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Irlan Soejono

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I. INTRODUCTION

Self-sufficiency in rice supply has become an important part of the national policy in Indonesia since the first program to increase rice production was launched in 1959 [58, p. 9]. As it is almost impossible to expand the physical areas for farming in Central Java, the only alternative left for increasing rice production is to induce millions of rice farmers to intensify their farming operations by using new and more productive technology.[1] At the same time, the food production policy of Indonesia was also intended as a means to raise the income of those farmers. Nevertheless, increasing domestic demand for rice has outrun supply and increasing quantities of rice have to be imported yearly [33, p. 112].

A series of improvements in the program's implementation have been made since that time. The introduction of high yielding varieties (HYV) from the International Rice Research Institute (IRRI) in 1967, and subsequently the domestic HYV from the Center of Research Institute in Agriculture (CRIA) at Bogor in 1971, had promised large increases in irrigated paddy yields. However, progress in the use of HYV has allegedly been fraught with problems related to differential adoption rates among farmers.[2]

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[1]By "new technology" it is meant any new, improved and more productive inputs including: high yielding varieties (HYV) seeds, industrial fertilizers, pesticides, farm practices, structures and equipments, etc. In this thesis, the term "HYV" is often used instead of the full words.

[2]See, for example, articles by Franke [23, pp. 41-47], Sajogyo [58, pp. 23, 51] and Sinaga and Collier [63, pp. 27-29].

It was not by coincidence that starting with the first Five Year Development Plan in 1968, in addition to the effort to increase production and farm income, the Government of Indonesia began to pay attention to the problem of unequal share of benefits derived from development programs. The present study aims to evaluate the impact of the introduction of new technology in paddy production on the growth of paddy farm production and income and its income distributional effect over time as related to various characteristics of the farms.

A. Position of Irrigated Paddy Farming in Central Java Economy

Irrigated paddy production plays an important role in economic growth and political stability in Indonesia.[1] At 1960 constant prices, the share of food crops alone in the gross domestic product for the year 1973 was 28 percent, which is the largest production component of the gross domestic product for that year [33, p. 145]. In terms of rupiah (Indonesian currency unit) value, using wholesale prices in Jakarta, the share of irrigated paddy production was estimated to be 62 percent of the total food crops in 1973 [33, pp. 43, 46 and 94]. As in the rest of Southeast Asia, rice is the staple food of the population constituting

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[1]"Irrigated paddy" is a paddy crop grown on wet field (in Indonesian: "sawah") surrounded by bunds, high enough to keep the soil submerged when necessary. At certain periods of the paddy's life, water should be made available either from reservoirs or dams of natural or rainfed rivers. In this thesis, for practical purposes, the term "paddy" is used interchangeably with "irrigated paddy."

67 percent of the caloric content and 50 percent of the market value of foods consumed.[1]

Similar conclusions can be applied to the Province of Central Java, the area selected for the present study. At constant prices of 1969, the share of food crops in the Central Java regional gross domestic product for the year 1971 was 39 percent, which is also the largest of any single contribution [34, p. 258]. Irrigated paddy production in Central Java in 1971 contributed 70 percent to the total value of all food crops.[2] The harvested area of irrigated paddy increased from 42 percent of the total food crops area in 1962 to 53 percent in 1972 (Appendix Table A.1). In terms of the area occupied and its value share in the regional economy, irrigated paddy farming has been since very long, and still is, the most important crop for Central Java farmers.

However, despite the important contribution of paddy farming to the economy, the domestic demand for rice has risen above its domestic supply, as was mentioned before. For Central Java, this could in part be explained by the more or less stagnant harvested areas and productivities of most food crops, except irrigated paddy (Appendix Tables A.1 and A.2). Hence, there is an important immediate need for increasing food crops productivities in general and rice in particular.

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[1]The caloric content figure was an average of 1053 households from 30 villages (a.o. 16 were from Java) in 8 provinces, Indonesia, in 1972 [75, p. I-29]. The market value was an average expenditure in 1964/65 on cereals, rather than on rice alone, as compared to the average expenditure on all foods consumed [50, p. 151].

[2]For Central Java, the seven most important food crops according to their decreasing relative total values in 1971 were: 1) irrigated paddy, 2) cassava, 3) corn, 4) peanut, 5) soybean, 6) upland paddy and 7) sweet potato [34, p. 111 and 34, pp. 38 and 43].

Referring to the size distribution of farms as presented in Appendix Table A.3, it would appear that food crops in Central Java are grown by millions of tiny farms. If a minimum subsistence standard for farm size were defined to be 0.5 hectare, the data show that 52.5 percent of all farms were undersized, in terms of the current level of technology.[1] Thus, there is also need to alleviate the productivity situation of more than 1.3 millions of food producers in Central Java, who are mostly irrigated paddy farmers.

B. New Technology and Paddy Intensification Programs

Historically, the first large scale effort to increase yield per hectare by using new technology, the so-called Paddy Center Program, was initiated in 1959 and laster for three years.[2] As a means to implement the program, a state-owned corporation known as PERTANI was created.[3] Its main business was to deliver the complete package of new technologies, including credit and intensive extension services to the farmers. Lack

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[1]It was proposed by Sajogyo [58, pp. 11 and 34] that farm sizes under 0.5 hectare are definitely undersized for an adequate living, especially if it is mainly nonirrigated land. More conservative estimate of farm size for some level of adequate living was suggested by Penny and Singarimbun [51, pp. 2-3], which consists of 0.7 hectare of rain-fed wet land plus 0.3 hectare of nonirrigated dry land. It should be noted that the 1963 Agricultural Census, which data are used in this calculation, had excluded farms with sizes under 0.1 hectare. If they were included, the figure would be 63.6 percent [57, p. 6].

[2]Most of the ideas presented in this section are adapted from Sajogyo [58, pp. 9-12].

[3]The term PERTANI was a formal abbreviation of "Perusahaan Pertanian Negara Indonesia" (State Agricultural Enterprises).

of organizational experience and insufficient trained personnel were the two main causes of its rather premature ending in 1963.

In 1964 PERTANI was then reorganized to limit its activities to storage and delivery handlings of physical inputs such as new seeds, fertilizers, pesticides and small equipment related to the use of new technology. In fact, fertilizer sale was monopolized by PERTANI. This status was maintained through 1970.

The second large scale program was implemented in 1964, which came to be known as the BIMAS program.[1] The BIMAS program was based on experiences gained through a pilot project in three villages in West Java conducted by Bogor Agricultural University in the wet season of 1963/64, partly in response to the failure of the earlier effort. The "ex-post" experiment by participating farmers showed that by optimally combining domestic high yielding varieties (HYV), fertilizers, pesticides, better cultural practices, adequate irrigation and intensive extension, yields showed more than 50 percent increase over normal yields [56, p. 64].

These impressive results attracted the attention of government policy makers, who quickly took steps to expand the area under BIMAS. As supportive means, the Bank Rakyat Indonesia (State People's Bank) and PERTANI were instructed to administer credit application and new inputs distribution. At village level, farmers were encouraged to form "farmer coops" as the new village institution responsible for local BIMAS activities. However, the intensive extension became "diluted" when students and other village-level workers had to cover entire

[1]An acronym in Indonesian meaning "mass guidance."

subdistricts as operational unit comprising from 250 to 500 farms, rather than small groups of 50 farms as was the case in the pilot project [56, p. 66]. Those concerted actions were the rule until 1970, when a major reorganization took place.

It should be mentioned that beginning in 1967, the fertilizer responsive HYV from the International Rice Research Institute (IRRI) were introduced. These were the well known IR-5 and IR-8 varieties. From 1967 on, the government differentiated BIMAS into "new" if IR-varieties were used and "ordinary" if domestic HYV were planted.[1]

The third program, named INMAS,[2] was initiated by a government decree in 1967 to make new inputs available for cash purchase by those farmers not participating in any current BIMAS programs. Paddy farmers who, by their own initiative, purchase and use the new inputs were defined to be in INMAS programs. It was necessary to do this since many paddy farmers had already been exposed to the beneficial use of new technology and, until that year, no formal source of cash fertilizer sale was permitted. In comparison to other previous programs, INMAS may be considered "loose," i.e., without direct government supervision. However, in view of the adoption stage where farmers buy new inputs on their own initiative, this type of program may be regarded as the more advanced one, when compared to the other (BIMAS) programs [12, p. II-7].

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[1]Domestic HYV have been developed by Central Research Institute for Agriculture at Bogor. Usually the emphasis has been more on resistance toward pests and diseases but less on fertilizer responsiveness. Nevertheless, domestic HYV are more responsive to fertilizer than local/traditional varieties.

[2]Abbreviated from "Intensifikasi Masal," meaning mass intensification.

After four years experience with these BIMAS type programs, many agricultural policy makers became optimistic. The BIMAS basic approach was adopted as a national policy for increasing rice production beginning with the first Five Year Development Plan (1968/69 - 1973/74).

The fourth program known as "BIMAS gotong royong" was implemented in 1968, in addition to current BIMAS and INMAS programs, mainly due to limited foreign currency reserves for fertilizer imports [12, p. II-6]. It involved several foreign companies, by special contracts with the government, furnishing all the necessary input packages and services to paddy farmers in return for a certain share of the farmer's next harvest.[1] PERTANI and People's Bank were not involved in this endeavor. After one year, the program suffered from problems similar to those of the regular BIMAS, including dilution of services, because it was expanded beyond the capacity of the agencies involved. It was terminated in 1970 due to mismanagement of credit repayments [58, p. 11].

The fifth and last program, started in 1970 and continuing to the present, was named "improved BIMAS" or in Indonesian: "BIMAS yang disempurnakan." The particle "improved" was given in the sense that the "old" BIMAS was reorganized, in order to make it more responsive to the individual farmer's need. It is assumed that most paddy farmers are by now familiar with the new inputs but do not have enough cash to buy them as needed. This was a step toward providing farmers a greater degree of participation in management decisions and less external "pressure" for compliance [42, p. 122].

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[1]Hence the name "BIMAS gotong royong," meaning mutual-aid BIMAS.

The main difference from the old BIMAS is that the People's Bank does not provide credit collectively to groups of farmers as before but, rather, to individual farmers as any other Bank's clients. In addition, PERTANI had to share the market with private companies, which marked the end of the monopolistic nature of fertilizer sales. With his money from the bank, a paddy farmer may buy the new inputs package anywhere he likes.

In order to get some impression on the recent intensification effort, data in Appendix Tables A.4, A.5, A.6 and A.7 respectively show area coverage by BIMAS and INMAS in Central Java and in Indonesia, levels of urea fertilizer application and levels of yield per hectare for both IRRA and domestic HYV.

These data indicate that domestic HYV contributed more than three times to all programs compared to IRRI-HYV, in terms of area coverage in Central Java particularly and in all Indonesia generally. If INMAS programs could be considered the most advanced stage of HYV adoption, the trends show that increasing areas have been covered over time by the program with both IRRI and domestic HYV (see Tables A.4 and A.5).

If data on urea fertilizer purchased could be assumed as a fairly good measure of its actual application by paddy farmers, the available data suggest increasing amounts have been applied over time. As with the HYV adoption in INMAS programs, the areas covered over time by urea fertilizer application have been increasing too (see Table A.6). Since the rates of fertilizer application, in terms of both quantity and area coverage, have been greater than the HYV adoption rates, Sajogyo [58, p. 13] asserted that BIMAS has been mostly a "fertilizer revolution" rather than an "HYV revolution." With increasing fertilizer applications, levels of yield per hectare have also been increasing (see Table A.7).

C. Generation of Problems

Since the very beginning of the large scale intensification effort, there have been many problems to be overcome in order to be able to meet the pressing demand to expand the BIMAS-type program as fast as possible. These are often called the first and the second generations of short run problems, which are inherent with any intensification program in a developing country [20, pp. 698-704].

Briefly, the first generation of problems in production include the difficulties in getting the optimum combination of new inputs in order to achieve optimum yields. For an agricultural production, especially irrigated paddy, it is indispensable that supplies of new inputs, including knowledge and management services, be available to the farmers at the right time, amounts and place. Most of the problems indirectly arise because of variabilities in basic resource endowments of both the farmers and the areas. A popular example would be geographical and individual differences in the availability of irrigation water (see Appendix Table A.8). Further, it should be obvious that lack of varietal research have compounded these problems [3, pp. 7 and 16].

The second generation problems involve marketing and demand difficulties created by the so-called green revolution.[1] Many problems arise

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[1]With the widespread large increases in wheat and rice production by using the new technology in many developing countries in the late sixties, the term "green revolution" has come in handy.

because of inadequacies in processing, transportation and storage facilities, in coping with the increased paddy production, both from the output and input points of view [44, pp. 13-14 and 20, pp. 701-704]. The problem arising from the less palatability of HYV rice also adds to the disincentives of adoption by farmers.

As time passed and the long run effect of the green revolution began to emerge, increasing concern is being expressed about changing equities, employment opportunities, social institutions and welfare in general.[1] These are the third generation of problems, which arise from (i) very low average income levels, coupled simultaneously with great regional and individual disparities in income and wealth, and (ii) limited opportunities for nonfarm employments.[2]

The present study concerns itself primarily with the third generation of problems, dealing mostly with distributional effects of the new technology on paddy farm income. Obviously, the three generations of problems briefly reviewed, are interrelated in the sense that one could not understand a specific problem without taking into account the others. The emphasis on paddy farmers is based on the fact that (i) paddy has been the only food crop receiving most exclusive attention in connection with the new technological development, (ii) the impact on paddy farm operation has not been fully understood, especially the differential distributional

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[1] For a brief review on these, one may be referred to Falcon [20, pp. 704-708], Wharton [77, pp. 464-476], World Bank report on agricultural sector, 1972 [3, pp. 3-16]. A rather detailed analysis on Indonesian problems may be found in Sajogyo [58].

[2] To these, Falcon [20, p. 705] added (i) extraordinarily dense population with high rates of growth, and (ii) fast technological improvements, often with labor-displacing potentials.

effects of additional costs related to the use of new technology, and (iii) paddy crop is still the most important farm enterprise in terms of rural income generation, area coverage and number of rural people involved.

D. Problem Statement for This Study

According to the first Five Year Development Plan (1968/69-1973/74), Indonesia should have increased its rice production from 10.4 million tons in 1968 to 15.4 million tons by the end of the planning period, which represents a 50 percent increase in five years period [54, p. 165]. It was to be achieved by means of increasing HYV adoption by paddy farmers and the rehabilitation of irrigation network, especially on Java. This short run target and the planned areas of intensification using HYV may be found, respectively, in Appendix Tables A.9 and A.10.

As regards the long run goal, the first Plan had recognized the equity implications when it specified the following:[1] "...the organization of factor supply should be arranged such that any farmer, who generally has only a limited size of farm, can benefit proportionately from the program" [54, p. 179]. The second Five Year Development Plan (1974/75-1978/79) has added that, on balance, expansion of employment opportunities should also be simultaneously considered in any program [53, p. 17]. All these specific objectives had been set in view of the country's more general goals: economic growth and political stability.[2]

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[1] Translated from Indonesian by the writer of this thesis.

[2] This is in general agreement with Mosher [43, pp. 1-38], Mellor [42, pp. 5-10] and Timmons [74, p. 85].

The present study is limited to the problems related to equity or, more specifically, to income growth and changes in income distributions of paddy farmers. It investigates other related problems as long as they help explain the income distribution or its change within and/or through period. The relevant periods of research correspond to the base and the end years of the first Five Year Development planning horizon, i.e., 1968/69 and 1973/74. By using data from both periods, comparisons could be made in a similar way as "before and after" type of study. Since no data were available between these two periods, no attempt will be made to study the path of change through time.

Apparently, judging from the lack of knowledge about current income distributions and relative efficiencies between groups and individual farmers, the normative condition to attain proportional gains by paddy farmers over time is about the best that could be developed. In economic terms, the normative condition means that every paddy farmer was expected to raise his efficiency by the same rate, regardless of farm size, toward the end of the planning period.

In other words, the first Five Year Development Plan had set the subobjective or means to achieve the main objective of increased rice production. This subobjective was that no change in paddy farm income distribution should occur over the period. The present study will take the normative condition of stable income distribution, while proportional growth in paddy farm income is expected, as a standard measure against which the actual results will be evaluated.

Following an analytical framework developed by Timmons [74, pp. 81-98], the normative target may be defined as the expected income distribution at the end period, which should be the same as the actual one at the base period. When the planning period ended in 1974, the corresponding actual income distribution can be taken as the existing situation resulting from tha program implementation. The problematic gap may then be expressed as a null hypothesis of no difference between the normative income distribution, i.e., equal to the actual one in 1968/69, and the actual income distribution achieved at the end of the planning period (1973/74).

In the diagnostic phase, several hypotheses explaining possible causes and nature of the gap may be formulated in the context of the internal farm operation. These will correspond to the "failure" and "success" elements related to the process of achieving the normative goal. The failure elements are those factors that cause the existing situation to differ from the desired goals. The success elements are the factors that have prevented the gap from being larger than it is [74, p. 88]. Some of the relevant hypotheses to be tested in this study will be made explicit in the next section. Later, in the remedial phase, effort will be made to expand the success elements and reduce the failure elements in view of the normative goal. These would take the form of new hypotheses and/or implications for policy.

E. Objective of Study

The main objectives of the present study are (i) to compare and evaluate the income distribution of paddy farmers in the adequately irrigated areas of Central Java for the years 1968/69 and 1973/74 respectively, (ii) to specify and measure the impacts of new production technology on the paddy farm income distribution, (iii) to measure and evaluate intertemporal changes in relative economic efficiency within particular groups of paddy farms, with the aim of explaining changes in income distribution over time, (iv) to examine some of the policy implications that the findings of the study might have, and (v) to suggest additional research that might be necessary to support some of the present study's findings.

The scope of data collection for this study should permit one to draw inferences that may have applications in terms of both geographical areas and types of paddy farming, in addition to implications within the study area. The period coverage of this survey relates to the planning period of the first Five Year Development Plan (1968/69 - 1973/74) and within the first year of the second Plan (1974/75 - 1978/79). Policy implications to be drawn from the study should provide more precise choices to be considered by planners and policy makers for improvement of the program's performance as the second Plan develops.

As guides for data analyses, and on the basis of the relevant economic theory and past studies of related problems, this study proposes the following three general hypotheses.

Hypothesis 1: The income distribution of paddy farmers in 1968/69 is the same with that in 1973/74. This is a null hypothesis,[1] formulated under the delimiting phase of the research problem, for verifying whether there is a problematic gap based on appropriate statistical tests. More precisely, if:

F_o = index of income distribution of paddy farmers in 1968/69,

F_t = index of income distribution of the same in 1973/74,

the null hypothesis can be restated as: $F_o = F_t$, while the alternative hypothesis is $F_o \neq F_t$.

Since paddy farmers in the survey area had been largely exposed to the new technology, as can be seen from Appendix Table A.11, the testing of the null hypothesis above would give some idea on the general impact of the new technology over time. If the null hypothesis were rejected or, what amounts to the same, if the alternative hypothesis were accepted, then the magnitude and direction of the change are amenable to evaluation.

Hypothesis 2: For a certain production year, the income relative variance of a group of paddy farmers is related to the relative variance and the average level of new technological input expenditures. This is the first of two hypotheses pertaining to the diagnostic phase of the study. In symbolic terms if, for a group of farms:

$V(Y_t)$ = relative variance of paddy farm incomes for the year t,

$V(E_t)$ = relative variance of expenditures on the new technological inputs for the year t, and

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[1]For exposition see, for example, Freund and Williams [24, pp. 221-225].

$M(E_t)$ = mean expenditure on the new technological inputs for the year t,

a linear relationship may be proposed as:

$$V(Y_t) = b_1 V(E_t) + b_2 M(E_t)$$

where b_1 and b_2 are the regression coefficients.[1] Statistical tests of significance on the estimated coefficients would indicate whether b_1 and/or b_2 are significant within the accepted probability limits.[2]

It should be noted that the relative variance of incomes may be taken as an indicator for income distribution. By statistically comparing the results of two hypotheses testings, each representing the empirical relationship for a certain year in the intertemporal framework, an evaluation could be made on whether an increase in the use of specified inputs including new technologies, would result in a more equal income distribution over time.

Hypothesis 3: High income paddy farmers have the same over-time growth of relative economic efficiency with low income paddy farmers. This is the other hypothesis pertaining to the diagnostic phase explaining the internal farm behavior and organization which, for example, may lead to the possible differential income growth between high income and low income groups of farms through time. By comparing the indices of relative economic efficiency,[3] an evaluation could be made on the null hypothesis of no difference between various groupings of farms in an

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[1] The relationship was first proposed by Singh [64, p. 8]. It will be specified more clearly in Chapter II.

[2] See, for instance, Ezekiel and Fox [19, pp. 281-287].

[3] The concept was due to Lau and Yotopoulos [39, pp. 94-109]. For exposition, it will be developed later in Chapter II.

intratemporal and/or intertemporal framework. If the result of the test indicates that a certain group of farms was more economically efficient than the other, policy measures may be proposed to improve and correct the existing trend, with the aim of achieving the overall development goals.

Other paddy farm groupings, such as (i) small and large farm sizes, (ii) owner-operators and tenants, and (iii) HYV and traditional variety growers, may also be subjected to this type of hypothesis testing. Results of the tests on these groupings might help explain the change in income disparities, if any, both within and between periods.

F. Methodological Approach

As was mentioned in the previous section, the main objective of study was to analyze the growth and distributional changes of paddy farm incomes between 1968/69 and 1973/74, with respect to several hypotheses explaining causal relationships. One of the most important "seeds of change" was the new HYV technology.[1]

In such a framework, the appropriate basic unit of analysis is the individual paddy farm, including the farm family who operates it. The choice was based on the fact that individual farm families are the relevant decision-making units with respect to farm income generation, expenditures for consumption and farm inputs and use of new technology. In order to see the impact of paddy HYV more clearly, the survey area was selected from the best irrigated rice producing areas in Central Java, where paddy double cropping is common.

[1]The specific terminology was due to Brown [15].

Although paddy cropping was the most important source of farm income, home garden produce and other nonpaddy crops may also contribute significantly to total farm income [58, p. 2]. Due to the seasonal nature of agricultural production, nonfarm sources of income may exist which, for many small farmers, may become the most important source of living. These incomes by sources will be taken into account in the present study, since the expanding use of HYV may affect those income sources differently.

As the focus of study is to analyze the change in income and its distribution in an intertemporal framework, two periods of observation are necessary. In 1968/69, the Agro Economic Survey of Indonesia had collected data from sample paddy farms for the rice intensification study in the survey area. The types of data collected were standard farm management data, with particular emphasis of getting information about the HYV adoption rate and its impact on farm income, expenditures and labor requirements.

In 1974, the same set of data were collected from the same sample by this study, thus making it possible for analyzing the "before and after" type of comparison and to test some hypothesized causal relationships. Details on the sampling procedures and characteristics of sample farms are presented in Chapter III.

Three kinds of analytical tools for testing the proposed hypotheses will be employed in this study. The first is the use of simple measures of income distribution to compare income inequalities between various groupings of paddy farms, both within and between periods. It may be possible to deduce some causal relations, if there are consistent shifts in the indices of income distribution, as a certain element of income, or cost, is added to previously defined income.

The second analytical tool is an exploration in the use of a causal model to explain shifts in income distribution.[1] Basically, the formal model will be used to explain variation in the indices of income distribution by some hypothesized causal variables expressed in their means and relative variances. In a regression framework, the relative contribution of a certain causal variable can be evaluated by taking into consideration the possible effects of the other specified variables.

The third analytical tool is a recently developed concept of relative economic efficiency between any two groupings of firms.[2] By grouping the sample into "small" and "large" paddy farms, for example, one can test the null hypothesis of equal economic efficiency. Implicitly, this means also a test of difference in that portion of profit contributed by the relative success in the maximization effort by each group. It should be clear, that if small farms are more economically efficient than large farms, then it may be inferred that farm incomes would be more equally distributed. More specifically, this is because small farms are relatively more successful in maximizing profit than large farms, given differences in fixed factor endowments and farm-gate prices of input and output.

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[1] For the original model, see Singh [64].

[2] See the basic model by Lau and Yotopoulos [39, pp. 94-109].

Although statistical tests of significance will be used throughout this study, the results must be interpreted with considerable care. Although the 1968/69 sample can be viewed as reasonably representative of rice producers in the villages sampled, the 1973/74 data for the same farmers represent an older than average set of farmers. Some of the changes observed may be, in part, due to an increase in assets and experience of the farmers in the sample. Such possibilities could not be fully analyzed either due to lack of data or too few observations. Some of the conclusions drawn about the farmers sampled should not be generalized to the entire villages. For example, in some cases the farmers sampled increased total land in production during the five year period. However, since total land in production remained fairly constant in the villages, the sample result implies that other farmers must have left farming or reduced their farm sizes.

G. Organization of Report

Chapter I introduces the reader to the distributional problems related to the effort to increase domestic rice production in Indonesia in general, and in the Province of Central Java in particular. The explicit objectives of study are delineated and the three general hypotheses, representing the scope of the present study, are formulated. This chapter ends with a presentation of the basic methodological approach to be used in the study.

Chapter II begins with a review of recent studies on growth and income distribution problems in India and Indonesia, to introduce the reader with similar types of problems and to review the methodological approaches employed in these studies. Next, a detailed account on the theoretical bases for measurements is presented, with the aim of reserving the later chapters mainly for empirical procedures and for discussing the results of data analyses.

In Chapter III, the selection of villages and farmers for the purpose of data collecting are discussed and evaluated with respect to the question of representativeness. This is followed by Chapter IV, which presents relevant characteristics of the samples and the statistical populations, changes in some important variables over time, and adoption rates of new inputs related to the HYV technology.

The results of the data analyses pertinent with the objectives and hypotheses of study are laid out in Chapters V, VI and VII, where each is preceded by definitions of terms used and empirical procedures followed. The final chapter (VIII) contains summaries of findings, suggestions for further research and policy implications of the results of study.

II. ANALYTICAL FRAMEWORK

In this chapter an analytical framework for study will be developed. As a background, it would be helpful first to review relevant studies on growth and income distribution. By comparing the methodologies and results of various studies, one would be in a better position to develop concepts of measurement and/or select appropriate tools of analysis.

The first part of Chapter II deals with a review on relevant studies in problems related to income distribution, while the second part describes the concepts of measurement and analytical tools to be used in this study.

A. Relevant Studies on Growth and Income Distribution

Very few studies on growth and income distribution have been made in Indonesia. Most of these few were at best descriptive and brought up as minor sections of different study objectives. In fact, no particular study has been made on the cause and effect of technological change on income inequality. For these reasons, some relevant studies from India, a country with similar farming conditions in general, will be reviewed in the interest of getting more background information on various methodological approaches.

1. Indonesian studies

Based on a two village case study in West Java (Indonesia) in 1969, Roekasah Adiratma [1, p. 183] asserted that the family income distribution by sources was apparently related to access to markets and services. This conclusion suggested that the better access the village had to market and services, the more equal was the income distribution. He concluded, further, that low income families had less access to services than high income families. No differential access to market for low and high income families was mentioned in the study.

In one village case study in Yogyakarta region (Indonesia), Penny and Singarimbun [51, pp. 44-49] reported that from 1959 to 1968 the region had experienced a worsening of farming household income distribution. The median household income of small farmers for the respective years were 352 and 266 kilograms rice equivalents per year, while the respective data for large farms were 1,237 and 1,411 kilograms rice equivalents per year. The researchers interpreted this evidence to support their assertion about the seriousness of problems related to very small landholdings in the region.

By comparing aggregated statistical income data from Java (Indonesia) at four points in time from 1963/64 to 1969/70, King and Weldon [36] found that rural income distribution had been more or less constant, while urban income inequality had increased. The two summary measures of income inequality,[1] i.e., the Gini ratio and the standard deviation of logarithms of per capita income in rural and urban Java, are presented in Table 2.1. A similar conclusion was reached by Ojha and Bhatt in India [48, pp. 711-720], using a time reference between 1953/54 and

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[1] In short, a summary measure (index) of income inequality, like Gini ratio or the standard deviation of logarithms of income, indicates the extent of income disparities between low income and high income groups of recipients. A larger index would mean a greater inequality, while a smaller one indicates otherwise. Detailed concepts on the relevant indices of income distribution are presented in the following Section B.

and 1956/57. Further, the Java study also found that, at constant prices during that period, the lower 60 percent of population in rural areas had undergone a 28 percent decline in total food consumption expenditures.

Table 2.1. Trends in per capita income distribution, rural and urban Java, 1963-1970[a]

	Rural		Urban (excluding Jakarta)	
Year	S.D. of logarithms	Gini ratio	S.D. of logarithms	Gini Ratio
1963/64	0.237	-	0.218	-
1964/64	0.256	0.328	0.239	0.301
1967	0.210	0.263	0.234	0.293
1969/70	0.242	0.309	0.259	0.332

[a]Source: 36, Table 3.

Increasing interest on the cumulative effect of the introduction of new technology has developed recently. The Agro Economic Survey, under the Department of Agriculture, has proposed a long term research project dealing with rural dynamics. Some of its central questions are directed at studying in detail the impact of new technology on the social-economic institutions and income distribution among groups of rural population [7]. Along the same line, in response to the Survey proposal, a paper from Satya Wacana University at Salatiga, Central Java, discussed the institutional changes occurring in some villages of study, which supposedly related to the effect of new technology [55]. It proposed detailed research on the positive and negative effects of those changes on income inequality and employment opportunity [25].

2. Indian studies

Shifting to India, Bal and Singh [10, pp. 81-91] studied rural family disposable income distribution in Punjab for two consecutive years, i.e., in 1967/68 and 1968/69. They reported that a worsening of income inequality had occurred to the farm operator families. Respectively, the Gini ratios were 0.37 and 0.43. On the other hand, farm labor and non-farm families did not seem to change their income inequalities. In 1967/68 the Gini ratios were 0.27 and 0.20, while in 1968/69 they were 0.27 and 0.22, respectively.

No specific reasons were given for both tendencies mentioned above. However, they asserted that the introduction of HYV technology has accelerated the transformation of the farm economy from subsistence to commercial type of business. The green revolution has increased incomes of the farm operator families which, in turn, will affect incomes of the other sections of the rural population [10, p. 82]. However, the results might be considered inconclusive since the intertemporal period of study was too short. Nevertheless, if anything, the direct impact of using the HYV technology in agricultural production seemed to be convincing.

The farm family income in Haryana (India) was investigated by Nandal [45, pp. 11-19] for three consecutive years: 1967/68, 1968/69 and 1969/70. His results confirmed the hypothesis that larger farms had benefited more from the green revolution than smaller farms. The data showed that the lower 40 percent income group of farm families shared 18 percent and 12 percent of the total income during 1967/68 and 1969/70, respectively. The respective percentage shares for the higher 40 percent income group were 70 percent and 74 percent [45, Table II].

He added that mechanized farms benefited more than nonmechanized farms under the period of study, where the percentage increases in income from 1967/68 to 1969/70 were 59 percent and 30 percent, respectively. Surprisingly, no meaningful difference in income change was reported on the effect of differential schooling from zero up to 12 years of formal education. Illiterate farmers had a 4.5 percent increase in income, while those with 6-12 years of schooling had only 3.9 percent increase in income [45, Table I]. No specific reasons were submitted for the differential income growth. However, the last conclusion might seem to contradict Schultz' assertion regarding high rates of return to be expected from schooling, especially in primary education [60, pp. 186-191]. The explanation would probably be found in the other factor since, after all, formal schooling is only one of the many factors that influences productivity growth.

Shah and Agrawal [62, pp. 110-115] asserted that in Uttar Pradesh (India), farm income disparities tended to widen between two classes of farmers, i.e., progressive and less progressive, and between the size groups of farms within each class due to the impact of new technology.[1]

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[1]A progressive farmer was defined as one who met at least three of the following conditions: (i) having 30 percent of his own area irrigated; (ii) having at least one agricultural machinery; (iii) having at least 20 percent of his cropped area under HYV; (iv) using chemical fertilizers in 20 percent of his own area; (v) having an owned means of irrigation. These two classes of farmers were further classified into three groups, viz., those with less than 10 acres, those having 10 to 30 acres and those with holdings above 30 acres.

Their assertion was mainly based on the differential farm net capital invested in 1967/68 by these two classes of farms. The small, medium and large progressive farmers, respectively, invested in the amounts of 437, 3,782 and 12,621 rupees. The data for the less progressive farmers were, respectively, 272, 1,678 and 478 rupees [62, Table V].

Garg, Singh and Srivastava [27, pp. 115-121] generated data on farm incomes for different size groups of farms and the adoption rates of HYV in Kalyanpur Block, Kanpur (India), but no analysis was provided for the trend in income disparities. However, it appeared that the income gap between small and large farms was increasing with the adoption of HYV. From 1966/67 to 1968/69, farms belonging to the size group of less than 2 hectares had experienced a 6 percent increase in net income, while the percentage area under HYV increased only 13 percent. The respective percentage increases for farms belonging to the size group of 4 to 6 hectares were 38 percent and 21 percent.[1]

This conclusion is consistent with the findings by Schluter and Mellor [59], who used Indian sample farm data of 1966-1968. With adoption defined as a case where any part of the farmer's acreage has been put under HYV, they found significant positive relations between adoption and size of farm in 17 out of 20 areas of study. This implies that income

[1]These trends seem to contradict the findings by Sohoni and Khandakar [67, pp. 132-133] in Wardha district of Maharashtra (India), who reported that although the income gap between small and large farms had widened with the increase in irrigation facilities in absolute terms, the small farms had done better in terms of the rate of growth in income between 1965/66 and 1967/68. Unfortunately, no specific data was presented in their summary report.

differentials resulting from HYV will persist longest in areas where the overall rate of adoption is slowest [59, p. 3].

If adoption rate is defined as the proportion of acreage under the new varieties, Schluter and Mellor found predominantly negative simple regression coefficients between farm sizes and adoption rates [59, Table 3]. From the viewpoint of the distributional impact to incomes this may serve as, what Timmons called, a success element [74, p. 88].

Regarding the tendencies above, Schluter and Mellor proposed the following explanations that (i) small farmer faced greater uncertainties and lack of operating funds as compared to the larger farmers, and (ii) larger farmers were constrained by labor management problems [59, pp. 15-16]. Remembering the dual objectives of achieving growth and more equal income distribution, the implications for policy are that credit and extension should be made available at minimum cost to reduce uncertainties faced by small farmers.

In his research, Katar Singh [64, p. 7] attempted to specify and measure the net influence of new agricultural technology on the farm income distribution in the Aligarh district of Uttar Pradesh, India. One of his encouraging conclusions was that the farm income inequality had been reduced, as demonstrated by a decrease in the estimated Gini ratios of 0.514 in 1963/64 to 0.428 in 1968/69, while the average income per farm recorded an increase of about 83 percent at constant prices of 1963/64 [64, Table 4 and p. 50]. The other important finding was that the new inputs expenditure over time was negatively related with the farm income inequality. This means that the goals of growth in productivity and more equal income distribution were complementary, in the sense that an increase in new input levels of use will improve income distribution in the study area [64, pp. 61 and p. 68].[1]

Another relevant study by Swenson [71] was conducted in two villages in the paddy area of Thanjavur district, Tamil Nadu State, India. The main objectives of study were (i) to evaluate the effect of increases in rice production on employment and income distribution, and (ii) to identify major factors influencing their changes. Briefly, some of the results of relevance to the present study are that: (i) no significant change had occurred in income distribution between 1965/66 to 1970/71, as evidenced by the respective estimated Gini ratios of 0.707 and 0.700, (ii) in both periods, total farm income from all sources were more equally distributed than income from paddy alone, as shown by the estimated Gini ratics of around 0.7 and 0.8, respectively, and (iii) in 1970/71, paddy prices were positively correlated to the quantity and time of sale.

In 1971, Lau and Yotopoulos [39, pp. 94-108] developed an interesting model to test the relative economic efficiency between any two groupings of farms. They tested the empirical applicability of the model to the Indian farm setting during the period of 1955-1957. The results of the test showed that small farms (i.e., farms of less than ten acres) were more economically efficient than large farms, in that

[1]Apparently, it is an interesting and useful methodological approach for specifying causal factors that may explain shifts in income distribution. In fact, the testing of hypothesis 2 of the present study will make use of this unique model, the derivation of which is presented in the next section.

particular point in time. This means that the actual gap between incomes of small and large farm groupings was minimized by the fact that the first was more efficiently organized than the latter. In terms of problem-solving approach [74, p. 88], this may be called a success element.

Methodologically, they asserted [39, p. 96], the model has some desirable features for measuring relative efficiency as follows: (i) it is a method that is based on the precepts of economic theory, i.e., the maximizing principle, (ii) it is more general than the existing alternative, i.e., it combines the concepts of technical and price (allocative) efficiency measures, and (iii) it is parsimonious in terms of data requirements.[1]

By applying the concept of relative economic efficiency, a study of farm data in three Indian States (Tamil Nadu, Punjab and Uttar Pradesh) in 1955-57 and 1967-69 by Crown and Nagadevara [17, pp. 1-13] indicated that large farms had gained economic efficiency more rapidly than small farms. Its implications to farm income distribution should be apparent, i.e., the differential economic efficiency should, at least partially, contribute to the widening income gap between small and large farms through time.

They pointed out, further, that with Thanjavur district (Tamil Nadu) being under the Intensive Agricultural Development Program (IADP) for the past decade, one would have expected the rates of efficiency growth to be

[1]For these reasons, the present study will employ this model for testing hypothesis 3. Details of the relative economic efficiency concept are found in the following section.

equal for all farm sizes.[1] However, the results of the analysis did not seem to agree with the expectation.

Having reviewed the methodological approaches and empirical results of some relevant studies in the past, the next section will be devoted to conceptual development of tools and measures to be used in the analyses of paddy farm income distribution.

B. Analytical Concepts

Generally, one can differentiate two basic analytical measures of income distribution: (i) the functional income distribution, which originates from the marginal productivity theory of distribution or input returns,[2] dealing with distributional shares of the gross returns among various inputs used in the production process, and (ii) the size distribution of income, which is (only) an empirical concept useful for determining how the "economic pie" has been divided among individual recipients.

