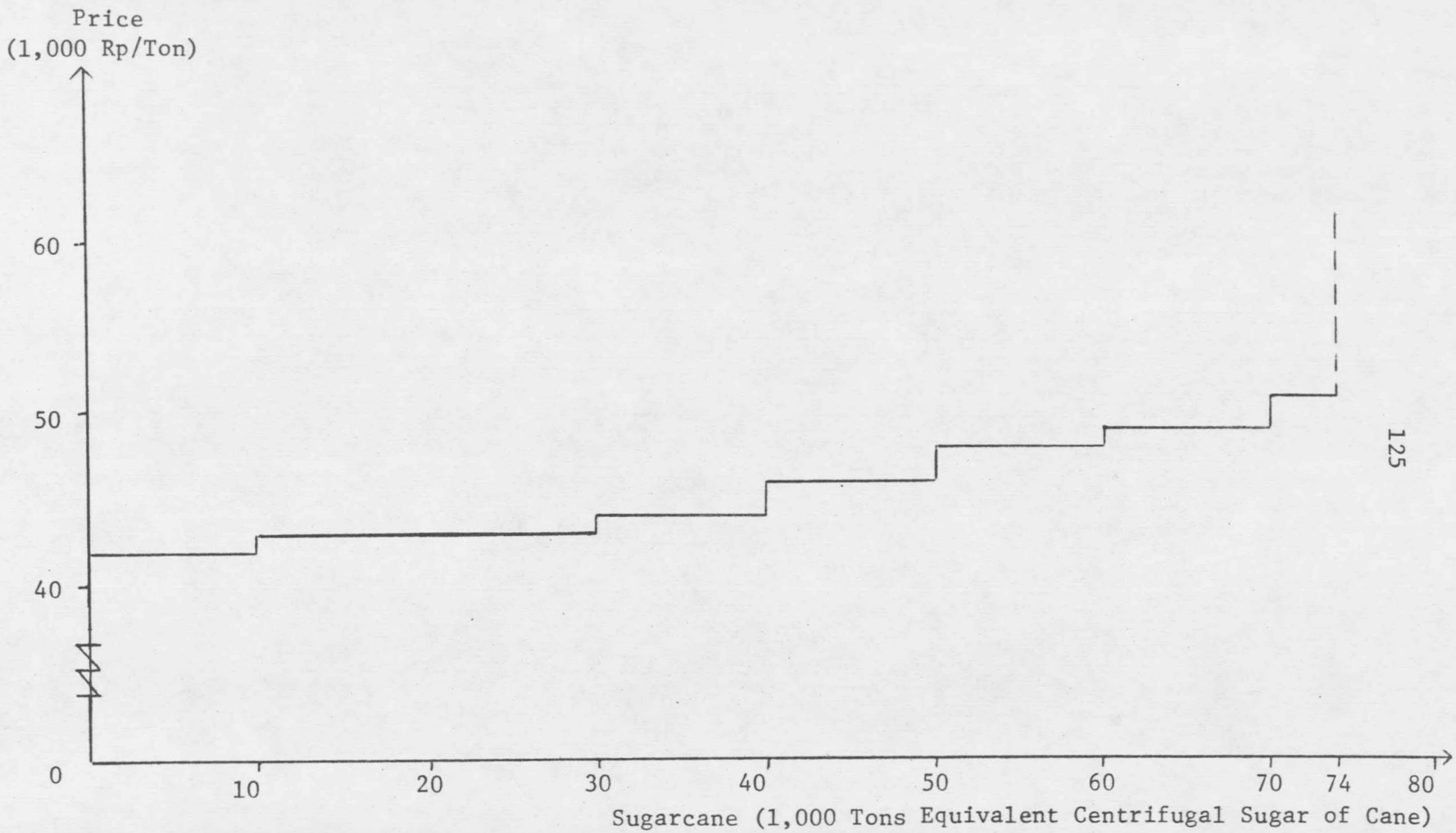

Figure V-2. Normative Sugarcane Supply Curve for the Sragi Sugar Factory in Its Current Working Area.

Estimated Average Production Cost Per Ton to Produce
70,000 Tons of Sugar for the Sragi Factory

Using the information in Table V-3 and Table 1 of Appendix V-4, the average total cost per ton to produce 70,000 tons of cane sugar at the Sragi factory site ready for sale can be calculated as presented in Table V-5. It is assumed in calculating the figures in Table V-5 that the factory costs, management costs, and miscellaneous costs per ton to produce 70,000 tons of cane sugar are the same as for producing about 20,000 tons in the 1972/73 crop season (see Appendix V-4, Table 1, col. 6). 4/

The average land rent per hectare paid by the Sragi factory in the 1972/73 crop season was Rp 85,737 per hectare (Appendix V-4, Table 1, col. 5). To produce 70,000 tons of cane sugar, the current study suggests that the factory should pay an average land rent per hectare of Rp 190,706 (Table V-5), more than twice the land rent paid in the 1972/73 crop season. However, the average total cost per ton to produce 70,000 tons of cane sugar with the proposed land-rental plan is only about 7 percent higher than the average total cost per ton to

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4/ It should be noted that the factory field cost (land rent, farming costs) of producing sugarcane calculated in the previous section is also based on factory farming costs per hectare and the prices of inputs and outputs paid and received by farmers in the 1972/73 crop season.

TABLE V-5. SRAGI SUGAR FACTORY: AVERAGE COST PER TON TO PRODUCE 70,000 TONS OF READY-FOR-SALE CANE SUGAR UP TO THE WAREHOUSE AT THE FACTORY SITE.

Item 1	Average Cost 2	Percent of Total Cost 3
	Rp/Ton	Pct.
1. Field Costs:		
a. Land rent	15,606	22.3
b. Farming cost	29,460	42.2
Subtotal	45,066	64.5
2. Factory Cost:		
a. Processing	8,599	12.3
b. Bagging, storing & handling	2,946	4.2
Subtotal	11,545	16.5
3. Management Costs:		
a. Management cost at the factory site	5,174	7.4
b. Management cost at the central office	4,007	5.7
Subtotal	9,181	13.1
4. Miscellaneous Costs:	4,042	5.8
TOTAL	69,834	100.0

Total Production = 70,000 Tons
Average Yield/Hectare = 12.22 Tons 1/
Average Land Rent/Hectare = Rp 190,706

1/ This yield is about the average yield of the 1971/72 and 1972/73 crop seasons, see Table 1 of Appendix V-4.

produce about 20,000 tons in the 1972/73 crop season. There are two reasons for this: (1) the average yield in the current study is 12.22 tons per hectare, about 13 percent higher than the yield in the 1972/73 crop season; hence, the farming cost per ton in the current study is slightly lower than that in the 1972/73 crop season 5/; and (2) although the land-rent cost in the current study is more than twice the land-rent cost of the 1972/73 crop season, the land-rent cost in the current study is still a minor cost item in the average total cost of production as in the case of the 1972/73 crop season. In the 1972/73 crop season, the land-rent cost was about Rp 7,900, or 12.1 percent of the average total cost per ton (Appendix V-4, Table 1, col. 7). In the current study, the land-rent cost is about Rp 15,600, or 22.3 percent of the average total cost per ton (Table V-5).

Farming costs per kilogram of sugar in the 1972/73 crop season and in the current study are Rp 32.8 and Rp 29.5, respectively. Hence, an increase in land cost of about Rp 7.7/Kg. for the proposed land-rental plan is partially compensated by the decrease in the farming cost of about Rp 3.3/Kg. due to a higher yield in the current study.

5/ Average yield per hectare in the current study, however, is about 10 percent below the yield in the 1971/72 crop season. The average yields used in the current study are average yields for the coming years estimated by the Sragi factory crop managers.

Therefore, although the land rent proposed in this study is more than twice the rent paid in the 1972/73 crop season, the average total cost to produce sugar is only about Rp 4.4/Kg. higher than the cost for the 1972/73 crop season.

CHAPTER VI

SUMMARY AND CONCLUSIONS, POLICY RECOMMENDATIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

Summary and Conclusions

In January, 1971, at the request of the Indonesian Government, the United Nations Development Program (UNDP) commissioned the Indonesian Sugar Study (ISS) to formulate a ten-year program to meet domestic demand for sugar, at the least cost to the Indonesian economy, and prepare a project to increase sugar production for international financing. The study was carried out by a British consortium.

In October-November, 1972, an International Development Association (IDA) appraisal mission to Indonesia conducted a further study. Based on the findings of the appraisal mission and on data from ISS, the IDA recommended major rehabilitation for three factories and minor rehabilitation for six others. The project would markedly increase the future milling capacity of the factories, ranging from 70 to 200 percent above their current capacities.

IDA is aware that adequacy of cane supply to meet the future milling capacities is critical. Therefore, the IDA recommended that assurance should be given that before any rehabilitation is planned, a survey would be carried out to make quite certain that sufficient land would be available for cane production in each factory working area.