But the marginal productivity theory does not go very far in explaining the term income distribution, as it has been used in this study, since it deals exclusively with the pricing of factors of production. It has little to say about the distribution of income among the individual

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[1] To a large degree, IADP represents an attempt to program an equity policy [17, p. 12]. This is comparable to BIMAS in Indonesia with dual goals of productivity growth and equity.

[2] As it is generally known, the neoclassical micro economics deals with the theory of value and distribution. The first refers to the theory of supply and demand for consumption goods, the second refers to the same for productive services, including the theory of relative share in total value of products. See for example: Ferguson [21], Henderson and Quandt [32], and other standard micro economic texts.

members of society. Consequently, the present study has been applying the second concept, i.e., the individual or group's shares of the economic pie, when it uses the terms: income distribution, income disparity, income inequality and so on.

Several methods of analysis are available to identify factors which, presumably, could explain a particular income distribution or its variation. One is the regression analysis on income with various independent factors. Many definitions of income, including its index of distribution, could be subjected to this kind of analysis.[1]

Still another one, is the marginal productivity analysis of relevant input factors which, for a certain range of prices and production relationship, would explain the trend in income growth for a certain class of farmers. By repeating the analysis on all classes based on a certain stratification of an explanatory variable, one would arrive at the conclusion describing the trend in income distribution for the statistical population. Although theoretically it is possible, the empirical application is rather risky because of the nature of most cross-sectional data and the possible existence of multicollinearity.[2]

In some instance, however, a simple comparative analysis based on several equal groupings (i.e., quintiles, deciles, etc.) of ordered income data would suffice. Further, by preparing a cross tabulation of important explanatory variables by equal groupings of income, many

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[1]See for example: Kuznets [38, pp. 1-28], Aigner and Heins [5, pp. 175-184], Gardner [26, pp. 753-769] and Singh [64].

[2]See for example: Swenson [71, pp. 281-283].

analyses could be performed. These kinds of analyses usually make use of group percentage distribution for empirical measures.

The empirical measures for use in the present study consist of the group percentage distribution and the summary measures of income inequality. The latter measures include: (i) equal share coefficient, (ii) Gini ratio, (iii) coefficient of variation, and (iv) standard deviation of the logarithms of the income.

1. Group percentage distribution

A familiar technique in cross-tabulation analysis is to arrange the ordered data in some clearly delineated groups and to take a critical look at how the corresponding relative shares from the total of the same, or some other, data variable is dispersed among those groups. This approach will yield a descriptive measure of that particular data distribution. If, for example, income data from two or more periods are available, the analysis would indicate changes in relative shares through time and, hence, a change in income distribution, if any.[1]

In the present study, various types of income data from sample farmers will be classified in five equal-size groupings, or quintiles, and the relative shares among the groups are expressed in percentages of total. But, for certain qualitative variables like tenure status and HYV versus traditional paddy growers, the delineated groups will be of unequal size in most cases.

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[1]This is what Lydall [41, pp. 139-141] did when comparing various income distributions of many countries. See particularly his Appendix 7 [41, pp. 283-370]. For Java study, the same method was followed by King and Weldon [36].

For the present analytical purposes, three different units of analysis will be employed: (i) one-village, (ii) all-villages combined, and (iii) particular economic or geographic areas. Since the emphasis of study is measuring changes in income distribution caused by the impact of new technology, comparative analyses will be made on relative shares of the same group in 1968/69 and 1973/74.

A related measure based on the above principle is the Lorenz curve. If on a plane of X and Y axes, the zero point on an horizontal X-axis is taken as the starting point of a cumulative percentage of the population of income recipients, and the zero point on a vertical Y-axis is the starting point of a cumulative percentage of total aggregate income, then a Lorenz curve could be drawn representing the increasing cumulative percentage of income held by the increasing cumulative percentage of the recipient population. The 45-degree line, or the egalitarian line, passing through the points (0,0) and (100,100) represents the norm of complete equality, indicating equal income shares for every recipient. The more unequal is the income distribution, the wider is the area between the egalitarian line and the Lorenz curve, as can be seen from Figure 2.1.

Theoretically speaking, in order to arrive at any ranking of income distribution, Atkinson [9, pp. 245-247] suggested that the utility function of income $U(y)$ be increasing and concave, i.e., $U' > 0$ and $U'' \leq 0$. He asserted that an income distribution $f(y)$ will be preferred to another income distribution $f^*(y)$, if the Lorenz curve corresponding to $f(y)$ will lie everywhere above that corresponding to $f^*(y)$, and the mean of $f(y)$ is equal or greater than that of $f^*(y)$.

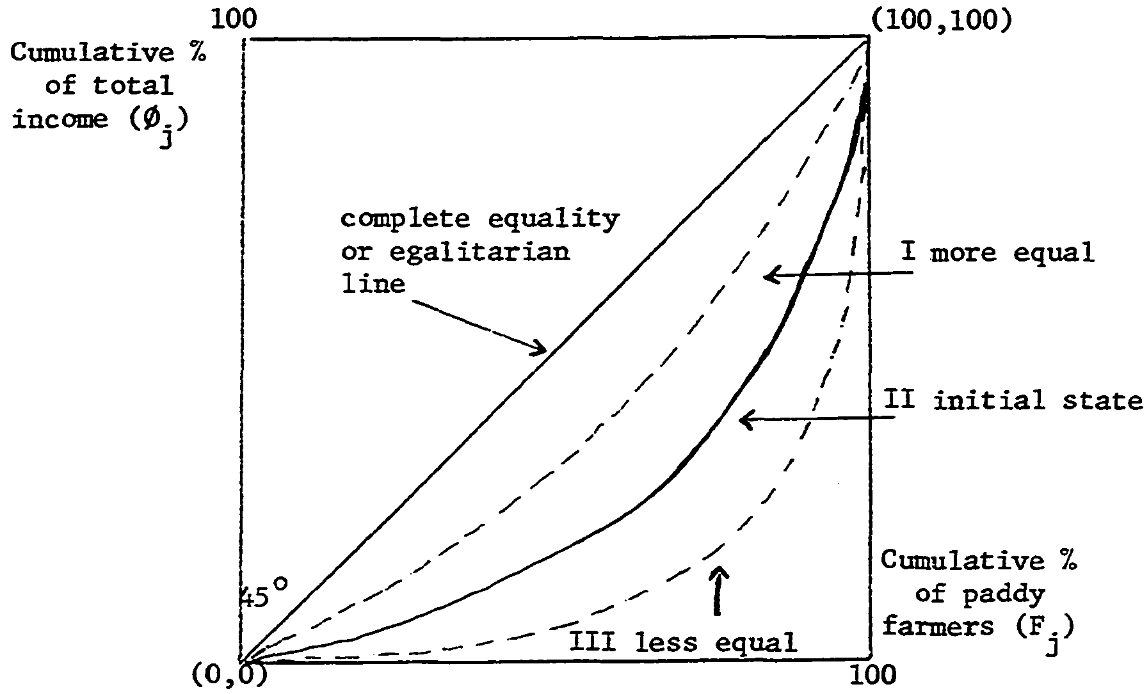

Figure 2.1. The Lorenz curves (I, II, III)

Thus, if their Lorenz curves do not intersect, an income distribution is preferred to the other when its curve lies closer to the line of complete equality than the other, as it is obvious from Figure 2.1. If their respective Lorenz curves do cross, the two income distributions are not comparable from the welfare standpoint, since each has a different ranking distribution function or, what amounts to the same, a different social welfare function [9, p. 247 and pp. 257-258]. Hence, in the present study, the Lorenz curve technique per se will not be used because of the inherent possible difficulties for comparison purposes.[1]

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[1]King and Weldon's study [36] on rural versus urban income distributions in Java (Indonesia) has presented a diagram on which the respective Lorenz curves in 1970 did cross each other more than once [36, Figure 1]. See also the present review on their study on pp. 23-24.

Nonetheless, it is important to have some knowledge of it, as the Lorenz curve is the basis for two well-known summary measures of income inequality.

2. Summary measures of income distribution

In order to confirm the results of a group percentage analysis on the difference between two or more income distributions, either for intra-temporal or inter-temporal comparison purposes, selected standard summary measures will be used. For any statistical population, the standard summary measure gives a single index of inequality for its income distribution. Before examining the implications of specific measures selected for this study, it is helpful to discuss some general properties that such measures should have, remembering the objectives and scope of study.

In particular, the appropriate measure should be one which possesses at least the following two general properties [9, pp. 253-255 and 72, pp. 13-14]. Firstly, it should be unaffected by equal proportional increases in all incomes, so that if every farm income receives an equal proportional increase in 1973/74 as compared to that of 1968/69, it can be said that there has been no change in inequality of income distribution.

Secondly, it should be sensitive to disproportionate changes at levels of income on either side of the mean, such that if from 1968/69 to 1973/74 the incomes of lower-income farmers increase disproportionately more than those of the higher-income farmers, this should result in positive reduction of the index of inequality. In short, the second requirement leads to summary measures having strictly concave distribution function [9, p. 254].

Based on these two properties, four indices of income distribution will be employed in the present study:[1] (i) the equal share coefficient, (ii) the Gini ratio, (iii) the standard deviation of the logarithms of the incomes, and (iv) the coefficient of variation.

Theoretical comparisons of the last three measures can be found in Theil [73, pp. 121-125] and Atkinson [9, pp. 252-257]. Empirical procedures for each measure, followed by some notes on the more important properties differentiating each from the others, will be presented subsequently.

a. Equal share coefficient If every member of an income recipient population received an equal share of the total income, which equals average income, the Lorenz curve would coincide with the diagonal line of complete equality (see Figure 2.1), and each point on that curve would have 45 degrees slope. For any continuous Lorenz curve representing an unequal income distribution, obviously there is only one such point, i.e., possessing the slope of 45 degrees, which defines the equal share coefficient.[2] The population portion to the right of this point

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[1] Two other measures, Pareto coefficient and Elteto-Frigyes index of inequality, will not be used here. Both of these measures do not have the second property mentioned above. The first measure describes only income changes by recipients at the upper tail of the distribution, but is not concerned with those at the lower tail of the distribution. The second measure is insensitive to income changes between recipients on the same side of the mean. If, for instance, there were disproportionate changes of incomes between people at the lower side of the mean, it will not alter the corresponding index of distribution [72, pp. 9 and 15, pp. 254-255].

[2] For a discrete Lorenz curve, the coefficient could only be approximated.

gets more than an equal share of income for each of its members. In other words, the equal share coefficient measures the percentage size of the under-privileged population with regard to whatever level of average income.

Since this index depends on the shape of income distribution, i.e., on the functional form, it does not change with proportional increases on all levels of income. But, when disproportionate income growth caused the Lorenz curve to shift, the equal share coefficient would, in most cases, shift too. Depending on the functional form after the shift, this index might shift to either direction.

b. Gini ratio Gini ratio has long been recognized as a measure of dispersion and has been, by far, the most utilized measure of inequality. By definition, it is exactly equal to the ratio of the area between the Lorenz curve and the diagonal to the total area under the diagonal [72, p. 28]. For a discrete individual distribution of income, without any kind of grouping at all, the Gini ratio is formulated as follows.

Assume farm incomes Y_1, Y_2, ...Y_k are arranged in ascending order, with probabilities p_1, p_2, ...p_k such that

$$\sum_{j=1}^{k} p_j = 1.$$

For individual farmers in actual condition, this always means:

$p_1 = p_2 = ...p_k = 1/k$. The mean income is then:

$$\sum_{j=1}^{k} y_j p_j = m.$$

Thus, the proportionate share of all individuals having $y \le y_j$ is: $\phi_j = \sum_{i=1}^{j} y_i p_i / m$, where j = 1, 2, ...k. If one plots ϕ_j from a vertical axis against the cumulative proportion of individuals: $F_j = \sum_{i=1}^{j} p_i$ from a horizontal axis, and joins them with the points (0,0) and (1,1) one would get the Lorenz curve (see Figure 2.1). From these cumulative numbers, the Gini ratio (GR) may be calculated by the formula based on the trapezoidal area rule [13, p. 145]:

$$GR = 1 - \sum_{j=1}^{k} p_j \, (\phi_j + \phi_{j-1})$$

Obviously, the more equal is the income distribution, the closer is the Gini ratio to zero and, conversely, the greater is the degree of inequality, the closer will be the ratio to one.

For group (or regional) distribution of income, if: $\bar{y}_j$ = average income in the j^{th} group from total, the cumulative proportionate income share of the groups with $\bar{y} \le \bar{y}_j$ is:

$$\bar{\phi}_j = \sum_{i=1}^{j} p_i \, \bar{y}_i \quad \sum_{i=1}^{k} p_i \bar{y}_i, \quad \text{where: } j = 1, 2, ...k \text{ is the}$$

the number of the group.

The Gini ratio is then computed similarly as above.[1]

$$GR = 1 - \sum_{j=1}^{k} p_j \, (\bar{\phi}_j + \bar{\phi}_{j-1})$$

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[1]There is another formulation of the Gini ratio, which is computed from the mean difference E $\bar{y}_i - \bar{y}_j$ divided by twice of the average, 2m, which was shown by Bhattacharya and Mahalanobis [13, p. 149] to be exactly equal to the formula above.

It has been shown that the Gini ratio is insensitive to changes near the center of the distribution.[1] This, in part, explains the difficulties which arise when Lorenz curves cross. The Gini ratio might not change even if the Lorenz curve shifts, indicating a change in income distribution, as long as the areas between the diagonal and the respective Lorenz curves are equal.

In spite of that, from the standpoint of research objectives, most crucial changes are expected to occur at the lower end of the income distribution, where the Gini ratio is known to be fairly sensitive to transfers at that part of the income spectrum [72, p. 16]. Hence, the alleged insensitiveness near the center of the distribution should create no serious problem. As the Gini ratio is defined relative to the mean, it is unaffected by proportional increases in all incomes [9, p. 253].

c. Standard deviation of the logarithms of the incomes   The empirical procedure to estimate the standard deviation of the logarithms of the incomes is as follows. If: y_j = income of the j^{th} individual, k = number of samples, and Y = the geometric mean income for all individuals, then $\log Y = \frac{1}{k} \sum_{j=1}^{k} \log y_j$. The standard deviation is defined as:

$$SD = \sqrt{\frac{1}{k-1} \sum_{j=1}^{k} (\log y_j - \log Y)^2}$$

$$= \sqrt{\frac{1}{k-1} \sum_{j=1}^{k} (\log \frac{y_j}{Y})^2}$$

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[1]See Newbery [47, pp. 264-265] for a sophisticated proof. However, it could also be shown simply by using the triangle area rule.

For grouped individuals some adjustments are necessary. If:
k_g = number of individuals in the set S_g, where g = 1, 2, ...G and $k = \Sigma k_g$, the geometric mean income of the set S_g is Y_g, then

$$\log Y_g = \frac{1}{k_g} \sum_{j \in S_g} \log y_j.$$

This is connected to the geometric mean income of all individuals Y as follows:

$$\log Y = \sum_{g=1}^{G} \frac{k_g}{k} \log Y_g$$

The standard deviation of the groups can be arrived at by making the proper adjustments to the formula for individuals as follows:

$$SD_{(groups)} = \sqrt{\frac{1}{G-1} \sum_{g=1}^{G} \left[\frac{1}{k_g} \sum_{j=1}^{g} \log y_j - \sum_{g=1}^{G} \frac{k_g}{k} \log Y_g \right]^2}$$

$$= \sqrt{\frac{1}{G-1} \sum_{g=1}^{G} (\log Y_g - \log Y)^2}$$

According to Szal and Robinson [72, pp. 16-18] and Atkinson [9, pp. 255-256], the use of standard deviation of the logarithms of the incomes is attractive because: (i) it is unaffected by proportional increases in all incomes, (ii) it is sensitive to nonproportional changes at all levels of income, especially at lower incomes, (iii) the use of logarithms leads to relatively greater weight being given to lower income recipients, and (iv) it is particularly useful when income is approximately log-normally distributed.

The last argument could not be overemphasized as many studies have indicated that incomes are not normally distributed, especially in developing countries, and that their log-transformations are.[1] It was shown in Appendix Table A.3, that farm size distribution in Central Java is highly skewed to the right. As farm income is believed to be closely related to farm size, then it might be that farm incomes are also not normally distributed.

Empirical testings of normality of distributions of the original versus log-transformed income data are provided in Appendix B. Apparently, based on the results, both the original and the transformed income data were not normally distributed. Hence, all statistical testings on the differences of means and standard deviations in this study should be considered as approximations [69, p. 55].

But, relatively speaking, the log-transformed income data distributions are closer to normal, implying that statistical testings of the log-transformed data are more reliable than those of the original data. Also, it should be noted that many of the tests of difference will use standard deviations and means, which distributions are known to be much closer to normal. If the number of cases are sufficiently large, the distribution of sample means is approximately normal, even if the parent population is considerably not normal [69, p. 53].

d. <u>Coefficient of variation</u> By definition, if: y_j = income of the j^{th} individual, and k = number of cases, the coefficient of variation (CV) is formulated as follows:

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[1]See for example: Bal and Singh [10, pp. 81-91], Singh [64, p. 51] for Indian farms, King and Weldon [36, p. 9] for Java's population.

$$CV = \frac{\sqrt{\dfrac{k \sum_{j=1}^{k} y_j^2 - (\sum_{j=1}^{k} y_j)^2}{k(k-1)}}}{\dfrac{\sum_{j=1}^{k} y_j}{k}} \cdot 100\%$$

Following Atkinson [9, pp. 253-256], the coefficient of variation is unaffected by proportional increases in all incomes and is sensitive to transfer by attaching equal weight at different income levels. This summary measure is heavily influenced by extreme values [72, p. 23], but is considered useful when comparing distributions of income between two recipient population or groups, which have very different income averages [36, p. 8].

As has been mentioned, the present study will utilize all four summary measures described above, and apply them together to any one income distribution being analyzed. This multi-indices approach is preferred to using only a single index because, as Lydall [41, p. 138] put it, the use of a single index of inequality is not an ideal arrangement, unless one can be fairly confident that the functional form of the distribution is not changing.

Specifically, the use of a single measure of dispersion, while convenient for some purposes, can also be misleading. It might leave out too much of the important detail on the characteristics of the income distribution. For instance, the Lorenz curves for both income distributions may cross each other indicating a change in inequality, and yet the corresponding Gini ratios may be the same. The use of the four measures at the same time will provide for the consistency checks and corroboration of results, such that a firmer basis for conclusions could be made.

3. Impact of causal factors on income distribution

In this section an attempt is made to provide the theoretical basis for suggesting hypothesis 2. In general, one could think of many factors which influence farm income distribution or inequality. From the marginal productivity theory of distribution, one can express the equilibrium gross farm income as the sum of payments to factors of production used by the farmer [32, pp. 83-84]. Assuming, for the sake of simple presentation, that there are only two variable input factors: capital (K) and labor (L), with the respective constant prices R and W, which produce an equilibrium gross income (Ye), the relevant relationship for the i^{th} farmer may be stated as:

$$y_{ei} = R_i K_i + W_i L_i$$

Spplying the variance formula for two variables, the variance of the equilibrium income of the farmers is:

$$V\ (Ye) = R^2 \cdot V(K) + W^2 \cdot V(L) + 2\ R.W.\ cov(K.L)$$

where V denotes variance and "cov" means covariance of the corresponding variables.

In this respect, two useful formulas are the coefficient of variation and the covariance.[1] The first is defined as:

$$C = \frac{SD}{M},\ \text{or}\ SD = M \cdot C$$

where SD means the standard deviation and M is the mean. Squaring the

[1]The idea was due to Singh [64, p. 90].

coefficient of variation, one will get the relative variance:

$$C^2 = \frac{V}{M^2}, \text{ or } V = C^2 \cdot M^2$$

The second is represented by:

$$\text{cov } (K,L) = r \cdot SD_K \cdot SD_L = r \cdot M_K \cdot M_L \cdot C(K) \cdot C(L)$$

where r is the correlation coefficient between K and L variables.

Substituting for variance and the covariance in the equilibrium equation, one gets:

$$C^2(Ye)M^2_{Ye} = R^2C^2(K)M^2_K + W^2C^2(L)M^2_L + 2RWrM_KM_LC(K)C(L)$$

which, when put in relative terms by dividing by M^2_{Ye} and using upper bar notations for the means, after rearrangement one will get:

$$C^2(Ye) = \left(\frac{R\bar{K}}{Ye}\right)^2 C^2(K) + \left(\frac{W\bar{L}}{Ye}\right)^2 C^2(L) + 2r\left(\frac{R\bar{K}}{Ye}\right)\left(\frac{W\bar{L}}{Ye}\right)C(K)C(L)$$

which, by substituting $\underline{f}$ for the relative share of returns within the brackets, yields:

$$C^2(Ye) = f_K^{\,2}C^2(K) + f_L^{\,2}C^2(L) + 2rf_Kf_LC(K)C(L)$$

Clearly, the relative variance of equilibrium income, which may be taken as a measure of income distribution, is the function of: (i) the relative variances of capital and labor, (ii) the relative shares of capital and labor, and (iii) the relative covariance between capital and labor used in production. It should be noted, that the relative covariance may be taken as representing the extent of multicollinearity, if any, and as such it needs no specific mention at this time.

a. Adjustment for empirical testing Since prices are assumed to be constant, the theoretical model derived above may be rearranged in a simple linear form as follows:

$$C^2(Ye) = a\,C^2(K) + b\,\bar{K} + c\,C^2(L) + d\bar{L} + e\,\bar{Y}e + U$$

where:

$C^2(Ye)$ = the relative variance of equilibrium income,

$C^2(K)$ = the relative variance of capital,

$\bar{K}$ = the mean of capital,

$C^2(L)$ = the relative variance of labor,

$\bar{L}$ = the mean of labor,

$\bar{Y}e$ = the mean of equilibrium income,

U = the disturbance term.

The variables in this equation are estimated using data on 30 farms in each of the 8 sample villages selected for this study. The statistical estimation and testing procedures used in this case require, among other things, (i) that relative variances and means are "variables" which are not random, and (ii) that no exact linear relations exist between any of the independent "variables."

In addition to the traditional inputs, the farmers included in this analysis adopted new technology. The extent to which new inputs were used can be measured by total expenditures on HYV seeds, fertilizers, pesticides and the like. The previous theoretical model therefore could be expanded and presented as:

$$C^2(Y_e) = aC^2(K) + b\bar{K} + cC^2(L) + d\bar{L} + e\bar{Y}_e + fC^2(T) + g\bar{T} + U$$

where:

$C^2(T)$ = the relative variance of expenditures on new technology inputs,

$\overline{T}$ = the mean expenditure on new technology inputs,

and the other variables are as defined previously. A regression model based on this equation is used in Section B of Chapter VI to determine to what extent changes in expenditures on new technology inputs are in fact associated with changes in the income distribution.

The use of relative variance of income might result in difficulties in testing the hypothesis, if income is not normally distributed. In the present study, where income tends to be log-normally distributed (see Appendix B), the inequality in income distribution can be measured by the standard deviation of the logarithms of the incomes

b. Description of the possible nature of relationships Based on the concept of production function and the assumption of constant prices, it is easy to see that an increase in input levels is expected to increase the level of income. For the relevant range of production, this implies a positive direct relationship between $\overline{Y}$, $\overline{K}$, $\overline{L}$ and $\overline{T}$ in the equation above.

The relationship between the mean input variables ($\overline{L}$, $\overline{K}$ and $\overline{T}$) and income inequality ($C^2(Y_e)$) is empirical in nature and cannot be predicted a priori. There is, however, a general relationship between the average value of an input and its relative variance. If an increase in a mean variable is brought about by a more than proportionate increased use by those at the higher end of the distribution (i.e., the higher income farmers), then the variable's relative variance increases. Conversely, if it is brought about by a more than proportionate increased use by those at the lower end of the distribution (i.e., the lower income farmers), the variable's mean and relative variance are negatively related.

Although the relative variance of an input variable is expected to be closely related to the inequality in income, the relationship may be either positive or negative. Some of the factors that may affect the direction of relationship are: (i) the shape of the relevant production function, (ii) the extent of change in relative variance of the input, and (iii) the unit prices of the input and output. These will be illustrated using three different assumptions about the nature of the production function.

The term "returns to scale" is usually employed to describe the nature of functional relationship between an output and all its inputs. Depending on whether a proportional increase in all inputs leads to a more than proportionate, proportionate, or less than proportionate increase in output, the functional relationship may be described as increasing, constant, or decreasing returns to scale. It must be noted that no relevant inputs have been excluded in this case, which is hard to fulfill for an empirical production function. Therefore, Heady [31, p. 232] suggested the term "economic returns to scale" which considers only the specified inputs, while the noncontrollable inputs should be held fixed at known levels.[1] In the following theoretical analysis, this more practical concept by Heady will be used.

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[1]He also suggested the term "physical returns to scale," when all inputs are increased proportionately.

It should be apparent that an increased (decreased) relative variance of an input variable signifies a more than proportionate (less than proportionate) use of it by higher income farmers, when compared to lower income farmers. Assuming that physical (paddy) yield and farm size, as measured by the hectarage, are closely related to farm income, the three hypotheses about factors which influence the impact of an input variable on income inequality could be described by the use of production function relation.

If the relevant production function takes the shape of constant returns, a rise (decline) in the relative variance of an input would result in a less equal (more equal) income distribution, as can be deduced from Figure 2.2 below. The following notations are used in this and subsequent figures. Y = physical paddy yield, P_y = unit price of X, X = a specified input, P_x = unit price of X, Rp = <u>rupiah</u> value, AB = absolute increase of X used by small farms, CD = absolute increase of X used by large farms.

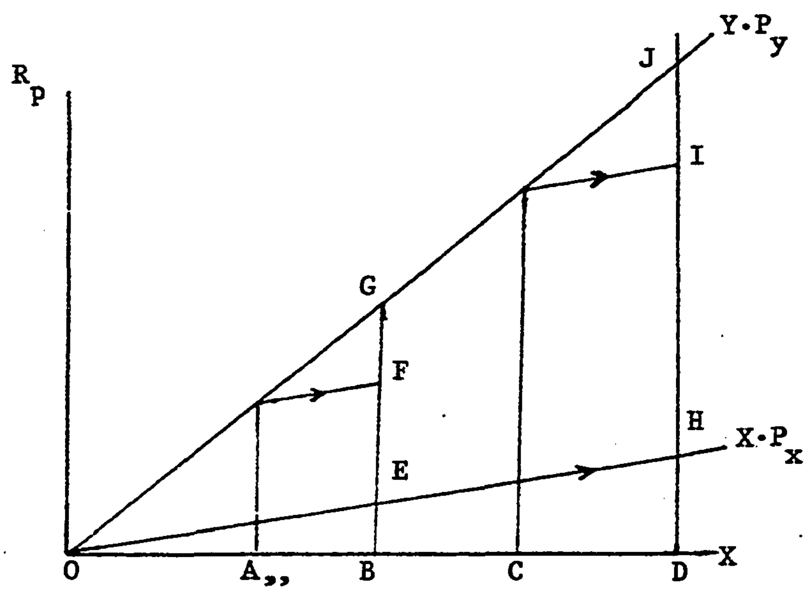

Figure 2.2. Constant returns to an input

In relative terms Figure 2.2 shows that, at constant prices, if $\frac{AB}{OA} > \frac{CD}{OC}$ then $\frac{GF}{FE} > \frac{JI}{IH}$, it implies that incomes will be more equally distributed. Conversely, if $\frac{AB}{OA} < \frac{CD}{OC}$ then $\frac{GF}{FE} < \frac{JI}{IH}$, this means that incomes will be less equally distributed.

If the relevant production function is of decreasing returns, a decline in relative variance of a specified input variable would result in a more equal income distribution. On the other hand, an increase in the relative variance of it could result in a less equal or a more equal income distribution, depending on the intensity of diminishing returns relationship, as can be observed from Figures 2.3 and 2.4 respectively.[1]

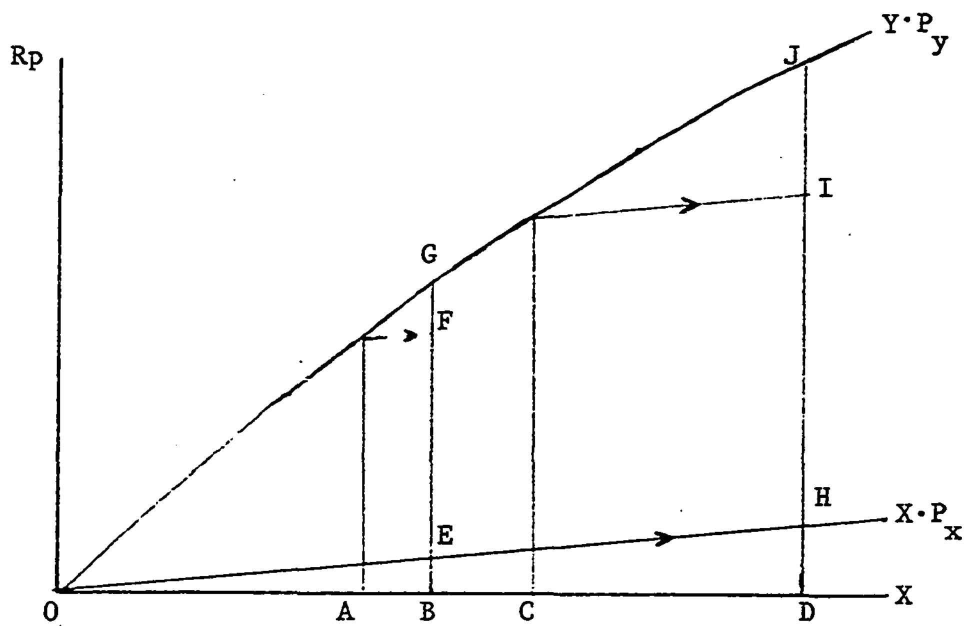

Figure 2.3. Less intense diminishing returns to an input

[1]These possibilities had not been explored by Katar Singh who, by using the same model for the Indian farmers in 1972, was fortunate enough in his findings that the relative variance of purchased inputs declined over time [64, p. 61]. Thus, assuming an aggregate production function with decreasing returns, the impact on farm income distribution will always yield a more equal share over time.

If in a production function exhibiting less intense diminishing returns such as presented in Figure 2.3, at constant prices, $\frac{AB}{OA} < \frac{CD}{OC}$ then $\frac{GF}{OC} < \frac{JI}{IH}$, incomes will be less equally distributed among the farmers.

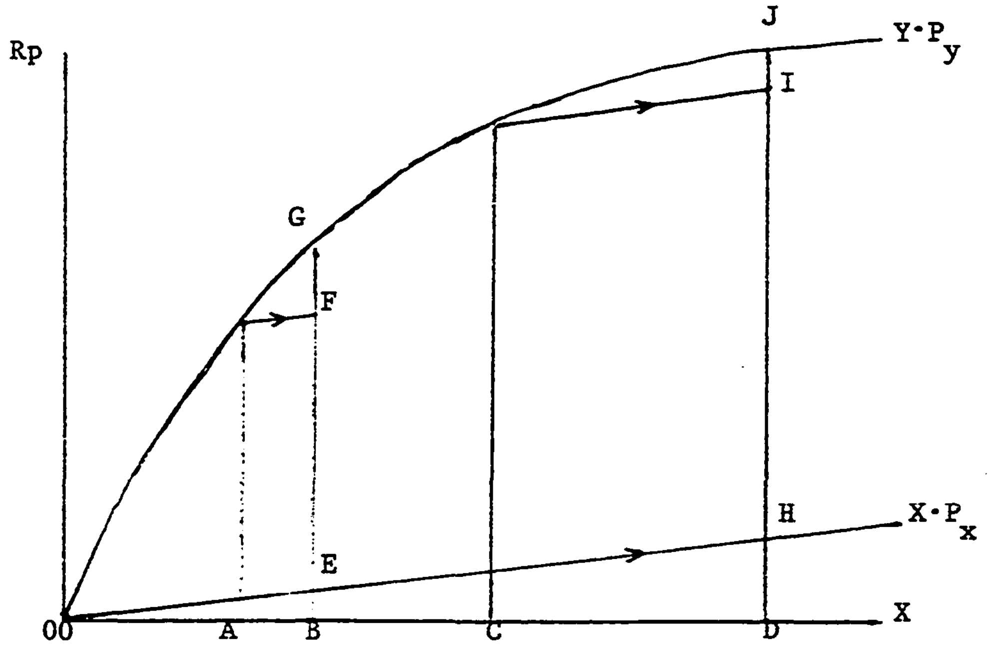

Figure 2.4. Intense diminishing returns to an input

If an intense diminishing returns relationship shown in Figure 2.4 indicates that, at constant prices, $\frac{AB}{OA} < \frac{CD}{OC}$ then $\frac{GF}{FE} > \frac{JI}{IH}$, farm incomes will be more equally distributed.

Contrary to the case found in diminishing returns relationship, if the relevant production function demonstrates increasing returns to a specified input, an increase in its relative variance would result in a less equal income distribution. However, it should be clear from Figures 2.5 and 2.6, respectively, that a decline in it could contribute to either a more equal or a less equal income distribution, depending on the intensity of increasing returns, <u>ceteris paribus</u>.

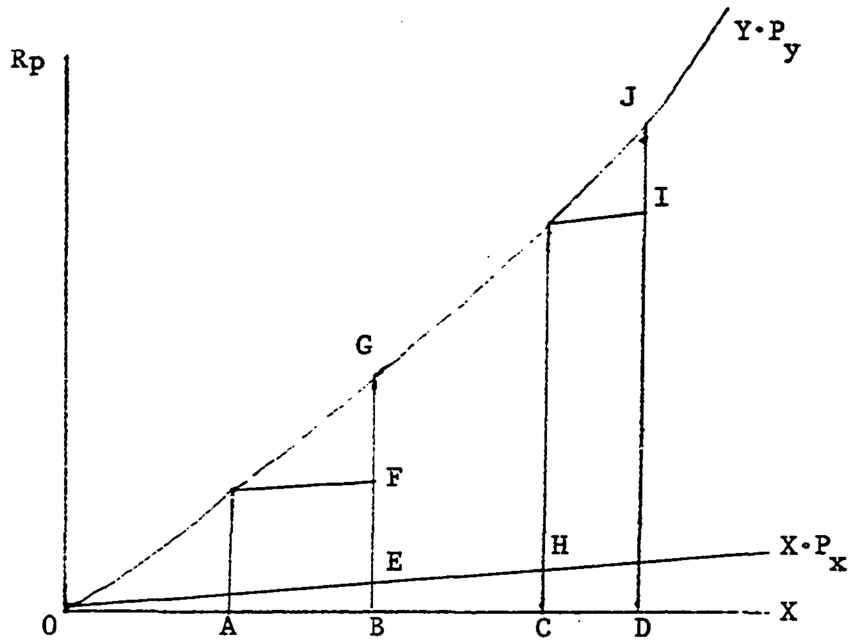

Figure 2.5. Less intense increasing returns to an input

At constant prices, Figure 2.5 illustrates that if $\frac{AB}{OA} > \frac{CD}{OC}$ then $\frac{GF}{FE} > \frac{JI}{IH}$, farm incomes will be more equally distributed.

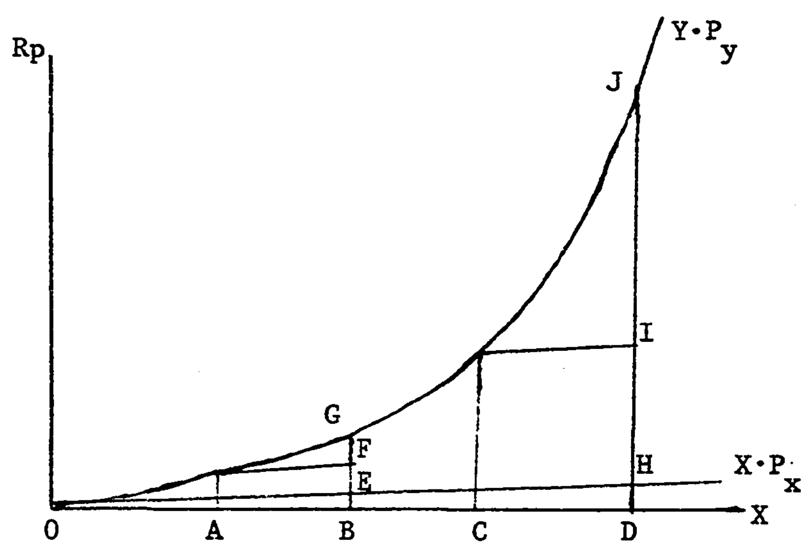

Figure 2.6. Intense increasing returns to an input

If intense increasing returns shown in Figure 2.6 indicate that $\frac{AB}{OA} > \frac{CD}{OC}$ then $\frac{GF}{FE} < \frac{JI}{IH}$, at constant prices, farm incomes will be less equally distributed.

As mentioned before, the change in input relative variance reflects the extent of nonproportional change in input use either by the lower or the higher income farmers. The higher the rate of nonproportional change in input use, the more distinct the impact on income inequality should be. To a certain extent, the change in input relative variance may change the direction of the relationship as suggested by the shape of the production function alone, all other things being equal.

When the price of input paid and the price of output received by farmers change independently with the farm size (or farm income), their impacts would be to modify the shape of both the total revenue and total cost functions independently. Depending upon the differential prices paid and received by lower income and higher income farmers, all other things equal, the impact on income distribution could go in either direction. A higher ratio of input to output prices would generally mean that the nonproportional impact of input use on income received is less pronounced. A lower ratio would tend to accentuate the impact on income inequality, <u>ceteris paribus</u>.

If, empirically, the various income grouping of farmers are not homogeneous in terms of their input qualities, the estimated production function would be of a hybrid type and estimates of coefficients derived from it would be misleading [31, p. 190]. In such a situation, each distinct group of farmers having more or less homogeneous input qualities should have a different production function.

4. Trends in relative economic efficiency

It is only logical that different income growth rates among members of a farm population would result in a change in income distribution over time. If lower income paddy farmers increase their incomes at the same rate with that of the higher income paddy farmers, no change in income inequality would occur at the end period. Thus, from the standpoint of income growth, one can arrive at estimates on changes of inequality of incomes after a time.

In this section, the relative income growth between different groups of farms will be analyzed from the viewpoint of their relative economic efficiency. More specifically, it attempts to determine whether the relatively higher income received by the farmers is consistent with a more economically efficient farm operation.

Measures of efficiency in general, and economic efficiency in particular, have been used, discussed and argued by both engineers and economists alike since very long. Apparently, the problems with the existing approaches to efficiency measurements are both conceptual and empirical [30, pp. 71-86]. Some of the technical measures are, at best, partial in nature in the sense that they are used to describe physical performances with respect to separate individual inputs which contribute to total production. At worst, the simple ratios are misleading and oftentimes contradictory [79, p. 265].

The economic measures of efficiency suffer from similar problems, which include also difficulties in weighing the various input contributions to production [18, pp. 597-608]. Even the equi-marginal concept of economic efficiency is fraught with problems in that farms are supposed to (i) apply the same technical production relationships, (ii) maximize profit perfectly and instantaneously, and (iii) face the same prices in the product and factor markets [79, pp. 265-266].

Considering all the difficulties involved in the use of conventional efficiency measures, an interesting concept of relative economic efficiency recently developed by Lau and Yotopoulos [39, pp. 94-109] seems appropriate for use by the present study. They asserted that a useful measure of relative economic efficiency should meet the following criteria: (i) it should account for firms producing different quantities of output from a given set of measured variable and fixed inputs. This is part of the component of differences in technical efficiency,[1] (ii) it should explain that different firms succeed to varying degrees in maximizing profits, i.e., in equating the value of the marginal product of each variable input to its price. This is the component of price efficiency, (iii) it should also take into consideration that firms operate at different sets of prices of inputs paid and output sold [39, p. 95].

Besides, in addition to farm-specific prices of input and output, a farmer may also have some personal weight to his decision rule, while he is applying the basic concept of profit maximization. An illustration might help at this point. Farmer 1 will maximize his profit when the farm-specific value of marginal product of an input equals the farm-specific price of that input, after it is corrected by some personal

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[1]Technical efficiency parameters represent differences in environmental factors, in managerial ability and in other nonmeasurable fixed factors of production [39, p. 99].

weighting factor. In algebraic form, the profit maximization is indicated by:

$$p^1 \cdot \frac{\partial Y^1}{\partial X_j^1} = k_j^1 \, c_j^1, \text{ where } k_j^1 \geq 0.$$

In this case p^1 is the farm-specific unit price of output Y^1, c_j^1 is the farm specific unit price of input X_j^1, while k_j^1 is the index (weighting) of personal decision rule by farmer 1 [39, p. 96]. Clearly, farmer 1 is a perfect profit maximizer if his $k_j^1 = 1$.

In this framework, two farms of equal technical efficiency and both have the same quantities of fixed inputs and face an identical set of prices, may still have different profits. The farm with the higher profit, within a certain range of prices, is considered the relatively more price efficient firm. If there are two farms with equal fixed factor endowments, but of varying degrees of technical and price efficiency, one is defined to be the relatively more efficient firm, within the same range of prices, if it has higher profit than the other.

Apparently, the inclusion of these criteria in an efficiency measure would reflect the contributions of most of the factors that might explain differences in profit, or net income, received by farmers. Undoubtedly, the consideration of personal weighting factor in a formal decision rule is very useful for capturing the actual practice by farmers, particularly in most developing countries where uncertainty is most prevalent.

The assumptions underlying the relative economic efficiency measure can be stated as follows [39, pp. 94-109]: (i) the existence of a profit function which is decreasing and strictly convex in the normalized prices of the variable inputs and increasing with the fixed input quantities, (ii) that farmers may use different criteria in addition to input market prices in their attempt to maximize profit, (iii) it contains the first and second order conditions for profit maximization, given farm-specific prices, and (iv) that farms concerned have identical production functions up to a neutral (technical) efficiency parameter and, yet, may differ in their quantities of comparable fixed inputs.[1]

Based on these assumptions, an attempt to derive the model will be made subsequently. For this purpose one can start from a Cobb-Douglas, or for that matter, from any other form of a function that satisfies the particular assumptions above. In this thesis, the profit function for empirical testing will be derived from the Cobb-Douglas function because it appears superior to the alternative functions [46, p. 101 and 39, p. 101]. Among others, it is rather easy to manipulate and to interpret the analytical results.

Consider two farms having identical Cobb-Douglas production functions with decreasing returns, except for the difference in technical efficiency parameters (respectively $\underline{A}$ and $\underline{B}$). For the sake of a simple presentation,[2] only one variable input ($\underline{X}$) and one fixed input ($\underline{Z}$) are used in the production of $\underline{Y}$. The production functions are defined for

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[1]Two farms with differing fixed factor endowments may have identical production functions, if there exists one explicit functional relationship that describes both [80, p. 44].

[2]The derivation for $\underline{m}$ variable input factors and $\underline{n}$ fixed factors of production is presented in Lau and Yotopoulos [39, pp. 101-102].

Farm 1: $Y_1 = A \cdot X_1^{a} Z_1^{b}$

Farm 2: $Y_2 = B\, X_2^{a} Z_2^{b}$, where: $a < 1$

The profit function (π_1) for Farm 1 can be stated as:

$$\pi_1 = AX_1^{a}Z_1^{b} - k_1 c_1 X_1$$

where π_1 is measured in unit output, i.e., the value of profit is deflated by the unit price of output p_1, k_1 is the personal weighting factor in the decision rule by Farm 1, and c_1 is the normalized unit price paid for input variable X, i.e., the nominal unit price of the input is divided by the unit price of output.

The profit maximization by Farm 1 is indicated by:

$\frac{\partial \pi_1}{\partial X_1} = 0$, which results in the marginal equation:

$$aAX_1^{(a-1)}\, Z_1^{b} = k_1 c_1$$

The optimal input X requirement, or the demand for factor X, can then be solved:

$$X_1 = k_1^{(a-1)^{-1}} c_1^{(a-1)^{-1}} a^{(1-a)^{-1}} A^{(1-a)^{-1}} Z_1^{b(1-a)^{-1}}$$

Substituting X_1 in the unit output profit (UOP) function, one gets:

$$\pi_1 = A^{(1-a)^{-1}} k_1^{a(a-1)^{-1}} c_1^{a(a-1)^{-1}} Z_1^{b(1-a)^{-1}} a^{a(1-a)^{-1}}$$

$$- A^{(1-a)^{-1}} k_1^{a(a-1)^{-1}} c_1^{a(a-1)^{-1}} Z_1^{b(1-a)^{-1}} a^{(1-a)^{-1}}$$

Collecting together the constant terms and expressed them in one constant term A*, where:

$$A^* \equiv A^{(1-a)^{-1}} k_1^{a(a-1)^{-1}} a^{a(1-a)^{-1}} (1-a),$$

the UPO function of Farmer 1 can then be stated simply as:

$$\pi_1 = A^* c_1^{a(a-1)^{-1}} Z_1^{b(1-a)^{-1}}$$

Similarly the UPO function of Farmer 2 can be derived and stated as:

$$\pi_2 = B^* c_2^{a(a-1)^{-1}} Z_2^{b(1-a)^{-1}},$$

where:

$$B^* \equiv B^{(1-a)^{-1}} k_2^{a(a-1)^{-1}} a^{a(1-a)^{-1}} (1-a)$$

Taking the ratio of the constant terms, one gets:

$$\frac{A^*}{B^*} = \left(\frac{A}{B}\right)^{(1-a)^{-1}} \left(\frac{k_1}{k_2}\right)^{a(a-1)^{-1}}$$

Inserting the ratio of constant terms, and defining

$$a^* \equiv (1-a)^{-1} \text{ and } b^* \equiv b(1-a)^{-1}$$

the UPO function of Farmer 1 is rewritten as:

$$\pi_1 = B^* \left(\frac{A^*}{B^*}\right) c_1^{a^*} Z_1^{b^*},$$

which is comparable to the UPO function of Farmer 2:

$$\pi_2 = B^* c_2^{a^*} Z_2^{b^*}$$

Taking the natural logarithms of these equations, one will arrive at the two estimating models of relative economic efficiency:

$$\ln \pi_1 = \ln B^* + \ln \frac{A^*}{B^*} + a^* \ln c_1 + b^* \ln Z_1$$

$$\ln \pi_2 = \ln B^* + a^* \ln c_2 + b^* \ln Z_2$$

From the ratio of constant terms, and knowing that ln 1=0, the two UOP functions should be identical, if and only if:

$$A^* = B^*.$$

This means that the two farms have the same economic efficiency or, in other words, the same net income or profit, within the range of observed prices and given the same fixed factor endowments. Therefore, in the Cobb-Douglas formulation of the profit function following Lau and Yotopoulos [39, pp. 102-103], the test of equal relative economic efficiency (hypothesis 3) can be done by utilizing a farm dummy variable in the logarithmic UPO function and examining if its value is equal to zero.

Note, however, that the UPO function is cast in normalized input prices. If one wants to use money prices, rather than the normalized ones, some modification is needed.[1] The UPO function of Farmer 1, for example, can be adjusted as follows:

$$\begin{aligned} \ln \pi_1 &= \ln \pi_{1m} - \ln p_1 \\ &= \ln B^* + \ln \frac{A^*}{B^*} + a^* \ln c_{1m} - a^* \ln p_1 + b^* \ln Z_1 \end{aligned}$$

Thus,

$$\ln \pi_{1m} = \ln B^* + \ln \frac{A^*}{B^*} + a^* \ln c_{1m} + (1-a^*) \ln p_1 + b^* \ln Z_1$$

and similarly:

---

[1]This has not been done by Crown and Nagadevara [17, pp. 1-13] in their study using money price data from India. No adjustment by using dummy variables to capture output price differences by the groupings of farmers, was made either. Consequently, it would seem that their conclusions were rather misleading. In this case, the implied assumption could be that the price of output was in a fixed proportion to the profit earned or was constant for the analytical period.

$$\ln \pi_{2m} = \ln B^* + a^* \ln c_{2m} + (1-a^*) \ln p_2 + b^* \ln Z_2,$$

where π_m and c_m refer to, respectively, profit and unit price of input in money terms.

Hence, the final estimating model based on money prices of the two-farm example can be written as:

$$\ln \pi = a_0 + eC + a_1 \ln c + a_2 \ln p + b_1 \ln Z,$$

where π is net income in rupiah (excluding interest on capital and land rent), c is the money price of variable input A, p is the money price of output Y, Z is the quantity per farm of the fixed factor Z. C is a dummy variable with a value of 1 for Farmer 1 or, in actual practice, a certain group of farmers, e.g., lower income farmers, and a value of 0 for Farmer 2, in line with the example, higher income farmers. The coefficient of the C dummy variable, e, is the index of relative economic efficiency.

If the null hypothesis of equal efficiency is rejected, and e turns out to be greater than zero, this means that the lower income farmers are relatively more economically efficient. On the other hand, if its value is less than zero, or negative, it will mean that the higher income farmers are more efficient.

Evidently, the unit output profit in its final estimating model is the function of normalized input prices and the physical quantity of fixed inputs. When one wants to use the money price profit, then the price of output enters the function in addition to the money price of the inputs and the fixed input quantities. The last model, the one with the money prices, will be used in the present study to test hypothesis 3 which proposed equal relative economic efficiency between various farmers' groupings.

III. SAMPLING PROCEDURES AND CHARACTERISTICS OF SAMPLES

A. Area Selection

Beginning with the crop year 1968/69 the Agro Economic Survey hereafter termed the AES, a research unit under the Ministry of Agriculture in Indonesia, conducted data collection in connection with its research project to evaluate the impact of a new production technology on rice farms [8]. This particular study has been known as the "Rice Intensification Study." Its statistical population of areas consisted of eight provinces, which are known to be the most important rice producing areas in Indonesia [16]. Their geographic locations may be observed from Figure 3.1. For details on how the areas of survey were selected, see Appendix C. It is essential to understand the steps taken in selecting the areas, since the same sampling frame will be adopted by the present study.

In 1971, the AES decided to carry out a partial census of the same villages included in the rice intensification study in seven out of the eight provinces [16, p. 2]. Only three to four hamlets, out of 20 to 30 hamlets within the sample villages of the previous survey, were included and full enumerations were obtained. Those hamlets were chosen according to the order of magnitudes, where most of the 30 sample farmers from the rice intensification survey were living [16, Appendix A, p. 4].

Some of the relevant information on socio-economic variables, obtained in that census of the household heads, are presented in Table 3.1. For comparison purposes, the census data have been standardized as village

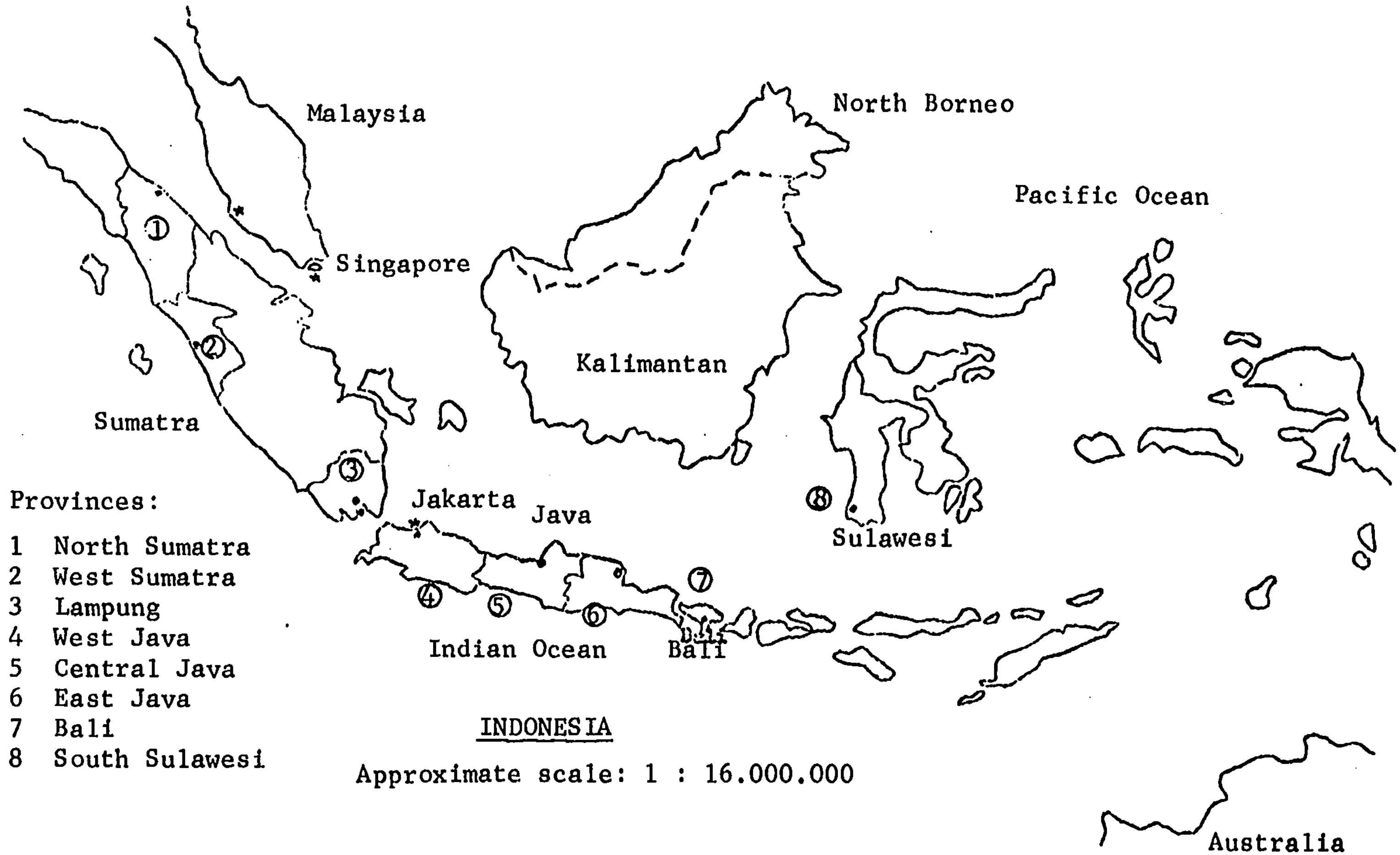

Figure 3.1. Major rice producing areas of Indonesia by province

percentages and averages, accompanied by their respective range of variation among sample villages within each province.[1]

From those seven provinces the present study chose only one, due to constraints in manpower, time and research funds available. Considering the objectives and hypotheses of this study the area chosen should, on the one hand, be relatively homogeneous with respect to other characteristics which are not of interest at present. This would result in minimal interference due to variations in the "unwanted" variables and, hence, more reliability could be expected from any contributory variations of the included variables. On the other hand, it should possess relatively more variation in variables included in this study, both for stratifications and for statistical testing of relationships. Based on these preconditions it appears from Table 3.1 that, compared to the other provinces, Central Java meets most of the requirements, hence the area was selected as the survey area of the present study.

The variables on age, family size, percentage of households operating irrigated fields and of households planting paddy crops, have relatively smaller range of variation for Central Java. The last two variables referred to the dry season of 1971, when irrigation water is supposed to be limiting for paddy cropping. The rest of the variables

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[1]Because of the selection of the hamlets ("pedukuhans") was not random, the partial census might not be taken as representative of the survey area. Based on the procedure of selecting sample farmers, which is discussed in Appendix C, it is believed that data from the partial census were somewhat biased upwards, i.e., in favor of the larger farmers. However, assuming that both sample farmers and sample villages were selected by the same procedures, the relevant data could still be used with caution, especially for intra-village comparisons.

Table 3.1. Standardized socio-economic variables from the major rice producing areas in 7 provinces, Indonesia, 1971[a]

Variables	West Sumatra and Lampung (6 villages 781 households)		West Java (6 villages 837 households)	
	(1)[b]	(2)[c]	(1)[b]	(2)[c]
1. Age (years) of family head (X)	43	37-46	40	37-42
2. Education (years) of family head (X)	3.8	2.9-4.8	2.2	1.0-3.1
3. Family size (X)	5.8	4.8-6.7	4.5	3.8-5.6
4. Farming as 1st source of income (%)	84	61-98	80	65-96
5. Family with irrigated fields (dry season) (%)	84	56-100	60	38-86
6. Family planting rice (%) (dry season)	87	54-100	63	1-84
7. Total farm land per family (all interviewed family, wet season) (Ha)	0.58	0.43-0.74	0.54	0.40-0.76

[a]Source: [3].

[b]If X, it means the average of the province; if %, it means percentage from total families (households) interviewed.

[c]Intervillage range of means (X), percentage (%), or hectares (Ha).

Central Java (8 villages 1416 households)		East Java (6 villages 1081 households)		South Celebes and Bali (6 villages 973 households)	
(1)	(2)	(1)	(2)	(1)	(2)
45	44-47	45	42-49	39	33-44
3.0	1.4-4.6	1.9	0.5-3.0	2.0	1.4-2.6
5.2	4.6-5.8	4.8	3.9-5.5	5.7	3.8-8.7
71	57-99	59	39-73	90	60-100
73	56-99	47	23-61	76	43-99
75	52-99	43	2-58	79	45-99
0.58	0.33-1.13	0.53	0.26-0.81	0.66	0.47-0.97

in Table 3.1 show that Central Java has a relatively greater range of variation for education levels of family heads, farming as the first source of income and agricultural population density expressed by total farm lands divided by the number of total households interviewed.

Since the main source of hired farm labor comes from people who have their own farms [16, p. 11], the landless farm laborers as a distinct social class should be of minor importance. Also from the standpoint of ethnic groups, Central Java could be considered as relatively more homogenous [2, Table 4]. These facts should add to the uniformity of the region with respect to the other variables not considered for analyses.

Following the same sampling procedure used by the AES (see Appendix C), Table 3.2 presents the names of the "kabupatens" (districts), the "kecamatan" (sub-districts), and the villages selected for the present study within the province of Central Java. The geographic locations of these villages may be found in Figure 3.2.

Table 3.2. Areas selected for study, Central Java, 1968-1974

Kabupaten (district)	Kecamatan (sub-district)	Desa (village)	Village numbering for this study
1. Kendal	1. Kota Kendal	1. Banyutowo	No. 1
	2. Weleri	2. Rowosari	No. 2
2. Pemalang	1. Petarukan	1. Serang	No. 3
	2. Bantarbolang	2. Wanarata	No. 4
3. Banyumas	1. Sumbang	1. Kebanggan	No. 5
	2. Sokaraja	2. Sokaraja lor	No. 6
4. Kebumen	1. Gombong	1. Patemon	No. 7
	2. Buluspesantren	2. Buluspesantren	No. 8

B. Agricultural Structure of the Survey Area

Before dealing with the socio-economic conditions, one should have some idea about the physical characteristics of the survey area. Soil types, agricultural land use areas and rainfall are the basic conditions which must be considered in any paddy production planning.

Most of the paddy areas in Central Java consist of alluvial soils deposited by rivers through the ages.[1] The other major soil type found in the survey area is the latosol, as can be seen from Table A.12 in Appendix A. Hence, the sample village soils may be grouped into two classes: the alluvial soils and the latosol soils. Based on experimental yields, these two soil types appeared to have different levels of productivity [6, pp. 7-10]. Appendix Table A.13 presents yield data by soil types of several improved rice varieties currently in use.

If one made a simple division of land use into irrigated (wet) and nonirrigated (dry) lands, the agricultural lands of the survey areas may be seen from Tables A.14 and A.15 in Appendix A. About 45 percent of the farm lands used mainly for growing food crops in the sample districts, belongs to the irrigated fields used primarily for paddy production. Some of them can be double-cropped within a year (see Table A.16). This information is consistent with the trends on the harvested crop areas in Central Java, as was shown in Appendix Table A.1. It is clear from Tables A.14 and A.15 that the proportion of the irrigated field to the total land area is increasing when one goes from the larger administrative

[1]For more information on soil types in Central Java, see Soepraptohardjo [66].

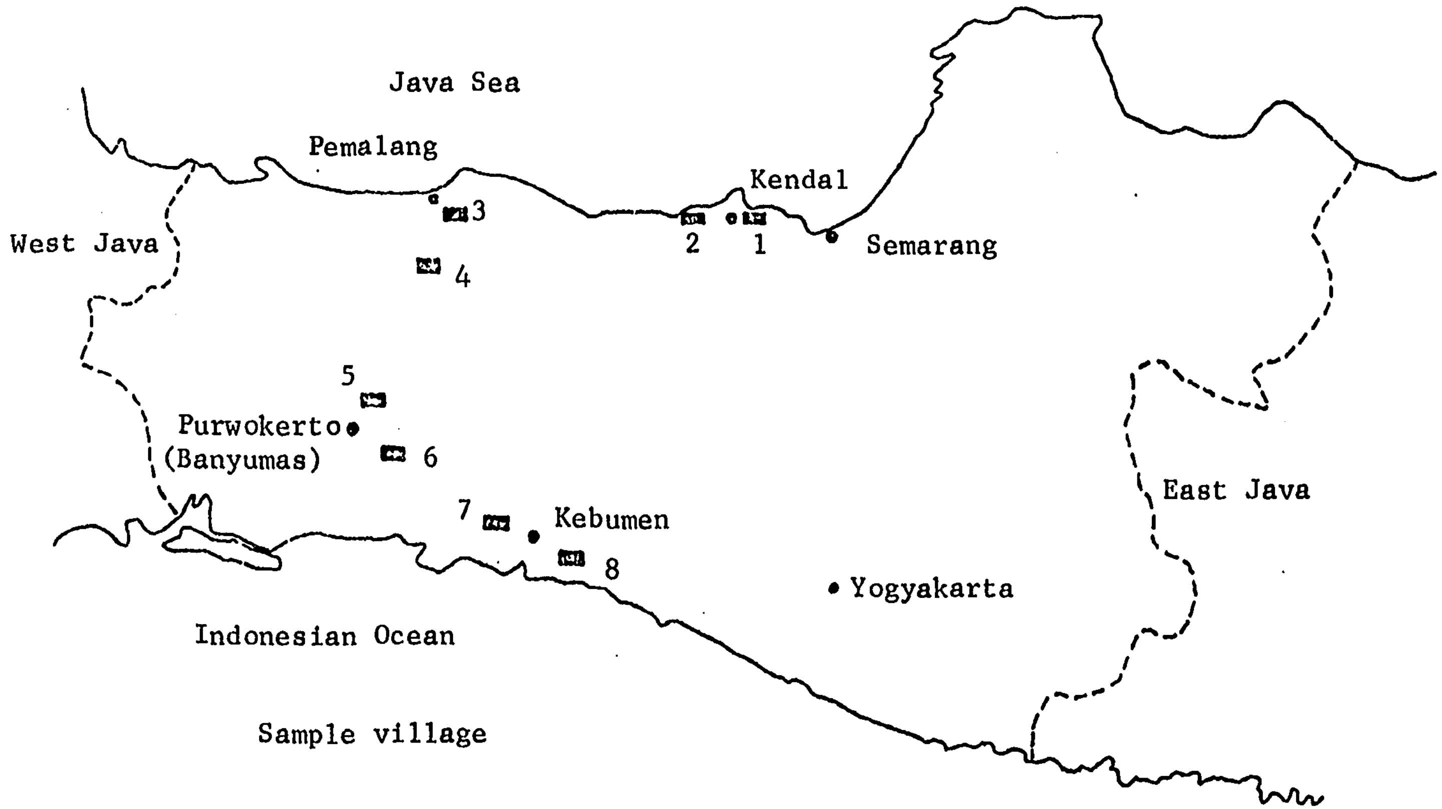

Figure 3.2. Province of Central Java (approximate scale: 1:1.500.000)

units down to the sample villages. This is a logical consequence of the selection procedure being followed (see also Appendix C. More on this will be discussed later.

Data on the amount of rainfall measured in millimeters, as well as the number of rainy days, revealed rather large variations both across areas and through the months, as can be observed from Table 3.3. However, one could easily distinguish similar trends in the monthly rainfall data from each area. The period from April or May till October or November, when rainfall is scarce, is usually called the dry season. From October or November to April or May, when rainfall is abundant, the period refers to the wet season. Normally, irrigated paddy crop could not grow well in the dry season without supplemental irrigation water during critical periods. But if adequate water is made available during the dry season, paddy yields may even be greater, and have less variability, compared to that of the wet season [11]. Although the variations of rainfall across areas are rather large, actually only one area has an exceptionally abundant rainfall, i.e., Burwokerto (Banyumas) area.

Beginning with the services supporting the use of new technology, Table 3.4 presents some aspects of the current situation in the respective sample villages. As it stands at present, however, no particular trends are worth mentioning. The quantities of urea fertilizer purchased by the farmers in the aggregate, do not seem to have definite relations with the different levels of services available. Perhaps, with fairly good accesses to the markets, which all sample villages appear to have, the effects of the different levels of other services are not very

Table 3.3. Number of measured rainfall in millimeters and rainy days, from four meteorological stations closest to the village of study, Central Java, yearly average of 1965-1971 (seven years)[a]

Month	Semarang Station[b]		Pekalongan Station[c]		Purwokerto Station[d]		Kebumen Station[e]	
	Millimeters[f]	Days	Millimeters	Days	Millimeters	Days	Millimeters	Days
January	305	14	617	17	926	18	381	17
February	318	12	477	14	897	14	628	14
March	169	11	324	13	775	19	372	16
April	176	7	190	8	1041	14	195	9
May	159	7	167	9	392	9	190	9
June	96	5	125	4	263	6	124	10
July	108	4	58	5	121	6	90	6
August	22	2	118	6	140	6	61	4
September	58	5	69	3	158	7	29	4
October	140	7	110	6	1105	11	154	8
November	140	8	111	6	1117	15	239	13
December	347	12	240	12	883	17	482	17
12 months	2038	94	2606	103	7818	142	2945	127

[a]Source: Jawa Tengah dalam Angka, Office of the Census & Statistics, Central Java, pp. 3-10, or [34].

[b]Located about 20 km from village No. 1, 30 km from village No. 2; 1 km (kilometer) = 0.6 mile.

[c]Located about 18 km from village No. 3, 40 km from village No. 4.

[d]Located about 7 km from village No. 5, 12 km from village No. 6.

[e]Located about 8 km from village No. 7, 20 km from village No. 8.

[f]1 millimeter = 0.04 inch; a rainy day corresponds to a measured minimum of 0.5 mm rain.

Table 3.4. Some aspects of services supporting the new technology in paddy production, 8 sample villages, Central Java, 1973[a]

Kinds of services	Sample village number							
	1	2	3	4	5	6	7	8
1. Nearest distance (kilometers) of								
a. Fertilizer store	2.0	5.5	2.0	8.0	7.0	1.0	2.0	4.0
b. Seed center	2.0	7.5	2.0	8.0	1.0	10.0	5.0	1.0
c. Local demonstration plot	2.0	7.0	9.0	8.0	1.0	3.0	1.0	1.0
2. Ratio of farm land area to the number of extension personnel at sub-district level[b]	1158	482	651	2577	1211	712	940	2299
3. Ratio of family heads to the number of extension personnel at sub-district level[c]	3734	2047	1935	2952	2796	2890	3222	4599
4. Percentage of the wet lands that can be double-cropped with paddy[d]	100	100	100	64	63	100	100	100
5. Sub-district average of amounts (in kilograms) of urea fertilizer bought per hectare of potential paddy area[e]	85	104	97	86	40	84	10	52

[a]Source: Local government officials.

[b]Hectares per personnel in the respective kecamatan area.

[c]By assuming that, on the average, a family consists of 4, 5 persons, the family heads can be derived from the total population number.

[d]Paddy double cropping requires adequate water supply through the year; it tends to require better services of the agencies involved.

[e]Bought by the farmers through BIMAS and INMAS facilities. The potential paddy area includes double-cropping possibilities.

important in explaining the village differences in the use of fertilizer by farmers.

Table 3.5 shows the population densities, variously defined in relation to the types of land use. It appears that the selected districts for study have more population per total area than the average (i.e., 639 people per square kilometer) for all Central Java. Since those areas are the major rice producing districts, they seem to suggest the hypothesis that rice farming could support more population than other types of agricultural enterprises.

Table 3.5. Population density in the survey area, Central Java, 1971[a]

Administrative Units	Number of people per square kilometer[b]		
	Wet lands	Farm lands[c]	Total area
All Central Java	2666	1207	639
A. District: Kendal	2095	801	656
1. Village No. 1	1050	877	736
2. Village No. 2	2456	1733	1626
B. District: Pemalang	2071	904	382
1. Village No. 3	1406	1233	1233
2. Village No. 4	1315	903	844
C. District: Banyumas	2828	1059	829
1. Village No. 5	1753	1330	1296
2. Village No. 6	1343	953	903
D. District: Kebumen	2157	876	748
1. Village No. 7	1903	1096	1079
2. Village No. 8	1085	696	667

[a]Source: Officials of local administrative units.

[b]1 square kilometer = .3861 square mile.

[c]Includes land used mainly for food crops, consisting of wet lands and dry lands. Large plantations and woodlands are excluded.

The population densities per irrigated (wet) land in the survey areas, on the other hand, are less than the Central Java average. These are the logical consequence of the village sampling procedure, which selected areas with relatively larger proportion of irrigated lands (see also Appendix Table A.16).

From the purposive sampling viewpoint, however, it may be said that the four selected districts have close similarities in the trends of population densities across types of land. Nevertheless, the two sample villages within each selected district show rather consistent large differences in population densities, especially as related to farm lands and total areas, which suggest that they may be grouped into two general classes, i.e., (i) less populated and (ii) more populated villages.

The selection of the study area, as was described in Appendix C, was based on two criteria: (1) it belongs to the major rice producing areas, and (2) it should have adequate irrigation facilities for growing paddy crops. Data presented in Table A.16 in Appendix A tend to verify the second selection criterion. The percentage of wet land to the total area is increasing, when one proceeds from the province level down to the selected villages. A similar trend is also found on the percentage of wet land to the farm land. More than half of the wet lands in the districts could be double-cropped with paddy, while paddy farmers in the six out of the eight selected villages could even double-crop all the wet lands if they wanted to.

These trends imply that the selection procedure had led to the so-called representative villages. It should be noted, however, that the selected villages are representative with respect to the objective and scope of study. As it may be recalled, the objective and scope of study would require the selection of adequately irrigated paddy farms in major rice producing areas of Central Java. As such, they may be less representative with respect to all Central Java.

C. Selection of Sample Farmers

The same thirty sample farmers selected for the Rice Intensification Study by the Agro Economic Survey constitute the basic samples for the present study.[1] Three population strata were made available from the village farmers' list in 1968 which comprised: (i) the large farmers, (ii) the BIMAS farmers, and (iii) the non-BIMAS farmers. Apparently, the large farmers stratum was not clearly defined as some samples from the other strata had turned out operating larger-sized farms. With the passage of time, differentiating farm operators on the basis of BIMAS participation has become obsolete, since most samples had participated in one or more programmes (see Table A.11 in Appendix A). Hence, the present study will not employ any population strata.

Although for statistical analysis purposes the original 30 sample farmers will be assumed as representing the same population, even though individually they had not been selected on an equal probability basis, some of the conclusions drawn later should not be generalized to the population and, pending further analysis, are assumed to apply only to the farmers sampled.

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[1] The population strata and the steps taken in the selection of sample farmers may be seen from Appendix C.

For various reasons, a few of the original samples had been dropped at the last (1973/1974) interview and were replaced randomly with new ones from the current farm operators' list. Of course, as with many empirical procedures, some sampling bias should be expected. This section will evaluate the representativeness of the sample farmers.

To begin with, it is customary to compare the averages, ranges and medians of farm size of the samples with their corresponding populations, as can be seen from Table 3.6 below. The farm size is represented by the area of irrigated field operated by the paddy farmer.

Except for the villages number 1 and 8, discrepancies are found between the villages' total irrigated fields derived from the respective farmers' population list (Table 3.6) and those reported by the village officials (see Table A.15 in Appendix A). Most of the differences can be explained by the fact that the farmers' population list was composed of operators living within the villages and, thus, excluding those who lived elsewhere.

In general, data from Table 3.6 indicate that half of the sample farm sizes are biased upward excepting those of sample farmers in villages number 1, 5, 6 and 8, which appear to be representative of their populations. Some idea on the upward bias is reflected by the average farm size of the sample in 1974, which was 37 percent higher than for all farms in the eight villages. The upward biases probably come from the greater chances given the BIMAS participants and the larger farmers to be selected as samples.

Table 3.6. Comparison of irrigated fields operated by the sample farmers with those by the corresponding populations, Central Java, 1968/1969-1973/1974[a]

Paddy farmers	Number of farmers	Size of irrigated fields (hectares)[b]			
		Total	Average	Range	Median
Village No. 1					
population in 1974	302	200.547	0.664	0.053-9.400	0.572
samples in 1974	30	21.624	0.721	0.200-2.680	0.560
samples in 1968	30	17.763	0.592	0.300-1.500	0.500
Village No. 2					
population in 1974	104	54.647	0.535	0.085-3.860	0.370
samples in 1974	30	22.710	0.757	0.175-3.860	0.462
samples in 1968	30	19.263	0.642	0.200-2.000	0.435
Village No. 3					
population in 1974	226	95.655	0.423	0.087-7.000	0.350
samples in 1974	30	32.330	1.078	0.170-7.000	0.637
samples in 1968	30	17.593	0.586	0.165-2.295	0.334
Village No. 4					
population in 1974	306	321.834	1.052	0.088-6.333	0.775
samples in 1974	30	58.916	1.964	0.167-6.333	1.291
samples in 1968	30	44.864	1.495	0.130-3.600	1.375
Village No. 5					
population in 1974	103	89.730	0.872	0.100-4.500	0.550
samples in 1974	30	27.972	0.932	0.140-4.500	0.542
samples in 1968	30	21.626	0.721	0.100-3.760	0.630
Village No. 6					
population in 1974	87	78.290	0.900	0.250-3.000	0.750
samples in 1974	30	23.080	0.769	0.350-2.000	0.710
samples in 1968	30	23.170	0.772	0.250-2.710	0.675
Village No. 7					
population in 1974	189	49.331	0.261	0.002-6.936	0.129
samples in 1974	30	14.157	0.472	0.110-2.570	0.330
samples in 1968	30	10.844	0.361	0.071-1.715	0.264
Village No. 8					
population in 1974	168	92.125	0.548	n.a.[c]	n.a.
samples in 1974	30	16.759	0.559	0.056-1.820	0.460
samples in 1968	30	14.365	0.479	0.114-2.078	0.385

[a]Source: Administrative offices of the villages, 1968 and 1974.

[b]This is a cross-sectional field size taken at the wet seasons of the respective years.

[c]n.a. = not available.

Firstly, because of cost considerations and the risk of defaults, BIMAS officials in practice tend to exclude the very small farmers. Secondly, in some of the selected villages, the BIMAS population strata were much smaller than those of the non-BIMAS farmers, and yet the same numbers of samples, i.e., respectively, ten and fifteen farmers, were drawn from each stratum. Thirdly, by including five out of the ten largest farmers it certainly would have the effect of lifting the average up, especially if the land-holding distribution is highly skewed.

As regards the village sample size of 30 farmers taken from each village population, it represented 10 percent to 34 percent of the population numbers in the village of study, as can be observed from Table 3.7 below. The areas of irrigated fields associated with the samples range from 11 percent to 44 percent of the village totals. However, it should be noted, only in three out of the eight sample villages have about the same percentages in both the number of farmers and the irrigated fields associated with the samples.

It is worth noting that the average farm size, as represented by the hectares of operated irrigated fields, is generally small by any standard. The large farms in the study area (the largest is 9.4 hectares) are not too large. This indicates a situation where inequality in the individual land resource endowments is not too bad, although the average is small.

Table 3.7. Percentages of sample sizes and the associated irrigated fields from the corresponding population data in the sample villages, Central Java, 1973/74

Village number	Sample farmers (percent)	Irrigated fields (percent)
1	10	11
2	29	41
3	13	34
4	10	18
5	29	31
6	34	29
7	16	29
8	18	18

D. Some Basic Characteristics of Sample Farmers

Basic properties characterizing individual farmers like, for example, formal schooling and family size, could be used as population or sample parameters. If variations on those parameters were judged to be too great, one might want to divide the population into strata having more homogeneous characteristics within each stratum. Some of the relevant parameters of the sample farmers will be presented subsequently.