In 1973, the Indonesian Sugar Project, on behalf of the Director General for Estates of the Ministry of Agriculture, appointed the

Indonesian Agro-Economic Survey (AES) to carry out a survey on the availability of sugarcane supply for the factory to process in each individual factory working area. As the first round of the survey, the AES conducted a survey in all three factories of the major project--Sragi, Gempolkrep, and Pesantren--in December, 1973-January, 1974. The author was appointed to supervise the survey. In April, 1974, the author took some of the data collected in the survey with him to Montana State University to provide data support for this dissertation.

The main objectives of this study are: (1) to derive a normative land-rent supply schedule faced by the Sragi factory in its working area, and (2) to derive a normative sugarcane supply function and to determine an optimum land-rental plan for the Sragi sugar factory.

Linear programming is the primary analytical tool used in this study. There are two linear programming models developed in this thesis. The first model is a maximizing linear programming model which permits the derivation of a normative land-rent supply schedule. The objective function of the model is to maximize the total return to land and family labor to the farmers in the factory working area. The technique of variable price linear programming is employed to generate the relationship between the minimum rental prices paid by the sugar factory and the corresponding maximum amounts of land the farmers would be willing to rent to the sugar factory. The land-rental prices are equal to the return to land and family labor the farmer must forego if he rents the land to the mill.

The second linear programming model is a cost-minimizing linear programming model which permits the derivation of a normative sugarcane supply function. The objective function of the model is to minimize total field costs to produce a given amount of sugarcane for the factory to process. The variable resource programming method is employed in the model to generate the relationship of various levels of sugarcane produced in the field and their associated marginal and average total costs of producing sugarcane in the field, and the optimum land-rental plan for the Sragi factory for various levels of sugarcane production.

The solutions to the first linear programming model show that a variation of the opportunity costs among various land types is very large. This is mainly due to the variation of the crop rotations that can be grown on each land type. The type of crop rotation that can be grown on each land type is mainly determined by the availability of water for each land type during the leasing period. The effort to increase rice production in the Sragi working area can be achieved mainly by improving irrigation and adopting high yielding varieties and better cultural practices. Adopting high-yielding rice varieties and better cultural practices such as petukan are possible only if water is adequate. Hence, improving irrigation will weaken the competitive position of the sugarcane in the rice producing areas at the current price relationship.

The land-rental supply schedule generated from the solution to the first linear programming model suggests that on the average, the land-rent rate paid by the factory should be at least twice the land rent paid in the 1972/73 crop season. Survey results show that the majority of the farmers would prefer a single payment in full at the time the farmer gives control of the land to the factory.

The current institutional constraint on land use for sugarcane had the announced purpose of insuring adequate local rice production for each village. The analysis shows this is not an effective means of insuring that rice production is at least equal to the rice needs for some of the kecamatans. This type of deficit apparently must be corrected by importing rice from neighboring kecamatans. There are some kecamatans that have been in a rice-deficit position without the introduction of sugarcane in the existing crop rotations. However, on the average, there will still be about 40 percent rice surplus for the whole expanded working area if no sugar is grown and a 16-percent rice surplus for the whole expanded working area if sugarcane is grown up to the limit allowed by the institutional constraint (one-third of the land in sugar). In the last situation (a 16-percent overall rice surplus), enough sugarcane will be available to produce at least 97,000 tons of refined sugar from the expanded working area. If enough sugarcane is produced within the current working area to provide 70,000 tons of refined sugar, a 30-percent overall rice surplus will exist in the current working area.

Two facts are obvious. First, the land use constraints do not insure that each kecamatan is rice sufficient. Second, the Sragi working area is capable of producing both the needed rice and the required sugarcane. Therefore, it may be advantageous for all concerned to modify the institutional constraints on land use if adequate provisions are made to insure that the small farmers retain their independence in each kecamatan.

If sugarcane were to be grown in the expanded factory working area up to the limit allowed by the institutional constraint, then, using available data in the analysis, there will be about 10 percent more farm labor employed but about 13 percent of the draft animals will be idle. Thus an increase in land devoted to sugarcane will increase the level of agricultural employment and to some extent this might reduce the flow of people from rural areas to the cities.

The solutions to the second linear programming model suggest that the Sragi sugar factory does not have to expand its current working area to get enough land to grow sugarcane to meet its cane needs for producing up to 70,000 tons of refined sugar. The average field cost of production per ton equivalent centrifugal sugar of cane grown within the current working area would be less than 1 percent more than for an expanded area. However, this may be more than offset by the fact that farmers within the current working area have already had experience in leasing land for the production of sugarcane.

If the Sragi factory were to expand its working area, the factory should give first priority to renting suitable, but lower quality, land (in terms of rice productivity), in its land-rental plan. The opportunity cost for this type of land is lower than for land suitable for sugarcane with a higher rice production capability over the entire 16-month period when the land would be in sugarcane. Renting lower quality rice land will have two results: a lower average total field cost of producing sugarcane, and a lesser impact on the total rice production in the factory working area.

The normative sugarcane supply function for the Sragi sugar factory is very elastic with respect to cost (see Figure V-2). This is mainly due to the following factors: (1) it is assumed in this study that the farming cost of sugarcane is the same on any land type and in any location in the factory working area, and (2) the farming cost constitutes more than 60 percent of the total cost to produce sugarcane in the field.

If the Sragi factory rents land and grows sugarcane exclusively in its current working area to produce 70,000 tons of cane sugar, the factory's average total cost will be Rp 69,834 per ton. As calculated in this study, land rent constitutes only 22.3 percent of the cost.

Farming costs, factory costs, management, and miscellaneous costs constitute 42.2, 16.5, 13.1, and 5.8 percent, respectively (see Table V-5). The average land rent should be Rp 190,706 per hectare. This is more than twice the rent paid in the 1972/73 crop season. However, the average total cost of producing cane sugar per ton will increase not more than 7 percent.

Policy Recommendations

1) The variation of the land opportunity costs among various land types in the Sragi sugar factory working area is large. Therefore, the factory should pay the land rent according to each land type's opportunity cost. However, if this approach is to be operational, there must be a land classification in each village which is acceptable to both parties: the factory and the farmers. This policy will give a minimum cost of land rent to the factory, subject to the constraint that each farmer would receive a rent at least equal to the opportunity cost for his land.

2) In keeping with the farmer's preferences determined during the field survey work, the land rent should be paid in full to the farmers at the time the farmers hand over their land to the factory. However, the land-rent rate should be announced to the farmers by the factory several months before the sugarcane crop season begins.

3) The land-rent rate calculated by the method used in this study should be considered as the minimum rent rate. When considerations are given to adequacy of data and analysis, rents below these levels will mean that either inadequate land is available to grow sugarcane for the factory to process or that the farmers must be coerced into releasing their land to the sugar factory against their free will.

The total cost of producing sugar at the factory door for the 1972/73 crop season is approximately Rp 65.5/Kg. Under the present rental payment, 12.1 percent, or about Rp 8/Kg., can be attributed to the cost of renting land from the farmers. Under the proposed rental plan (and assuming all other costs but land rent and farming costs remain constant), total cost could increase to Rp 69.8/Kg., and 22.3 percent, or about Rp 15.6/Kg., would be attributed to the cost of renting land from farmers who would release their land voluntarily to the sugar factory. If it were the goal to hold down the price of sugar at the factory door, then farming costs to the mill, factory, costs, and other mill costs such as management costs could be reduced by Rp 7.6/Kg. (or 13 percent of total cost for the 1972/73 crop season exclusive of land rent), and the proposed rents could be paid. If these costs could not be reduced, the government could increase the wholesale price of sugar. Either alternative would probably be more desirable than coercing the farmers into accepting rental payments that are less than their opportunity costs.

4) The current institutional constraint on land use for sugarcane is not an effective means of insuring that rice production will at least equal rice needs in some of the kecamatans in the Sragi sugar factory working area. Some of these kecamatans have been in a rice deficit without growing sugarcane. However, if the Sragi factory is to be supplied enough sugarcane by the current factory working area to produce up to 70,000 tons of refined sugar, there would still be a rice surplus of about 30 percent for the whole current working area. Hence, it might be wise to substitute a minimum rice requirement constraint for the current institutional land constraint for each kecamatan. This will reduce the factory land-rent cost and yet the sugarcane crop will not create or worsen the rice deficit in any kecamatan in the factory working area. It would have the advantage of "highlighting" the real problem--which is a rice-inadequacy problem, not a land-use problem. For example, a kecamatan which is rice deficient would have none of its land used for sugarcane, while a rice surplus kecamatan may have more than one-third of its land used for sugarcane and still have adequate rice.

Some Comments on Implementation

If an active market for sugarcane land had been operating in the Sragi working area, and if both the factory and the farmers had been fully informed, this study could have been approached as a positive rather than as a normative problem. But since an active market for sugarcane land did not exist, the principal purpose of the normative approach used in this study was to estimate the results that would exist if rental transactions were made between willing and informed buyers and sellers. The marketplace solution would involve more information than the analysis used in this study. It is unlikely that the results would be precisely the same. In practice, the goal of paying farmers their opportunity cost for land rented to the sugar mill can probably only be realized by making administrative adjustments to the rentals proposed in this study.