Data in Table 3.8 show the age parameter of sample farmers in the survey area. Except for village number 5, the rest of the sample villages had averages of sample farmers' ages between 43 to 50 years. Only one percent, or two farmers out of 240 samples, were found below thirty years of age.

Table 3.8. Age distribution of sample farmers, Central Java, 1974

Sample village number	Age (years) of farm operators							
			Percentage distribution					
	Average	Range	20-29	30-39	40-49	50-59	60-69	70 and over
1	46.	25 - 74	3	20	33	33	3	7
2	46.	30 - 65	-	20	40	33	7	-
3	43.	28 - 73	3	37	37	13	3	7
4	45.	30 - 61	-	33	37	17	13	-
5	55.	35 - 79	-	10	17	30	27	17
6	48.	30 - 67	-	27	23	30	20	-
7	50.	32 - 72	-	10	33	37	13	7
8	47.	30 - 80	-	23	33	23	13	7
All villages[a]	48.	25 - 80	1	22	32	27	13	5

[a]Each village has 30 sample farmers, making up a total of 240 sample farmers for all villages.

Although village averages of formal schooling were rather varied, the percentage distribution were more or less uniform, as may be observed from Table 3.9. Most sample farmers have had formal education ranging from 3 to 6 years, which should be enough to enable them to read and write.

The family size averages, as shown in Table 3.10, appeared to be rather high. The percentage distribution for all sample villages shows that 73 percent of sample farmers have family sizes exceeding 5 persons. However, the partial census by the Agro Economic Survey in 1971 reported family size averages on Java somewhere around 5 persons per family [2, Table 5; see also, 1, p. 49 and 51, p. 8].

If twelve years of age and older could be considered to be in the labor force potential, as suggested by data in Table 3.11, the average for all sample villages in the survey area was 4.2 persons per sample farm household. Although there was little variation in the sample village averages, the percentage distributions had very wide variations.

Table 3.9. Formal schooling of sample farmers, Central Java, 1974

Sample village number	Formal schooling of farm operators (years)						
			Percentage distribution				
	Average	Range	0	1-2	3-4	5-6	Over 6
1	2.0	0 - 6	43	3	43	10	-
2	2.5	0 - 6	30	10	33	27	-
3	3.7	0 - 13	37	-	17	37	10
4	6.2	2 - 13	-	3	20	50	27
5	3.7	0 - 12	10	10	47	30	3
6	4.3	0 - 9	20	3	7	63	7
7	3.5	0 - 6	17	7	33	43	-
8	4.2	0 - 8	10	10	27	50	3
All villages[a]	3.8	0 - 13	21	6	28	39	6

[a]Each village has 30 sample farmers, making up a total of 240 sample farmers for all villages.

Table 3.10. Family size distribution of sample farmers, Central Java, 1974

Sample village number	Family size of farm operators							
			Percentage distribution					
	Average	Range	2[a]	3-4	5-6	7-8	9-10	Over 10
1	6.4	2 - 11	3	17	30	37	10	3
2	7.0	2 - 12	7	10	27	30	13	13
3	6.0	2 - 14	17	20	27	20	10	7
4	7.3	3 - 15	-	10	33	30	20	7
5	6.2	2 - 12	3	27	27	23	13	7
6	5.6	2 - 10	3	30	37	13	17	-
7	5.9	2 - 10	3	20	50	17	10	-
8	5.0	2 - 10	7	40	33	13	7	-
All villages[b]	6.2	2 - 15	5	22	33	23	12	5

[a]The smallest family size for all villages is two.

[b]Each village has 30 sample farmers, making up a total of 240 farmers for all villages.

Table 3.11. Number of people older than 11 years per sample farm household, Central Java, 1974

Sample village number	Sample farm household member older than 11 years							
			Percentage distribution					
	Average	Range	2	3	4	5	6	Over 7
1	4.1	2 - 7	7	37	17	23	13	3
2	4.6	2 - 8	20	10	27	-	27	17
3	3.6	2 - 12	43	23	17	3	3	10
4	5.8	2 - 12	3	10	27	10	17	33
5	4.4	2 - 10	13	23	20	30	-	13
6	3.7	2 - 7	27	23	27	7	7	10
7	4.1	2 - 10	7	10	37	20	20	7
8	3.3	2 - 6	33	27	20	17	3	-
All village[a]	4.2	2 - 12	19	20	24	14	11	12

[a]Each village has 30 sample farmers, making up a total of 240 sample farmers for all villages.

IV. OVER TIME CHANGES IN ADOPTION LEVEL AND FARM SIZE

When the Rice Intensification Study began in 1968, which was also the time when the government decided to use the BIMAS approach in its first Five Year Development Program, some paddy farmers had already been exposed to the new technology in one way or another. An assessment of the existing situations with respect to some variables and their over time trends would provide some background to understanding the changes in income distribution. This section is intended to serve as an introduction to the basic changes happening in the survey area.

A. Trends in Adoption Levels of New Technology

Table 4.1 provides information on the levels of several innovations pertaining to the improved technology in 1968.

Table 4.1. Innovation status of 240 sample paddy farmers, 8 sample villages, Central Java, 1968

Time reference of innovation	Kinds of innovation			
	Domestic HYV[a]	IRRI-HYV	Fertilizers	Pesticides
% using before 1961	5	0	7	3
% using between 1961-1967	61	10	65	65
% never used before 1968	34	90	28	32

[a]HYV = high yielding varieties.

Except for the IRRI-HYV, the data suggest rather high levels of innovation by sample farmers at the start of the Development Program. About two-thirds of the farmers had used the new inputs some time before 1968. The presumption is, that these levels had been achieved after 10 years of interest in the large scale program approach (see Chapter I, Section B). Their corresponding levels for the year 1961 were practically non-existent. Further, only 10 percent had access to the IRRI-HYV at 1967, the year this HYV was formally introduced to the farmer participating in BIMAS.

Tables 4.2 and 4.3 present the general trends in the survey villages regarding how the farmers had combined the separate new inputs, respectively in 1968/69 and 1973/74.

Table 4.2. Trends in the use of new inputs for paddy production by sample farmers, 8 sample villages, Central Java, 1968/69

Combination of new inputs[a]	Village number and percentages of sample farmers[b]							
	1	2	3	4	5	6	7	8
1. Used all new inputs[c]	10	0	27	73	30	10	7	0
2. Used fertilizers and HYV	77	73	20	13	60	7	13	40
3. Used only fertilizers	13	27	37	3	3	57	63	57
4. Used fertilizers and pesticides	0	0	17	3	7	27	17	0
5. Used only HYV	0	0	0	3	0	0	0	3
6. Used HYV and pesticides	0	0	0	0	0	0	0	0
7. Used only pesticides	0	0	0	0	0	0	0	0
8. Did not use any	0	0	0	3	0	0	0	0

[a]The new inputs include: (i) HYV seeds, (ii) industrial fertilizers, and (iii) pesticides.

[b]A farmer was defined using a new input if he applied it on any part of his irrigated field.

[c]Percentage columns may not add up to 100 percent due to roundings. n = 30 for each sample village.

It should be noted, that the data only indicated whether the farmer had used the new inputs on any part of his irrigated field, without differentiating the quantitative aspects or the accompanying management practices. The data on HYV include both the domestic and the IRRI varieties.

As might be expected, data from Table 4.2 show rather wide variation of the new input applications by sample farmers in 1968/69. Excepting village number 4, in general it could be said that the full use of new inputs had only been enjoyed by a village-average of 10 percent of the sample farmers. About half of the farmers in the sample villages were still at the stage of using mostly only fertilizers (villages number 3, 6, 7 and 8), while the other half (villages number 1, 2, 4 and 5) had progressed further by using a combination of fertilizers and HYV. Only village number 4 had distinguished itself by showing that almost three-fourths of the sample farmers had already adopted the full combination of HYV, fertilizers and pesticides.

The data shown on Table 4.3 are encouraging. Almost all sample villages, except villages number 7 and 8, show quite high adoption levels of complete new inputs use in 1973/74. The situation in villages number 7 and 8 calls for more explanation. Some farmers had turned back to growing traditional varieties without use of any fertilizers in 1973/74 (respectively, 13 percent and 7 percent in villages number 7 and 8), although almost all had used it in 1968/69. Only a little decrease (4 percent) of HYV growers was reported in village number 7, while 43 percent of the samples in village number 8 had reverted back to growing traditional varieties after experimenting with the HYV. The interesting thing is, that they did not seem to lose interest in applying fertilizers.[1]

Table 4.3. Trends in the use of new inputs for paddy production by sample farmers, 8 sample villages, Central Java, 1973/1974

Combination of new inputs[a]	Village number and percentages of sample farmers[b]							
	1	2	3	4	5	6	7	8
1. Used all new inputs[c]	80	80	87	90	77	83	0	0
2. Used fertilizers and HYV	7	20	10	7	23	17	13	0
3. Used only fertilizers	0	0	0	0	0	0	57	93
4. Used fertilizers and pesticides	13	0	3	0	0	0	13	0
5. Used only HYV	0	0	0	3	0	0	0	0
6. Used HYV and pesticides	0	0	0	0	0	0	3	0
7. Used only pesticides	0	0	0	0	0	0	0	0
8. Did not use any	0	0	0	0	0	0	13	7

[a]See footnote Table 4.2.
[b]See footnote Table 4.2.
[c]See footnote Table 4.2.

In an attempt to explain the phenomena more fully, observation revealed natural causes as the prime factor which had led farmers in villages number 7 and 8 to take decision not to plant HYV anymore. In village number 7, the upper water reservoir responsible for the regular

[1]This tendency should support Sajogyo's assertion that BIMAS has been mostly a fertilizer revolution rather than an HYV revolution [58, p. 13].

irrigation did not function very well since 1970, imposing constraints on the use of limited water supply. Since the HYV generally could not grow very well in "less-than-perfect" water condition, no increase in HYV growers had resulted. In village number 8 the problem was different. The area was known for its near-swampy condition. Thus, after several attempts at growing HYV failed to yield reasonable results, they reverted back to the traditional varieties.[1]

In terms of paddy varieties grown, one could differentiate farmers into: traditional variety growers, domestic HYV growers and IRRI-HYV growers, or any combinations possible between those two or those three varieties. The related data for the sample farmers may be found in Tables 4.4 and 4.5. Assuming specialization in growing only one variety (preferably a HYV) is the most economical paddy production, after some experimentation period, the data on these tables suggest similar consistent trends with the findings from Tables 4.2 and 4.3. The same explanation applies for villages number 7 and 8.

B. Trends in Farm Size Distribution and Land Tenure

Farm size represents the most important factor endowment to a farmer. It largely determines the income received by the farmer and thus, in this way, affected the income distribution among farmers.[2] In many cases, production under tenancy arrangement has led to disincentives for the producers to apply the new inputs.[3] The last data collected in 1974,

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[1]See also Barker [11, p. 3] for similar situations in the large flood plain of South Vietnam, Central Thailand, East Pakistan and Lower Burma.

[2]See for examples: Swenson [71], Crown and Nagadevara [17, pp. 1-13] and Park [49, p. 155].

[3]Analytical examples may be found in Gittinger [29, pp. 255-259] and Timmons [74, pp. 91-96].

Table 4.4. Trends in paddy HYV adoption by sample farmers, 8 sample villages, Central Java, 1968/1969

Varieties planted[a]	Village number and percentages of sample farmers (n = 30)							
	1	2	3	4	5	6	7	8
1. All IRRI	0	0	0	0	0	0	0	0
2. All domestic	53	40	20	37	0	0	0	0
3. IRRI and domestic	0	3	0	17	0	0	0	0
4. IRRI and domestic and traditional	0	0	0	7	17	0	7	0
5. IRRI and traditional	0	7	0	0	73	17	0	43
6. Domestic and traditional	33	23	27	30	0	0	13	0
7. All traditional	13	27	53	10	10	83	80	57

[a]The words: "variety," "HYV" and "combination" are omitted to save space. Percentage columns may not add up to 100 percent due to roundings.

Table 4.5. Trends in paddy HYV adoption by sample farmers, 8 sample villages, Central Java, 1973/1974

Varieties planted[a]	Village number and percentages of sample farmers (n = 30)							
	1	2	3	4	5	6	7	8
1. All IRRI	0	10	7	7	13	93	0	0
2. All domestic	70	60	70	30	67	0	7	0
3. IRRI and domestic	0	17	13	53	10	3	0	0
4. IRRI and domestic and traditional	0	7	0	3	3	0	0	0
5. IRRI and traditional	0	0	3	0	0	3	0	0
6. Domestic and traditional	17	7	3	7	7	0	10	0
7. All traditional	13	0	3	0	0	0	83	100

[a]See footnote Table 4.4.

reported many changes in individual farm sizes and land tenancy. Knowledge on these provide important background for the analysis of changes in income distribution. For example if, at the end period, large farms increased their average size nonproportionately more than that of the small farms, it might contribute to the tendency of a more unequal income distribution.

Data presented in Table 4.6 indicate the existing farm size situations in the respective years and the reported changes after five years had passed since the first enumeration took place. The first impression one gets is the great variations in the farm sizes operated by sample farmers in the survey area, suggesting unfavorable basic resources distributions in both periods. The second important finding is that there had been net increases in the sample averages of farm size, except in village number 6, where a net reduction in the farm size average had occurred. Unfortunately, no specific reason could be made available to explain these facts.[1] At any rate, these factors could cause additional biases in the sample farmers against the smaller-sized farm population in the corresponding villages.

Referring to changes in farm size distributions from 1968/69 to 1973/74, data on Table 4.6 show a common trend of worsening farm size distribution, except in villages number 4 and 6. However, only two of the eight villages had showed statistically significant relative decreases (as percentage of total) in the average sizes of small farms (i.e., villages number 2 and 3). These had taken place in spite of the net

[1]Some theoretical explanation are presented later in this section.

Table 4.6. Changes in the distribution of operated farm size, 8 sample villages, Central Java, 1968-1974[a]

Village	Size groups (15 samples each)	1968/1969 Average (Ha)	1968/1969 % of total	1973/1974[b] Average (Ha)	1973/1974[b] % of total	t-test of no difference[c]
No. 1	small farms	0.455	23	0.452	20	0.50
	large farms	1.562	77	1.745	80	0.20
No. 2	small farms	0.369	25	0.432	22	0.02
	large farms	1.119	75	1.506	78	0.30
No. 3	small farms	0.229	17	0.323	14	0.05
	large farms	1.110	83	2.016	86	0.10
No. 4	small farms	0.668	20	1.053	21	0.01
	large farms	2.671	80	3.934	79	0.02
No. 5	small farms	0.344	19	0.405	19	0.40
	large farms	1.449	81	1.744	81	0.50
No. 6	small farms	0.461	26	0.468	30	0.50
	large farms	1.307	74	1.087	70	0.20
No. 7	small farms	0.327	29	0.325	25	0.50
	large farms	0.813	71	0.972	75	0.50
No. 8	small farms	0.394	29	0.419	27	0.50
	large farms	0.973	71	1.113	73	0.50

[a]Farm size consists of: (i) operated irrigated fields (owned minus rented-outs plus rented-ins), (ii) house gardens (if any), and (iii) dry lands (which are separated from housing compounds, if any). These were cross-sectional farm size situations during the wet seasons of the respective years, measured in hectares (Ha).

[b]Sample farmers in each size category are not necessarily the same with those of 1968/69, since they have been reordered in line with the current relative position of each.

[c]The figures show the probability levels of getting wrong inferences, when the null hypotheses of no differences between the averages should be rejected.

increases in almost all farm size averages. Assuming that most farmers invested their increases in incomes in the form of net additions to the farm sizes, the resultant changes would improve the relative position of the large farmers as a group.[1]

Changes in farm size distributions in villages number 4 and 6 are rather difficult to explain. Apparently, little significant change in distribution had occurred in village number 4 as the larger net addition to the large farm group had resulted in a less-than-proportionate increase in its farm size average, as compared to that of the small farm group. In village number 6, a net size reduction in the large farm group had occurred, while practically no change was observed in the small farm group. Thus apparently, without even trying, the smaller farm group had improved its relative position in the farm size distribution of that village.

If the changes were accounted for the same individual samples in 1968/69, i.e., if no new ranking is attempted for the 1973/74 data, fairly large net increases had been found in all small farm group averages, as can be seen from Table A.17 in Appendix A. On the other hand, the large "old" farm groups had only minor increases in farm size in the six sample villages, while no change was reported in village number 5 and even a net decrease in the average farm size was found in village number 6. These increases were not similarly reflected in the ranked-distribution for the year 1973/74 (see Table 4.6), since some of the "old" small farmers had increased their farm sizes large enough to become "new" large

[1]This is not to say that some of the small farmers had not succeeded in moving up to become large farmers after some time.

farmers after five years had elapsed. In total, the farm size changes had resulted in a "new" ordering of percentage size distribution in 1973/74, as compared with the "old" distribution in 1968/69.

It was discussed before that in the major rice producing areas, from which the survey area was selected, irrigated fields constituted the biggest components of farm sizes. In terms of paddy production in those areas, the irrigated field is one of the essential fixed factors directly contributing to the paddy yield, and hence, also the major income of the paddy farmers. Needless to say that information on the existing situation and over time changes on the irrigated fields operated and owned by sample farmers is useful for explaining differences in income distributions.

Table 4.7 presents data on irrigated fields operated by sample farmers in the two periods. The data were made up of crop areas during the year, i.e., the sum of uses in the wet and the dry seasons, rather than cross-sectional areas at a point in time. In many ways, the distributional trends had been similar to those of the farm size presented in Table 4.6. In one way, however, the trends were more definite. It seems that the irrigated field was a better indicator for describing the change in basic resources of the sample farmers. In village number 4, unlike the trend observed from Table 4.6, the distribution of the operated irrigated fields had worsened too. The same individual accounts of the changes in operated irrigated fields may be seen from Table A.18 in Appendix A, which appeared to be similar to those changes in farm sizes (see Table A.17). The same phenomena of "old" small farms shifting into "new" large farm groups might explain the worsening of the "new" ranked-distribution.

Table 4.7. Changes in the distribution of operated irrigated fields, 8 sample villages, Central Java, 1968-1974[a]

Village	Size groups (15 samples each)	1968/1969 Average (Ha)	1968/1969 % of total	1973/1974[b] Average (Ha)	1973/1974[b] % of total	t-test of no difference[c]
No. 1	small farms	0.797	35	0.802	29	0.50
	large farms	1.478	65	1.972	71	0.20
No. 2	small farms	0.658	27	0.676	23	0.50
	large farms	1.814	73	2.289	77	0.50
No. 3	small farms	0.390	18	0.509	13	0.20
	large farms	1.849	82	3.576	87	0.05
No. 4	small farms	1.087	18	1.144	15	0.50
	large farms	4.847	82	6.711	85	0.05
No. 5	small farms	0.580	18	0.585	16	0.50
	large farms	2.694	82	3.124	84	0.50
No. 6	small farms	0.922	27	0.905	30	0.50
	large farms	2.446	73	2.147	70	0.40
No. 7	small farms	0.399	24	0.389	21	0.50
	large farms	1.279	76	1.498	79	0.50
No. 8	small farms	0.551	25	0.509	23	0.50
	large farms	1.624	75	1.689	77	0.50

[a]Measured in crop areas during the year, i.e., the sum of uses in the wet and dry seasons. The operated fields include: (i) owned fields and (ii) fields rented in, excluding fields rented out.

[b]See footnote Table 4.6.

[c]See footnote Table 4.6.

In contrast to the tendency found in irrigated fields operated by sample farmers, the distribution of owned irrigated fields had exhibited a tendency to improve in five out of the eight sample villages. The relevant data may be seen from Table 4.8. Without exception, all sample village averages on the owned irrigated fields had gone up, reflecting the tendency of nonproportionate increase by small farms, as compared to those by large farms.

One possible hypothesis in connection with these seemingly contradictory phenomena is that the smaller farmers has succeeded in buying,

Table 4.8. Changes in the distribution of owned irrigated fields, 8 sample villages, Central Java, 1968-1974[a]

Village	Size groups (15 samples each)	1968/69 Average (Ha)	1968/69 % of total	1973/74[b] Average (Ha)	1973/74[b] % of total	t-test of no difference[c]
No. 1	small farms	0.737	31	0.938	32	0.05
	large farms	1.659	69	2.014	68	0.40
No. 2	small farms	0.286	16	0.580	18	0.01
	large farms	1.537	84	2.746	82	0.10
No. 3	small farms	0.336	17	1.058	17	0.001
	large farms	1.694	83	5.241	83	0.01
No. 4	small farms	1.098	18	1.122	14	0.50
	large farms	4.875	82	6.788	86	0.05
No. 5	small farms	0.273	7	0.460	11	0.10
	large farms	3.689	93	3.807	89	0.50
No. 6	small farms	0.343	19	0.451	21	0.50
	large farms	1.472	81	1.671	79	0.30
No. 7	small farms	0.262	15	0.351	17	0.40
	large farms	1.548	85	1.704	83	0.50
No. 8	small farms	0.563	27	0.582	26	0.50
	large farms	1.565	73	1.660	74	0.50

[a]Including lands rented out, but excluding rented-ins. Measured in crop areas during the year, i.e., the sum of uses in the wet and the dry seasons.

[b]See footnote Table 4.6.

[c]See footnote Table 4.6.

or otherwise acquiring, irrigated fields which formerly were rented but, afterwards, were either having difficulties in finding more lands to rent or even had rented out the lands already bought. The larger farmers had also bought additional irrigated lands, or otherwise had acquired some, but had succeeded in doing so only in less-than-proportionate sizes in some villages, if compared to the smaller farms' successes. The supporting evidence may be seen from Table 4.9 where the corresponding individual accounts of the changes were presented, and also the opposing trends found in Tables 4.7 and 4.8. Since the "new" distributions of the owned irrigated fields had shown improvements, the shifting of "old" small owners into "new" large owners should have been less than in the cases found in farm sizes and operated irrigated fields.

The previous analyses have dealt with intra-village distributional changes of farm land resources, which showed some variation between sample villages. By combining all sample farms from the eight villages, it appears that the distributions of farm land resources tended to worsen over time, as shown by data on Table 4.10, although changes in the indices of their distributions are not significant statistically at 5 percent level. From the standpoint of basic resource endowments (i.e., farm lands) alone, _ceteris paribus_, these trends would contribute to the worsening of farm income distribution over time.

By grouping sample farmers according to their tenancy positions in relation to the irrigated fields operated, some light may be thrown upon the reported changes after five years. The relevant data are presented in Table 4.11. Again, from 1968/69 to 1973/74, similar trends about

Table 4.9. Changes in owned irrigated fields by the same (original) group of sample farmers, 8 sample villages, Central Java, 1968-1974[a]

Village	Size groups (10 samples each)	1968/69 Average (Ha)	1968/69 % of total	1973/74[b] Average (Ha)	1973/74[b] % of total	Group net addition (%)[c]
No. 1	small	0.624	18	1.061	24	70
	medium	1.055	29	1.163	26	10
	large	1.916	53	2.205	50	15
No. 2	small	0.125	5	1.168	24	834
	medium	0.665	24	0.865	17	30
	large	1.945	71	2.956	59	52
No. 3	small	0.206	7	2.295	25	1013
	medium	0.756	25	2.293	24	203
	large	2.082	68	4.860	51	133
No. 4	small	0.724	8	0.850	7	17
	medium	2.501	28	3.215	27	28
	large	5.734	64	7.800	66	36
No. 5	small	0.098	2	0.834	13	749
	medium	0.930	15	0.828	13	-11
	large	4.915	83	4.739	74	- 3
No. 6	small	0.110	4	0.984	31	794
	medium	0.934	34	0.860	27	- 8
	large	1.679	62	1.338	42	-20
No. 7	small	0.126	5	0.412	14	227
	medium	0.710	26	0.719	23	1
	large	1.880	69	1.950	63	4
No. 8	small	0.463	15	0.605	18	30
	medium	0.866	27	0.930	28	7
	large	1.864	58	1.830	54	- 2

[a]See footnote Table 4.8.

[b]See footnote Table A.17.

[c]See footnote Table A.17.

Table 4.10. Distributional percentage trends of farm sizes, operated irrigated fields and owned irrigated fields from 1968/69 to 1973/74, 240 farms, 8 villages combined, Central Java

Item	Period	Average (hectares)	Relative shares (%) of the aggregates by quintile groups of sample farms: First (bottom) 20%	Second 20%	Third 20%	Fourth 20%	Fifth (top) 20%	SD[a]
1. Farm size[b]	1968/69	0.888	5.6	9.3	13.5	21.1	50.4	0.35100
	1973/74	1.118	5.0	8.3	12.2	19.1	55.4	0.38220
2. Operated irrigated field[c]	1968/69	1.462	5.2	9.0	13.8	21.7	50.3	0.36570
	1973/74	1.783	4.1	7.8	12.1	18.8	57.1	0.41750
3. Owned irrigated field[d]	1968/69	1.532	5.4	10.3	13.2	18.8	52.3	0.34980
	1973/74	1.999	4.8	8.7	11.6	17.8	57.1	0.38465

[a]Standard deviation of the logarithms. It is used as a summary measure of the distributional inequality. A greater index means a larger inequality, etc. See further details in Chapter II. All intertemporal differences are not statistically significant at 5 percent.

[b]See footnote Table 4.6.

[c]See footnote Table 4.7.

[d]See footnote Table 4.8.

Table 4.11. Pattern of distribution of irrigated fields by tenures and by tenants, 240 sample farmers, 8 sample villages, Central Java, 1968-1974

Classes of tenants or operators	% of total sample	Wet season 1968/1969 Types of tenures (weighted averages in hectares)				% of total sample	Wet season 1973/1974 Types of tenures (weighted averages in hectares)			
		Owned	Rented out[a]	Rented in[b]	Operated[c]		Owned	Rented out[a]	Rented in[b]	Operated[c]
1. Owner only	53	0.751	-	-	0.751	55	0.975	-	-	0.975
2. Owner & rented out[d]	11	1.013	0.475	-	0.537	24	1.504	0.618	-	0.885
3. Owner & rented in[e]	16	0.534	-	0.350	0.885	12	0.722	-	0.410	1.132
4. Rented in only[f]	15	-	-	0.528	0.528	6	-	-	0.544	0.544
5. Others[g]	5	0.704	0.491	0.656	0.869	3	0.584	0.486	0.385	0.483

[a]Part of the owned field which was rented out on fixed renting or crop-sharing bases.

[b]Part of the operated field which was rented in on fixed renting or crop-sharing bases.

[c]Actual irrigated fields used for paddy production comprising of owned field minus rented out plus rented in portions.

[d]Owner-operators who, at the same time, rented out parts of their owned fields.

[e]Owner-operators who, at the same time, rented in fields from others.

[f]Operators who did not own any irrigated field.

[g]Including owners who, at the same time, rented out and rented in parts of the field, on fixed renting or crop-sharing bases.

increasing size averages had been shown by almost all operator's classes of sample farmers and their related types of tenures across the table.

The largest increase (about 65 percent) was found in the average operated irrigated fields of owners-operators who, at the same time, rented out parts of their fields. Their number had increased the largest too, which was more than doubled physically and in percentage-wise from 11 percent in 1968/69 to 24 percent in 1973/74, with the pure owner-operator's class more or less stable and the rest decreasing. Meanwhile, the number of pure tenants had experienced the largest decrease. If tenants could be identified with small farmers, all those changes would support the proposed hypothesis previously stated to explain the discrepancy between the distributional trends in owned and operated irrigated fields (see Tables 4.7 and 4.8 before).

Up to this point, no discussion has been presented on where the net size increases had come about. As stated before, no empirical data have been available to keep track of all transactions of lands bought and sold among sample farmers, and between sample farmers and the rest of the village population. The following is an attempt to evaluate theoretically the situation leading up to the net size increases of the sample farms.

Firstly, if the net increases had originated from fields owned by the rest of the village population, it would imply a worsening size distribution between sample farmers as a group and the rest of the land owners population in particular villages. Secondly, if the net size increases came from owners who resided outside the village boundaries, nothing could be said about distribution between sample and nonsample farmers, since the population was defined to include only owner-operators residing and operating local fields within the village.

Thirdly, if the net size increases had come from biased sample replacements, the effect could only partially be accounted for, based on the assumption that no change had occurred to the areas owned by the missing original samples. Table 4.12 provides data on the area changes resulting from sample replacement after five years period. It should be noted, that the analysis could be misleading since many samples in the village where no sample replacements were reported had increased their

Table 4.12. Estimated effects of sample farmers replacements on the net size increases of the owned irrigated fields, 8 sample villages, Central Java, 1968-1974[a]

Village	Number of substitute (new) samples	Area in hectares: Net size addition by new samples[b]	Area in hectares: Net size increases by all samples at 1973/74[c]	% of new supplies additional area to the total net increase in 1973/1974
No. 1	1	0.200	8.342	2 %
No. 2	9	7.035	22.536	31 %
No. 3	12	29.327	64.033	46 %
No. 4	0	0	29.059	0
No. 5	4	5.240	4.574	114 %
No. 6	14	-2.191	4.593	-32 %
No. 7	3	1.845	3.656	50 %
No. 8	0	0	1.113	0
Total	43	41.456	138.506	30 %

[a]Assuming no change had occurred to the irrigated field areas owned by the missing original samples.

[b]The differences between the area owned by the missing original samples in 1968/69 and the area owned by the substitute samples.

[c]The differences between total areas owned by sample farmers in 1968/69 and the same in 1973/74.

owned field size too. Therefore, the contribution of the new substituted samples size changes could only be estimated as a maximum possible effect.

Data from Table 4.12 show that in villages number 1 and 6 no sizeable changes had resulted from sample replacements. Rather large effects were shown in villages number 3, 5 and 7, where additional biases in sampling might contribute to the village average size increases. In villages number 4 and 8, where no sample substitutions had taken place, all size increases should be attributed to investments by the same original sample farmers. In any case, however, those size changes would generally cause some upward biases in the sample farmers, in addition to the inherent biases due to the original sampling procedures (see Section C, Chapter III).

V. CHANGES IN THE PATTERN OF INCOME DISTRIBUTION

Before any meaningful analysis of income distribution can be made the concepts and measures of farm income should be stated. There are several ways of measuring incomes and the choice of a method depends on the purpose of the analysis at hand and on the nature of farm operations. In any case, the actual method employed to estimate income levels should be delineated.

The predominance of irrigated fields in the survey area has led to the fact that sample farmers did not have any other major crop enterprises except paddy throughout the year. Many gardens around the homes were planted to fruit trees, tuber plants, herbs and some vegetables, constituting a minor source of other (nonpaddy) farm income. Some of the paddy farmers also engaged in various nonfarm activities which could serve as additional sources of income.

In 1968/69, respectively 80 percent and 35 percent of the sample farmers engaged in other farm enterprises (including gardening around the house) and off-farm production activities. In 1973/74, the respective percentages were 63 percent and 58 percent, reflecting the shift in emphasis toward the relative importance of off-farm sources of income.

However, as shown later, farm incomes in the study area were predominantly derived from paddy crops. Several income concepts and definitions, which are used in the analysis of changes in the distributional pattern of income, are given below.

A. Income Concepts and Definitions

1. <u>Quintals of net paddy yield</u>

This is the physical quantity a paddy farmer would get from his irrigated field during the production year after a certain proportion, ranging from 1/5 to 1/20 of the gross yields, are subtracted and given out as harvest shares to the harvesters. A production year refers to both the wet and the dry seasons combined.

2. <u>Value of net paddy yield</u>

When the quintals of net paddy yield are multiplied by a farm specific "price" coefficient, the result is defined as the value of net paddy yield received by the farmer. The "price" coefficient is the weighted average of the prices a farmer had received throughout a particular year.

3. <u>Value of net paddy yield minus cost of variable inputs other than labor</u>

It is useful to aggregate variable costs other than labor since these are believed to be the cost in paddy production most affected by the change in technology. For example, seed, fertilizers and pesticides expenditure would tend to increase, as the farmer adopted new practices.

4. <u>Farm family income from paddy</u>

This definition of income is arrived at by subtracting all variable costs, including pre-harvest hired labor but excluding operator and family labor, from the value of net paddy yield. Female labor and animal inputs were converted into male labor equivalents, using their respective wage rates per day as their weights.

5. Net return from paddy

Some paddy farmers were tenants who rented in lands from owners, while others were renting out part of their lands. If payments of rents are considered and added to, or subtracted from the farm family income, then the residual amount is called: the net return from paddy.

6. Net farm returns

When the estimated market value of the garden products and the net returns from the unirrigated (dry) field, if any, are added to the net return from paddy, a more complete farm income measure is defined, which is termed the net farm returns.

7. Net returns from all sources

This is the most complete income measure which, in addition to the net farm returns, includes also off-farm sources of net incomes. However, payments received for incidental and exchange work as hired labor on other farms were not taken into account due to problems of estimation. It could be argued that this exclusion should have minimal effect since incidental work outside the farm by a sample farm family is generally based on the exchange between neighboring farms and, thus, should compensate for each other.

Aside from the technical difficulties of its measurement, the conceptual problem on the definition of the appropriate income measure has long been discussed by many economists. Generally, the main concern has been with an ideal measure which (1) should reflect in some way the total remuneration within an appropriate earnings period, and (2) should be closely correlated with the actual living level of the income recipient and/or his family.

For the purpose of income distribution analysis, Kuznets [42] emphasized the appropriateness of a measure including both money income and income in kind and reflecting average remuneration for a sufficiently long period of time. The present study follows this approach by estimating the incomes as defined above. At the same time, the periods under study could be considered average in terms of yields and farm prices and hence the trends of incomes over time should also contribute to the long term average income.

Up to this point no specific mention was made about the income recipient. Now it should be apparent from the income definitions above that the recipient is the farm family, rather than the individual farmer. Two reasons could be given in support of the choice, i.e., (1) it is difficult to differentiate between the farmer's labor and his family labor, and (2) the average family size was more or less the same for the villages in the survey area (see Table 3.10).

In addition to some suspected sampling biases previously reported in Chapter III, some nonsampling errors might be found in the estimation of incomes. These include misreporting by some respondent farmers and erroneous entries by enumerators. It should also be obvious that errors which are cancelling out in making the averages would, by contrast, affect the analysis of income distribution of individual farmers.

Suspected biases due to the existing sampling errors could be minimized by giving careful interpretation of the results and by taking into consideration the direction and extent of the bias. The non-sampling errors could only be minimized by selecting competent enumerators and by preparing simple but adequate questionnaires, under proper supervision. These were the basic approaches adhered to by the present research from the start and during the analysis of data.

To make income data from both periods (1968/1969 and 1973/1974) comparable for certain purposes, the 1973/1974 income data were deflated by using paddy price indexes. Table A.19 in Appendix A shows various deflators estimated from village sample farm average prices received or paid by the farmers.

B. General Trends Over Time

The last three income definitions presented above were intended for measuring sample farm's yearly income by sources, i.e., from paddy cropping, from all farm enterprises and from all (farm and nonfarm) sources. In this section visual comparison and statistical tests on the extent of changes in various incomes between periods, and within any period, will be presented in tabular forms. Causal relations of functional types on the change of income distribution will be analyzed in the next chapter using regression methods.

From the methodological point of view, it would be interesting to compare the distributional changes of income by sources, and by periods, as can be observed from Tables 5.1 and 5.2 for the total sample paddy farms. For village-wise analyses one should consult Tables A.20 and A.25 in Appendix A.

Table 5.1. Growth and distributional percentage trends of farm incomes from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 240 farms, 8 villages, Central Java

Farm income by sources	Period (year)	Average income (rupiah)	Relative shares (%) of aggregate income received by various quintile groups of sample farmers: First (bottom) 20%	Second 20%	Third 20%	Fourth 20%	Fifth (top) 20%
1. Net return from paddy	68/69	24, 47	1.1	4.8	8.9	18.8	66.3
	73/74	54,718	2.7	6.6	10.8	18.1	61.8
2. Net farm return	68/69	28,997	1.8	6.1	11.3	20.3	60.5
	73/74	58,296	3.3	7.2	11.3	18.2	59.9
3. Net returns from all sources	68/69	33,220	2.7	7.7	12.2	20.1	57.3
	73/74	70,795	4.3	7.9	12.4	19.3	56.1

The first impression from Table 5.1 is the relatively high rates of increase in the average incomes. In five years average incomes had more than doubled since the base period. Equally important was the tendency for the percentages of aggregate incomes received by various quintile groups to become more evenly distributed. This tendency of more equal income distributions is confirmed by changes in the indexes over time, as shown by the data in Table 5.2. All indices were invariably decreased in the second period, where both the shifts on the coefficient of variation (CV) and the standard deviation of the logarithms of the incomes (SD) were highly significant statistically.

Note that the tendency of more equal income distribution had occurred despite of the worsening trends in farm land resource distributions (see Table 4.10). This suggests that small farms had succeeded over time in increasing their incomes more than proportionately, relative to large farms.

However, the general tendency should not distract one from observing the wide spatial variation on the changes over time, as exhibited by the village-wise results found in Tables A.20 to A.25 in Appendix A. Specifically, inconsistencies in village number 8 and 7 might be due to other causes than those of villages number 2 and 3. The first might be related to the maintenance of traditional paddy varieties by sample farmers (see Chapter IV, Table 4.5), while the second could be attributed to the larger nonfarm work opportunities in small towns close to those villages.

The second impression from Table 5.1 is that the addition of non-paddy sources of income, whether they came from home garden produce or from nonfarm sources, had resulted in more equal distributions of incomes at any period. In 1968/1969 the fifth (top) 20 percent group of farms received more than 66 percent of the aggregate net return from paddy, while the first (bottom) and second groups (40 percent) only received 6 percent. In the same period, about 57 percent of the aggregate net returns from all sources was shared by the top 20 percent of the group, while more than 10 percent was distributed among the bottom 40 percent. In the second period (1973/1974), the portions of the net return from paddy for the respective recipient groups were 62 percent and 9 percent,

Table 5.2. Changes in distributional indices of farm income distribution from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 240 paddy farms, 8 villages, Central Java

Farm income by sources	Indices of income distribution[a]									
	GR		ES		CV			SD		
	68/69	73/74	68/69	73/74	68/69	73/74	F-test	68/69	73/74	F-test
1. Net return from paddy cropping	0.638	0.564	0.896	0.875	209.0	134.8	**[b]	0.9508	0.5704	**
2. Net farm returns	0.578	0.540	0.867	0.862	177.4	127.8	**	0.7675	0.4657	**
3. Net returns from all sources	0.533	0.495	0.846	0.837	156.9	110.7	**	0.6846	0.3922	**
Bartlett test:[c]										
- between (1) and (2)	-	-	-	-	**	**	--	**	**	--
- between (1) and (3)	-	-	-	-	**	**	--	**	**	--
- between (2) and (3)	-	-	-	-	ns[d]	**	--	ns	*[e]	--

[a]GR = Gini ratio, ES = equal share coefficient, CV = coefficient of variation, SD = standard deviation of the logarithms of the incomes. F-test of differences in CV and SD are performed only if all four indices change consistently in the same direction. Two-tailed tests are used.

[b]** = significant difference at 1 percent.

[c]See Steel and Torrie [69, p. 347] for the test of homogeneity of variances. It is used here instead of nonindependent comparisons by F-test.

[d]ns = nonsignificant difference at both levels.

[e]* = significant difference at 5 percent.

while the portions of the net returns from all sources were 56 percent and 12 percent respectively. Shifts in the indices of incomes found in Table 5.2 tend to verify the trends just mentioned. Most differences are highly significant at 1 percent levels. Possible explanation of these differences are offered below.

C. Distributional Effects of Variable Inputs

Farmers have different endowments with respect to management capabilities, capital, land, water and other physical resources. Combined together, these resources work to produce different farm incomes. Assuming that farm size is the most important single factor determining farm income,[1] it is practical to use farm size as a quick reference to estimate farm income. It is not by coincidence that one of the criteria to judge a new input being introduced is how its usage is related to farm size.

Some farm inputs are neutral to size, meaning that when they are used proportionately by farms of different size the effects on the net incomes are proportional. Some others are not neutral to size, which means that their proportionate usage by different farms would affect their net incomes nonproportionally. Based on the direction of the net effect on incomes from different farm sizes, the latter input category may be divided into (1) increasing net benefits with size and (2) decreasing net benefits with size.

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[1] This was confirmed by Moehammad Nazir [46] in his study in West Java, by analyzing CES and Cobb-Douglas production functions of sample paddy farms. See also Chapter VII of the present thesis.

As was mentioned in Chapter I, one of the objectives of development is to arrive at a more equal income distribution or, at least, to keep it stable over time. It becomes relevant to know which specific input factors have contributed to which direction of distributional change in incomes. This knowledge should be useful in evaluating the impact of new technology requiring mostly quantitative changes in certain inputs. Tables 5.3 and 5.4 present an attempt to analyze the specific partial contribution of the average change in certain inputs to the change in paddy farm income distribution in the survey area after five years. Similar attempts by using regression analysis will be presented in the next chapter.

Data from Table 5.3 suggest that no significant effect had occurred in the income distribution as a result of incorporating variable cost other than labor in any period. Also, indirectly, no significant effect could be observed on the indices of income distribution as a result of the increase in that variable during the five years period. Neither significant shift within any period, nor consistent change between periods, was exhibited by the corresponding indices. This should mean that the change in variable cost other than labor had been neutral to size, at least within the five years period of study.

Table 5.4 shows the trends on the effects of pre-harvest hired labor cost on income distribution.[1] The deflated average cost of pre-harvest

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[1] It should be noted that no data on harvest labor were collected because of the difficulties in estimating the input. In most cases the farmer does not decide on how much labor he would use for harvest. He only knows that he pays the harvesters in kind based on certain proportions of the harvest collected. Detailed descriptions about this may be found in Sajogyo and Collier [57, p. 22] and Stoler [70].

Table 5.3. The effects of variable cost other than labor on income distribution from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 240 paddy farms, 8 villages, Central Java

Items	Average value (Rp)		Income distribution indices[a]			
			CV		SD	
	68/69	73/74	68/69	73/74	68/69	73/74
1. Variable cost other than labor	7,745.9	8,167.9	-	-	-	-
2. Value of net paddy yield	53,634.4	79,040.8	109.0	121.0	0.3658	0.4381
3. Value of net paddy yield minus variable cost other than labor	45,888.5	70,872.9	113.5	122.2	0.3667	0.4407
4. F-test of difference in the indices	-	-	ns[b]	ns	ns	ns
5. Percentage change in index	-	-	4.1	1.0	0.3	0.6

[a]GR and ES indices are not presented here to save space. F-test of differences are performed only if all four indices change consistently in the same direction. See further, footnote Table 5.2.

[b]Nonsignificant.

Table 5.4. The effects of pre-harvest hired labor cost on income distribution from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 240 paddy farms, 8 villages, Central Java

Items	Average value (Rp)		Income distribution indices[a]			
			CV		SD	
	68/69	73/74	68/69	73/74	68/69	73/74
1. Cost of pre-harvest hired labor	20,038.7	17,227.4	-	-	-	-
2. Value of net paddy yield minus variable cost other than labor	45,888.5	70,872.9	113.5	122.2	0.3667	0.4407
3. Farm family income from paddy cropping	25,849.8	53,645.5	160.4	130.1	0.8632	0.5507
4. F-test of differences in the indices	-	-	-	ns[b]	-	-
5. Percentage change in index	-	-	41.3	0.7	135.4	24.9

[a]See footnote Table 5.3.
[b]Nonsignificant.

hired labor for 1973/1974 appeared to be lower than for 1968/1969,[1] when actually the average physical inputs for the respective years were 360 and 277 mandays per farm. On a per-hectare basis, the pre-harvest hired labor inputs for 1973/1974 and 1968/1969 were, respectively, 202 and 189 mandays. (See Table 4.7 for changes in the average operated field per farm in the five years period.) However, the rate of increase in wages

[1]In this particular case, rice price deflators were used instead of wage deflators (see Appendix Table A.19).

would have been slower if compared to the same for paddy prices (see Table A.19 in Appendix A). Hence, the possibility existed of getting a lower deflated cost even when the physical input was higher.

Specifically, data in Table 5.4 show decreasing effects on income inequality as the pre-harvest hired labor cost, in terms of paddy prices, became relatively smaller in the second period. In 1968/1969 an average hired labor cost of RP 20,038 had contributed to 41.3 percent significant increase in CV, while in 1973/1974 a smaller relative cost of Rp 17,227 had accounted for only 0.7 percent nonsignificant increase for the same index. A similar tendency was observed in SD indices in the respective years.

It should be apparent that preharvest labor use in the survey area was still nonneutral to size, because the net effect was increasing net benefits with farm size. In other words, smaller farms tended to use hired labor more than proportionately to size when compared to the larger farms. However, as time passed the effect apparently had been reduced. This suggests the hypothesis that the effect of pre-harvest labor use, with regard to expanding HYV technology usage, is to reduce the income inequality.

D. Distributional Effects of Soil Type Differences

There are two major soil types on which paddy crops are mostly grown in Central Java: (1) alluvials, in the coastal areas and river plains, including hydromorphic soils, and (2) latosolic soils in the rolling hills. As shown on Table A.13 in Appendix A, these two soils in general have different levels of productivities. This section attempts to analyze growth and distributional changes of paddy farm incomes by soil types between the two periods. Since both the net farm returns and the net returns from all sources had positive effects on reducing farm income inequality (see Tables 5.1 and 5.2), from here on the analyses will deal only with the net return from paddy.

It can be seen from Table 5.5 that, on a per-farm basis, sample farms of latosolic soils had a higher average net return from paddy of Rp 39,950 in 1968/1969 compared to those alluvial soils with Rp 14,506. But, with the spreading of the HYV (high yielding variety) technology, paddy farms in alluvial soils had experienced relatively faster income growth to Rp 46,696 than those in latosolic soils which had reached Rp 68,087. Thus, it becomes relevant to ask what are the impact of these differential income growth rates upon the trend in farm income distribution.

Table 5.6 presents the income distributions by soil types in the two periods. According to these data, farm incomes from latosolic soils were more unequally distributed in 1968/1969 than those from alluvial soils. The Gini ratios (GR) were, respectively, 0.640 and 0.546. However, the distributional difference between the two was reduced as farm

Table 5.5. Growth of net return from paddy by soil types, from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 240 farms, 8 villages, Central Java

Soil type	Operated hectares of rice field per farm		Net return from paddy (Rp) per farm		
	68/69	73/74	68/69	73/74	t-value[a]
1. Latosols[b]	2.096	2.436	39,950	68,087	2.4574*[c]
2. Alluvials[d]	1.084	1.391	14,506	46,696	5.4056**[e]
t-value			3.1092**	2.1434*	

[a]Since the variances were unequal, the null hypotheses of no-difference were tested by Behrens-Fisher method (see [69, p. 81] for the formulae used).

[b]Sample villages number 4, 5 and 6 with a total of 90 sample farms belonged to this soil type.

[c]Significant at 5 percent.

[d]Sample villages number 1, 2, 3, 7 and 8 with a total of 150 sample farms belonged to this soil type.

[e]Highly significant at 1 percent.

income from latosolic soils become more evenly distributed in the second period, while those from alluvial soils had more or less maintained their income distribution index. The respective GR estimates in 1973/1974 were 0.565 and 0.537.

At the base period, before the introduction of HYV technologies, it seems that higher productivities in latosolic soils were accompanied by relatively less equal income distribution, in contrast to corresponding trends found in alluvial soils. The introduction of HYV in latosolic soils appeared to open up the opportunity more in favor of small farms, rather than large farms, which eventually resulted in a more equal income distribution. In alluvial soils, no differential response was found

Table 5.6. Change in distribution indices of net return from paddy by soil types, from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 240 farms, 8 villages, Central Java

	Income distribution indices									
	GR		ES		CV			SD		
Soil types	68/69	73/74	68/69	73/74	68/69	73/74	F-test[a]	68/69	73/74	F-test[a]
Latosols	0.640	0.565	0.889	0.844	191.2	113.4	**[b]	1.0606	0.7164	**
Alluvials	0.546	0.537	0.840	0.860	124.2	151.3	-	0.8657	0.4619	-
F-test					**	-		*[c]	-	

[a]F-tests of no-difference in CV and SD are performed only if all four indices change consistently in the same direction. Two-tailed tests were performed.

[b]Highly significant at 1 percent.

[c]Significant at 5 percent.

between small and large farms and, hence, the stable income distribution at the end period. However, no conclusive explanation is available at this stage and more research is needed to study the differential response to HYV with respect to soil type differences.

Based on the trends found in Table 5.5 and 5.6, it appears that soil type differences did not pose any serious problem to the effort to expand HYV technologies. The twin development objectives, i.e., (i) growth in farm incomes and (ii) more equal or, at least, stable income distribution could be achieved simultaneously.

E. Distributional Effects of Paddy Varietal Differences

In terms of their origin and levels of productivity, paddy grown by farmers may be distinguished as follows: (i) traditional or local varieties, usually with comparatively lower productivity levels, (ii) domestic HYV, developed by the Central Research Institute for Agriculture, which have high productivity potentials, and (iii) IRRI-HYV, originated from the International Rice Research Institute in the Philippines, which also have high productivity potentials but are generally of lower eating quality.

In order to increase the domestic supply of rice as planned, more and more paddy farmers should adopt HYV technologies.[1] Obviously, on the one hand, paddy farmers would need increased net returns as their tangible

[1]See objectives of the Five Year Development Plans discussed in Section D, Chapter I.

incentives to do so. On the other hand, the policy-makers would like to check on the distributional aspects of the increased incomes.

Data on Table 5.7 show the average net return from paddy by varieties grown in the two periods of study. On a per-farm basis net returns from HYV tended to be higher than that of the traditional varieties. The average net return from paddy per farm in 1968/1969 were, respectively,

Table 5.7. Growth of net return from paddy by varieties grown, from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 8 villages, Central Java

Varieties of paddy grown	Operated hectares of rice field per farm[a]		Net return from paddy (Rp) per farm		
	68/69	73/74	68/69	73/74	t-value[b]
1. All IRRI-HYV	- (0)	1.513 (37)	-	38,369	-
2. All domestic HYV	1.876 (45)	1.511 (93)	19,704	48,880	4.8673
3. All traditional	1.022	0.940	16,088	21,496	1.5825[ns][d]
Duncan's test of no-difference[c]					
a. between (1) and (2)			-	ns	
b. between (1) and (3)			-	ns	
c. between (2) and (3)			ns	-	
d. between (1+2) and (3)			-	-	

[a]Figures in parentheses indicate particular number of cases. Only pure variety growers were considered. In 1968/1969 no IRRI-HYV growers were found in the survey area.

[b]See footnote Table 5.5.

[c]These are "nonindependent" comparisons [69, p. 105]. The method followed here is a multiple-range test with unequal number of cases [69, p. 114].

[d]Nonsignificant.

Rp 19,704 and Rp 16,088. On a per-hectare basis, however, the net return of traditional varieties growers was higher than that of HYV growers. Nevertheless, the difference was nonsignificant probably because of the large variation found in domestic HYV productivities.[1]

In 1973/1974, the net returns from paddy per farm of the IRRI and the domestic HYV were, respectively, Rp 38,369 and Rp 48,880, while traditional varieties only produced an average net return of Rp 21,496. Statistically significant differences were found between the average net return per farm of the traditional varieties and those average net returns from both, respectively, the domestic and the combined HYV. Similar tendencies could still be found on a per-hectare basis of comparison.

The shift in breeding program emphasis toward developing more fertilizer responsive paddy varieties began to produce results in 1973/1974. Highly significant increase in the average net return of more than 100 percent of its value in 1968/1969 had been experienced by the domestic HYV growers in 1973/1974. In the mean time, only 34 percent nonsignificant increase was achieved by the traditional variety growers. There also was a tendency that in 1973/1974 the average net return per

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[1]It should be noted that until the early sixties, the emphasis of domestic rice breeding programs was more on the disease and pest-resistance, although yield potentials were also higher than those of traditional varieties. Beginning with the late sixties, the emphasis had changed toward higher yield potentials and responsiveness to fertilizers. This was implied by Siregar [65, p. 4], a well-known Indonesian rice breeder specialist, when he wrote that the "Green Revolution" actually began in 1965 in Indonesia.

farm from IRRI-HYV was lower than that of the domestic HYV, even though the difference was nonsignificant.[1]

Apparently, improvement in the average incomes did not affect the income distribution adversely through time, as can be observed from Table 5.8. Regardless of varieties grown, all indices of income distribution were significantly decreased in the second period (1973/1974), i.e., showing less inequality in incomes. The Gini ratios (GR) for incomes from the domestic HYV and from the traditional varieties were, respectively, 0.603 and 0.583 in 1968/1969. These coefficients had decreased to 0.443 and 0.388, respectively, in 1973/1974.

Roughly speaking, farmers currently growing HYV had a more unequal distribution of incomes than those growing traditional varieties. Although the distributional index differences between incomes from domestic HYV and from traditional varieties were not testable,[2] the distributional index of incomes from combined HYV (IRRI and domestic), and of IRRI-HYV alone, were significantly different from that of the traditional varieties.

Theoretically, the fact that current HYV growers had a more unequal income distribution, compared to traditional variety growers, could be explained by the differential adoption rates of HYV between (i) low and

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[1]Two recent domestic HYV, Pelita I/1 and Pelita I/2, were released in April 1971. Both originated from a cross of IR5 X Syntha. Their yields have been consistently higher than that of IR5; they have better eating quality and are more resistant to bacterical leaf blight [6, p. 2]. In 1973/1974, most of the domestic HYV planted by sample farms were of these varieties.

[2]As data from Table 5.8 indicate, the differences of all indices were not consistent within any period of study.

Table 5.8. Changes in distribution indices of net return from paddy by varieties grown, from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 8 villages, Central Java

Varieties of paddy grown	Income distribution indices									
			ES		CV			SD		
	68/69	73/74	68/69	73/74	68/69	73/74	F-test[a]	68/69	73/74	F-test[a]
1. All IRRI-HYV	-	0.530	-	0.838	-	135.1	-	-	0.8463	-
2. All domestic HYV	0.603	0.443	0.844	0.796	122.9	94.1		1.5229	0.3620	-
3. All traditional varieties	0.583	0.388	0.880	0.750	166.9	76.1		0.6809	0.4018	-
Bartlett test[b]										
a. Between (1) and (2)					-	-		-	-	
b. Between (1+2) and (3)					-	-		-	-	
c. Between (1) and (3)					-	-		-	-	
d. Between (2) and (3)					-	-		-	-	

[a]See footnote Table 5.6.

[b]See Steel and Torrie [69, p. 347] for this test of homogeneity of variances. It was used here to avoid nonindependent comparison by F-test.

high income farmers, and (ii) small and large size farms [40, pp. 100-101]. The underlying assumption, following Schultz [60, pp. 24-35], is that farms growing traditional varieties were in a sort of equilibrium state, while those growing HYV were in a disequilibrium state in terms of returns to investment. Based on these assertions, it is logical that high income farmers were the early beneficiaries of the new technology, since they tended to become first adopters when compared to low income farmers.

F. Distributional Effects of Population Density Differences

Village population densities estimated per square kilometer of (1) irrigated lands, (2) farm lands and (3) total area were presented in Table 3.5. A closer look at the data would reveal that those three density measures had consistent rankings, which suggest analytical relevance of grouping the eight sample villages according to population density. Sample villages number 2, 3, 5 and 7, having the range from 1079 to 1626 people per square kilometer of the respective village total area, were grouped into "more populated" villages. The rest of the sample villages, having the range from 667 to 903 people per square kilometer of the corresponding total area, were designated as "less populated" villages.

Since population density is an important exogenous variable, which is also readily available for any area, its relationship with average income, the rate of income growth and the trend on income distribution should provide background information on policy formulations. For example, what priority bases should be followed in deciding which area, *ceteris paribus*, should be dealt with first when the budget is limited. Tables 5.9 and 5.10 provide the necessary data on income growth and income distribution with respect to village population densities.

Data from Table 5.9 indicate that paddy farmers from more populated villages tended to have a higher average net return from paddy than those from less populated ones, though the differences were nonsignificant in both periods. This tendency is very much in accord with Geertz' assertion [28, p. 75] that rice yield per hectare tended to increase with population density, especially in areas producing both sugar and rice, like the sample villages of the present study. The greater efficiency in cultivation derived almost entirely from a greater intensification of labor [28, p. 77].

Table 5.9. Growth of net return from paddy by levels of population density, from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 240 farms, 8 villages, Central Java

Levels of population density	Operated hectares of rice field per farm		Net return from paddy (Rp) per farm		
	68/69	73/74	68/69	73/74	t-value[a]
1. More populated villages (village No. 2, 3, 5 and 7)	1.208	1.581	28,247	60,741	3.2603
2. Less populated villages (village No. 1, 4, 6 and 8)	1.719	1.985	19,848	48,695	5.0098
t-value			1.2961[ns][b]	1.2662[ns]	

[a]See footnote Table 5.5.

[b]Nonsignificant.

However, during the five years period (1968/69-1973/74) paddy farmers from less populated villages had a faster income growth rate (145 percent) compared to that of the more populated villages (115 percent). At this stage, no specific reason could be given for the observed trends. Both income growth rates were statistically significant at 1 percent levels. Thus, apparently, it had been relatively easier to increase farmers net income in less populated villages than in more populated ones.

The difference in population density appeared to be generally reflected in the differential income distribution as shown by data on Table 5.10. Higher inequality of incomes tended to be found in more populated villages. Only one index, i.e., the SD of logarithms of the incomes for 1968/1969, showed an exception to the general trend. Nonetheless, no statistical conclusion could be given here.

Unfortunately, the faster growth rate of average net return in less populated villages (see Table 5.9) had resulted in an indeterminate trend of income distribution, as shown by inconsistent changes of income distribution indices found in Table 5.10. The indices of GR, ES and CV had registered some increases, while the SD index showed a drastic decrease of more than 50 percent. No particular reason could be given in this case, except that the Lorenz curves from both periods had crossed each other.

The distributional percentages of net returns from paddy in 1968/69 and 1973/74, in the less populated villages, are presented in Table 5.11. Their corresponding Lorenz curves, which do cross each other are shown in Figure 5.1.

Table 5.10. Changes in distribution indices of net return from paddy by levels of population density, from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 8 villages, Central Java

Levels of population density	Income distribution indices									
	GR		ES		CV			SD		
	68/69	73/74	68/69	73/74	68/69	73/74	F-test[a]	68/69	73/74	F-test[a]
1. More populated villages	0.696	0.573	0.925	0.875	239.2	141.2	-	0.7577	0.6227	-
2. Less populated villages	0.546	0.548	0.833	0.867	109.6	121.6	-	1.1093	0.5136	-
F-test[a]					-	ns[b]		-	-	

[a]See footnote Table 5.6.

[b]Nonsignificant.

Table 5.11. Distributional percentages of net returns from paddy in less populated villages, 1968/69 and 1973/74, 120 paddy farms, 4 villages, Central Java

	Relative shares (%) of aggregate income received by various quintile groups of sample farmers					
Year	First (bottom) 20%	Second 20%	Third 20%	Fourth 20%	Fifth (top) 20%	Gini ratio
1968/69	0.9	6.2	12.6	24.2	56.1	0.546
1973/74	2.7	7.0	11.0	18.7	60.6	0.548

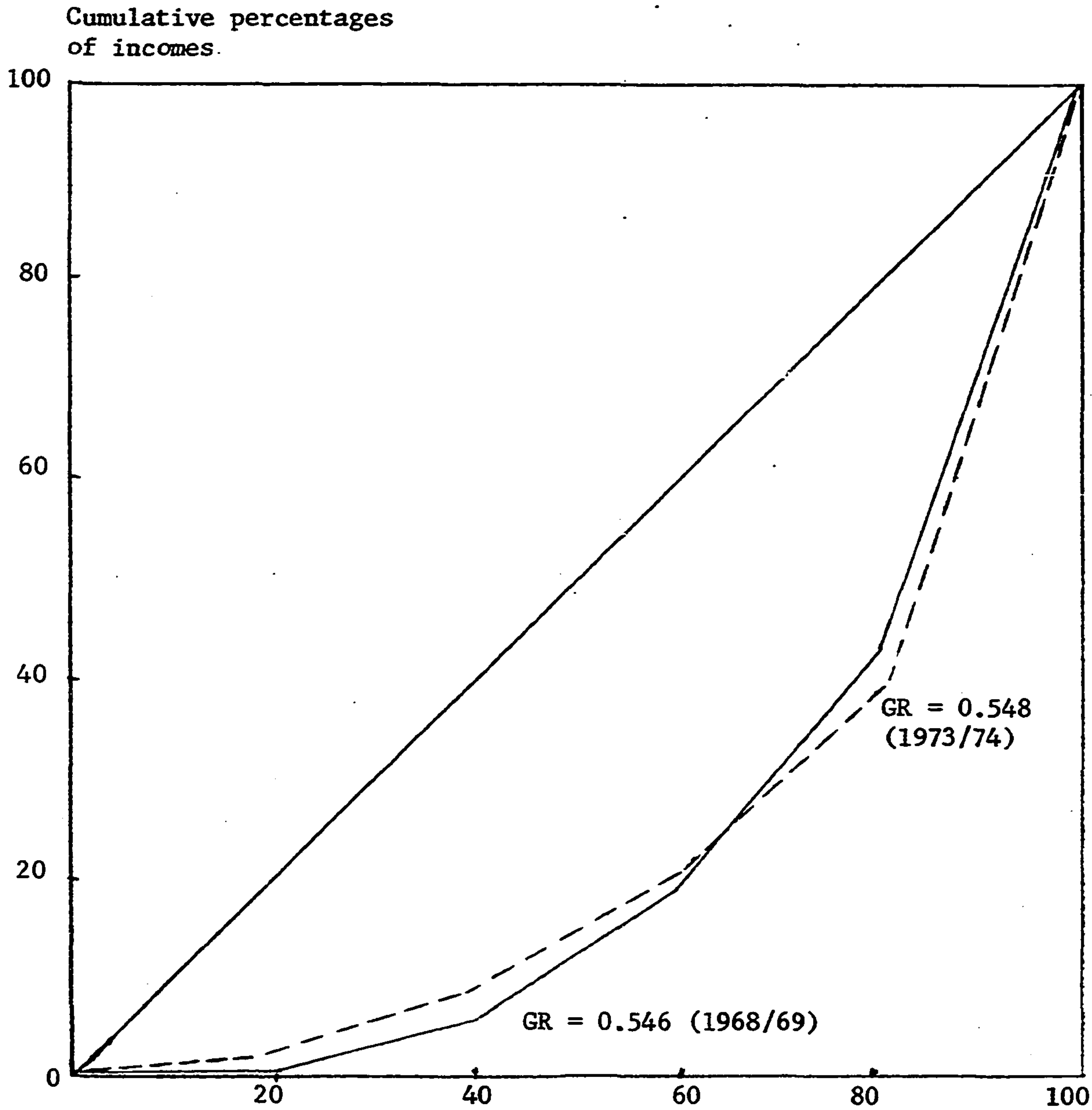

Figure 5.1. Lorenz curves of net returns from paddy in less populated villages, 1968/69 and 1973/74

Contrary to the case found in less populated villages, definite reduction had taken place in income inequality indices of paddy farmers in more populated villages. The Gini ratio (GR) had shifted from 0.696 in 1968/1969 to 0.573 in 1973/1974 in line with statistically significant decreases in CV and SD indices. This tendency, together with the slower income growth mentioned above, should lead to a working hypothesis characterizing "involuted" villages as asserted by Clifford Geertz in 1968 [28, pp. 74-82].

G. Distributional Effects of Land Tenure

Five mutually exclusive categories of tenures could be discerned among paddy farmers in the survey area (see Table 4.10, Chapter IV), which are: (1) owner-operators, who work their own fields with neither renting out parts of their lands nor renting in from others, (2) owner and renting-outs, who operated their own fields and, at the same time, rented out part of their lands to others, (3) owners and renting-ins, who operated their own fields plus renting in additional fields from others, (4) tenants, who do not have fields of their own and operate entirely rented-in fields from others, (5) others, including owners who, at the same time, renting out and renting in part of the lands.

About 45 percent of the sample farmers had engaged in one or the other tenancy relations, belonging to categories number 2 to 5 inclusive. Owners received payments of rents in addition to their usual crop incomes, while tenants would consider the rents as part of their business costs deducted from their crop incomes.[1] It would be interesting to analyze the general effects of the existing tenure relations on income distribution. Because of data limitation, no attempt will be made to look into the differential effects of fixed rentals versus share tenancy.

As defined in section A above, farm family income from paddy could be regarded as the amount which would be received by each farmer if there were no tenancy relations. The corresponding income distribution could then be compared with that of the net return from paddy, which includes the calculation of net rents paid and received, to test whether the prevailing tenancy relations had a significant effect on income distribution. Table 5.12 presents data on income differences and the shifts on income distribution through time, with and without the existing tenure relations.

In 1968/1969, sample farmers had paid out an average net rent in the amount of Rp 1,802, or about 7 percent of the farm family income from paddy, to nonsample farmers in the area. It seems that the small sample farmers had been renting in more lands than the larger sample farmers could afford to rent out. Hence some of the land had to be rented in from the nonsample paddy farmers and other landlords. In 1973/1974, after five years, the situation had been reversed, where sample farmers had become the net receiver of rents paid by nonsample farmers, although it amounted to only 2 percent of the current average farm family income from paddy.

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[1]Rental payments were either paid in kind or in cash. Basically, there are two methods of payment: (1) fixed rentings, where a fixed amount is paid before or after production, and (2) crop sharing, paid after harvest with various proportional arrangements.

Table 5.12. The effects of land tenure relationships on income distribution, from 1968/1969 to 1973/1974 at 1968/1969 paddy prices, 240 farms, 8 villages, Central Java

	Average value (Rp)		Income distribution indices[a]			
			CV		SD	
Items	68/69	73/74	68/69	73/74	68/69	73/74
1. Net rents paid and/or received[b]	-1,802	+1,072	-	-	-	-
2. Farm family income from paddy	25,850	53,646	160.4	130.1	0.8632	0.5507
3. Net return from paddy	24,048	54,718	209.0	134.8	0.9508	0.5704
4. F-test on index differences			-	ns[c]	ns	ns
5. %-change in index			30.3	3.6	10.1	3.5

[a]GR and ES indexes are not presented here to save space. A test of difference was performed only if all four indices changed consistently in the same direction.

[b]If sample farmers did not have tenure relations with nonsample farmers in the statistical population, this amount should be equal to zero. The positive sum indicates the net aggregate amounts received, while the negative sum represents amounts paid out, by sample farmers as a group having tenure relations with nonsample farmers.

[c]Nonsignificant.

Data on the trends of income distribution suggest that in 1968/1969 the effect of tenure relations had resulted in a larger inequality than that in 1973/1974. Observing the shifts in CV indices within any period, the significant increase of 30 percent in income inequality due to tenure relations in 1968/1969, was reduced to a 4 percent nonsignificant increase in 1973/1974. Similar trends are also found in SD indices.

Evidently, the more general use of new technology in paddy production had resulted in tendencies that (1) average income had more than doubled since the base period, and (2) income inequality due to tenure relations had been reduced. This is in general agreement with Sajogyo's findings from the 20 village study in Java in 1968-1971 [58, p. 23 and Table 8), who reported that lessees had reached relatively higher net rice revenues, in comparison to owner-operators in 1970/71.

VI. IMPACT OF CAUSAL FACTORS ON INCOME DISTRIBUTION

The previous chapter analyzed the growth and distribution of variously defined incomes of paddy farmers between 1968/1969 and 1973/1974. Based on this analysis, the hypothesized influences of selected factors were investigated. However, the analyses employed were similar to simple or bivariate regression techniques in that the influence of other factors, beside the particular independent variable being considered, was not accounted for and assumed to be randomly distributed. Thus, the relationships analyzed were likely an oversimplification of actual phenomena.

In this chapter an attempt is made to present more inclusive analyses by employing the method of multiple or multivariate regression. By such method, an assessment is made of the contribution of each particular factor to the variation in the income inequality indices, while at the same time controlling the influences of the other factors included in the regression model.[1]

It should be noted, however, that an income inequality index refers to a certain group of income recipients and, as such, the units of analysis should consist of groups of farmers rather than separate individual farmers. Since this study is concerned with growth and distributional changes of paddy farm incomes in the survey area as a whole,

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[1]For details on the multiple regression method, see for instance: Ezekiel and Fox [19, pp. 151-199].

the appropriate grouping of paddy farms would be according to the eight sample villages. Based on these eight cases, an attempt is made to explain the spatial variation and the intertemporal change in income inequality, as may be suggested by the relevant contributing factors.

A. Selection of Relevant Causal Factors

Many variables are thought to affect paddy yields and, hence, farm incomes. In one respect, some variables are more essential than others in explaining the variation in paddy yields. For example, for rice farms in West Java, Indonesia, it was found by regression analysis that cultivated area contributed more to the variation in paddy yields than nonfarm current inputs. The respective regression coefficients for the 1970/1971 wet season were +0.5917 and +0.0520 [46, p. 62].

In another respect, and even more important, some of the variables are more amenable to change as a result of certain policy implementations, while others are not so. For instance, using the example cited above, it appears that inducing changes in nonfarm inputs through policy measures is much less costly than changes in cultivated areas.

In looking for ways to improve income distribution, it becomes necessary to test certain explanatory variables which could readily change with suitable programs and, thus, indirectly would affect income inequality among paddy farmers. Since the units for estimation were limited to the eight sample villages, the number of selected independent variables should be limited accordingly to permit sufficient degrees of freedom for statistical testings.

The three variables proposed for testing are (1) farm income, (2) expenditures on seed, fertilizers and pesticides, and (3) man-days of total pre-harvest labor. The reasons why these variables can be expected to influence income inequality are discussed in the following subsections.

1. Farm income

Before proceeding with the discussion, it is appropriate to define the term farm income as used in this chapter. More precisely, the concept of income followed is that of the net farm returns, where the estimated value of house garden products and other farm products, if any, are added to the net return from paddy.[1]

This farm income definition is considered the most suitable for the present analysis, which attempts to explain the variation in farm income inequalities based on the farm input-output relationship,[2] for the following reasons. Based on the assumption that paddy and house garden products are competitive in their use of farm inputs including labor, the incomes derived from each are interdependent, and should be treated as coming from one production unit. Income from nonfarm sources is considered not relevant here because it is of supplementary nature to the farm income with respect to the use of labor and other farm inputs. Traditionally, a paddy farmer would engage in nonfarm employment only when it does not interfere with his farming operation.

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[1]See Chapter V for other definitions of farm income.

[2]See Chapter II, particularly p. 46, for the general model proposed.

As was discussed in the previous chapter, the average net farm return in the area of study had more than doubled, between 1968/69 and 1973/74, which simultaneously resulted in a more equal income distribution after the five years period. In addition, the averages of net farm returns by sample villages as given in Appendix Tables A.21 and A.24, showed a tendency to vary in a negative direction with the income inequalities. Within a national framework, a hypothesis was proposed by Kuznets [38, pp. 1-28] suggesting that an increase in the level of mean income could lead to a drop in income inequality. Therefore, an effort is made to test whether there is a significant causal relation between income growth and reduction in its inequality. This would also serve as an evaluation of the general success of the BIMAS extension programs in the survey area between 1968/69 and 1973/74.

2. Expenditure on seed, fertilizers and pesticides

It was mentioned elsewhere in the last two chapters that adoption of new technology had been increased by sample paddy farmers. The package of new paddy technology consisted of high yielding variety (HYV) of seed, fertilizers and pesticides. These new inputs have been the subject-matter of current extension programs, where implementations have changed according to time and place, in line with the current levels of knowledge and institutional capabilities.

In light of recent interest in dealing with the distributional impact of BIMAS programs, it is timely here to appraise what possible effects the increase in farm expenditure for the new inputs has had on income inequality. As data in Table 6.1 show, the average farm expenditure for the new inputs had gone up appreciably in the study area between 1968/69 and 1973/74. Simultaneously, it appears that the relative variance of these expenditures has increased also.[1]

Table 6.1. Mean and relative variance of expenditure on seed, fertilizers and pesticides, 1968/1969 and 1973/1974 valued at 1968/1969 prices, 240 paddy farms, 8 villages, Central Java

Expenditure on seed, fertilizers and pesticides	1968/1969 (rupiahs)	1973/1974 (rupiahs)[a]	Tests of difference[b]
Mean	7,745.97	16,021.27	t = 5.7334**
Relative variance	1.0865	1.6938	F = 1.5589**

[a]Each cost component was deflated by its own specific price deflator (see Appendix Table A.19).

[b]** = significant difference at 1 percent level.

Based on the earlier discussion in Section B.3, Chapter II, there is a valid theoretical reason to expect close relationships between income inequality and the relative variances of important inputs, in addition to similar relationships between mean income and mean levels of input use. The influence of a change in mean level of input use on income inequality would depend on how it is related to the inequality in the rates of its use among the farmers, as measured by its relative variance.

Data from Table 6.1 amply suggest that there was a positive relationship between the mean expenditure on purchased inputs and its relative variance over time. Thus, an increase in the mean expenditure is accompanied by an increase in its relative variance. Distributionally,

[1]A relative variance is equal to squared coefficient of variation. See Chapter II for further details.

this implies that larger farmers increased their input use more than proportionately, when compared to smaller farmers. Now, since farm incomes became more equally distributed over time (see Chapter V), i.e., they had less relative variance, empirically there is reason to believe that income inequality will be related negatively to the relative variance of expenditure on purchased inputs. Thus, by the same reasoning, the mean level of that input also is expected to be related negatively with income inequality over the period of study.

3. Man-days of pre-harvest labor input

Elsewhere in the previous chapter it was reported that the mean level of pre-harvest hired labor had increased from 277 to 360 man-days per paddy farm during the five years period of study.[1] At the same period, the increased rate of use had tended to reduce the income inequality (see Table 5.4).

Table 6.2. Mean and relative variance of total pre-harvest labor 1968/1969 and 1973/1974, 240 paddy farms, 8 villages, Central Java

Total pre-harvest labor	1968/1969 (man-days)	1973/1974 (man-days)	Test of difference[a]
Mean	306.7	401.4	t = 2.3434**
Relative variance	0.9729	1.8688	F = 1.9208**

[a]** = significant difference at 1 percent level.

[1]The total pre-harvest labor (family and own labor included) were, respectively, 307 and 401 man-days.

From Table 6.2 it appears that the significant increase in the mean level of total pre-harvest labor was accompanied by a rise in its relative variance. As in the case of purchased input, distributionally this means that larger farmers increased their pre-harvest labor input more than proportionately, when compared to smaller farmers. In similar fashion, considering the fact that farm incomes became more equally distributed, it could be expected that both the mean level and the relative variance of pre-harvest labor would be negatively related to income inequality.

The main reason for testing the relationship between labor use and income inequality is obvious, if one recalls the three general objectives of the second Five Years Development Plan, namely: increased income, more equally distributed benefits and provision of more employment. In terms of policy implications, the observed relations between labor use and paddy varieties as presented in Table 6.3 provides additional impetus for testing the proposed causal relationship.

It can be seen from Table 6.3 that the increase in pre-harvest labor was due mainly to the improvement inherent in increased adoption of HYV technology by paddy farmers in the survey area. At the beginning of the period, no significant difference in labor use was found between traditional variety growers and HYV growers. However, by 1973/1974, any shift from planting purely traditional variety into planting purely HYV involved 30 percent additional labor absorption per hectare.

Table 6.3. Varieties of paddy planted in relation to the average pre-harvest labor use per hectare, 1968/1969 and 1973/1974, 240 paddy farmers, 8 villages, Central Java

Paddy varieties planted[a]	Per hectare average pre-harvest labor use (man-days)[b]			Tests of difference[c]
	1968/1969	1973/1974	% change	
All traditional var.	214 (100)	187 (100)	- 13	t = 2.6309*
All domestic HYV	202 (45)	244 (130)	+ 21	t = 3.3689**
% - change	- 6	+ 30		
Test of difference[c]	t = 1.2338[ns]	t = 5.2336**		

[a]Only pure-variety growers were considered. In 1968/69 no pure-variety IRRI-HYV growers were found in the survey area. See Table 5.7 for further information.