This admission permits two competing tendencies to come into play. First, the nearly universal urge of farmers to bargain is likely to result in initially stated rental proposals that exceed opportunity costs. Second, there is a tendency for managers of organizations such as sugar factories to try to keep costs down. Administrative adjustments can therefore open the door to a mediator between the farmers and the sugar factory managers. The mediator can best work with both the farmers and sugar mill managers if he has the objective in mind of improving the estimates of the farmers' opportunity cost for land.

Suggestions for Future Research

Two general types of studies suggested for future research are: (1) research to improve the current study, and (2) research to inquire about the feasibility of the sugar factory relying on farmers in its working area to supply sugarcane for processing.

Research Needed to Improve Current Study

This study was a case study of the Sragi sugar factory working area. Because conditions may vary in other areas, the current type of study should be carried out for each individual sugar factory in Java. The key to an equitable land-rental program is the accurate estimate of opportunity cost to farmers. Ideally, opportunity costs should be re-estimated every year. If this cannot be done, opportunity costs must at least be re-estimated every time either relative crop prices or production technology changes. The suggestions outlined below mainly deal with the improvement of the reliability of the estimation of some relevant parameters and improvement of the current model used.

1) In the current study, it is assumed that all land in each village is homogeneous. Hence, the solution to the model suggests that a uniform land rent should be paid by the factory for all land in each village. This might under- or over-estimate the true opportunity cost of renting land to the factory for some farmers in the village. A reclassification of the land in each village should be carried out to enable the assessment of the real opportunity costs for each land type in the village.

2) Studies on seasonal labor demand and draft animal demand for each crop grown in the factory working area should be conducted. These labor demand and draft animal demand should be incorporated into the current model to see whether they have an effect on the current optimal solution to the model with respect to farm organization and land opportunity cost for renting.

3) Studies on the factory farming costs for each land type and for the transportation costs of cane from various land locations to the factory site should be made. In the current study, it is assumed that the factory's farming and transportation costs of cane are the same for the various land types and locations.

4) Studies should be made which include ratooning sugarcane by the factory in the model. The needed linear programming will be more complex, but the model is easily understandable and the results should be of practical and of significant interest.

Studies to Inquire About the Feasibility of the Sugar Factory Relying on Its Cane Supply from the Small Sugarcane Farmers in Its Working Area

Taiwan has been successful with her sugar industry where more than 70 percent of the cane processed by the factories is supplied by the small sugarcane farmers in the factories' working areas. A transition stage might be needed before the factory depends entirely on the small farmers' cane; i.e., the farmers are motivated to ratoon cane which was previously grown by the factory on their land. Hence, the following studies are suggested:

1) The economies of factory ratoon sugarcane managed by the farmers should be studied and the supply function for this type of ratoon sugarcane estimated. This alternative of growing sugarcane might be studied by establishing pilot areas. Some experience already exists with ratooning in several factories in East Java.

2) The economies of small farm sugarcane production should be studied and the supply function of sugarcane estimated when the small farms in the factory working area can produce both sugarcane and ratoon sugarcane.

APPENDICES

APPENDIX I 1/

INDONESIA

SUGAR PROJECT

Draft Terms of Reference for Cane Supply Survey

Composition of Survey Team

1. The same team, so far as possible, would be engaged by all the PT, coordinated by the Joint Sugar Projects Unit, and would consist of a sugarcane economist and an agricultural economist, assisted by the village headmen in the area to be surveyed. Specified factory staff would be assigned to assist with the survey, with one staff member primarily responsible for co-ordination.

Phasing

2. The Joint Sugar Projects Unit would determine the order in which the surveys would be conducted, beginning with the factories initially selected for rehabilitation under the project. Each survey is expected to take two to three weeks, on average, including reporting.

Rent

3. The survey would particularly study land rents paid by sugar factories and would make recommendations to them on equitable rents for the land they require, separately for plant and ratoon cane, having regard to:

(a) the opportunity cost of the different areas of land required, based on net income from alternative crops;

(b) the rental period and the discounted value of rent and alternative net income;

(c) the risk involved;

(d) the incentive required to persuade farmers to sacrifice alternative net income for rental income;

(e) employment opportunities and the economic value (shadow price) of labor;

(f) ability of factories to pay.

The survey would also make recommendations on procedures for fixing rents over periods longer than the traditional 16 months, decide on and advise SCS of criteria and formulae to be used in calculating equitable rents, and justify its conclusions.

1/ The material in this appendix is a copy of Annex 7 and its appendix taken from reference [1].

Purpose

4. The survey would determine for each factory:

(a) total area of factory concession;

(b) area currently in factory cane; estimated yields;

(c) area currently in farmers' cane; estimated yields;

(d) area available for expansion by factory, within concession area, divided into area available for planting and area available for factory ratoon; estimated yields;

(e) area available for ratooning by farmers within concession area regardless of factory capacity; estimated yields;

(f) at rents proposed, and existing prices for sugar and other crops:

(i) what area farmers would be willing to lease; estimated yields;

(ii) what total area farmers would be willing to ratoon; the number of years' ratooning desired; estimated yields.

Conclusions

5. On conclusion of the survey, the factory would prepare and agree with the survey team a plan for annual supply of cane over the next five years in a form similar to the attached Appendix.

6. On completion of the survey of the factories scheduled for rehabilitation, the team would continue surveys for the remaining factories according to a schedule agreed with the Joint Sugar Projects Unit.

7. Based on 36 man days for each of the first 9 factories, or 324 man days, and 1,296 man days for the remaining 36 factories, at a cost of Rp 6,250/day for two men, plus other costs of Rp 5,000/day, a total of Rp 11,250/day, the total cost of the surveys would be Rp 18.2 M.

8. The survey team would be called upon each year to assist SCS in the determination of rents appropriate to the areas in which sugar is grown.

Attached: Appendix

May 12, 1973

INDONESIA

SUGAR PROJECT

Draft Terms of Reference for Cane Supply Survey

Form of Plan for Annual Supply of Cane

	Year	1	2	3	etc.
Factory capacity					
Tons cane per day					
Days grinding					
Tons cane per year					
Cane supply					
Hectares under cane					
Plant (factory)					
Factory ratoon					
Farmers' cane, plant and ratoon.					
Total hectares					
Tons cane/ha					
Plant					
Factory ratoon					
Farmers'					
Total tons cane					
Plant					
Factory ratoon					
Farmers'					
Total tons cane					
Sugar production					
Rendement (percent)					
Plant					
Factory ratoon					
Farmers'					

	Year	1	2	3	etc.
Total tons sugar					
Plant					
Factory ratoon					
Farmers'					
Total					
Total (rounded)					
Tons sugar/ha					
Plant					
Factory ratoon					
Farmers'					
Average					

May 12, 1973

APPENDIX II

ADMINISTRATIVE DIVISION OF INDONESIA

Indonesia is divided into 26 "propinsi" (provinces) and the head of a province is a "gubernur" (governor). Each propinsi is divided into several "kabupaten" (districts), and head of a kabupaten is called a "bupati." Each kabupaten is divided further into several "kecamatan" (sub-districts), and the head of a kecamatan is called "camat." 1/ Each kecamatan consists of several "desa" (villages). Desa is the lowest administrative level in the Indonesian government administration. 2/ The head of each desa is called "kepala desa" (village head). 3/

Gubernur, bupati, and lurah are elected by the people for a certain period of time, and both wedana and camat are appointed by the bupati. Each propinsi, kabupaten, and desa is an autonomous region of the first, second, and third level of the region, respectively. The gubernur has the right to issue rules and regulations for his region to conform with

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1/ In the past several kecamatan in a kabupaten were grouped into one administrative unit called "kewedanaan," and the head of this kewedanaan was called "wedana." This level of government administrative division is in the process of being abandoned.

2/ Within a desa it is divided further into groups of household compound called "rukun kampung," and each rukun kampung is divided into several smaller groups of household called "rukun tetangga."

3/ In Java, kepala desa is called "lurah." In other parts of the country the village head is called by different names.

the central government's rules and regulations at Jakarta. The bupati also can issue rules and regulations in his own region also conforming with the rules and regulations issued by the gubernur. Lurah is supposed to be the third level of an autonomous region, but in practice, village heads only implement rules and regulations from above. Wedana and camat have no right to issue rules and regulations; they only assist the bupati in implementing rules and regulations issued by the bupati or the gubernur.

Schematically the administrative division of the Indonesian government is illustrated by the following chart:

Menteri dalam Negeri
(Minister of Internal Affairs at Jakarta)

↓

Propinsi
(Gubernur)

↓

Kabupaten
(Bupati)

↓

Kewedanaan
(Wedana)

↓

Kecamatan
(Camat)

↓

Desa
(Lurah)

APPENDIX III

For the purpose of illustration, data for a specific linear programming model are prepared in this appendix. The nature of the problem and the data used here are selected purposively to give a relevant problem along with the empirical one. A kecamatan is picked as an illustration in a reduced format but the essence of the problem is kept.