[b]Figures in parentheses indicate the number of particular cases. Labor use includes hired, own and family labor.

[c]** = significant at 1 percent level, * = significant at 5 percent level, ns = nonsignificant at the above levels.

B. Specification of the Regression Model

The basic model was originally derived from the definitional identity that gross farm income is equal to the sum of payments to factors of production, as presented in Section B.3, Chapter II. In order to make it empirically operational, the model should also take into account the fact that (1) observation units (cases) are limited, i.e., only eight sample villages per period, (2) the relevant data sets were obtained from two different periods, and (3) the mean farm income had increased significantly.

1. The model

Because of the very limited number of cases available, only three basic variables are included as the explanatory variables, namely: farm income, expenditure on seed, fertilizers and pesticides, and man-days of total pre-harvest labor use. This allows sufficient degrees of freedom for statistical testings of the regression coefficients. Since data on the same variables were collected from two distinct periods, the use of a period dummy variable helps to expand the degrees of freedom by combining the two sets of village data.

Therefore, a single regression model instead of two separate ones, with the provision of a period dummy variable and its interaction with other independent variables are specified as follows:[1]

$$Y_i = b_0X_0 + b_1D_i + b_2X_{1i} + b_3D_iX_{1i} + b_4X_{2i} + b_5D_iX_{2i} + b_6X_{3i} + b_7D_iX_{3i} + b_8X_{4i} + b_9D_iX_{4i} + U_i$$

where;

Y_i = income inequality as measured by the standard deviation of the logarithms of the farm incomes in the i-th village,

b_j = unknown parameters to be estimated,

X_0 = dummy variable given the value of one for all villages,

D_i = period dummy variable for the i-th village, where $D_i = 0$ for the first period (1968/1969) and $D_i = 1$ for the second period (1973/1974),

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[1]A similar example on consumption function model was given by Johnston [35, p. 223].

X_{1i} = mean of the logarithms of the farm incomes in the i-th village,

X_{2i} = relative variance (squared coefficient of variation) of farm expenditure on seed, fertilizers and pesticides in the i-th village,

X_{3i} = mean farm expenditure on seed, fertilizers and pesticides in the i-th village,

X_{4i} = mean man-days of farm total pre-harvest labor was in the i-th village,

U_i = random or residual variable for the i-th village

The standard deviation of the logarithms of the incomes was used to measure income inequality because the log-transformed income data tended to be more normally distributed than the original income data (see Appendix B for the statistical tests). Hence, more accurate results from statistical testings may be expected than if other summary measures such as the Gini ratio or the coefficient of variation, using original income data, were used. It is noted again, however, that the sample size is very small, only 16 observations, and the 1973/74 data were not selected in a random fashion. Therefore considerable care must be exercised in generalizing the sample results to population.

It should be obvious that the purpose of fitting the pooled regression model involving period dummies is to test the null hypothesis that there is no temporal effect on the estimated coefficients [35, p. 221]. With the expansion of the degrees of freedom, one would be able to place more confidence in testing whether there is need for fitting two separate regressions for the two distinct periods of observations. If the regression coefficient of one or more variables containing period dummies are statistically significant, then the two separate regressions are mandatory for testing the estimates of coefficients in each specific period.

From that single (pooled) model with period dummies, if one is only interested in getting the regression coefficient estimates, the respective particular period model can be derived as follows:

For period I (1968/69),

$$Y_i = b_0X_0 + b_2X_{1i} + b_4X_{2i} + b_6X_{3i} + b_8X_{4i} + U_i$$

For period II (1973/74),

$$Y_i = (b_0 + b_1) + (b_2 + b_3)X_{1i} + (b_4 + b_5)X_{2i} + (b_6 + b_7)X_{3i} + (b_8 + b_9)X_{4i} + U_i$$

In addition to the possible separate period regression analyses just described, two similar models for evaluating the relationship of changes of the same variables between the two periods will also be tested. Two measures of change in the values of variables between the two periods are employed: (i) the absolute difference and (ii) the relative (percentage) change, and the corresponding regressions will be developed.

It should be apparent that important policy implications might be derived from the results of such regression analysis. As was mentioned before, Kuznets [38, pp. 1-28] hypothesized that income inequality tends to decline as economic development proceeds. Using a linear regression model, Aigner and Heins [5, pp. 175-184] provided further evidence in support of Kuznets' hypothesis that the personal income of a region tends to be more equally shared, the more maturely developed is the region.

2. <u>The assumptions</u>

In order to estimate the actual contribution of variation by each independent variable to the variation in the dependent variable, as would be given by b_i parameters, several basic assumptions are necessary about how the observations have been generated. The simplest set of crucial assumptions is:[1]

$E\ (u) = 0$ . . . . (5a)

$E\ (uu') = \sigma^2\ I_n$ . . . . . . (5b)

X is a set of fixed numbers . (5c)

X has rank $k < n$ . . . . (5d)

Assumption (5a) says that $E(U_i) = 0$ for all i. This means that each random variable, including each unspecified nonrandom variable, is assumed to have zero mean.

Assumption (5b) in matrix form is really a double assumption. First, it implies that $E(U_i^{\ 2}) = \sigma^2$ for all i, which means that each U_i has the same variance and, hence, the term homoscedasticity for this condition. Second, for any pair of U_iU_j, where $i \neq j$, $E(U_iU_j) = 0$ or, what amounts to the same, $Cov\ (U_iU_u) = 0$. This means that the random disturbance terms U_i and U_j are not correlated.

Assumption (5c) means that any specified X_i is not a random variable, It is fixed, in some sense, by the inherent characteristics of the units of observations.

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[1]See, for example, Johnston [35, pp. 107-108].

Assumption (5d) says that the number of parameters to be estimated (k) must be less than the number of observations (n). It also implies that no exact (complete) linear relations exist between any of the X_i variables. This assumption is needed if one expects to have only one set of solutions for the k parameters.

C. Analyses of Regression Results

The linear regression models specified in the previous section were estimated by the least-squares method. Computations were achieved by the use of an IBM 370 version of SPSS multiple regression subprogram. The first model with period dummies attempts to explain the causal contribution of village-to-village variation in some explanatory variables to the variation in farm income inequalities, based on the data from sixteen combined sample villages of the two periods. From this model, the null hypothesis of no temporal effect is analyzed and, if the need arises, two separate period regression estimates will also be presented.

In the second and third regression models, attempts are made to evaluate the impacts of temporal changes in spatial differences of the specified variables. Respectively, the absolute and the relative changes in income inequalities from 1968/1969 to 1973/1974 are related to similar changes in the explanatory variables. Hopefully, the resulting estimates from these two regressions should support the observed trends as shown by estimates from the first regression model.

1. Interpretation of regression results

Table 6.4 presents the result of fitting the first regression model which involves period dummy variables. Considering the significantly high coefficient of multiple determination (R^2), it appears that the specified explanatory variables can "explain" much of the spatial variation in income inequalities. However, statistical F-tests show that only three explanatory variables are significant, namely, X_1, DX_2 and DX_4.

Since two of these significant variables contained period dummies, it follows that the null hypothesis of no temporal effect is rejected and separate estimates of each period regression must be made available.

Table 6.5 presents the estimates of 1968/1969 and 1973/1974 regression coefficients, together with the two sets of regression coefficients estimated by fitting the absolute and relative changes of the same variables between the two periods of observation. In three out of four regressions, including the one fitted on the absolute temporal changes of the variables, the mean (log) farm income (X_1) is the only explanatory variable which has a significant impact on the farm income inequality. In each of the regressions, this particular coefficient has a negative sign, which leads to the conclusion that the decline in income inequality was closely associated with the increase in the mean farm income. In other words, the more equal farm income distribution, both across villages and through time occurred at the same time that mean farm income was increasing. This conclusion supports the Kuznets hypothesis stated previously that income inequality tends to decline as economic development, measured in terms of net income, proceeds.

Table 6.4. Estimated regression coefficients of some mean and relative variance variables on paddy farm income inequalities, by combining data from 1968/1969 and 1973/1974, 240 paddy farms, 8 villages, Central Java[a]

Explanatory variables	Symbol	Regression coefficient	F-ratio	Significant level[b]
1. Constant term	X_0	+ 4.58130		
2. Period dummy	D	+ 0.33511	0.096	ns
3. Mean logarithms of farm income	X_1	- 1.13105	31.707	**
4. Interaction	DX_1	+ 0.15763	0.345	ns
5. Relative variance of expenditure on seed, fertilizers and pesticides	X_2	+ 0.42519	5.602	ns
6. Interaction	DX_2	- 0.60078	9.373	*
7. Mean expenditure on seed, fertilizers and pesticides	X_3	+ 0.03508	3.115	ns
8. Interaction	DX_3	+ 0.00973	0.155	ns
9. Mean man-days of pre-harvest total labor use	X_4	+ 0.42415	1.126	ns
10. Interaction	DX_4	- 1.76084	6.258	*

Coefficient of multiple determination, R^2 = 0.95854

F-ratio = 15.41170**

Number of cases = 16

[a]The dependent variable is the standard deviation of the logarithms of the farm incomes.

[b]** = significant at 1 percent level, * = significant at 5 percent level, ns = nonsignificant at the above levels.

Although all coefficients of the relative variance of expenditure on purchased inputs (X_2) are not significant statistically, some useful impressions may still be derived. As it appears, the coefficient has a positive sign at the base period (1968/1969), which became negative for the second period (1973/1974). Its temporal growth as was fitted in each of the last two regressions also has a negative coefficient which means that, as time progressed, the more than proportionate increased use of the inputs by the high income farmers was associated with a decline in farm income inequality across villages.[1]

The same line of analysis may be applied for both the mean expenditure on purchased inputs (X_3) and the mean man-days of pre-harvest labor (X_4). A very high correlation (0.95416) was found between X_3 and X_4 in 1973/1974, as shown in the correlation matrix presented in Appendix Table A.27. This may cause a suspected high multicollinearity (interaction) between these two variables and, hence, the doubtful nature of the positive sign for X_3 coefficient in that period. Nevertheless, based on the results of regressions of temporal changes between the two periods, it appears that the mean expenditure on purchased inputs (X_3) had the expected negative sign, but none of the coefficients were significant.

As discussed previously in Section A.2 of this chapter, the influence of a change in mean level of input on income inequality would depend on its relationship with the relative variance of input use. Data in Table 6.1 suggested that there was a positive relation between

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[1]For a possible explanation, see Section B.3, Chapter II.

Table 6.5. Results of the regressions of farm income inequality on selected causal variables, 8 villages, Central Java[a]

Regression equation[c]	No. of cases	Regression coefficients and their calculated F-ratios[b] X_1	X_2	X_3	X_4	X_0	R^2	Regression F-ratio
1. 1968/1969	8	- 1.13105 (34.227)**	+ 0.42519 (6.048)	+ 0.03508 (3.362)	+ 0.42415 (1.216)	+ 4.58130	0.95645	16.47182**[d] (4,3, df)
2. 1973/1974	8	- 0.97342 (27.898)*	- 0.17559 (4.603)	- 0.04481 (8.720)	- 1.33669 (4.957)	+ 4.91640	0.96014	18.06426* (4,3, df)
3. Absolute change 1968/69 - 1973/74	8	- 0.80030 (7.750)*	- 0.14744 (0.604)	- 0.02439 (2.026)	-	- 0.45505	0.86858	8.81207*[e] (3,4, df)
4. Relative change 1968/69 - 1973/74	8	- 8.34009 (5.166)	- 0.04348 (0.014)	- 0.01623 (0.001)	-	- 0.86270	0.79664	5.22333 (3,4, df)

[a]The dependent variable in all the four regressions is the standard deviation of the logarithms of the farm incomes.

[b]X_1 = mean logarithms of farm income, X_2 = relative variance of expenditure on seed, fertilizers and pesticides, X_3 = mean expenditure on seed, fertilizers and pesticides, X_4 = mean man-days of pre-harvest total labor use, X_0 = constant term. Figures in parentheses are calculated F-ratios.

[c]Equation No. 1 and No. 2 are 4-variable regressions; equations No. 3 and No. 4 are 3-variable regressions.

[d]** = significant at 1 percent level.

[e]* = significant at 5 percent level.

the mean and the relative variance of input expenditure. Hence, the negative sign of X_3 coefficient conforms with what has been expected. Similar conclusions might be applicable for the mean man-days of pre-harvest labor (X_4), when its temporal changes were fitted in the regression together with the other variables already specified.[1]

The conclusions would be more convincing, if we observe the trends in data presented in Table 6.6. Apparently, there were negative relationships between both the distributional rates of increase in adopters of

Table 6.6. Group-wise rates of increase in farm income, number of all HYV adopters and expenditures on seed, fertilizers and pesticides from 1968/1969 to 1973/1974, 240 paddy farms, 8 villages, Central Java[a]

Farm income group	Rates of increase (%) from 1968/69 to 1973/74		
	Farm income[b]	Number of adopters[c]	Expenditure on purchased inputs
Bottom 20%	279	77	50
Bottom 40%	176	138	32
Top 40%	97	229	144
Top 20%	99	144	181

[a]The absolute figures in each of the respective period are found in Appendix Table A.30. Incomes and expenditures in 1973/1974 were made comparable to those in 1968/1969 by using, respectively, paddy and corresponding input prices as deflators. See Table A.19 for details about deflators used.

[b]Defined as the sum of net return from paddy cropping, value of house garden products and other farm products.

[c]Including only adopters of all HYV, planted on all plots of their irrigated fields.

[1]Actually, the two regression runs were attempted with those four variables, and each of the X_4 coefficients had a negative sign, but the F-ratios were far too small to be significant.

HYV and expenditure on purchased inputs with the distributional change in income received. Data in Table 6.3 provided evidence that in 1973/1974 significantly more labor input was needed for growing HYV, compared to the same for traditional varieties. Thus, the increase in number of HYV adopters could also be interpreted as the need for more labor use.

Evidently, much higher rates of increase in purchased input use, together with higher rates of increase in the number of HYV adopters, implying higher rates of increase in labor use, were achieved by the higher income group. And yet, at the same period of time, higher rates of income growth were experienced by the lower income group, as compared to the higher income group.

2. Some hypothetical explanations

These seemingly inconsistent empirical relationships might be explained by hypotheses,[1] that (i) the aggregate production function had the shape of intense diminishing returns,[2] (ii) higher income farmers were operating close to the intensive margin while, in contrast, lower income farmers were operating near the extensive margin of production, (iii) higher income farmers received relatively higher prices for their products and paid relatively lower prices for inputs, when compared to

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[1]The theoretical bases for these hypotheses are found in Section Section B.3.b., Chapter II.

[2]The term "diminishing returns" here is used in terms of partial relationships with respect to each specified input. It has nothing to do with "returns to scale" in which all inputs changed simultaneously. See Section B.3.b, Chapter II.

lower income farmers. In short, the input-output price ratio is decreasing with size, and (iv) combination of these hypotheses. Attempts will be made to explore these hypothetical explanations. The assumption here is that farm income is closely related to paddy yield and farm size, as measured by the acreage of operated field, which is empirically shown by data in Table 6.7.

The first hypothesis about the nature of production relationships appears most crucial since any other functional shape, except that of diminishing returns, would yield different effects from what was actually found. For testing purposes, the results of fitting relevant data to a Cobb-Douglas model of production function are presented in Table 6.8.

Clearly, the Cobb-Douglas model fits very well with the available data in both periods. Each of the regression coefficients is a fraction of unity and has a positive sign. All coefficients, except X_3 in the first period, are significant at 1 percent level. If operated paddy field (X_1) is fixed at certain levels, it appears that particular input-output relationships would take the shape of diminishing returns.

The second hypothesis is, obviously, another way of saying that the change in relative variance of any input should be sufficiently large to permit discernible impacts on income distribution. In fact, the relative variances of any inputs became significantly larger in the second period (1973/74), as data from Tables 6.1 and 6.2 have shown.

Empirical data to test the third hypothesis are presented in Tables 6.9 and 6.10, respectively, for the paddy price received and the wage paid per man-day for hired labor.

Table 6.7. Per-farm averages of farm income received, paddy yield and acreage of operated field, based on quintile groups of farm income, 240 farms, 8 villages, Central Java[a]

Quintile group (%) of farm income	Farm income received (Rp)[b]		Paddy yield (Qt)[c]		Operated field (Ha)[d]	
	1968/69	1973/74	1968/69	1973/74	1968/69	1973/74
Bottom 20%	2,610	9,895	21.8	25.8	0.748	0.701
Second 20%	8,844	21,694	24.1	28.9	0.815	0.813
Third 20%	17,039	33,914	29.9	43.6	1.014	1.161
Fourth 20%	29,432	56,711	48.0	65.1	1.740	1.520
Top 20%	87,716	174,308	102.8	237.7	3.043	4.723

[a]Incomes in 1973/74 were made comparable to those in 1968/69 by using paddy prices as deflators.

[b]Defined as the sum of net return from paddy cropping, value of house garden products and other farm products.

[c]Village-dry stalk paddy gross yield less the amount for harvest share.

[d]Total operated net paddy field in a year, i.e., wet and dry seasons.

Table 6.8. Estimated Cobb-Douglas production functions, 1968/1969 and 1973/1974, 240 paddy farms, 8 villages, Central Java[a]

Regression equation	No. of cases	Regression coefficient[b] $\ln X_1$	$\ln X_2$	$\ln X_3$	$\ln X_0$	R^2	F-ratio
1968/1969	240	+ 0.64313 (65.333)**	+ 0.27287 (71.507)**	+ 0.06900 (0.964)ns[d]	+ 0.61147	0.87852	568.889**[c] (3,236 df)
1973/1974	240	+ 0.53087 (59.008)**	+ 0.34070 (87.668)**	+ 0.19664 (11.265)**	- 0.51780	0.92308	944.054** (3,236 df)

[a]The dependent variable in the two regressions is the net paddy yield in quintals, i.e., the gross paddy yield less the amount given out as harvest share.

[b]X_1 = operated paddy field in hectares, X_2 = expenditures on seed, fertilizers and pesticides in rupiahs, X_3 = total pre-harvest labor use in man-days, X_0 = constant term. Figures in parentheses are calculated F-ratio.

[c]** = significant at the 1 percent level.

[d]ns = nonsignificant at 5 percent level. Simple correlations between any pairs of explanatory variables are presented in Appendix Tables A.31 and A.32.

From Table 6.9 it can be seen that in both periods paddy prices received by small farms appeared to be higher than those received by large farms. The difference was more pronounced in the second period. This tendency would seem to weaken the proposed hypothetical explanation mentioned above.

Admittedly, the empirical finding that large farms received lower paddy prices was rather unusual. Swenson [71, pp. 77-78] found in his study in Thanjavur District, India, that large farms received relatively higher prices for their paddy than small farms did. His explanation was straightforward in that large farmers managed to store their paddy for later sale and higher prices. In the present study of Central Java paddy farmers, the reversed trend in prices received was caused by the higher percentage of operated fields planted to local paddy varieties by small farmers, as can be seen from Table 6.9. It is common knowledge that the price of a local paddy variety is higher than that of the high yielding variety since, by local standards, there is a high preference for the eating quality of local (traditional) varieties compared to the high yielding varieties.

In the meantime, trends in average wage paid by various income groups of farmers, as shown in Table 6.10, tend to support the third hypothesis. In both periods of observation, lower income farmers paid higher wages for hired labor than higher income farmers.[1]

[1]Although it would be interesting to know what was the reason behind the differential wage rates, the tendency is considered as given for the present study. It might be hypothesized that traditional "patron-client" relations between landowners and landless laborers were still prevalent.

Table 6.9. Relation between farm size, area planted to local varieties and paddy price received, 1968/69 and 1973/74, 240 paddy farms, 8 villages, Central Java

Items	1968/69 farm size[a]		1973/74 farm size[a]	
	Small	Large	Small	Large
1. Average (Ha)	0.609	2.353	0.622	2.948
2. Number of cases	123	117	120	120
3. Percentage of farm size planted to local varieties[b]	71	50	36	15
4. Weighted average of paddy price (Rp/Qt)[c]	1351	1337	3248	3020
5. t-test of difference between prices received[d]	0.5453ns[d]		3.0175**[e]	

[a]Small-sized farms in both periods refer to those with total yearly harvested acreage of less than or equal to 1.0 hectare.

[b]Other paddy varieties planted were domestic and IRRI high yielding varieties (HYV). In 1968/69 most of HYV were of domestic origin, while in 1973/74 both IRRI and domestic HYV were planted, next to local (traditional) paddy varieties.

[c]Weighted average of nominal prices (<u>rupiahs</u> per quintals) received during particular years.

[d]ns = nonsignificant at 5 percent level.

[e]** = significant at 1 percent level.

If the tendency found in wage rates can be regarded as representing the general input price trend, input-output price ratios can be derived using the paddy prices found in Table 6.9. The calculated price ratios are presented in Table 6.11.

Apparently, high income farmers tended to face lower input-output price ratios, compared to those faced by low income farmers. This tendency should also support the third hypothesis explaining the fact

Table 6.10. Average wage per man-day paid by various income categories of farmers, 1968/69 and 1973/74, 240 farmers, 8 villages, Central Java

For income group	Average wage per man-day (Rp)[a] 1968/69	1973/74
Bottom 20%	81	144
Bottom 40%	85	148
Top 40%	60	114
Top 20%	58	108

[a]Weighted average of nominal wages paid during the year. It included also the estimated value of food given during the working hours.

Table 6.11. Input-output price ratios of the various income categories of farmers, 1968/69 and 1973/74, 8 villages, Central Java

Farm income group	Input-output price ratio[a] 1968/69	1973/74
Bottom 20%	0.065	0.047
Bottom 40%	0.066	0.047
Top 40%	0.043	0.038
Top 20%	0.043	0.038

[a]Average wage paid divided by average paddy price of the respective farm income groups.

that nonproportionate increases in input use by high income farmers had resulted in a more equal income distribution.

It appears that most hypotheses forwarded can help explain the empirical relationship that income inequality dropped, as a result of more than proportionate use of input by larger farms. Combined together, the particular relational trend can be explained by the existing production function showing diminishing returns with respect to each specified input and relatively lower input prices paid by larger farmers, which also led to lower input-output price ratio faced by the same.

In general, the result of analyses by regression method suggests some encouraging conclusions. Even though the facts indicate more than proportionate increases in the use of inputs by higher income farmers, the evidence remains that income distribution has improved. Essentially, this means that one should be more careful in interpreting the income impact of the observed empirical fact that higher income farmers applied more than proportionate increases in production inputs.

For a long term policy implication this phenomenon should not be taken as an ideal condition, since the hypothesis implies that only in a special production relationship and a certain range of price ratios would inequality in income drop, as higher income farmers manage to have a more than proportionate increase in input use. To ensure better chances for a more equal income distribution over time, lower income farmers should be encouraged to increase their application of the new inputs proportionately more than the higher income farmers. In this way, almost any shapes of aggregate production function relationship would yield an impact toward a more equal income distribution over time (see Section B.3.b, Chapter II).

Examples of policy measures to induce low income farmers to apply more than proportionate increase in purchased input use are as follows: (1) new inputs should be made accessible at low cost close to the farmers. In places where private distribution of the inputs is not remunerative, state agencies (PERTANI, see Section B, Chapter I) should take over the responsibility. (2) Small farmers should be encouraged to build local associations which could tie individual farmers into a wider service organization. (3) Credit should be provided at lower interest rates to small farmers who proved themselves capable of using it productively.

D. Possible Limitation on the Use of Regression Results

Because of the limited number of observations used for estimating the regression equation and the possible existence of multicollinearity problems between specified variables, some discussion on limitation on the use of regression results is in order.

As mentioned before, a measure of distributional inequality always refers to a certain group of individuals. In the present context, the most appropriate grouping was by the eight sample villages. Any other classification yielding more than eight groups would seem to invalidate one or more of the assumptions needed for least-squares method of estimation. It should be apparent that this would involve the division of a village's sample farmers into subgroups, whose characteristics would most likely be interdependent. On the other hand, the eight observations available for a regression estimation would severely limit the number of degrees of freedom for statistical testing and the number of variables included in the model.

With only three or four variables specified in the regression model, some important explanatory variables might be left out. So long as the omitted variable is uncorrelated with any of the specified variables, it would not have any influence on the estimated coefficients. In reality, this is not likely to hold and a certain degree of positive correlation may be expected. The result will be a tendency to overestimate one or more of the regression coefficients [31, pp. 214-215]. However, the R^2 of the regression equations were fairly high and statistically significant, which indicates that a large proportion in the variation of spatial income inequality (Y) could be explained by the combined variations of the included variables. This should mean that upward biases in the estimated coefficients due to the omission of some explanatory variables, if any, were negligible.

The second problem concerning multicollinearity, i.e., high correlation between two or more of the independent variables, is considered more serious. Since simple correlation coefficients between any two explanatory variables may serve as indicators of the possible presence of multicollinearity, it becomes necessary to calculate and examine all these coefficients for the sample data [31, p. 136]. Tables A.26, A. 27, A.28 and A.29 in Appendix A present the simple correlation coefficients between the independent variables.

Empirically, the suspicion that high correlations existed between income variable (X_1) and input variables (X_3 and X_4) found no support, as the highest estimated correlation was only 0.50959, namely, between X_1 and X_3 for the fourth regression equation (see Table A.29). Only one correlation coefficient turned out to be very high, i.e., between the means of purchased inputs (X_3) and the means of labor input (X_4), which is 0.95416 in the second regression (see Table A.27). This may cause indeterminacy of the estimates [35, p. 206], as already discussed in the analyses of the results.

But when labor input (X_4) was not included, as in the third and fourth regression (see Table 6.5), the respective estimated coefficients of X_3 variable were judged as logical, although they were not significant statistically. The X_3 coefficients showed negative signs, which mean that income inequality would drop as labor use is increased. This tendency is consistent with the empirical fact.

Further, since farm income is assumed to be functionally related to inputs and expenditure on those inputs is also functionally related to the previous income, there might be some unaccounted influence of the cumulative effects between these two variables over time. This would be true for the first and second regressions in Table 6.5 which, probably, also contributed some upward biases to the estimated coefficients. By fitting the third and fourth regressions on the changes of these variables from 1968/1969 to 1973/1974, this particular problem of cumulative effects was avoided and more accurate estimates may be expected.

It should be noted that the regression analyses presented in the previous section did not deal explicitly with errors of observation and measurement, i.e., the disturbance term (u) in general. If satisfactory estimates are to be expected, the relevant assumption is that all types of error, bunched together in the disturbance term, should be normally and independently distributed with zero expectations [35, p. 156]. If one of the requirements on the errors of observation and measurement is not met, for example, if there is a dependence between errors of measurement and the observed value of an explanatory variable, the least-squares estimates would be biased and inconsistent [35, p. 149]. In the present thesis, this problem has been anticipated by special efforts to minimize such nonsampling errors, for instance by employing experienced enumerators and preparing clearly defined questionnaires.

VII. TRENDS IN RELATIVE ECONOMIC EFFICIENCY

The previous chapter attempted to explain the causal relationship between inequalities in income distribution and specified explanatory variables. In a regression framework the interspatial and intertemporal variations in income inequalities were correlated to the same variations in averages and relative variances of specified causal variables. In general, based on the assumption of production with decreasing returns to each specified input, the results of the regression analysis could reasonably explain the existing causal relationships which, after the five years period, had led to a more equal income distribution.

However, some interesting questions remained as to (i) whether the general over-time increase in farm (net) income had been achieved through a relatively more efficient operation, (ii) whether there was a differential growth in the efficiency of farm operations between lower-income (or smaller-sized) farms and higher-income (or larger-sized) farms over time, (iii) whether HYV growers were more efficient operators than traditional variety growers, and (iv) whether tenants tended to have lower efficiency levels than owner-operators. The last two questions are considered important since tenants and traditional variety growers were mostly found among low income (or small size) farms, as may be seen from Tables 4.10 and 5.7 respectively.

By using the concept of relative economic efficiency,[1] this chapter attempts to explain the differences in farm income received by various groups of farmers, both within and between periods, with respect to their

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[1] The relationships are expressed in terms of absolute prices.

relative success in maximizing profit given the observed prices and the distribution of fixed factor endowments. By ascertaining the absolute size of incomes and the corresponding relative efficiency levels of the various groups of farmers, one may expect to set priorities on policy measures aiming at the dual development goals of increasing income and improved income distribution. Since marginal returns on the fixed factors can be derived from the measurement of relative economic efficiency, certain policy implications based on their comparison within and between the respective farm groups may also be suggested.

A. Relevance of the Concept

Based on the details described in Section B.4, Chapter II, the concept of relative economic efficiency may be summarized as follows. Specifically, the concept deals with the comparison of net incomes that result from different combinations of a certain set of variable and fixed inputs, within the range of observed farm-specific prices and uncertainties faced by the farmers. In an actual condition, these profits may be considered as the consequence of maximizing production goals, be it the net farm income and/or satisfaction or something else, within the constraints of prices, measurable and nonmeasurable fixed inputs and uncertainties.

In the framework of profit maximization, the concept means that some personal weighting factor must be incorporated with the (farm-specific) prices used for marginal equation. This should help explain why different farms succeed in varying degrees in maximizing profits, i.e., in equating the value of marginal product of each variable input to its price [79, p. 269]. At the same time, different exogenous factors like endowments in fixed inputs and prices paid and received, also contribute to the differential combinations of inputs used in production and, hence, the differential actual (maximized) profits.

Those endogenous factors (e.g., uncertainties faced, personal decision rules, etc.) and exogeneous factors are reflected as independent variables in the profit function model, which is used to derive the relative economic efficiency concept. Its general model will be presented in the next section. In this connection, the following statement by Yotopoulos, Lau and Somel [80, p. 55] is relevant and revealing:

> A conclusive test of economic efficiency should, therefore, include two parts. First, given different regimes of prices of the variable factors of production and of quantities of fixed factors of production, it should determine if firms behave according to a decision rule such as profit maximization. Second, if and only if, a decision rule appears to be generally applicable, then the question arises whether a set of firms is more economically efficient than another because it is more successful in responding to the set of prices it faces (price efficiency) and/or because it has higher quantities of (non-measurable)[1] fixed factors of production, including entrepreneur ip (i.e., it is technically more efficient).

B. The General Model

Following the foregoing reasoning, a general model of profit function to estimate levels of relative economic efficiency will have to include the price received for output, prices of variable inputs and quantities of fixed inputs used in the production. An example of deriving a profit function from a Cobb-Douglas production function was presented in Section B.4, Chapter II. Due to lack of some of the necessary data, the

[1]The term in parentheses is lacking in the original quotation, and is added here for the sake of clarity.

empirical model will only involve the output (paddy) price received, the wage paid to labor as the only variable input, and capital and the operated field as the two fixed inputs used in production. Since the net return from paddy cropping in 1968/69 and 1973/74 made up, respectively, 79 percent and 92 percent of the total net farm income, the measure of relative economic efficiency may be regarded as representing the efficiency level of the paddy farm as a whole.

1. Specification of the included variables

The model implies that the dependent variable is profit. Specifically, it is the difference between the estimated gross value of paddy output and all the variable costs involved in producing that output, including labor, seed, fertilizers and pesticides costs.[1] With regard to income definitions given in Chapter V, it is equal to the farm family income from paddy less the imputed value of family and own labor. In terms of the residual method of farm income determination [78, pp. 55-56], it may be called returns to land, capital and management.

To make the 1973/74 observations on income and expenditure comparable in real terms with the 1968/69 observations, various deflators presented in Appendix Table A.19 were used.

A weighted average price received for paddy sales by each farmer in a particular year was taken as the price of output for the relevant year. The price of labor was determined from the actual wage paid to the preharvest hired labor, including estimates of value of any additional

[1]The fixed cost is irrelevant in this case, since the concept of relative economic efficiency deals basically with short-run maximization problems (see derivation in Section B.4, Chapter II, this thesis).

amount given out as food. Family and own labor were imputed the same price as hired labor. Since, on the average, the respective family and own labor in 1968/69 and 1973/74 amounted to only 9.8 percent and 10.2 percent out of the total labor used, the imputation should result in negligible errors.

Farm capital was measured as values of the total depreciation rates based on the replacement costs of agricultural tools, work animals, barns, bins, and so on. The underlying assumption is that these depreciation rates should proportionately represent the corresponding capital stock values of each farm. Land was defined as the total operated irrigated field within a particular year, i.e., the sum of operated fields in two seasons, and measured in hectares. Capital and land are treated as fixed factors of production in the short run because of both the nature of paddy production process and institutional reasons [39, p. 103].

It should be noted that if data on prices of other variable inputs and quantities of other fixed inputs were available, they should also be included as independent variables in the profit function. To the extent that these data varied only across villages, their effects could be captured by providing village dummy variables. An alternative rationalization is that those excluded variables were employed in fixed proportions to output [39, footnote 25]. Otherwise they would be assumed as randomly distributed throughout the observations.

2. The profit function model

With the specification of basic variables described above, the general statistical model may then be formulated. As was shown in the derivation of the basic model in Chapter II, the differences in technical efficiency and in price efficiency, or in a combined terminology: the relative economic efficiency, were built into the estimating equation right from the start. This makes it possible to systematically relax some of the most constraining assumptions underlying the pure competition case [14, p. 23].

Starting from a Cobb-Douglas production function, the index of relative economic efficiency can be incorporated in the derived profit function model and presented as the coefficient of a dummy variable, which differentiates the two relevant groupings of farms. For empirical analysis, the estimating model equation is given as follows:

$$\ln \pi = a_0 + c\,E + b_1 \ln P + b_2 \ln W + b_3 \ln K + b_4 \ln T + \sum_{i=1} d_i V_i + U \qquad (6.1)$$

in which the measurements of all variables refer to yearly per farm situations, and where:

π = I - C, or the profit (net income) from paddy cropping,

I = value of paddy output, actually received or imputed,

C = L + X, or the total variable cost,

L = total pre-harvest labor wages, actually paid or imputed,

X = other variable costs, consisting of seed, fertilizers and pesticides expenditures,

P = I/NY, or the average price of paddy received,

NY = paddy net physical output, after harvest shares were given out to the harvesters,

W = L/M, or the average man-day wage (price) of labor,

M = total pre-harvest man-days of labor, including family and farmer's own labor,

$K = \sum_{j=1} \frac{k_j}{t_j}$, or the linear depreciation rate of capital,

k_j = replacement cost of the j-th fixed (capital) input,

t_j = years of age when the j-th fixed input becomes economically obsolete,

T = total hectares of paddy cropping area,

V_i = dummy variable for the i-th village, where particular farms are situated, to capture unspecified variations across villages. It is given the value of one for all villages under consideration except the last, and zero elsewhere including the last,

U = disturbance terms,

E = efficiency dummy variable, given the value of one for farms belonging to the group having a specified characteristics (for example, <u>large</u> farms) and zero for the rest which do not have that characteristic (thus, <u>small</u> farms, following the example above). For further possibilities see text below.

3. <u>The relative measure of economic efficiency</u>

By way of anti-logarithmic operations, the exact relationship in equation 6.1 above can be rewritten as:

$$\pi = (\text{anti-ln } a_0)(\text{anti-ln } c)^E \, P^{b_1} \, W^{b_2} \, K^{b_3} \, T^{b_4}$$

$$(\text{anti-ln } d_1)^{V_1} \ldots (\text{anti-ln } d_i)^{V_i} \qquad (6.2)$$

Based on the theoretical derivation of the relative economic efficiency concept presented in Chapter II,

$$\text{anti-ln } c = A_2^*/A_1^* \qquad (6.3)$$

where A_2^* and A_1^* correspond to the respective indices of economic efficiency of farms (groups) 2 and 1.

It should be remembered that A_2^* contains A_2 and K_2 which are, respectively, the technical efficiency and the price efficiency levels of farm group 2. Similarly, A_1^* contains A_1 and k_1 of farm group 1.[1] However, in the profit function model derived from a Cobb-Douglas production as presented above, the specific levels of A_2^* and A_1^* cannot be separately identified. As was shown in equation 6.3, A_2^* and A_1^* indices were combined in the form of a ratio, and expressed as coefficient c of the dummy variable E in equation 6.1. Obviously, this will result in the impossibility to determine separately the difference in technical efficiency, i.e., between A_2 and A_1, and the difference in price efficiency, i.e., between k_2 and k_1 [39, p. 103].

As such, anti-ln c reflects the relative nature of economic rationality which must be judged within the specific technical and price framework of each farm group to be compared. It also assumes implicitly that rationality may be imperfect and varied, i.e., that the inequalities $k_1 \neq k_2 \neq 1$ hold [79, p. 271]. Therefore, a farm group with higher actual profits resulting from relatively larger quantities of measurable

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[1]The derivations were found in p. 59, Chapter II, of this thesis. See also Yotopoulos [79, p. 271].

fixed inputs used and more favorable input-output prices, may be relatively less economically efficient than the farm group with lower actual profits given less quantities of the fixed inputs and less favorable input-output prices.

Thus, regardless of the amounts of actual profits, if coefficient c of the dummy variable E is not significantly different from zero, the two farm groups are said to have the same relative economic efficiency. If coefficient c is significantly different from zero, the sign of the coefficient will tell whether farm group 1 is relatively more or less economically efficient than farm group 2, regardless of the sizes of actual profits (net incomes). In this case, if c is positive, the farm group given the value of one for the dummy variable E is relatively more efficient. On the other hand, if c is negative, that particular farm group is relatively less efficient.

If it is desired to test the difference in any two relative economic efficiency indices, the following statistical t-test could be used [77]. The null hypothesis is that the two indices are equal, so that the difference between them is zero.

$$t = \frac{c_1 - c_2}{\sqrt{s_w}} \tag{6.4}$$

where:

c_1 = relative economic efficiency index of the first two farm groupings,

c_2 = relative economic efficiency index of the second two farm groupings,

$$s_w^2 = \frac{(n_1 - k_1)\, s_1^2 + (n_2 - k_2)\, s_2^2}{(n_1 - k_1) + (n_2 - k_2)} ,$$

s_1^2 = variance of estimated c_1,

$(n_1 - k_1)$ = degrees of freedom for the first regression residual to estimate c_1,

k_1 = number of variables used in the first regression, including the dependent variable,

n_1 = number of cases used in the first regression.

C. Test of Relative Economic Efficiency

As was mentioned in Chapter V the average net return from paddy in the survey area had increased in real terms from Rp 24,047 in 1968/69 to Rp 54,718 in 1973/74. The increase was accompanied by a more equal income distribution among paddy farms. From the standpoint of farm management as well as policy making, it would be of interest to investigate (i) whether the income increase had been achieved through more economically efficient farms, (ii) whether small-sized farms had become more economically efficient than large-sized farms after the five years period, (iii) whether owner-operators tend to be more efficient than tenants, and (iv) whether HYV growers are more efficient than traditional variety growers.

This knowledge should be of help in deciding whether there are opportunities for improving the farms' efficiency, notwithstanding the observed favorable trends in income distribution. At least it would indicate whether the existing input combination, given current prices, might be improved to yield more profit under the prevailing technology.

1. Inter-period comparison of all farm samples

By fitting the necessary variables of all farm samples of both periods into equation 6.1, and assigning the value of ones to the efficiency dummy variable E for farms in 1973/74 and zeros for those in 1968/69, one could estimate the inter-temporal relative economic efficiency between the base year (1968/69) and the end year (1973/74). The resulting coefficients of regression, estimated through the least-squares method, are presented in Table 7.1.

Considering that 44 percent of the variation in the dependent variable could be explained by variations in the independent variables, as shown by R^2 estimate, it appears that the model fits fairly well with the data. The F-value indicates that the hypothesis stating all coefficients other than a_0 are zero should be rejected. The coefficient of the wage rate (b_2) is negative, while those of the paddy price (b_1) and paddy cropping area (b_4) are positive, which are in accord with the underlying assumption that the profit function is decreasing in b_2 and increasing in b_1 and b_4.

The negative coefficient of capital service flow (b_3) is rather difficult to explain. It might be that in the real world depreciation rates were not based on replacement costs of fixed capital as specified for the test. Since the coefficient is not statistically significant, the negative sign is also of doubtful nature.

The statistically significant c coefficient indicates that the null hypothesis of equal economic efficiency between paddy farms in 1968/69 and 1973/74 should be rejected. In comparative static terms, the negative sign of the coefficient suggests that 1968/69 farms tended to be more

Table 7.1. Estimates of coefficients from a Cobb-Douglas profit function based on combined 480 sample farms, 1968/69 and 1973/74, 8 villages, Central Java[a]

Explanatory variables	Parameter	Regression coefficients[b]	
1. Constant (intercept) term	a_0	-11.61973	
2. Efficiency dummy variable	c	- 2.22578**[c]	(0.4648)
3. Price of paddy	b_1	+ 3.23330**	(0.5203)
4. Wage rate per man-day	b_2	- 0.65014	(0.3436)
5. Depreciation rate of capital	b_3	- 0.03670	(0.0603)
6. Hectares of cropping area	b_4	+ 1.36575**	(0.0994)
7. Dummy variable for village 1	d_1	- 1.23143**	(0.3562)
8. Dummy variable for village 2	d_2	+ 1.01956*[d]	(0.4009)
9. Dummy variable for village 3	d_3	+ 0.81194*	(0.3459)
10. Dummy variable for village 4	d_4	+ 0.41681	(0.3919)
11. Dummy variable for village 5	d_5	+ 0.85132**	(0.3151)
12. Dummy variable for village 6	d_6	+ 0.89767*	(0.3467)
13. Dummy variable for village 7	d_7	+ 0.15689	(0.3088)

Coefficient of multiple determination, R^2	=	0.44061
F-ratio	=	30.65320**
Number of cases	=	480

[a]For details on the estimating model, see Section B.2 of this chapter (equation 6.1).

[b]Figures in parentheses are estimated standard errors.

[c]** = significant at the 1 percent level.

[d]* = significant at the 5 percent level.

economically efficient than 1973/74 farms, at all observed paddy prices and given the distribution of the paddy cropping areas. Note, however, that the average actual profit in 1973/74 was higher than that in 1968/69.

Given the empirical finding that paddy farms in 1973/74 were less efficient than those in 1968/69, it might be useful to look into the rates of return on the fixed inputs in each period. Based on the relationship demonstrated by Binswanger [14, pp. 12-13] that partial derivatives of a normalized (i.e., in relative prices) profit function with respect to the fixed inputs are equal to their marginal products, the following relationships in terms of absolute prices will also hold:

$$\frac{P \cdot \partial Y}{\partial K} = \frac{\partial \pi}{\partial K} \text{ and } \frac{P \cdot \partial Y}{\partial T} = \frac{\partial \pi}{\partial T} \qquad (6.5)$$

With these relationships one can, respectively, estimate the shadow prices (opportunity costs) of both capital and land from the profit function as follows:[1]

$$\frac{\partial \pi}{\partial K} = b_3 \cdot \frac{\pi}{K} \text{ and } \frac{\partial \pi}{\partial T} = b_4 \cdot \frac{\pi}{T} \qquad (6.6)$$

The estimates of the respective rates of return, computed at their geometric means, are reported in Table 7.2.

By comparing data from Table 7.2, it appears that the rate of return on fixed capital was larger in 1968/69, while that on land was larger in 1973/74. Apparently, if the estimate of the rate of return on fixed capital were reliable, the actual use of it in paddy farming would

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[1]The relationships are expressed in terms of absolute prices.

Table 7.2. Comparison of the rates of return on capital and land, 1968/69 and 1973/74 paddy farms, 8 villages, Central Java

Items	1968/69 farms	1973/74 farms
Geometric means:		
Profit ($\bar{\pi}$), rupiahs	8,396.75	16,604.02
Depreciation rate ($\bar{K}$), rupiahs	484.06	707.97
Cropping area ($\bar{T}$), hectares	1.05	1.14
Rates of return:		
$\frac{\partial \pi}{\partial K}$, rupiahs per rupiah	-0.64	-0.86
$\frac{\partial \pi}{\partial T}$, rupiahs per rupiah	10,921.77	19,892.05

involve a very large opportunity cost to the farmer.[1] Since the adoption of the HYV technology does not in general require new fixed capital, this tendency would reflect the low rate of return on traditional capital as asserted by Schultz [60, pp. 83-89], which also means that the cost of its maintenance is relatively high.

By contrast, it appears that the current use of cropping areas for paddy growing had implied relatively low opportunity cost. In other words, based on the available alternatives, the land had been put into a comparably high use.[2]

[1]The minimum rate of interest for private deposits (savings) in commercial banks was 24 percent per year in that particular period.

[2]For practical reasons, the current best alternative use is to rent it out for Rp 23,000, - per hectare per year.

2. Inter-period comparison of farm size groupings

In the previous subsection an attempt to test the null hypothesis of no inter-temporal change in economic efficiency was presented. Its general purpose was to study whether the higher average profit realized at the end period was achieved through a more efficient farm operation. The test showed that on the average there was a significant efficiency difference in favor of paddy farms in 1968/69 as compared to those in 1973/74. Of course, this does not necessarily mean that, in distributional terms, small farms had the same tendency of inter-temporal change in efficiency as large farms.

In the present subsection, an evaluation of the distributional change in efficiency between small and large farms will be attempted. The result would indicate whether the tendency of a more equal income distribution at the end period had been accomplished together with a more efficient paddy farming by small farmers. If this is true, it would be a better condition for achieving the dual objectives of increasing income and improving its distribution. If not, attention should be given to the possibility of improving the economic efficiency of small farms.

In order to assess the inter-temporal changes in economic efficiency within small and large farm groupings, the combined total farm sample of both periods was divided into five analytic classes. The class limits were arbitrarily made with a view of having five groups about equal in number, within both the combined and the two separate periods sample. Table 7.3 provides the result of grouping the sample into five analytic classes based on the size of operated paddy field.

The results of least-squares method of estimation by analytic classes are presented in Table 7.4. As in the previous analysis, each efficiency dummy variable E is given the value of one for paddy farms in 1973/74 and zero otherwise. In general, the estimated coefficients indicate that farm size has important relationships with (i) the intercepts a_0, (ii) the relative change in economic efficiency, as represented by the c coefficients, and (iii) the influence of paddy price received, as demonstrated by the b_1 coefficients.

Table 7.3. Farm operator sample by analytic size groupings

Analytic class	Class marks (hectares)	Number of cases in 1968/69 sample	1973/74 sample	Combined sample
1	≥ 2.100	44	52	96
2	1.285 - 2.099	48	49	97
3	0.850 - 1.284	49	46	95
4	0.560 - 0.849	47	48	95
5	< 0.560	52	45	97
	Total number of cases	240	240	480

As expected, the smaller fixed inputs used by small farms generally had resulted in lower profits, in contrast to the large farms where larger fixed input endowments had made possible the higher profits. The fifth analytic group of farms, i.e., the smallest-sized farms, had an intercept value of -18.0088, while the first group, i.e., the largest-sized farms, had an intercept term of -1.1481.

Table 7.4. Estimates of coefficients from Cobb-Douglas profit functions by analytic farm size groupings, 1968/69 and 1973/74 data combined, 8 villages, Central Java[a]

Analytic size class[c]	Estimated regression coefficients[b]						
	a_0	c	b_1	b_2	b_3	b_4	R^2
1 (83)	- 1.1481	- 0.7571 (0.4192)	+ 1.3617**[d] (0.4798)	+ 0.1132 (0.3430)	+ 0.0367 (0.0720)	+ 0.7995** (0.1706)	0.4853**
2 (84)	- 4.3089	- 0.9980*[e] (0.4011)	+ 1.6662** (0.4398)	+ 0.2509 (0.3003)	+ 0.0218 (0.0397)	+ 1.5570** (0.4920)	0.4884**
3 (82)	-13.3670	- 2.5483* (0.9773)	+ 3.8875** (1.1380)	- 1.2994 (0.7557)	- 0.1037 (0.1650)	+ 1.0524 (1.6507)	0.3706**
4 (82)	-33.8764	- 5.0698** (1.9099)	+ 6.4462** (2.1711)	- 1.1846 (1.2434)	- 0.0584 (0.2305)	- 0.2975 (2.1413)	0.4961**
5 (84)	-18.0088	- 2.9368 (1.5233)	+ 3.8203* (1.6702)	- 0.1174 (0.8447)	+ 0.0861 (0.1932)	+ 1.6992* (0.6498)	0.1788

[a]See Section B.2. for the general estimating model (equation 6.1).

[b]For details on the parameters, see Table 7.1. Figures in parentheses are estimated standard errors. To save space, coefficients of dummy variables for the 7 villages are not presented.

[c]Parentheses contain number of degrees of freedom.

[d]** = significant at the 1 percent level.

[e]* = significant at the 5 percent level.

The negative signs of all c coefficients indicate that all analytic size classes of farms in 1973/74 had relatively lower economic efficiency, when compared to those respective farm classes in 1968/69. Furthermore, the smaller the size of farms, the larger the inter-temporal difference in economic efficiency had become, as can be observed from the values of the c coefficients. The first analytic class of farms had experienced a non-significant relative decrease of 0.7571 units in economic efficiency through time, while those in the fourth analytic class (i.e., the smaller farms) had an inter-temporal significant decrease of 5.0698 units.

Table 7.5. Test of equal c coefficients between i-th and j-th analytic classes[a]

i-th class	j-th class			
	2	3	4	5
1	- 0.2409	- 1.7912	- 4.3127	- 2.1797
2		- 1.5503	- 4.0718	- 1.9388
3			- 2.5215	- 0.3885
4				+ 2.1330

[a]Equation 6.4 was employed for conducting the two-tailed tests. A negative sign of the difference indicates that the c coefficient from the i-th class is greater than that of the j-th class, a positive sign indicates otherwise.

Table 7.5 presents result of the tests conducted to determine whether the estimates of c for each analytic class are statistically different from the others. Clearly, except for the two differences all the other differences of the c coefficients are significant.

This means that, at the end period, the empirical evidence of a more equal income distribution had been accompanied by a faster decrease in relative economic efficiency by small farms. Thus, almost tautologically, paddy farm income distribution could still be improved by inducing small farms to combine inputs more effectively.

It should be noted that the analytical model does not allow for a conclusion that small farms were less efficient than large farms. It should be clear that no mention was made of the relative efficiency between small and large farms within each period. It could be that small farms were more efficient at the base period (1968/69), and still were but at a lesser degree, at the end period (1973/74).

Another finding which deserves attention is the important role of paddy prices received by different classes of farm size. Clearly, all b_1 coefficients from Table 7.4 are significantly positive and increasing, as farm size becomes smaller. Assuming that prices received are the same for all farms, this means that one unit increase in price received by smaller farms will contribute more profit than that received by larger farms. The following example would make this point clear.

If other specified variables are held at certain fixed levels, the partial contribution of paddy price to profit may be estimated by the following relation:

$$\ln \pi = \ln Q + b_1 \ln p,$$

where ln Q is the fixed levels of other specified variables. If $\ln p = 1$, the paddy price contribution to $\ln \pi$ is b_1 <u>rupiahs</u>, holding other variables constant. In original number, this means that the partial contribution of p = e to profit π will be equal to e^{b_1}, where e is the natural number 2.71828. In a similar way, if p increases to e^2, π will increase to e^{2b_1}, and so on.

In such a framework, the fact that small farms received higher paddy prices compared to those received by large farms in 1973/74 (see Table 6.9) would improve the equality of income distribution. It could not be over-emphasized that the negative impact on income distribution of relatively less efficient small farms, was partly neutralized by the positive impact of paddy prices they received. In this case, it is helpful to remember that relative increases in profit, and not the absolute increases, will affect income distribution.

The rest of the coefficients, i.e., b_2, b_3 and b_4 coefficients, did not show any consistent trends either in their signs or their contributions to profits of the respective farm size classes. Hence, not much can be said regarding their specific role with respect to farm size.

3. <u>Intra-period comparison of owner-operators versus tenant farmers</u>

A combination of high uncertainties and lack of incentives have been cited as the main reason for the relatively slower response to new inputs by tenant farmers.[1] Since most tenant farmers have smaller size of farms compared to those of owner-operators (see Table 4.10), it is of interest to study the possible impact, if any, of their theoretical production behavior just mentioned on the farm income distribution.

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[1]See, for example, Gittinger [29, pp. 255-259] and Timmons [74, pp. 91-94].

The 1968/69 paddy farm sample consisted of 145 owner-operators and 95 tenants, including fixed-renters, share-croppers, and part owner-part tenants. For practical reason, in this study tenants are defined as paddy farm operators who (i) rented in all the operated crop lands from others on a fixed rent basis, (ii) share-cropped all the operated lands based on various sharing arrangements, and (iii) operated partly owned and partly rented in or share-cropped lands from others. Some reduction in the number of tenants had occurred in the second period. The 1973/74 sample consisted of 186 owner-operators and 54 tenants.

By assigning the value of ones to the efficiency dummy variable E of owner operators, and zeroes to those of tenants, the results of least-squares fitting of the relevant data may be seen from Table 7.6.

The estimated coefficients of multiple determination (R^2) in both periods are more than 40 percent, which means that that much of the profit variations in the respective periods could be explained by variations in the included explanatory variables. Except for the capital depreciation rate (b_3), the rest of the estimated coefficients have the expected signs, i.e., positive signs for b_1 and b_4, and a negative sign for b_2. The negative sign for b_3 is of doubtful nature, which is also not significant statistically. Tentatively, this is probably because of observational and specification errors.

Based on the inter-period significant increase of b_1 coefficient, it may be concluded that paddy prices relatively had contributed most to the higher average income (profit) received at the end period. This confirms the similar trend observed in the previous subsection. Wage

Table 7.6. Estimated coefficients from Cobb-Douglas profit functions to test the relative economic efficiency between owner-operators and tenants, 1968/69 and 1973/74, 8 villages, Central Java[a]

Explanatory variables	Parameter	Regression coefficients[b] 1968/69	1973/74	Difference[c]
1. Constant term	a_0	- 1.22148	-20.52285	
2. Efficiency dummy	c	- 0.73767**[d] (0.2563)	- 0.01303 (0.2256)	- 0.72464 (1.4748)
3. Paddy price	b_1	+ 1.96455 (1.4532)	+ 3.85683** (0.7953)	- 1.89228*[e] (1.7484)
4. Wage rate	b_2	- 0.73347 (0.8065)	- 0.34323 (0.4141)	- 0.39024 (0.4874)
5. Depreciation rate of capital	b_3	- 0.03440 (0.0841)	- 0.03710 (0.0877)	- 0.00270 (0.0092)
6. Cropping area	b_4	+ 1.42069** (0.1650)	+ 1.32222** (0.1227)	+ 0.09847 (0.2582)
R - coefficient		0.44962	0.46124	
F-ratio		15.45352**	16.19457**	
Degrees of freedom		227	227	

[a]For details of the model used, see equation 6.1, Section B.2.

[b]In order to save space, estimated coefficients of the 7 villages dummy variables are not presented. Figures in parentheses are standard errors.

[c]Two-tailed t-tests are conducted by using equation 6.4. Figures in parentheses are calculated t-values. A positive sign means that the 1968/69 coefficient is greater than that of the 1973/74, a negative sign means otherwise.

[d]** = significant at the 1 percent level.

[e]* = significant at the 5 percent level.

rates and capital never seemed to contribute significantly to the size of profit in those periods, while cropping areas tended to be relatively of less influence on profit in the second period.

As the estimated c coefficient in 1968/69 is significantly negative, this means that owner-operators were less economically efficient producers than tenant farmers in that particular period. Knowing that tenants were slower in the adoption of new inputs, this observed tendency at the time when IRRI high yielding varieties had just been introduced, is in general agreement with Schultz' theoretical assertion [60, p. 30].

Although the c coefficient is still negative in 1973/74, it is not significantly different from zero, which implies that owner-operators were as economically efficient as tenant farmers. Probably, this particular tendency of equal economic efficiency could be explained as follows. After five years, owner-operators had gained more experience in achieving better input allocation and, hence, increased their economic efficiency. Over the same time span, increasing numbers of tenants had begun adopting the new techniques, with a consequence of some reduction in their economic efficiency. This is understandable, since they were shifting from the old production technique and stepping into a relatively new method of production, which entailed the trial and error stage.

Referring back to the role of paddy prices received by farmers, the previous inter-period analysis had found that paddy price had relatively larger contribution to the small farms' profit. Now, if tenants could be identified with small farmers (see Table 4.10), its reduced number in the second period would render the significantly greater b_1 coefficient in 1973/74 to have less impact on improving the income distribution.

4. Intra-period comparison of HYV versus traditional variety growers

In 1968/69, a year after the introduction of IRRI high yielding varieties (IR 8 and IR 5), no sample farm was found growing 100 percent (pure) IRRI varieties on all plots of its land. A few farmers (23 percent) began to plant it together with the traditional (local) and national improved varieties. Only 19 percent of the farms were growing only national improved varieties (i.e., domestic HYV) such as Sigadis, Dewi Tara, etc. Quite a large proportion (42 percent) of the farms were still growing only local varieties in all of their plots.

After five years, in 1973/74, the pattern of adoption had changed significantly in favor of the HYV. More than 15 percent of the farms were then growing only IRRI varieties, while 39 percent were growing only improved national varieties like Dewi Ratih and Pelita I, etc., thus making a total of 54 percent farmers growing HYV on all plots of their lands. Only 24 percent of the farms were then growing only local varieties.

With this kind of an adoption framework, and following the reasoning in the previous subsection on the "trial and error" stage, a hypothesis could be proposed that local variety growers were relatively more efficient than HYV growers, at least in the base year. It suggests that the null hypothesis of equal relative economic efficiency between local variety and HYV growers should be tested within each separate period of observation. For this purpose the sample in each period will be divided into two groups: (i) paddy farms growing only high yielding varieties (HYV) including the mix between IRRI and domestic HYV, and (ii) the rest, consisting of paddy farms growing local varieties, including those with some mixtures of HYV planted on parts of their lands. The respective number of cases for the first group in 1968/69 and 1973/74 were, respectively, 63 and 165.

These two characteristics will serve as a base for assigning the value of ones to the efficiency dummy variable E belonging to paddy farms growing only HYV, and zeroes to those of paddy farms growing mainly local varieties. By fitting the values of the efficiency dummy and other relevant variables to the regression equation 6.1, one would be able to test the null hypothesis of equal relative economic efficiency. The least-squares estimates of the regression coefficient are presented in Table 7.7.

The nonsignificant c coefficient in 1968/69 indicates that HYV growers had the same economic efficiency as local variety growers. After five years, the c coefficient became significantly different from zero and had a positive value. This means that in 1973/74, HYV growers had even become more efficient when compared to local variety growers. Both tendencies reject the hypothesis that local variety growers were more efficient, which expects the c coefficients to have negative signs and be significant statistically.

A tentative explanation on the observed tendencies may run as follows. The currently introduced HYV technology was not too complicated for most farmers to comprehend and not too costly to adopt [15, p. 19],

Table 7.7. Estimated coefficients from Cobb-Douglas profit functions to test the relative economic efficiency between HYV growers and local variety growers, 1968/69 and 1973/74, 8 villages, Central Java[a]

Explanatory variables	Parameter	Regression coefficients[b] 1968/69	1973/74
1. Constant term	a_0	+ 0.32303	-21.32277
2. Efficiency dummy	c	+ 0.02067 (0.3536)	+ 1.04583 (0.3270)
3. Paddy price	b_1	+ 1.74303 (1.4790)	+ 3.97960 (0.7781)
4. Wage rate	b_2	- 0.82775 (0.8204)	- 0.37384 (0.4048)
5. Depreciation rate of capital	b_3	- 0.03477 (0.0858)	- 0.04968 (0.0856)
6. Cropping area	b_4	+ 1.46667 (0.1756)	+ 1.31370 (0.1193)
R^2 coefficient		0.42954	0.48447
F-ratio		14.24354	17.77671
Degrees of freedom		227	227

[a]See footnote Table 7.6.

[b]See footnote Table 7.6.

especially with government subsidies on most of the inputs. Once adoption is underway, it is easy for farmers to adjust for mistakes. Presumably, in a relatively short time HYV growers had become adept in their production. It would then be possible for them in no time to arrive at an efficiency level comparable to that of the local variety growers at 1968/69.

Since the HYV technology, given comparable fixed inputs and current prices, is generally more profitable than the traditional one, it would be possible for HYV growers to be more economically efficient than local variety growers. This was probably happening in 1973/74, as was shown by the significantly positive c coefficient.

As in the previous subsection, the contribution of paddy price to profit generation is worth mentioning, especially if the relationship presented in Table 7.8 were true, where pure local variety growers tended to have the smallest average size of farms, i.e., 0.801 and 0.702 hectares respectively in 1968/69 and 1973/74, in comparison to the size classes of HYV growers, which had more than 1.00 hectare in each period. Based on the relationship of paddy price and profit generation, as shown in Table 7.4, the decreased number of local variety growers in 1973/74 would mean a reduction of the paddy price impact to even out income distribution as mentioned previously.

Table 7.8. Relation between average cropping areas and types of exclusive variety growers, 8 villages, Central Java

Exclusive variety growers	Average cropping area (hectares)[a]	
	1968/69	1973/74
1. Local/traditional	0.801 (100)	0.702 (60)
2. National improved (Domestic HYV)	1.441 (45)	1.064 (93)
3. IRRI - HYV	-	1.218 (37)

[a]These are geometric means, and, as such, the values are appropriate only for comparison purposes. Figures in parentheses are number of cases.

D. Impact of HYV on the Relative Economic Efficiency Between Farm Sizes

Many controversial arguments have been written about the beneficiaries of the HYV technology in the developing countries.[1] It would seem, however, that the question is best resolved by empirical findings. As farm lands are the basis of most of the inequalities in farm output, income and adoption of new technology,[2] it would be interesting to study the impact of the HYV introduction on the relative economic efficiency of small and large farms.

More specifically, this section attempts to analyze whether the HYV adoption had a differing impact between small and large farms in terms of their economic efficiency, a short time after its adoption (1968/69) and five years after that (1973/1974). By constructing pure variety growers groups from the paddy farms sample in each period of observation, one could study the impact by ascertaining whether there were differential economic efficiencies between small and large farms in each group. Implicitly, the purpose of this study is to identify whether relative economic efficiency is a factor influencing paddy farm income distribution.

The null hypothesis of equal relative economic efficiency in each pure variety grouping will be tested by fitting the relevant data to equation 6.1. For practical reasons, the small farm group was defined to

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[1]See, for instance, Wharton [77, pp. 464-476], Brown [15], Falcon [20, pp. 704-708] and Franke [23, pp. 41-47].

[2]See relevant studies by Sajogyo [58, pp. 14-15 and p. 33], Frankel [22], Schluter and Mellor [59, pp. 15-16].

be paddy farms with less than or equal to 1.0 hectare of cropping area per year. The remaining farms with greater than 1.0 hectare of cropping area belonged to the large farm group. As usual, values of ones were assigned to the dummy efficiency variable of the large farms and zeroes otherwise. The results of least-squares estimation for each pure variety group in each period are presented in Tables 7.9 and 7.11.

1. Base period comparison

The relevant groupings of pure variety growers in the base period (1968/69) were (i) local/traditional variety growers, consisting of 100 paddy farms, out of which 34 belonged to the large farms category, and (ii) domestic HYV growers, which is composed of 45 paddy farms, 28 of which belonged to the large farms group. Pure IRRI variety growers did not exist yet in that period. The estimated coefficients are found in Table 7.9.

As expected, the c coefficient of local variety growers was not significantly different from zero, which means that the corresponding small and large farms had the same economic efficiency. This tendency would seem to support the following hypothesis of Schultz [60, p. 37]:

> There are comparatively few significant inefficiencies in the allocation of the factors of production in traditional agriculture.

On the other hand, the c coefficient of domestic HYV growers was significant and had a positive sign, which means that the corresponding large farms had higher relative economic efficiency than the small farms. A tentative explanation to this tendency is that large farms were more successful in combining the new inputs together with the HYV, while the small farms presumably were still at a learning stage.

Obviously, the tendency on relative economic efficiency with respect to domestic HYV growers would lead to a less equal income distribution, if it persisted long enough. As Schluter and Mellor put it [59, p. 3]:

> ...if adoption ceases to be closely related to farm size only when almost all farms have adopted the new varieties, income differential resulting from the new varieties will persist longest in areas where the overall rate of adoption is slowest.

Table 7.9. Estimates of coefficients from Cobb-Douglas profit functions by pure variety grouping of farms, 1968/69, 8 villages, Central Java[a]

		Regression coefficients[b]	
Explanatory variables	Parameters	Local variety growers	Domestic HYV growers
1. Constant term	a_0	- 0.46939	- 33.46956
2. Efficiency dummy	c	+ 0.25124 (0.5662)	+ 4.72460 (1.3956)
3. Paddy price	b_1	+ 1.68613 (1.8106)	+ 5.87721 (7.6492)
4. Wage rate	b_2	- 0.63512 (1.2140)	- 0.13084 (2.8322)
5. Depreciation rate of capital	b_3	+ 0.00523 (0.1081)	- 0.14889 (0.2403)
6. Cropping area	b_4	+ 1.15893 (0.4101)	- 0.21461 (1.0009)
R^2 coefficient		0.41545	0.56378
F-ratio		5.15262	5.81596
Degrees of freedom		87	36

[a]See footnote Table 7.6. Zero-one efficiency dummy pertains to small and large farms.

[b]See footnote Table 7.6.

All the other coefficients of local variety growers had the expected signs, but only that of cropping area was significant. One gets the impression that the estimates reflect the equilibrium nature of the underlying production relationships. Comparatively speaking, the signs of b_3 and b_4 coefficients in domestic HYV regression estimates seem to reflect the disequilibrium nature of the corresponding production relations.

This contrasting situation between local variety and domestic HYV growers could also be demonstrated by the estimated geometric mean values of the included variables, as can be observed from Table 7.10. Clearly for the domestic HYV growers, the mean profit was lower, the wage rate paid was higher, paddy price received was lower and capital depreciation rate was higher, when compared to those corresponding values of the variables belonging to the local variety growers. If domestic HYV is to be a more profitable technology, those discrepant values should change in a short time.

Table 7.10. Comparison of geometric mean values of the included variables from the estimating profit function, 8 villages, Central Java 1968/69

Variables[b]	Geometric mean values[a]	
	Local variety growers (100 farms)	Domestic HYV growers (45 farms)
1. Profit	7395.	5056.
2. Wage rate/man-day	74.	88.
3. Paddy price/quintal	1358.	1219.
4. Cropping area (Ha)	0.801	1.441
5. Capital depreciation rate	359.	608.

[a]These are appropriate only for comparison purposes.

[b]Except for cropping area, all included variables were measured in current *rupiah* values, where U.S. $1.00 = Rp 41,500.

2. End period comparison

At the end period (1973/74) another relevant pure grouping in addition to the two existing groups, became possible. It was the pure IRRI varieties growers, consisting of 37 farms, which were mostly (28 farms) found in only one sample village, i.e., Sokaraja (village No. 6). The number of local/traditional variety growers had decreased from 100 to 60 farms, while that of domestic HYV growers had increased from 45 to 93 farms. The results of the least-squares estimation for each group are presented in Table 7.11.

Table 7.11. Estimates of coefficients from Cobb-Douglas profit functions by pure variety grouping of farms, 1973/74, 8 villages, Central Java[a]

Explanatory variables	Parameter	Regression coefficients[b] Local variety growers	Domestic HYV growers	IRRI-HYV growers
1. Constant term	a_0	-68.17824	- 8.03203	+ 0.27170
2. Efficiency dummy	c	+ 1.32732 (0.8145)	+ 0.06649 (0.4294)	- 0.56674 (0.6921)
3. Paddy price	b_1	+ 9.21850 (3.2733)	+ 2.64921 (0.9913)	+ 0.84896 (3.1081)
4. Wage rate	b_2	- 0.17883 (1.6526)	- 0.68852 (0.5062)	+ 0.95543 (0.6537)
5. Depreciation rate of capital	b_3	+ 0.25566 (0.1946)	- 0.07785 (0.1420)	- 0.13356 (0.1793)
6. Cropping area	b_4	+ 0.52457 (0.4819)	+ 1.19368 (0.2978)	+ 1.91761 (0.5973)
R^2 coefficient		0.44544	0.34749	0.84113
F-ratio		5.12070	4.36691	15.88343
Degrees of freedom		51	82	27

[a]See footnotes Tables 7.6 and 7.9.
[b]See footnote Table 7.6.

In general, after a period of five years, it may be concluded that all c coefficients were not significantly different from zero, which means that differences in farm size for each class of pure variety growers did not significantly influence the efficiency levels. This empirical finding should throw more light upon the conclusion reached in Section C.2, this chapter, that small farms experienced more (faster) decline in relative efficiency over time compared to large farms. Based on the present result, it appeared that in the base period (1968/69) small farms had higher efficiency levels relative to large farms. The reported faster efficiency decline by small farms at the end period (1973/74) only resulted in equal relative economic efficiency between small and large farm groups.

Further, paddy price seemed to contribute most to profits of local variety and domestic HYV growers, while cropping areas appeared to have significant role in both types of HYV growers' profits. The rest of the estimated coefficients were either never significantly different from zero or had wrong signs and, as such, almost nothing could be said about their trends.

Since small and large farms do not show differences in efficiency levels in any varieties grown, this should mean that in 1973/74 farm sizes were no longer affecting the rates of HYV adoption. Thus, following Schluter and Mellor [59, p. 3], adoption ceased to be closely related to farm size after five years period or perhaps even less, which probably accounts for the minimal effect that HYV had on income distribution at the end period. This conclusion would lend support to the one arrived at from Table 5.8, Chapter V, which indicated that the differences of the various indices of income distribution between domestic HYV and local variety growers were inconsistent.

The geometric mean values of the included variables of the corresponding pure variety grower groups may be seen from Table 7.12. At a first glance, when one reads the figures from left to right, meaning from traditional to the most modern techniques of paddy production, the sequences of the values are mostly logical and reasonable. These tendencies, in contrast to those found before in Table 7.10 should give ample evidence that the last two HYV groups, i.e., the domestic HYV and the IRRI variety growers were already operating close to what may be called a temporary Schultzian equilibrium state [60, p. 30].

As data on Table 7.12 have clearly shown, the use of HYV technologies should be more profitable, if compared to those of local/traditional varieties. This is as it should be, if the new technology is introduced for adoption.

Wage rates were comparable for the first two groups, but appeared to be too low for the third group (IRRI-HYV). Actually, this was due to the prevailing lower wage rates in that particular village No. 6, from where 76 percent of the sample had come.

In many cases, local variety of rice is of a higher eating quality and, hence, its price is higher. With the passing of time this particular tendency might change.

A traditional farmer growing a local paddy variety is very much a risk-averter. Comparatively, his farm land is very limited. Since it is,

Table 7.12. Comparison of geometric mean values of the included variables from the estimating profit functions, 8 villages, Central Java, 1973/74

Variable[b]	Geometric mean values[a]		
	Local variety growers (60 farms)	Domestic HYV growers (93 farms)	IRRI-HYV growers (37 farms)
1. Profit	7,354	17,826	16,963
2. Wage rate/man-day	74	72	52
3. Paddy price/quintal	3,624	3,109	2,501
4. Cropping area (Ha)	0.702	1.064	1.218
5. Capital depreciation rate	949	710	329

[a]See footnote Table 7.6.

[b]See footnote Table 7.6. All values were deflated at 1968/69 prices.

in most cases, his only source of living, it is only logical that his risk-aversion tendency is very high. If he had a larger farm size, his risk bearing capacity would be greater and possibly he would adopt the HYV.

The largest farm land of the third group was accompanied by relatively the smallest capital depreciation rate. If for no other reason, this was probably caused by the fact that large farmers do not usually have high quality tools, which they would never use anyway. They prefer to hire laborers who, traditionally will bring along their needed tools wherever they go.

VIII. SUMMARY, CONCLUSION AND RECOMMENDATION

Increasing food production, especially rice, has become the focus of the first and second Five Year Development Plans of the Indonesian Government since 1968. In achieving the objective, the implementation has been based on (i) the success of BIMAS intensification programs, and (ii) the discovery of the fertilizer responsive high yielding varieties (HYV).

In order to sustain increases in domestic paddy production over time, the Five Year Development program has been directed at (1) increasing paddy farm incomes, and (2) insuring that the program's benefits are shared proportionately by all paddy farms, such that the current income distribution would, at least, be maintained or, if possible, be improved. These are the two sub-objectives, which serve as the means to achieve the main objective of increasing domestic rice supply. The present study considered these as the normative condition, upon which analytical comparisons were based.

In the context of real world situation, one could think of many causal factors that may affect the attainment of the two sub-objectives, either positively or negatively. Certain causal factors originated from BIMAS program implementation, directly and indirectly. Other causal factors stemmed from variabilities of inherent operational characteristics of the paddy farmers themselves.

The present study aims to evaluate the impact of the effort to increase paddy production by inducing paddy farmers to use HYV, in terms of growth and distributional consequences on paddy farm incomes between 1968 and 1974.

A. Summary of Study

The study begins with an introduction to the position of irrigated paddy farming in national and regional economies in general. Many programs to increase rice production, and subsequently also many resulting problems, existed in connection with the attempt to achieve self-sufficiency in rice domestic supply. Specifically, the main objective of study is to compare and evaluate the growth and distributional changes in incomes of paddy farmers in Central Java for the years 1968/69 and 1973/74, in terms of hypothesized causal factors and relative economic efficiency levels.

Identical kinds of data were collected from the same sample farms for the two periods of study. This provides for the "before and after" type of comparison and to test some causal relationships. Because of the unavailability of an appropriate sampling frame and the inadequacies of sampling procedures followed at the base period, some upward biases may have existed in farm sizes and operated (irrigated) fields of the sample paddy farms. Possibilities of such biases are emphasized in drawing inferences from the data.

Reviews of recent studies on farm income distribution, both in Indonesia and India, revealed the following results: (i) that farm household incomes tended to become less equally distributed over time in Java [36, 51], (ii) at constant prices, farm income distribution in India showed contrasting changes, depending upon the specific locational and environmental conditions [10, 45, 62, 64, 67], (iii) that farm income inequalities in India were affected by the rates of adoption of new technology which, in turn, were affected by farm sizes [27, 59, 62, 64], (iv) that farm incomes from all sources in Thanjavur District (India) were more equally distributed than net returns from paddy alone [71], (v) that in Aligarh District (India), the new input expenditures were negatively related to the farm income inequalities over time [64], (vi) that small farmers in India were more economically efficient than large farmers during the period of 1955-1957 [39], and (vii) that large farms in three Indian States (Tamil Nadu, Punjab and Uttar Pradesh) between 1955/57 and 1967/69 had gained economic efficiency more rapidly than small farms [17].

The present study proposed three general hypotheses as follows: (1) income distribution of paddy farmers in 1968/69 is the same as it was in 1973/74, (2) for any particular production year, the income relative variance of a group of paddy farmers is related to the relative variance and the means of new technological input expenditures, (3) high income paddy farmers experience the same over-time rate of growth of relative economic efficiency as do low income paddy farmers.

Three analytical tools are used in the present study to evaluate the change in income distribution and to test the corresponding hypotheses. The first method of analysis makes use of the group percentages distribution and summary measures or indices of income distribution, which are presented in tabular forms. By this simple analysis, various income distributions can be compared and evaluated, including causal relationships which are indicated when a certain element of income, or cost, is added to a previously defined income. This is the method by which hypothesis 1 is tested for defined income groupings.

The second method is a causal model cast in a regression framework, relating indices of income distribution of certain farm groupings as a dependent variable to explanatory variables consisting of relative variances and means of certain hypothesized causal factors. In contrast to the first method, the influences of other specified causal factors can be simultaneously taken into consideration. This is the method employed to test hypothesis 2 of the study.

The third analytical method is an exploration in the use of a recently developed concept of relative economic efficiency between any two groupings of farms. If, for example, the low income group is more economically efficient than the high income group, the first group is defined to be more successful (in money terms) in profit maximization, given comparable fixed inputs and the prevailing range of prices. This particular method is used for testing hypothesis 3. By this analysis, one can decide whether a certain income distribution could be made more equal by improving the economic efficiency of the low income group. If such improvement appears unlikely, more fundamental changes in the farming structure may be the only choice open for more equal distribution of incomes.