As an aggregate the farmers in the kecamatan want to maximize the net return to their paddy land and family labor. There are three types of paddy land in the kecamatan owned by the farmers: Land type A, 1,565 hectares; land type B, 745 hectares; and land type D, 1,255 hectares. The farmers in the kecamatan have the alternative of whether they will grow food crops on all of these lands or rent some or all of these lands to the sugarcane factory. In each land type there is only one crop rotation in 16 months. However, the sugarcane factory is able to use any land type to grow sugarcane. In addition to this, there are 55,504,800 hours labor and Rp 400,000,000 cash capital available for the rice farmers to operate their food crop farming operations. The complete data information is presented in the following three tables.

TABLE 1. INPUT-OUTPUT COEFFICIENTS (RESOURCE REQUIREMENTS PER HECTARE) OF EACH CROP ROTATION ACTIVITIES.

		Activities					
		Growing Food Crops			Renting Land 1/		
		AR_1	BR_2	DR_1	RLA	RLB	RLD
Resource	Units	(x_1)	(x_3)	(x_5)	(x_2)	(x_4)	(x_6)
1	2	3	4	5	6	7	8
Labor	Hrs.	3,057	1,354	2,237	7,343	7,343	7,343
Cash capital	Rp.	95,467	34,619	65,205	0.0	0.0	0.0
Land Type:							
A (ALAND)	Ha.	1	0.0	1	1	0.0	0.0
B (BLAND)	Ha.	0.0	1	0.0	0.0	1	0.0
D (DLAND)	Ha.	0.0	0.0	1	0.0	0.0	1

1/ The farmers can rent their land to the sugar factory only if there is labor available for the factory to hire. Hence, farmers renting land activities require labor.

TABLE 2. DATA ON RETURN AND EXPENDITURE FOR CROP AND RENTING LAND ACTIVITIES.

		Activities					
		Growing Food Crops			Renting Land to Factory		
Item 1	Units 2	AR_1 (x_1) 3	BR_2 (x_3) 4	DR_1 (x_5) 5	ARL (x_2) 6	BRL (x_4) 7	DRL (x_6) 8
Gross return	Rp.	360,840	93,315	280,580	90,000	90,000	90,000
Variable costs 1/	Rp.	98,527	38,711	68,625	0.0	0.0	0.0
Cash expenditures (cash capital)	Rp.	95,467	34,619	65,205	0.0	0.0	0.0
Return to land and family labor	Rp.	266,313	54,604	212,315	90,000	90,000	90,000

1/ Variable costs = total cost excluding land and family labor costs.

TABLE 3. RESOURCE CONSTRAINTS.

Resource 1	Units 2	Quantity 3
Labor	Hrs.	55,504,800
Cash capital	Rp.	400,000,000
Land Type:		
ALAND	Ha.	1,565
BLAND	Ha.	745
DLAND	Ha.	1,255
All Land	Ha.	3,566

APPENDIX IV-1

METHOD OF CALCULATING RETURN TO LAND AND FAMILY LABOR

Unlike rice and other food crops, sugarcane is an exogenous crop in the rice-producing areas of Java. It was introduced by the sugar factories as one crop in the existing crop rotations by replacing one or more traditional crops in the rotation for some period of time (usually 16 months). The sugarcane will stay in the crop rotation as long as it can compete with the other crops which can be grown on the same land. The strength of the competitive position of sugarcane for land from other crop alternatives is measured best in terms of its opportunity costs, i.e., the costs of the sacrifices of the alternative crops that can be grown on the land during the time sugarcane occupies the land. For the purpose of comparison of the opportunity cost to the rental paid by the sugarcane factory, income data relating to other crops should comprise gross returns (GR) based on farm gate prices. This sum, after deducting all input costs other than land and family labor, represents net return to farmer's land and family labor (RLFL) employed for the production of crops other than factory sugarcane.

As required by regulations, the rental has been paid in two installments. The first installment is paid six months prior to the official handing over of the land and the second installment is paid at the time the land is handed over to the factory. However, the AES sugar survey found out that 80 percent of the sampled farmers prefer the payment of the rent at one time--at the handing over of the land to the factory--while 20 percent of the farmers are indifferent between two installments and one installment. Hence, it is assumed in this study that rent will be paid once--at the handing over of the land to the factory. Since the farmers also recognize that the advance payment of the land rent will incur interest costs, the return to the farmers' land and family labor from their cropping activities within the land-lease period must be discounted to the present value.

Within the 16 months of land lease for sugarcane, there will be at most three crops that can be grown: one crop at the first dry season, one crop at the rainy season, and another crop at the second dry season. 1/ For simplicity of calculation, it is assumed that each crop on the average will take 5 months from soil preparation to harvesting. In other words, the farmers will receive income every 5 months if the farmers can grow three crops in 16 months.

It is assumed that the money interest charged is 2 percent per month, and simple discounting procedure is employed to calculate the present value of the crops grown in the 16 months' leasing time. 2/

1/ See Table IV-1 on common crop rotations in the sampled villages.

2/ This interest rate is very low compared to the going interest rate on borrowing in the sampled villages. Village "cooperatives," on the average, charge 7 percent interest a month for loan in kind (rice), and 10 percent per month for loan in cash. Interest charged among individuals is believed to be much higher. Currently, the Government Banks charge 1 and 2 percent interest on agricultural credit.

The Total Present Value of the Return to Land and Family Labor of a crop rotation is calculated in the following manner:

$$\text{PV of RLFL for CR} = \frac{\text{RLFL of Crop 1}}{1 + 5(0.02)} + \frac{\text{RLFL of Crop 2}}{1 + 10(0.02)} + \frac{\text{RLFL of Crop 3}}{1 + 15(0.02)}$$

where: PV = present value;

RLFL = return to land and family labor;

CR = crop rotation;

Crops 1, 2, and 3 are crops in the first, second, and third seasons, or crops in the first dry season, rainy season, and second dry season, respectively.

TABLE 1. POPULATION BY SEX AND AGE GROUP IN SRAGI SUGARCANE FACTORY WORKING AREA, 1973.*

Kecamatan	Population by Sex and Ages												
	Below 15 yrs.		5-14 years		15-24 years		25-50 years		51-65 years		Over 65		
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	-----Number-----												
1. Petarukan	7,662	9,167	9,336	9,628	8,032	7,906	13,983	15,663	6,617	7,551	1,614	1,958	99,127
2. Taman	8,320	8,732	11,257	11,969	6,987	7,412	10,452	12,143	5,154	5,574	3,273	3,587	94,860
3. Kesesi	3,679	3,922	5,792	6,344	3,115	3,937	5,140	8,042	2,886	2,459	1,115	1,266	47,697
4. Sragi	5,286	5,590	7,414	7,784	5,853	6,368	10,457	11,122	3,672	4,195	864	879	68,484
5. Ampelgading	2,444	2,657	3,713	3,653	4,825	4,948	4,709	5,231	2,784	3,135	797	928	39,824
6. Bojong	2,200	3,515	5,190	6,522	6,207	7,348	3,897	3,799	na	na	746	592	40,016
7. Wirodesa	3,788	4,020	4,404	4,509	4,352	4,547	9,897	11,027	3,760	3,939	992	1,093	55,700
8. Kedungwuni	3,197	3,577	6,968	7,066	5,904	6,332	13,097	13,258	3,707	4,003	576	723	68,408
9. Wonopringgo	2,487	2,679	2,985	3,086	2,210	2,405	3,402	3,731	1,327	1,510	538	531	26,891
10. Comal	3,832	4,275	4,983	5,283	3,814	4,601	4,772	4,792	3,907	4,243	2,445	2,339	49,287
11. Bodeh	2,801	3,210	4,041	4,410	3,161	3,645	4,002	4,614	2,116	2,124	1,014	1,270	36,408
12. Ulujami	5,050	5,876	7,009	7,481	5,142	5,929	5,875	6,735	3,693	4,467	1,481	2,216	60,954

*Source: From office records of each Kecamatan, 1973. Collected by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 2. POPULATION OF WORKING PEOPLE, 15-65 YEARS OF AGE, BY OCCUPATION IN SRAGI FACTORY WORKING AREA, 1973.*

Kecamatan	Occupation									Farmers + No Job as Percent of Total
					Government					
Kecamatan	Farmer	Laborer	Merchant	Business	Employee	Officers	Other	No Job	Total	of Total
1	2	3	4	5	6	7	8	9	10	11
	Number									
1. Petarukan	50,861	482	1,221	242	576	290	10,630	1,754	66,057	80
2. Kesesi	20,540	3,915	3,540	—	488	22	1,720	—	30,225	68
3. Sragi	8,822	705	2,836	26	594	436	13,019	26,438	52,876	67
4. Ampelgading	18,718	676	885	183	278	188	4,848	1,932	27,705	75
5. Bodeh	23,877	226	314	—	179	202	111	—	24,907	96
6. Ulujami	19,176	9,272	318	9	169	217	3,182	9,272	41,615	68

NOTE: Farmers are people whose main income is from farming or as a farm worker. Laborers are labor outside farm.

*Source: From office records of each Kecamatan, 1973. Collected by AES sugar survey team, Dec., 1973-Jan., 1974.

APPENDIX IV-3

TABLE 1. LAND OFFERED FOR RENT TO SUGAR FACTORY AND ITS ASSOCIATED RENT VALUES AND YIELD.

Location		Land Offered for Rent			
Kecamatan	Code No.	Type	Size	Rent	Yield 1/
1	2	3	4	5	6
			Ha.	Rp/Ha.	Tons/Ha.
1. Petarukan	1	A	522.00	228,760	11.56
	1	D	765.00	167,700	12.38
2. Taman	2	A	262.00	239,400	12.77
	2	D	859.00	163,800	12.10
3. Kesesi	3	A	215.00	231,800	11.71
	3	B1	51.54	157,080	12.57
	3	B2	119.46	209,440	12.57
	3	D	102.00	165,600	10.60
4. Sragi	4	A	598.00	228,780	12.20
	4	B1	138.50	151,320	12.11
	4	B2	322.50	214,370	12.11
5. Ampelgading	5	A	459.00	228,135	13.03
	5	D	258.00	161,784	12.00
6. Bojong	6	D	622.00	167,720	11.50
	6	F1	204.09	100,000	9.60
	6	F2	22.91	120,000	9.60
7. Wirodesa	7	D	310.00	564,960	11.30
8. Kedungwuni	8	D1	385.90	171,900	11.00
	8	D2	339.10	561,540	11.00
9. Wonopringgo	9	D1	26.52	171,900	11.00
	9	D2	226.48	561,540	11.00
10. Comal	10	B1	187.32	155,520	12.44
	10	B2	418.67	194,400	12.44
	10	B3	18.01	220,320	12.44
11. Bodeh	11	B1	82.05	161,980	11.96
	11	B2	190.95	211,820	11.96
	11	E1	110.43	91,680	11.00
	11	E2	73.57	126,060	11.00
12. Ulujami	12	B1	7.43	304,560	12.18
	12	B2	16.57	761,400	12.18
	12	C1	100.30	222,530	12.57
	12	C2	10.70	261,800	12.57
	12	E1	34.74	195,300	12.50
	12	E2	22.26	234,360	12.50
	12	F1	169.60	151,200	12.10
	12	F2	18.40	189,000	12.10

1/ Tons equivalent centrifugal sugar of cane.

TABLE 1. SRAGI SUGARCANE FUTURE PLAN OF MILLING CAPACITY, HECTARES OF LAND CULTIVATED, AND ESTIMATED YIELD AND TOTAL PRODUCTION.*

	1972*	1975**	1976**	1977**	1978*
	1	2	3	4	5
Factory Milling Capacity					
1. Tons cane/milling day	1,600	16,150	15,000	35,000	36,000
2. Milling days/year	120	205	240	163	196
3. Rated Annual Capacity (T)	192,000				
Hectares of Land Cultivated					
1. Factory plant	1,600	2,450	2,800	4,900	4,900
2. Factory ratoon	--	350	350	1,000	1,000
3. Farmers ratoon	--	450	500	800	900
Total	1,600	3,250	3,650	6,700	6,800
Tons Cane/Ha					
1. Factory plant	115.5	110	107	100	101
2. Factory ratoon	--	80	80	80	80
3. Farmers ratoon	--	75	75	75	75
Tons Cane Harvested					
1. Factory plant	184,800	2,695,000	2,996,000	4,900,000	4,949,000
2. Factory ratoon	--	280,000	280,000	800,000	800,000
3. Farmers ratoon	--	337,500	375,000	600,000	675,000
Total	184,800	3,312,500	3,651,000	6,300,000	6,424,000
Rendament (%)					
1. Factory plant	11.6	11.30	11.30	11.00	11.20
2. Factory ratoon	--	10.00	10.00	10.00	10.00
3. Farmers ratoon	--	9.00	9.00	9.00	9.00
Tons Sugar/Ha					
1. Factory plant	13.39	12.43	12.09	11.00	11.31
2. Factory ratoon	--	8.00	8.00	8.00	8.00
3. Farmers ratoon	--	6.75	6.75	6.75	6.75
Total Tons Sugar					
1. Factory plant	21,436	304,535	338,548	539,000	554,288
2. Factory ratoon	--	28,000	28,000	80,000	80,000
3. Farmers ratoon	--	30,375	33,750	54,000	60,750
Total	21,436	362,910	400,298	673,000	695,038
Total Tons Molasses	6,420	11,594	12,779	22,050	22,484

*Source: AES sugar survey team, Dec., 1973-Jan., 1974.
**Source: Master Plan (Tahun Giling 1975 s/d 1979) Pabrik Gula Sragi, Semarang 5 Juli, 1974, PT PERKEBUNAN XV (PERSERO).

TABLE 1. THE SRAGI FACTORY PHYSICAL LAND RENTAL PLAN TO FULLY UTILIZE THE FACTORY'S NEW MILLING CAPACITY.*

Kecamatan	Type	Total Land available in Kecamatan	Total Land in the Assigned Villages	Total Land that will be Rented in 3-years	Total Land that will be Rented Each Year	Sugar Yield 1/
1	2	3	4	5	6	7
		Ha.	Ha.	Ha.	Ha.	Tons/Ha.
1. Petarukan	A	1,567.650	1,567.650	1,293.4	431.1	11.56
	D	2,297.505	2,297.505	1,660.0	553.3	12.38
	E	1,547.198	--	--	--	--
2. Taman	A	786.021	786.021	630.4	210.1	12.77
	D	2,577.096	2,577.096	1,900.0	633.3	12.10
	E	823.537	--	--	--	--
3. Kesesi	A	646.693	646.693	468.0	156.0	11.71
	D	307.845	307.845	270.0	90.0	10.60
	B	515.370	515.370	377.2	125.7	12.57
	D	2,006.574	--	--	--	--
4. Sragi	A	1,796.788	1,796.788	1,449.4	483.1	12.20
	B	1,385.020	1,385.020	1,048.3	349.4	12.11
	E	699.623	--	--	--	--
5. Ampelgading	A	1,377.625	1,377.625	1,363.9	454.6	13.03
	D	776.660	776.600	150.0	50.0	12.00
	D	200.545	--	--	--	--
	F	1,306.640	--	--	--	--
6. Bojong	D	1,867.462	1,867.462	1,861.0	620.3	11.50
	F	682.970	682.970	335.0	111.6	9.60

(table continued)

TABLE 1. CONTINUED.

Kecamatan	Type	Total Land available in Kecamatan	in the Assigned Villages	that will be Rented in 3-years	that will be Rented Each Year	Sugar Yield 1/
1	2	3	4	5	6	7
		-----------Ha.			-----------	Tons/Ha.
7. Wirodesa	D	931.731	931.731	695.00	231.6	11.30
8. Kedungwuni	D	2,175.970	2,175.970	1,446.00	482.0	11.00
	E	369.750	--	--	--	--
9. Wonopringgo	D	759.891	759.891	510.50	170.1	11.00
	D	9.645	--	--	--	--
10. Comal	B	1,873.186	1,873.186	1,074.60	358.2	12.44
	E	247.430	--	--	--	--
11. Bodeh	B	820.474	820.474	711.80	237.2	11.96
	E	552.126	552.126	475.00	158.3	11.00
	E	1,247.054	--	--	--	--
12. Ulujami	B	74.270	74.270	55.10	18.3	12.18
	E	173,689	173.689	120.00	40.0	12.50
	C	334.324	334.324	150.50	50.2	12.57
	F	565.325	565.325	435.00	145.0	12.10
	F	1,733.345	--	--	--	--

1/ Equivalent centrifugal sugar of cane.

*Source: Calculated from Tables 1-12 of Appendix V-3.

APPENDIX V-3

SRAGI SUGARCANE FACTORY LAND RENTAL PLAN AT VILLAGE LEVEL IN ITS WORKING AREA

A tentative land rent plan at the village level in each of the twelve kecamatans in Sragi factory working area is presented in Tables 1-12. It is obvious from these tables that not all land available in a village will be rented, and some villages in a kecamatan are not included in the factory land rental plan. The factory determines in which village land should be rented, and how much of the land in that village will be rented, by taking several factors into consideration. The most important factors the factory has to consider are the following: 1/

1) Paddy land in the village must be suitable for growing cane. The current Reynoso sugarcane cultural practice adopted in Java requires land with good water supply and drainage. Historically, all sugarcane factories in Java were built in paddy land areas with the best irrigation facilities. Extension and improvement of irrigation in paddy areas of Java were purposely designed by the former Dutch colonial government primarily for the interest of the sugarcane factories. Currently, water needed by the factory in its working area is mainly supplied by the public irrigation service. In Sragi area, where water supply from

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1/ This information was obtained by the AES sugarcane survey team by interviewing the Sragi factory crop managers, Dec., 1973-Jan., 1974.

the public irrigation service is not enough, the factory installs water pumps to pump water from a river or creek into the cane fields.

2) The village should not be too far from the factory. Technically and economically, transportation of cane from a village to the factory must be feasible. It is preferred that cutting and milling of the cane occur on the same day or that, at the latest, the cane be milled on the day following cutting in order to maintain the highest sugar content of the cane. If the village is too far from the factory, it will be more costly and difficult for the factory to supervise cropping activities and to control the crop in that village. Radius of a working area varies from one factory to another; Sragi factory working area lies within the radius of about 30 kilometers.

3) The amount of land in a village suitable for growing cane must meet at least a minimum size for the factory to grow cane efficiently. This minimum size varies from one factory to another. In Sragi factory working area, minimum size is 15 hectares. The land must be continuous in one plot, although the land in that plot may be owned by many farmers.

4) The size of land rented by the factory in any village must not exceed a maximum limit allowed by government regulation. As has been mentioned in the section on land-lease system in Chapter II, any sugar factory may rent land in any village not to exceed one-third of the total size of paddy land in that village.

TABLE 1. LAND RENT PLANNING IN KECAMATAN PETARUKAN.*

Village Name	Available Paddy Land	Type of Land	Current Concession Size	Current Concession Yield/Ha.	Expansion Size	Expansion Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Widodaren	412.250	A	68.6	12.71	230.0	12.7
2. Sirangkang	148.510	"	53.0	11.91	70.0	11.9
3. Kalirandu	240.175	"	74.7	10.66	130.0	10.6
4. Pesucen	286.140	"	75.6	10.82	170.0	10.8
5. Petanjungan	163.790	"	83.9	9.80	60.0	12.0
6. Iser	200.673	"	73.5	11.93	90.0	11.9
7. Karangasem	116.112	"	84.1	12.00	30.0	12.0
Subttl./Weighted Ave.	1,567.650		513.4	11.35	780.0	11.69
8. Petarukan	277.950	D	--	--	240.0	12.5
9. Tegalmelati	387.525	"	--	--	310.0	12.5
10. Bulu	101.165	"	--	--	90.0	12.5
11. Pengundan	260.000	"	--	--	220.0	12.5
12. Loning	632.175	"	--	--	400.0	12.5
13. Temuirang	325.000	"	--	--	200.0	12.0
14. Serang	313.690	"	--	--	200.0	12.0
Subttl./Weighted Ave.	2,297.505				1,600.0	12.38
15. Klayeran	557.370	E	--	--	--	--
16. Kendaldoyong	495.690	"	--	--	--	--
17. Panjungan	71.435	"	--	--	--	--
18. Kendalsari	422.703	"	--	--	--	--
Subtotal	1,547.198					
TOTAL	5,412.353		513.4		2,440.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 2. LAND RENT PLANNING IN KECAMATAN TAMAN.*

Village Name	Available Paddy Land	Type of Land	Current Concession Size	Current Concession Yield/Ha.	Expansion Size	Expansion Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Gondang	204.555	A	43.9	11.00	140.0	12.5
2. Jrakah	279.740	"	79.6	12.56	90.0	12.5
3. Sitemu	128.060	"	68.8	13.26	50.0	13.0
4. Sukowati	173.671	"	18.1	13.38	140.0	13.5
Subttl./Weighted Ave.	786.021		210.4	12.53	420.0	12.89
5. Beji	253.110	D	--	--	200.0	12.0
6. Kebunan	420.963	"	--	--	300.0	12.0
7. Pedurungan	217.838	"	--	--	200.0	12.2
8. Kedungbanjar	412.165	"	--	--	360.0	12.5
9. Penggarit	166.460	"	--	--	125.0	12.0
10. Kejambon	79.843	"	--	--	60.0	11.2
11. Pener	221.335	"	--	--	90.0	11.5
12. Benjaran	170.600	"	--	--	140.0	11.6
13. Banjardawa	77.590	"	--	--	60.0	12.0
14. Cibelok	174.175	"	--	--	145.0	12.5
15. Jebed	244.445	"	--	--	200.0	12.2
16. Kaligelang	138.572	"	--	--	100.0	12.2
Subttl./Weighted Ave.	2,577.096				1,900.0	12.10
17. Taman	177.850	E	--	--	--	--
18. Wonorejan	317.517	"	--	--	--	--
19. Asemdoyong	328.530	"	--	--	--	--
Subtotal	823.537					
TOTAL	4,186.654		210.4		2,320.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 3. LAND RENT PLANNING IN KECAMATAN KESESI.*

Village Name	Available Paddy Land	Type of Land	Current Concession		Expansion	
			Size	Yield/Ha.	Size	Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Sidosari	195.005	A	113.7	12.70	60.0	12.7
2. Mulyorejo	124.440	"	20.1	10.69	100.0	10.7
3. Ponolawen	81.374	"	82.9	11.77	--	--
4. Krendon	187.059	"	69.8	11.32	--	--
5. Srinahan	58.815	"	20.5	10.23	--	--
Subttl./Weighted Ave.	646.693		308.0	11.84	160.0	11.45
6. Karyomukti	174.145	D	--	--	150.0	10.8
7. Karangrejo	133.700	"	--	--	120.0	10.5
Subttl./Weighted Ave.	307.845				270.0	10.67
8. Sidomulyo	137.815	B	13.7	15.67	120.0	10.6
9. Sukorejo	98.795	"	40.9	14.11	50.0	14.1
10. Kwigaran	136.565	"	92.6	13.78	--	--
11. Pantirejo	142.195	"	60.0	11.59	--	--
Subttl./Weighted Ave.	515.370		2207.2	13.34	170.0	11.63
12. Kesesi	319.975	D	--	--	--	--
13. Kaibahan	170.032	"	--	--	--	--
14. Watugajah	152.300	"	--	--	--	--
15. Watupayung	110.000	"	--	--	--	--
16. Jagung	100.421	"	--	--	--	--
17. Langensari	114.575	"	--	--	--	--
18. Kwasen	268.611	"	--	--	--	--
19. Podosari	149.345	"	--	--	--	--
20. Kalimade	106.965	"	--	--	--	--
21. Brondong	132.273	"	--	--	--	--
22. Ujungnegara	124.695	"	--	--	--	--
23. Windurejo	257.382	"	--	--	--	--
Subtotal	2,006.574					
TOTAL	3,476.482		515.2		600.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 4. LAND RENT PLANNING IN KECAMATAN SRAGI.*

Village Name	Available Paddy Land	Type of Land	Current Concession Size	Current Concession Yield/Ha.	Expansion Size	Expansion Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Tengengkulon	125.420	A	65.9	13.31	60.0	13.3
2. Tengengwetan	176.940	"	68.2	14.21	--	--
3. Blimbing	110.000	"	11.6	12.48	--	--
4. Bulakpelem	165.545	"	124.6	11.45	40.0	11.4
5. Gebangkerep	219.820	"	151.5	11.94	--	--
6. Tegalsurur	181.128	"	163.2	10.71	--	--
7. Purworejo	159.865	"	133.5	12.79	20.0	12.7
8. Kedungjaran	102.215	"	71.4	13.16	30.0	13.1
9. Ketanonageng	61.615	"	40.1	12.87	20.0	12.8
10. Sumubkidul	107.650	"	91.6	12.48	--	--
11. Kresakageng	187.840	"	155.2	11.73	30.0	11.7
12. Kalijambe	138.160	"	87.5	13.10	30.0	13.1
13. Merican	60.590	"	55.1	11.70	--	--
Subttl./Weighted Ave.	1,796.788		1,219.4	12.21	230.0	12.61
14. Rembun	140.423	B	66.7	12.82	72.0	12.8
15. Pait	179.030	"	61.6	12.42	90.0	12.4
16. Wonosari	108.365	"	77.4	13.09	--	--
17. Mejasem	47.700	"	34.4	14.45	--	--
18. Sragi	103.444	"	93.3	11.17	--	--
19. Purwodadi	106.116	"	83.3	11.80	--	--
20. Tegalontar	134.000	"	72.2	11.61	--	--
21. Klunjuran	112.010	"	28.4	11.87	48.0	11.8
22. Sijeruk	124.050	"	97.4	11.94	--	--
23. Bulaksari	183.847	"	116.6	11.31	--	--
24. Sumublor	146.035	"	107.0	11.97	--	--
Subttl./Weighted Ave.	1,385.020		838.3	12.04	210.0	12.40
25. Tunjungsari	23.485	E	--	--	--	--
26. Boyoteluk	120.585	"	--	--	--	--
27. Siwalan	98.933	"	--	--	--	--
28. Blacanan	112.025	"	--	--	--	--
29. Depok	237.150	"	--	--	--	--
30. Yosorejo	107.445	"	--	--	--	--
Subtotal	699.623					
TOTAL	3,881.431		2,057.7		440.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 5. LAND RENT PLANNING IN KECAMATAN AMPELGADING.*

Village Name	Available Paddy Land	Type of Land	Current Concession Size	Current Concession Yield/Ha.	Expansion Size	Expansion Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Jatirejo	157.165	A	115.9	13.33	100.0	12.6
2. Wonogiri	181.100	"	51.5	13.79	120.0	13.0
3. Kemuning	36.085	"	20.7	14.18	--	--
4. Blimbing	127.375	"	53.1	13.62	60.0	12.9
5. Losari	59.950	"	36.2	13.27	--	--
6. Karangtengah	52.244	"	28.7	12.89	30.0	12.2
7. Cibiyuk	113.606	"	50.0	12.60	60.0	12.0
8. Banglarangan	82.430	"	59.7	13.53	--	--
9. Ampelgading	179.340	"	81.8	13.70	90.0	12.9
10. Ujunggede	152.065	"	86.6	12.12	40.0	11.5
11. Karangtolak	101.180	"	137.1	13.68	--	--
12. Kebagusan	135.085	"	72.6	13.49	70.0	12.7
Subttl./Weighted Ave.	1,377.625		793.9	13.33	570.0	12.62
13. Tegalsari	776.125	D	--	--	--	--
14. Sidokare	50.140	"	--	--	--	--
15. Sukowati	150.405	"	--	--	--	--
Subtotal	200.545					
16. Sukowati	1,306.640	F	--	--	--	--
TOTAL	3,660.935		793.9		720.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 6. LAND RENT PLANNING IN KECAMATAN BOJONG.*

Village Name	Available Paddy Land	Type of Land	Current Concession Size	Current Concession Yield/Ha.	Expansion Size	Expansion Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Bojongwetan	143.435	D	--	--	143.0	11.5
2. Bojonglor	94.000	"	--	--	94.0	11.5
3. Duwet	59.968	"	--	--	59.0	11.5
4. Menjangan	29.000	"	--	--	29.0	11.5
5. Randumuktiwaren	308.750	"	--	--	308.0	11.5
6. Sumurjumlangbogo	421.000	"	--	--	421.0	11.5
7. Rejosari	18.639	"	--	--	18.0	11.5
8. Pantianom	125.175	"	--	--	125.0	11.5
9. Legokelile	144.804	"	--	--	144.0	11.5
10. Bukur	96.830	"	--	--	96.0	11.5
11. Kalipancur	284.225	"	--	--	284.0	11.5
12. Wangandowo	81.000	"	--	--	81.0	11.5
13. Ketitanglor	27.925	"	--	--	27.0	11.5
14. Ketitangkidul	32.711	"	--	--	32.0	11.5
Subttl./Weighted Ave.	1,867.462				1,861.0	11.5
15. Bojongminggir	80.825	F	--	--	40.0	9.6
16. Babalanlor	70.591	"	--	--	35.8	9.6
17. Babalankidul	81.933	"	--	--	40.0	9.6
18. Wiraditan	79.200	"	--	--	39.0	9.6
19. Sembungjambu	204.325	"	--	--	100.0	9.6
20. Kemasan	33.200	"	--	--	16.0	9.6
21. Jajarwayang	62.087	"	--	--	30.0	9.6
22. Karangsari	70.814	"	--	--	35.5	9.6
Subttl./Weighted Ave.	682.975				335.0	9.6
TOTAL	2,550.437				2,196.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi Factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 7. LAND RENT PLANNING IN KECAMATAN WIRODESA.*

Village Name	Available Paddy Land	Type of Land	Current Concession		Expansion	
			Size	Yield/Ha.	Size	Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Pecakaran	56.935	D	--	--	42.0	11.0
2. Api-Api	66.415	"	--	--	50.0	11.0
3. Pekuncen	12.865	"	--	--	9.0	11.0
4. Kampil	40.500	"	--	--	30.0	11.0
5. Wirodesa	71.145	"	--	--	57.0	11.0
6. Kadipaten	66.000	"	--	--	50.0	11.0
7. Warukidul	50.920	"	--	--	36.0	11.0
8. Warulor	40.038	"	--	--	30.0	11.0
9. Badarsari	88.000	"	--	--	66.0	11.0
10. Rowoyoso	95.250	"	--	--	73.0	11.0
11. Werdi	76.013	"	--	--	57.0	11.0
12. Tratebang	75.793	"	--	--	56.0	11.0
13. Wonokertokulon	25.591	"	--	--	18.0	11.0
14. Bebel	16.850	"	--	--	12.0	11.0
15. Kauman	30.000	"	--	--	22.0	11.0
16. Simut	100.490	"	--	--	75.0	11.0
17. Kemplang	18.926	"	--	--	12.0	11.0
Subttl./Weighted Ave.	931.731				695.0	11.0
18. Sijambe	--	--	--	--	--	--
19. Pesanggrahan	--	--	--	--	--	--
20. Karangjati	--	--	--	--	--	--
21. Petukangan	--	--	--	--	--	--
22. Delegtukang	--	--	--	--	--	--
23. Wonokertowetan	--	--	--	--	--	--
24. Majangan	--	--	--	--	--	--
25. Gumawang	--	--	--	--	--	--
26. Kepatihan	--	--	--	--	--	--
27. Benor	--	--	--	--	--	--
TOTAL	931.731				695.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 8. LAND RENT PLANNING IN KECAMATAN KEDUNGWUNI.*

Village Name	Available Paddy Land	Type of Land	Current Concession		Expansion	
			Size	Yield/Ha.	Size	Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Pekajangan	71.000	D	--	--	50.0	11.0
2. Pakisputih	75.189	"	--	--	54.0	11.0
3. Podo	30.000	"	--	--	20.0	11.0
4. Kwayangan	51.850	"	--	--	34.0	11.0
5. Tangkilkulon	53.850	"	--	--	35.0	11.0
6. Bitungangan	47.941	"	--	--	30.0	11.0
7. Krangdowo	75.497	"	--	--	54.0	11.0
8. Kedungwuni	423.000	"	--	--	280.0	11.0
9. Kedungpatung	46.000	"	--	--	30.0	11.0
10. Rengas	77.200	"	--	--	55.0	11.0
11. Longkap	151.215	"	--	--	100.0	11.0
12. Rowocacing	31.037	"	--	--	20.0	11.0
13. Pajombangan	65.770	"	--	--	42.0	11.0
14. Proto	46.735	"	--	--	30.0	11.0
15. Salakbrojo	79.440	"	--	--	55.0	11.0
16. Tasaran	57.000	"	--	--	38.0	11.0
17. Pegunnunganmas	210.145	"	--	--	140.0	11.0
18. Jubengkemang	138.000	"	--	--	90.0	11.0
19. Kebonrowopucang	115.500	"	--	--	75.0	11.0
20. Kebonsari	52.600	"	--	--	28.0	11.0
21. Pengandon	80.789	"	--	--	55.0	11.0
22. Karangsedap	146.000	"	--	--	98.0	11.0
23. Kalilembu	50.215	"	--	--	33.0	11.0
Subttl./Weighted Ave.	2,175.973				1,446.0	11.0
24. Ambakembang	20.000	E	--	--	--	--
25. Bujangan	47.941	"	--	--	--	--
26. Kaligawe	62.000	"	--	--	--	--
27. Logandeng	93.000	"	--	--	--	--
28. Kedungkebo	138.000	"	--	--	--	--
29. Pangkah	8.807	"	--	--	--	--
Subtotal	369.748					
TOTAL	2,545.721				1,446.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 9. LAND RENT PLANNING IN KECAMATAN WONOPRINGGO.*

Village Name	Available Paddy Land	Type of Land	Current Concession		Expansion	
			Size	Yield/Ha.	Size	Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Surabayan	29.500	D	--	--	22.0	NA
2. Pegaden Tengah	30.000	"	--	--	22.5	"
3. Tetak Lengkong	23.575	"	--	--	18.0	"
4. Gedong Pengapon	69.000	"	--	--	58.0	"
5. Legok Gudung	107.041	"	--	--	87.0	"
6. Sastrodirjan	104.390	"	--	--	76.0	"
7. Tetak Kidul	207.305	"	--	--	126.0	"
8. Kewagean	23.440	"	--	--	8.0	"
9. Getas	56.000	"	--	--	18.0	"
10. Wonopringgo	48.590	"	--	--	37.0	"
11. Rawakembu	32.000	"	--	--	22.0	"
12. Wonorejo	28.405	"	--	--	16.0	"
Subttl./Weighted Ave.	759.891				510.5	
13. Sampih	0.645	D	--	--	--	--
14. Gandang	9.000	"	--	--	--	--
Subtotal	9.645					
TOTAL	768.891				510.5	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

TABLE 10. LAND RENT PLANNING IN KECAMATAN COMAL.*

Village Name	Available Paddy Land	Type of Land	Current Concession		Expansion	
			Size	Yield/Ha.	Size	Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Purwoharjo	269.126	B	80.4	12.08	22.0	12.1
2. Gintung	84.525	"	31.0	14.05	30.0	14.0
3. Sembokulon	103.825	"	22.6	12.55	50.0	12.5
4. Growo	63.038	"	28.0	11.23	10.0	11.3
5. Sarwodadi	201.200	"	30.3	9.96	80.0	11.0
6. Sidorejo	178.415	"	91.2	13.22	19.0	13.2
7. Gedek	83.376	"	19.1	13.59	29.0	13.6
8. Sekayu	101.583	"	45.7	12.52	12.0	12.5
9. Purwosari	88.165	"	25.6	12.18	15.0	12.2
10. Tumbal	129.289	"	70.3	12.13	15.0	12.2
11. Pecangakan	166.690	"	54.4	12.05	60.0	12.0
12. Klegan	74.644	"	37.5	14.84	6.0	14.8
13. Suukan	122.110	"	57.9	13.25	12.0	13.2
14. Kandang	87.830	"	22.2	11.90	30.0	11.9
15. Kebojongan	119.370	"	48.4	12.01	20.0	12.0
Subttl./Weighted Ave.	1,873.186		664.6	12.54	410.0	12.27
16. Wonokromo	127.755	E	--	--	60.0	11.5
17. Candu	119.675	"	--	--	50.0	11.5
Subttl./Weighted Ave.	247.430				110.0	11.5
TOTAL	2,120.616		664.6		520.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973–Jan., 1974.

TABLE 11. LAND RENT PLANNING IN KECAMATAN BODEH.*

Village Name	Available Paddy Land	Type of Land	Current Concession Size	Current Concession Yield/Ha.	Expansion Size	Expansion Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Kelangdepok	168.885	B	87.9	13.09	40.0	13.1
2. Muncang	167.143	"	119.3	13.53	30.0	13.5
3. Pendowo	146.638	"	97.9	12.13	30.0	12.1
4. Karangbrai	202.350	"	109.3	9.69	70.0	11.0
5. Kebandaran	60.512	"	46.5	11.37	15.0	11.4
6. Bodeh	74.946	"	15.9	11.16	50.0	11.2
Subttl./Weighted Ave.	820.474		476.8	11.99	235.0	11.89
7. Babakan	126.380	E	--	--	1100.0	11.0
8. Kesesirojo	226.200	"	--	--	200.0	11.0
9. Jraganan	108.086	"	--	--	100.0	11.0
10. Kebandungan	91.340	"	--	--	75.0	11.0
Subttl./Weighted Ave.	552.126				475.0	11.0
11. Jatiroyom	154.161	E	--	--	--	--
12. Cangak	62.620	"	--	--	--	--
13. Payung	55.840	"	--	--	--	--
14. Parunggalih	40.520	"	--	--	--	--
15. Kwajen	82.854	"	--	--	--	--
16. Jatingarang	415.947	"	--	--	--	--
17. Gunungbatu	114.345	"	--	--	--	--
18. Pasir	103.441	"	--	--	--	--
19. Longkeyang	217.326	"	--	--	--	--
Subttl./Weighted Ave.	1,247.054					
TOTAL	2,619.654		476.8		710.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973–Jan., 1974.

TABLE 12. LAND RENT PLANNING IN KECAMATAN ULUJAMI.*

Village Name	Available Paddy Land	Type of Land	Current Concession Size	Current Concession Yield/Ha.	Expansion Size	Expansion Yield/Ha. 1/
1	2	3	4	5	6	7
	Ha.		Ha.	Tons	Ha.	Tons
1. Batekan	74.280	B	55.1	12.18	--	--
2. Rowosari	173.689	E	--	--	120.0	12.5
3. Sukorejo	181.870	C	73.3	12.19	--	--
4. Ombowetan	64.204	"	9.2	14.68	--	--
5. Pagargunung	88.250	"	18.0	14.68	50.0	12.0
Subttl./Weighted Ave.	334.324		100.5	12.86	50.0	12.0
6. Wiyorowetan	92.685	F	--	--	70.0	12.1
7. Samong	99.795	"	--	--	75.0	12.1
8. Bumirejo	76.660	"	--	--	60.0	12.1
9. Pamutih	181.755	"	--	--	140.0	12.1
10. Padek	114.520	"	--	--	90.0	12.1
Subttl./Weighted Ave.	565.325				435.0	12.1
11. Taskikrejo	250.520	F	--	--	--	--
12. Kaliprau	328.930	"	--	--	--	--
13. Kerotsari	204.565	"	--	--	--	--
14. Blendung	228.105	"	--	--	--	--
15. Ketapang	103.535	"	--	--	--	--
16. Limbangan	263.265	"	--	--	--	--
17. Mojo	119.025	"	--	--	--	--
18. Pesantren	235.400	"	--	--	--	--
Subtotal	1,733.345					
TOTAL	2,880.953		155.6		605.0	

1/ Equivalent centrifugal sugar of cane.

*Source: Obtained from Sragi factory by AES sugar survey team, Dec., 1973-Jan., 1974.

APPENDIX V-4

SRAGI FACTORY PRODUCTION COST OF CENTRIFUGAL CANE SUGAR

Average production cost of centrifugal sugar for Sragi factory in the 1971/72 and 1972/73 crop seasons is presented in Table 1. In Table 1, the cost of production is broken down into four major cost components: (1) Field Costs, consisting of land rent and farming costs (seedlings, planting and cultivation, harvesting and transportation costs), (2) Factory Costs, consisting of processing, bagging, storing, and handling costs, (3) Miscellaneous Costs, and (4) Management Costs.

The land rent cost for Sragi factory in 1971/72 and 1972/73 crop seasons was 10.1 and 12.1 percent of the total costs, respectively. 1/ The farming costs (Field Costs - Land Rent) for the 1972/73 crop season were Rp 355,737.50 per hectare. In the calculation of Average Total Cost (ATC) and Marginal Cost (MC) in Chapter V, it is assumed that the total farming costs are Rp 360,000 per hectare regardless of the type of land and its location. An amount of Rp 4,000 for land clearing is included in the total farming costs. 2/ This land clearing cost should be paid to the farmers in addition to rent of their land.

1/ Mubyarto reported that the land rent was 13.26 percent of the total cost for all government-owned sugar factories in 1967 [10,p.83].

2/ For the 1972/73 crop season, Sragi factory paid a land clearing fee of Rp 960.0 per hectare to the farmers (see section on Land Lease System in Ch. II). However, the sampled farmers in Sragi working area reported that on the average, it costs Rp 4,000 extra for the farmer to prepare his land for other crops after the land has been used for sugarcane.

TABLE 1. SRAGI SUGAR FACTORY: AVERAGE COST FOR PRODUCING READY-FOR-SALE CANE SUGAR UP TO WAREHOUSE AT FACTORY SITE FOR 1971/72 AND 1972/73 CROP SEASONS.*

Item	Cost in 1971/72			Cost in 1972/73		
	Per Hectare	Per Ton	% of Total	Per Hectare	Per Ton	% of Total
1	2	3	4	5	6	7
1. Field Costs:						
a. Land rent	60,845.30	4,585.61	10.1	85.737.29	7,908.78	12.1
b. Seedling cost	12,900.90	972.28	2.1	18,160.85	1,675.23	2.6
c. Planting & cultivation	220,593.58	16,623.48	36.7	239,406.06	22,085.43	33.7
d. Harvesting & transportation	71,330.71	5,375.84	11.9	98,170.59	9,055.68	13.8
Subtotal	365,683.76	27,557.21	60.9	441,474.79	40,725.12	62.2
2. Factory Costs:						
a. Processing	84,318.46	6,354.66	14.1	93,221.69	8,599.17	13.1
b. Bagging, storing & handling	31,391.65	2,365.83	5.2	31,937.10	2,946.02	4.5
Subtotal	115,710.11	8,720.49	19.3	125,158.79	11,545.19	17.6
3. Management Costs:						
a. Management cost at the factory site (Pimpinan & T.U.)	56,723.37	4,274.96	9.4	56,096.63	5,174.60	7.9
b. Management cost at central office (PNP & BKU)	2,159.77	162.77	0.4	43,441.71	4,007.25	6.1
Subtotal	58,883.14	4,437.73	9.8	99,538.34	9,181.85	14.0
4. Miscellaneous Costs	60,087.12	4,528.46	10.0	43,823.96	4,042.51	6.2
TOTAL COST	600,384.13	45,243.89	100.0	709,995.88	65,494.67	100.0
Total Production (Tons)	212,300				195.134	
Average Yield/Hectare (Tons)	13.4				10.84	

*Unofficial figures obtained by AES sugar survey team from Sragi factory, Dec., 1973-Jan., 1974.

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