For the purpose of this study the survey area was selected from the adequately irrigated, major rice producing region of Central Java. This particular survey area was chosen from among seven provinces, known as the most important rice producing areas in Indonesia, based on the following criteria: (i) the area was relatively homogeneous with respect to other characteristics (variables) not of interest to the present study, and (ii) it has relatively larger variations in the included variables of interest. Eight villages were chosen by similar procedures used in selecting the province.

Thirty sample farms were selected at random per village, but not on equal probability bases. Originally in 1968/69, the Agro Economic Survey of Indonesia had selected these thirty paddy farms based on three strata: (1) five farms were picked from the ten reported largest farms in the village, (2) fifteen farms were selected from the BIMAS participant list in the village, and (3) ten farms were chosen from the non-BIMAS farm population in the village.

As mentioned before, some upward biases were found in the size of farm selected. The average farm size of the sample in 1974 was estimated to be 37 percent higher than that of the paddy farm population in the selected villages.

In practice, the differentiation between BIMAS and non-BIMAS sample farms was not relevant for the present study. With the passage of time, most farms in the selected villages had participated in one or more BIMAS programs. Hence, the original thirty sample farms per village were assumed as representing one and the same village population, and were interviewed in 1973/74 using the same questionnaire as in 1968/69.

As this study is concerned with inter-temporal changes of paddy farm incomes, supposedly caused by the increased adoption of HYV, an analysis of the trends in the levels of adoption by sample farmers was made. In

1968/69, only 20 percent of sample farmers had already used all new inputs (i.e., HYV seeds, fertilizers and pesticides combined), while in 1973/74 more than 60 percent were using the complete mix of new inputs. If only fertilizer use is considered, then 97 percent adoption rate was achieved (see Tables 4.2 and 4.3). This is the reason why Sajogyo [58, p. 13] suggested the term "fertilizer revolution," rather than the HYV or the green revolution.

After five years, some changes in operated farm sizes had occurred, which led to a worsening tendency of its distribution within most of the sample villages (see Table 4.6). The same trend was apparent for the operated irrigated fields of the sample farms. However, in contrast to the previous tendencies, the distribution of owned irrigated fields had exhibited a tendency to improve in five out of the eight sample villages. In only two out of the eight sample villages, that nonproportionate (but nonsignificant) decreases in owned irrigated fields by small farms, compared to nonproportionate increases by large farms, were apparent (see Table 4.8). Since irrigated fields are factors directly contribute to paddy yields and, hence, the major income source of paddy farmers, knowledge on their changes is useful in the analysis of income distribution.

B. Conclusion

Both the quintile group percentages and the indices of income distribution have shown that the increased farm incomes had become more equally distributed at the end period (see Tables 5.1 and 5.2). Within any particular period, the addition of nonpaddy sources of income (including nonfarm sources of income) had resulted in a more equal income distribution. In 1968/69, the respective Gini ratios of net returns from paddy, net farm returns and net returns from all sources were 0.638, 0.578 and 0.533. For 1973/74, the respective indices were 0.564, 0.540 and 0.495.

All inter-temporal shifts in the indices of income distribution were significant at 1 percent levels (see Table 5.2). However, it appears that the distribution of net returns from paddy experienced the greatest over-time decline (about 12 percent) between 1968/69 and 1973/74. This implies that distributional index differences between the sequential income definitions became relatively smaller after five years. In 1968/69 the index difference between the net returns from paddy and the net returns from all sources was 16.5 percent, while in 1973/74 it was 12.2 percent. Thus, it seems that the capacity of nonpaddy additional sources of income to even out income distribution in the second period was not as great as in the first period; nevertheless, the impact was still significant (see Table 5.2). In other words, it indicates that the distributional impact of the increasing net returns from paddy over time tends to be greater than that of the nonpaddy additional sources of income. Furthermore, this should mean that BIMAS programs had been successful in achieving the dual objectives of increasing farm incomes and improving their distribution.

Assuming that adoption of new technology may be represented by the level of expenditures on HYV seeds, fertilizers and pesticides, their subtraction from the value of net paddy yield had resulted in natural shifts of the indices of income distribution, i.e., no significant change was observed in the indices within any periods (see Table 5.3). Respectively, in 1968/69 and in 1973/74, only 4 percent and 1 percent non-significant changes in the coefficients of variation (CV) were observed.

The labor use impact on the distribution of income in 1968/69 was not neutral to size, i.e., the effect of labor cost on income distribution was of increasing net benefits with farm size. This means that the subtraction of labor cost from (gross) incomes had caused a worsening of farm income inequality as shown by the increase in the relevant index in 1968/69. However, the over-time rate of impact was decreasing (see Table 5.4). In 1968/69, the subtraction of pre-harvest labor cost from the value of net paddy yield less expenditures on purchased inputs,[1] had caused the latter CV index to increase significantly by 41 percent. In 1973/74, the particular increase was only 0.7 percent, which is non-significant. Apparently, the small farmers became more efficient users of pre-harvest labor over time, compared to large farmers. Further research is necessary to determine the causal nature of the observed tendency. However, the fact remained that, at the end period, the pre-harvest labor use impact on paddy farm income distribution became almost neutral to size.

[1]Which is defined as the farm family income from paddy cropping.

By grouping sample farms according to the existing two major soil types, i.e., (i) latosols and (ii) alluvials, it was found that at the base period paddy farms belonging to the first soil group had both a higher per-farm average net return from paddy and a higher income inequality, compared to those from the second soil group (see Tables 5.5 and 5.6). Apparently, these were mostly due to the larger average farm size and higher average productivity per hectare (see Appendix Table A.13), in addition to the possibility that farm sizes were more unevenly distributed in latosolic soils, compared to those in alluvial soils. With the increasing use of HYV during the five years period, however, paddy farms in alluvial soils had experienced relatively faster income growth (69 percent) when compared to that of paddy farms in latosolic soils (41 percent). At the same time, farm incomes in latosolic soils became more evenly distributed than those in alluvial soils. Thus, differences in soil types did not seem to interfere with the achievement of the twin goals of development, i.e., growth in incomes and more equal income distribution among farmers, through increasing the adoption of HYV.

The inequality and the average of net returns from paddy per farm belonging to the pure HYV growers tended to be higher than those of the traditional variety growers in any period, especially in 1973/74 (see Tables 5.7 and 5.8). In the five year period (1968/69 to 1973/74), net returns from HYV had a significant increase (at 1 percent probability level) of more than 100 percent, compared to only 34 percent non-significant increase (at 5 percent level) in the net returns from traditional varieties. Encouragingly, these income increases were accompanied by more equal distributions of the incomes for growers of both varieties (see Table 5.8).

When sample villages were divided into two groups according to their relative population densities, it appeared that paddy farms in more populated villages had experienced a slower growth in net returns from paddy, but with a more equal income distribution over time, as compared to those paddy farms in less populated villages (see Tables 5.9 and 5.10). The more populated villages had a Gini ratio of 0.696 in 1968/69, which dropped to 0.573 in 1973/74. The respective Gini ratios for the less populated villages were 0.546 and 0.548. This tendency supports Geertz' assertion that an involution process is likely to occur in more populated areas in Java [28, pp. 74-82].

The evaluation on the general impact of the existing tenure relations as a whole on income distribution revealed the fact that the increased inequality due to tenure relations had been reduced over time. As the analysis deals only with tenants as a whole, the separate impact of a specific tenant group (i.e., share or fixed rentals) on income distribution cannot be evaluated. The increases in the coefficients of variation due to tenure relations respectively, in 1968/69 and in 1973/74, were 30 percent and 4 percent (see Table 5.12).

By employing regression method, causal factors responsible for the change in income distribution were identified. It appeared that the increase in mean farm returns was the factor most associated with the decrease in income inequality, both between villages and through time.

Unfortunately, the contributions of purchased input use as well as pre-harvest labor use were not significantly different from zero at the 5 percent probability level (see Table 6.5). But, over time, both the relative variance and the mean of expenditure on purchased inputs were negatively related to income distribution, meaning that its increased use by higher income farmers tended to lead to a more equal income distribution. The following is an attempt to explain these trends.

Some suggested explanations on these seemingly unusual relationships are offered subsequently: (i) the aggregate production function with respect to each specified input had the shape of intense diminishing returns. Each specified input, holding the others constant, had a positive partial elasticity of production of less than unity; the largest of which was 0.64 (see Table 6.8); (ii) high income farmers were operating near the intensive margin while, in contrast, low income farmers were operating close to the extensive margin of production. The relative variances of the specified inputs were, respectively, 0.9 and 1.8, which may be considered fairly high (see Tables 6.1 and 6.2). This means that there were fairly large differences in the levels of input use by small versus large farmers in the survey area. (iii) High income farmers paid relatively lower prices for inputs, when compared to low income farmers. Respectively, in 1968/69 and in 1973/74, the top 40 percent of high income farmers paid average wage rates of Rp 60 and Rp 114 per man-day, while the bottom 40 percent of low income farmers paid Rp 85 and Rp 148 (see Table 6.10). Although there was a tendency that high income farmers received lower paddy prices compared to low income farmers,[1] the empirical ratios between nominal wage rates and paddy prices (see Table 6.11) would further explain the observed relationship resulting in a more equal income distribution. Respectively, in 1968/69 and in 1973/74, the top 40 percent of high income farmers faced ratios of 0.043 and 0.038, while the bottom 40 percent of low income farmers faced ratios of 0.066 and 0.047.[2]

In an attempt to analyze the change in income distribution which was due to differences in the response to price and the nonmeasurable fixed inputs, the concept of relative economic efficiency was employed. The purpose of analysis was to identify whether relative economic efficiency is a factor influencing paddy farm income distribution. The resulting conclusions are as follows. (i) Paddy farms in 1973/74 were less economically efficient than those in 1968/69 (see Table 7.1). On the whole, this was probably because of the disequilibrating impact of the increased HYV adoption among paddy farmers. (ii) Smaller farms had experienced the largest inter-temporal decrease in relative economic efficiency, if compared to larger farms, between 1968/69 and 1973/74 (see Table 7.4). A tentative explanation for this trend is that small farms tended to lag behind in adjusting their farm operation to HYV planting. (iii) In 1968/69, owner-operators were less economically efficient than tenants, while in 1973/74 both groups had the same levels of

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[1]The reason was that low income paddy farmers planted larger percentages of their fields to local (traditional) paddy varieties, compared to high income paddy farmers. It is well known that traditional paddy varieties command higher prices than HYV do (see Table 6.9).

[2]See, further, the conclusions derived from Table 6.11 on page 104.

efficiency (see Table 7.6). The probable reason for this trend is that owner-operators were among the first who took the risk of adopting HYV in 1968/69, and came to an equilibrium in 1973/74 after a trial and error stage within five years period. In the meantime, increasing number of tenants began adopting HYV, with the consequent decrease in their relative efficiency. (iv) In 1968/69, HYV growers had the same level of economic efficiency with local variety growers, suggesting that HYV technology was easily adoptable (see Table 7.7). By contrast, in 1973/74, HYV growers were more economically efficient than local variety growers, which indicates that the HYV technology was more profitable than that of local varieties, after five years of experience.

The question about who gets the benefit of the HYV technology was investigated with respect to differences in farm sizes, by using the concept of relative economic efficiency. For pure HYV growers, it was shown that, in the first period (1968/69) when the introduction of HYV technology had just begun, large farms tended to have higher economic efficiency than small farms (see Table 7.9). Apparently, being early adopters, large farms had managed to use more complete components of the HYV technology, compared to small farms. At the end period (1973/74), it appears that variation in the components of HYV technology being used was no longer related to farm size, and no significant difference in economic efficiency between large and small farms was observed (see Table 7.11). In other words, adoption ceased to be closely related to farm size within five years or less because all farms had reached about the same level of adoption of the HYV technology.

Furthermore, it appears that paddy prices contributed significantly to the incomes received by small farms (see Table 7.4). In such a framework, the fact that small farms received higher paddy prices because they produced relatively more local paddy varieties than large farms did (see Table 6.9), would improve the equality in income distribution. However, it should be noted that these higher prices were of temporary nature, since the number of local variety growers among them was decreasing over time. Thus, whatever paddy price structure will prevail in the future, and considering that small farmers tend to sell their paddy a short time after harvest when prices tend to be relatively low, a timely Government floor-price policy seems appropriate.

C. Suggestion for Further Research

As was mentioned in the characteristics of sample farms, upward biases had been found in the average values of certain variables in both periods. The use of the same original sample from the first period (1968/69) to collect data for the second period (1973/74) had some consequences that variables related to wealth and experience would be biased upward too, as the (original) sample became "older" with respect to age, capability and experience, when compared to the actual population parameters in 1973/74. In the present study, this was unavoidable since appropriate sampling frames were not available in the second period. For the sake of getting more reliable results, research on the over-time trend in income distribution should make use of a new sample for the second period observation.

In the attempt to specify causal factors influencing income distribution, it was obvious that the number of units of analysis, i.e., the eight sample villages, was very limited. Some of the hypothesized causal factors could not be analyzed probably due to lack of variation in the sample. If more complete and conclusive results were expected, further attempts in this kind of analysis should include more sample villages. Approximately 20 to 30 sample villages would be needed to provide enough variation for statistical testing purposes.

Results from individual village analyses, as compared to those from the survey area as a whole, revealed differences in the trends of income distribution (see Appendix Tables A.23, A.24 and A.25). The trend in income distribution over time in the survey area as a whole indicated a more equal share of the aggregate income (see Table 5.2). However, as can be observed from Appendix Table A.23, only four out of the eight sample villages showed significant decline in the distribution indices of net returns from paddy. The rest of the four sample villages either showed nonconsistent changes in the indices or nonsignificant decline in income inequality. These suggest that, in order to understand thoroughly the process of change in income distribution, care should be taken in formulating recommendations applying to larger areas. This means that sampling procedures should be carefully prepared, with provision for pre-stratification if necessary to take into account of the variations in the excluded (nonspecified) variables in the population to be studied.

D. Implications for Policy

The addition of nonpaddy sources of income, both from home gardens and nonfarm sources of income, had resulted in a more equal income distribution. It should be noted, however, that these nonpaddy sources of income were never regarded as the primary sources of income by those paddy farmers, even though the relative amounts may exceed the net returns from paddy earned by the lower income farmers. These trends suggest that policies should be developed to induce the expansion of nonpaddy sources of income, especially those of nonfarm activities, which serve as additionals to the net returns from paddy. Such policies may take the form of BIMAS-type programs for other farm enterprises (including home gardening) and/or suitable nonfarm employment creation in rural areas.

It was shown that while net returns from paddy had increased in the sample areas, which was mainly due to extension of HYV technology, they also became more evenly distributed over time. Although sample farms for this study were drawn from the most favorable areas for paddy growing, the observed trends indicate the possible direction of future change in less favorable paddy growing areas, following basic changes in production condition such as provision of adequate irrigation and an efficient distribution system.

Since increased expenditures for HYV seeds, fertilizers and pesticides can be identified with more use of new technology on paddy production, it is encouraging to know that the suspected negative effect of these expenditures on income distribution was not verified by the survey data. Thus, increasing adoption of HYV technology may be encouraged in order to achieve higher yields, without undue concern about its distributional impact, since the cost involved was found to be proportionate (or neutral) to size of farms. It should be noted that this analysis has nothing to do with efficiency levels.

The increased use of pre-harvest labor over time, presumably in connection with the more adoption of HYV, had a decreasing rate of impact on paddy farm income inequality. Between 1968/69 and 1973/74, an increase of 30 percent more labor use was accompanied by a drop in the impact on the income distributional index (the coefficient of variation, CV) from 41 to 0.7 percent. Hence, increasing adoption of HYV through BIMAS programs which involves the use of more labor should be induced, at the minimal risk that the increasing labor cost would contribute to a worsening of income distribution among paddy farmers.

The policy implication just mentioned is in the interest of paddy farmers alone, without considering what happened to the other groups of rural people. Especially for those who are affected directly by the introduction of HYV, like landless rural laborers, additional research is needed to assess the impact of HYV on their earnings.

From the viewpoint of input allocation, it was found that small paddy farms were less economically efficient than large farms, and the gap was increasing with size differences. This means that small farms were less successful in equating the marginal value product to its farm-specific price and/or they tended to have less managerial capability in paddy production, compared to large farms. With the emphasis on alleviating problems faced by the small farms, it appears that reducing uncertainties, improving input and output marketing system, and intensifying extension service are the appropriate programs that can be recommended.

It is commonly known that paddy prices tend to be the lowest at harvest time, in contrast to higher prices in the off season periods. Further, the present study indicates that paddy prices contributed significantly to the profits (net income) received by small farmers, more than those received by large farmers (see Table 7.4). Considering that small farmers are likely to sell their paddy yields within a short period after harvest, when low paddy prices are prevalent, the establishment of a farmers association like Village Unit Cooperatives is desirable. The association could provide credit to farmers in return of paddy consignments, which it will arrange for the sale at higher prices later on. In this case, the Government could help in guaranteeing higher prices by an appropriate floor-price policy.

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XI. APPENDIX A. SUPPLEMENTARY TABLES

Table A.1. Harvested areas of 7 most important crops and the percentage of irrigated paddy areas from total, Central Java, 1962-1972[a]

Year	Irrigated paddy		Corn	Cassava	Soy Bean	Peanut	Sweet potato	Upland paddy
	Ha	%	Ha	Ha	Ha	Ha	Ha	Ha
1962	1,119,891	42	825,235	371,955	125,000	87,830	87,705	50,479
1963	963,334	43	563,164	417,681	107,421	81,997	64,103	43,090
1964	995,626	37	941,372	408,371	126,591	70,925	130,520	48,437
1965	1,109,825	47	504,338	444,632	121,171	73,785	72,279	50,022
1966	1,127,462	39	969,026	401,536	144,608	96,942	63,380	62,558
1967	1,103,385	48	508,912	389,028	108,275	83,040	50,336	62,052
1968	1,208,584	46	694,079	369,284	126,248	91,063	63,035	69,226
1969	1,240,485	54	454,651	349,259	76,520	76,515	49,248	52,170
1970	1,204,817	47	690,729	321,844	152,889	84,198	47,740	54,492
1971	1,262,848	52	504,667	346,411	133,986	79,643	43,225	58,522
1972	1,230,948	53	418,745	357,150	121,725	83,585	44,974	52,737

[a]Source: [34, p. 109]. According to the Agricultural Census in 1963, peasant agriculture in Central Java occupied an area of 1,812,907 hectares, consisting of 820,502 hectares irrigated paddy lands and 992,405 hectares uplands (nonirrigated dry lands). 1 hectare = 2.47 acres.

Table A.2. Average productivities of seven most important crops Central Java, 1962-1972[a]

	Quintals per hectare						
Year	Wet paddy	Corn grains	tubers	Soybean	Peanut	Sweet potato tubers	Upland paddy
1962	30.6	10.4	68.6	5.2	6.8	52.2	18.4
1963	23.8	8.9	66.2	5.2	6.0	50.4	14.7
1964	26.9	10.2	66.8	6.5	6.5	40.0	15.8
1965	28.8	8.7	62.6	5.1	6.4	47.8	14.3
1966	29.5	9.2	60.3	4.7	5.9	45.8	16.0
1967	29.4	8.2	59.6	4.6	6.1	45.8	15.8
1968	30.7	8.0	57.7	4.4	6.4	45.8	15.8
1969	31.5	7.1	51.4	4.8	6.2	41.1	15.2
1970	32.3	7.7	53.7	5.2	6.6	39.5	18.8
1971	35.4	7.1	54.0	4.5	6.6	39.9	17.6
1972	36.1	7.8	50.1	4.8	6.0	40.5	24.5

[a]Source: [34, p. 111].

Table A.3. Number of farms and percentage distribution according to farm size, Central Java, 1963

Class of farm size[a] (hectare)	Number of farms	Percent
0.10 - 0.49	1,378,675	52.5
0.50 - 0.99	731,946	27.9
1.00 - 1.49	276,163	10.5
1.50 - 1.99	113,844	4.3
2.00 - 2.99	79,289	3.0
3.00 - 3.99	25,314	1.0
4.00 - 5.00	10,092	0.4
more than 5.00	8,020	0.3
Total[b]	2,623,343	100.0

[a]Farms with sizes under 0.1 Ha were excluded, but the number were known to be 805,863 [57, p. 6].

[b]The average farm size was 0.69 Ha.

Table A.4. BIMAS and INMAS paddy intensification area as percentage of total harvested area of irrigated paddy, Central Java, 1969-1972[a]

Year	Harvested area of irrigated paddy (hectare)	Percentage of harvested area in hectares under								
		BIMAS[b]			INMAS[c]			All programmes		
		Domestic HYV	IRRI HYV	All HYV	Domestic HYV	IRRI HYV	All HYV	Domestic HYV	IRRI HYV	All HYV
1969	1,240,485	24	6	30	10	2	12	34	8	42
1970	1,204,817	25	5	30	9	3	12	34	8	42
1971	1,262,848	27	7	34	12	5	17	39	12	51
1972	1,230,948	19	8	27	30	8	38	49	16	65

[a]Source: [37, pp. 38-67].

[b]Programmes with credit on new input package and intensive extension, including BIMAS by foreign companies (BIMAS gotong royong").

[c]Programmes with only cash purchase of new inputs, sometimes not in optimal combination.

Table A.5. BIMAS AND INMAS paddy intensification area as percentage of total harvested area of irrigated paddy, Indonesia, 1969-1972[a]

	Harvested area of irrigated paddy (hectare)	Percentage of harvested area in hectares under								
		BIMAS			INMAS			All programmes		
		Domestic HYV	IRRI HYV	All HYV	Domestic HYV	IRRI HYV	All HYV	Domestic HYV	IRRI HYV	All HYV
1969	6,544,000	14	6	20	11	2	13	25	8	33
1970	6,679,000	12	6	18	8	5	13	20	11	31
1971	6,783,000	12	8	20	14	7	21	26	15	41
1972	6,690,857[b]									

[a]Source: [37, pp. 38-67 and 68].
[b]Preliminary figure.

Table A.6. Weighted (by season) average of urea (N) fertilizer bought per hectare by farmers participating in paddy intensification programmes and percentage of program area affected, Central Java and Indonesia, 1969-1973[a]

	BIMAS[b]				INMAS	
	Central Java		All Indonesia		All Indonesia	
Year	Urea Kg/Ha	Program area covered (%)	Urea Kg/Ha	Program area covered (%)	Urea kg/Ha	Program area covered (%)
1969	22[c]	44	82[c]	45	114	34
1970	55	34	69	23	65	30
1971	102	100	117	100	75	25
1972	113	100	132	100	72	62
1973[d]	121	100	141	100	111	99

[a]Source: [37, pp. 196-204]. In general two kinds of fertilizer are recommended, i.e., nitrogenous and phosphatic. Urea (N) fertilizer expenses are more or less twice as much as the phosphatic fertilizer.

[b]Data for the years 1969 and 1970 do not include BIMAS by foreign companies ("BIMAS Gotong-Royong").

[c]Data for dry season 1969 only.

[d]Data for wet season 1972/73 only.

Table A.7. Quintals of yield per hectare of irrigated paddy under intensification programmes, Indonesia, 1969-1973[a]

Year	BIMAS Domestic HYV	BIMAS IRRI HYV	BIMAS Weighted average all HYV	INMAS Domestic HYV	INMAS IRRI HYV	INMAS Weighted average all HYV	Weighted average of all programmes, all HYV
1969	35.85	42.47	38.14	32.52	36.87	33.08	36.28
1970	40.74	53.12	44.98	34.35	40.12	36.31	41.92
1971	37.91	53.41	44.23	31.13	42.23	34.92	39.45
1972	42.96	56.24	49.38	36.44	44.87	39.87	43.48
1973	44.00	58.00	52.00	36.00	45.00	40.00	46.00

[a]Source: [53, p. 22].

Table A.8. Availability of wet-fields from total farming area in Central Java and Indonesia, 1963[a]

Region	Wet-field in hectares[b]	Total farming area in hectares[c]	% of wet-field from total
1. Four districts ("Kabupaten") sample in Central Java			
a. Kendal	30,829	62,396	49
b. Pemalang	27,153	53,995	50
c. Banyumas	29,105	69,776	42
d. Kebumen	31,297	73,009	43
2. Province of Central Java	820,502	1,812,907	45
3. All Indonesia	4,285,739	12,737,697	34

[a]Source: [3, pp. 10 and 12].

[b]Including technically irrigated and rainfed gravitationally irrigated "sawah" (wet-fields). All irrigated paddy crops are grown on these fields.

[c]Aggregates of wet-fields and dry-fields, the latter being non-irrigated lands depending only on uncontrolled rainfall.

Table A.9. Rice production targets and achievements, Indonesia 1968-1973[a]

Year	Production (X 1000 tons)	
	Target	Achieved
1968	9,800	11,666
1969	10,520	12,249
1970	11,430	13,140
1971	12,520	13,724
1972	13,810	13,305[b]
1973	15,420	14,455[c]

[a]Source: [52, pp. 3-4].

[b]Provisional data.

[c]Estimated figure.

Table A.10. Planned areas of paddy using HYV's in million hectares, Indonesia, 1969-1973

	Areas with intensification		% from total harvested area of paddy	
Year	Domestic HYV	IRRI-HYV	Domestic HYV	IRRI-HYV
1969	1.80	0.79	23.7	10.4
1970	1.50	1.40	18.8	17.6
1971	1.00	2.15	12.0	25.9
1972	0.40	3.08	4.6	35.1
1973	-	4.00	-	43.0

Table A.11. Percentage of sample farmers participating in BIMAS programmes of the current seasons and years, eight sample village, Central Java, 1968/69 - 1972/73[a]

Sample village[b]	Wet season 1968/69	Dry season 1969	Wet season 1969/70	Dry season 1970	Wet season 1970/71	Dry season 1971	Dry season 1972	Wet season 1972/73
1. Banyutowo	100	63	93	40	73	20	48	na[c]
2. Rowosari	100	100	70	43	48	36	57	na
3. Serang	100	100	42	0	17	11	18	na
4. Wanarata	0	73	67	0	53	73	73	na
5. Kebanggan	80	96	100	100	95	61	?	75
6. Sokaraja Lor	77	86	86	100	83	69	?	71
7. Patemon	63	86	73	13	70	20	?	78
8. Bl. Pesantren	56	63	50	0	0	0	?	33

[a]Source: [4].

[b]In each sample village 30 sample farmers were selected. The same farmers were interviewed in each current season and year. In Central Java generally wet season refers to the period November-April and dry season refers to May-October.

[c]na = not available.

Table A.12. General soil types of the sample kecamatans (sub-districts), Central Java, 1957[a]

Kecamatan and village	Soil types	Parent material
1. Kota Kendal (village No. 1)	Grey alluvial	Silt and loam deposits
2. Woleri (village No. 2)	Grey alluvial	Silt and loam deposits
3. Petarukan (village No. 3)	Dark-grey alluvial	Silt and loam deposits
4. Bantarbolang (village No. 4)	Reddish dark-brown latosol	Intermediate volcanic tuffs
5. Sumbang (village No. 5)	Brown latosol and brown regosol	Intermediate volcanic tuffs
6. Sokaraja (village No. 6)	Brown latosol and brown regosol	Intermediate volcanic tuffs
7. Gombong (village No. 7)	Grey alluvial and low-humic glei	Silt deposit
8. Buluspesantren (village No. 8)	Grey alluvial and low-humic glei	Silt deposit

[a]Source: [66].

Table A.13. Average irrigated paddy grain ("gabah") yields in quintals per hectare of some improved varieties by soil types, 1970-1971[a]

Current improved varieties	Year released for public	General soil types: Wet season 1970/1971 Latosol	Wet season 1970/1971 Alluvial	Dry season 1971 Latosol	Dry season 1971 Alluvial
		(14 sites)	(14 sites)	(8 sites)	(5 sites)
1. IR5/84	1967	58.9	46.2	55.4	54.0
2. C4-63 8b/63	1969	54.3	39.0	-	-
3. IR20/2	1970	54.3	46.7	-	-
4. Pelita I/1	1971	57.8	45.5	62.6	58.0
5. Pelita I/2	1971	59.8	46.9	66.5	58.4
6. Dewi Ratih/1	1969	57.6	47.7	-	-

[a]Source: [6, pp. 7 and 10]. These experiments were carried out at CRIA substations and farmers' fields, tested in Randomized Block Design of 4 x 5 square meters with four replications. Elemental nitrogen and phosphate fertilizer applications were, respectively, 120 kilograms/Ha and 60 kilograms/Ha. Cultural practices were similar.

Table A.14. Land areas in 4 sample kabupatens (districts) according to land use, Central Java, 1973

Administrative units	Types of land use (hectares)				Total land area (hectares)
	Wet fields[a]	Dry lands[b]	Farm lands[c]	Others[d]	
Sample kabupatens					
1. Kendal	31,239	50,320	81,559	18,200	99,759
2. Pemalang	39,056	50,398	89,454	2,282	91,737
3. Banyumas	36,846	61,573	98,419	27,269	125,688
4. Kebumen	42,832	62,631	105,463	18,086	123,549
All Central Java[e]	820,502	992,405	1,812,907	1,607,693	3,420,600

[a]In Indonesian: "Sawah," meaning irrigated fields used mainly for paddy growing.

[b]In Indonesian: "Tanah darat," including house gardens, dry fields, woodlands.

[c]This is the sum of wet fields and dry lands, used mainly for food crops.

[d]Usually, it includes lands for large plantations, housings, fish ponds, cemeteries, etc.

[e]Taken from Agricultural Census 1963.

Table A.15. Land areas in 8 sample kecamatans (subdistricts) and 8 sample villages according to land use, Central Java, 1973[a]

Kecamatans abd villages	Types of land use (hectares)				Total land area (hectares)
	Wet fields[b]	Dry lands[c]	Farm lands[d]	Others[e]	
A. Kecamatan					
1. Kota Kendal	1.556	761	2,317	98	2,416
2. Weleri	3,642	134	3,776	1,124	4,900
3. Petarukan	5,518	1,643	7,161	267	7,428
4. Bantarbolang	2,692	7,616	10,308	283	10,591
5. Sumbang	2,071	2,775	4,846	-	4,846
6. Sokaraja	1,807	1,041	2,848	172	3,020
7. Gombong	1,160	1,660	2,820	128	2,948
8. Buluspesantren	2,484	2,114	4,598	234	4,832
B. Villages					
1. Banyutowo	201	39	240	46	286
2. Rowosari	103	43	146	10	156
3. Serang	314	44	358	-	358
4. Wanarata	543	247	790	56	846
5. Kebanggan	127	40	167	4	171
6. Sokaraja lor	195	80	275	15	290
7. Patemon	72	53	125	2	127
8. Buluspesantren	92	51	143	6	149

[a]Source: Administrative Offices in the respective units.

[b]See footnote Table A.14.

[c]See footnote Table A.14.

[d]See footnote Table A.14.

[e]See footnote Table A.14.

Table A.16. Comparative data characterizing important rice producing regions in the survey area, Central Java, 1974[a]

Administrative units	Percentage		
	Wet land per farm land	Wet land per total area	Paddy double-cropping potential per wet land
All Central Java	45	24	na[b]
A. District: Kendal	38	31	na
1. Village No. 1	84	70	100
2. Village No. 2	70	66	100
B. District: Pemalang	44	42	69
1. Village No. 3	88	88	100
2. Village No. 4	69	64	64
C. District: Banyumas	37	29	64
1. Village No. 5	76	74	63
2. Village No. 6	71	67	100
D. District: Kebumen	41	35	59
1. Village No. 7	58	57	100
2. Village No. 8	64	62	100

[a]Source: Officials of local administrative units.

[b]na = not available.

Table A.17. Changes in farm sizes by the same group of sample farmers, 8 sample villages, Central Java, 1968-1974[a]

Village	Size groups (10 samples each)	1968/1969 Average (Ha)	1968/1969 % of total	1973/1974[b] Average (Ha)	1973/1974[b] % of total	Group net addition (%)[c]
No. 1	small	0.407	13	0.543	16	33
	medium	0.621	20	1.362	42	119
	large	1.351	67	1.390	42	3
No. 2	small	0.341	16	0.571	20	67
	medium	0.498	22	0.709	24	42
	large	1.378	62	1.627	56	18
No. 3	small	0.190	9	0.861	25	353
	medium	0.436	22	0.885	25	103
	large	1.381	69	1.762	50	28
No. 4	small	0.412	8	0.933	13	126
	medium	1.506	30	2.181	29	45
	large	3.090	62	4.367	58	41
No. 5	small	0.250	9	0.495	16	98
	medium	0.635	24	0.917	28	44
	large	1.804	67	1.811	56	0
No. 6	small	0.396	15	0.599	25	51
	medium	0.762	29	0.808	35	6
	large	1.494	56	0.924	40	-38
No. 7	small	0.272	16	0.458	24	68
	medium	0.493	29	0.409	21	-17
	large	0.944	55	1.079	55	14
No. 8	small	0.341	16	0.548	24	61
	medium	0.547	27	0.539	23	- 1
	large	1.163	57	1.210	53	4

[a]See footnote Table 4.6 for the definition of farm size.

[b]Sample farmers within each group are the same individuals with that of 1968/1969, i.e., no re-ordering has been made. This is not representative of the current distribution of the farm sizes.

[c]Percentage increases from the averages of 1968/1969.

Table A.18. Changes in operated irrigated fields by the same group of sample farmers, 8 sample villages, Central Java, 1968-1974[a]

Village	Size groups (10 samples each)	1968/1969 Average (Ha)	1968/1969 % of total	1973/1974[b] Average (Ha)	1973/1974[b] % of total	Group net addition (%)[c]
No. 1	small	0.714	21	1.046	25	46
	medium	1.037	30	1.044	25	1
	large	1.662	49	2.072	50	25
No. 2	small	0.608	16	0.915	21	50
	medium	0.879	24	0.977	22	11
	large	2.221	60	2.555	57	15
No. 3	small	0.343	10	1.098	18	220
	medium	0.698	21	2.095	34	200
	large	2.318	69	2.935	48	26
No. 4	small	0.690	8	1.000	8	45
	medium	2.477	28	2.900	25	17
	large	5.734	64	7.883	67	37
No. 5	small	0.399	8	0.668	12	67
	medium	1.118	23	1.481	27	32
	large	3.394	69	3.416	61	1
No. 6	small	0.798	16	1.247	28	56
	medium	1.429	28	1.487	32	4
	large	2.825	56	1.844	40	-35
No. 7	small	0.332	13	0.504	18	51
	medium	0.630	25	0.641	23	2
	large	1.555	62	1.686	59	8
No. 8	small	0.479	15	0.618	18	29
	medium	0.814	25	0.817	25	0
	large	1.969	60	1.873	57	- 5

[a]See footnote Table 4.3.

[b]See footnote Table A.17.

[c]See footnote Table A.17.

Table A.19. Deflators of price data of 1973/1974, for comparison with the same at 1968/1969, 8 villages, Central Java[a]

Price item	Village number							
	1	2	3	4	5	6	7	8
1. Harvest-dry stalked paddy or paddy seed	1.27	2.36	3.02	2.84	2.63	2.48	2.43	2.43
2. Urea (nitrogenous) fertilizer	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
3. Wages of hired man labor	2.27	1.01	1.63	2.53	2.25	2.75	2.34	2.16
4. Yearly depreciation of capital	1.77	1.64	1.99	1.78	1.00	1.00	1.00	1.00

[a]Based on village average prices paid or received by sample farmers. This means that deflators for all price items in all villages in 1968/1969 are equal to 1.00.

Table A.20. Growth and distributional percentage trends of net returns per farm from paddy, 240 farms, 8 villages, Central Java, from 1968/1969 to 1973/1974 at 1968/1969 prices

Village number	Year	Average net returns per farm from paddy (Rp)	Relative shares (%) of aggregate net returns per farm from paddy received by various quintile groups of farmers				
			First (bottom) 20%	Second 20%	Third 20%	Fourth 20%	Fifth (top) 20%
1	68/69	10,170	0.3	2.8	10.6	18.9	67.4
	73/74	39,008	4.1	9.2	14.4	18.9	53.5
2	68/69	17,606	2.0	6.0	9.2	21.7	61.0
	73/74	71,470	5.9	9.4	11.6	15.5	57.7
3	68/69	16,209	1.4	4.1	9.6	18.0	66.9
	73/74	76,520	3.5	6.5	10.7	17.6	61.6
4	68/69	28,411	0.6	4.5	14.8	28.3	51.7
	73/74	100,893	1.8	6.2	13.8	31.7	46.5
5	68/69	67,518	0.9	2.3	8.0	15.5	73.3
	73/74	75,264	1.5	5.5	10.3	23.4	59.3
6	68/69	23,920	1.9	6.7	13.1	26.9	51.4
	73/74	28,104	4.1	9.5	15.0	23.2	48.2
7	68/69	11,655	4.3	9.6	14.3	21.9	49.9
	73/74	19,710	5.0	11.1	16.9	20.6	46.4
8	68/69	16,892	6.5	11.3	20.1	28.4	33.7
	73/74	26,773	4.5	12.3	16.0	23.6	43.6

Table A.21. Growth and distributional percentage trends of net farm returns, 240 farms, 8 villages, Central Java, from 1968/1969 to 1973/1974 at 1968/1969 prices

Village number	Year	Average net farm returns (Rp)	Relative shares (%) of aggregate net farm returns received by various quintile groups of farmers: First (bottom) 20%	Second 20%	Third 20%	Fourth 20%	Fifth (top) 20%
1	68/69	13,084	0.9	5.6	15.2	21.0	57.3
	73/74	42,515	3.9	8.9	14.4	17.8	55.0
2	68/69	20,397	3.1	6.7	9.5	20.3	60.4
	73/74	74,375	5.9	9.6	11.9	15.7	57.0
3	68/69	21,069	1.2	4.7	11.4	22.0	60.6
	73/74	76,904	3.6	6.5	10.7	17.7	61.5
4	68/69	34,596	0.7	4.2	16.2	28.0	50.9
	73/74	104,623	1.9	6.8	14.4	31.1	45.8
5	68/69	69,100	1.2	2.6	8.1	15.6	72.5
	73/74	79,028	2.3	6.2	10.8	23.0	57.6
6	68/69	30,853	3.8	9.9	16.2	26.3	43.8
	73/74	29,383	4.3	9.9	15.9	23.7	46.2
7	68/69	18,295	6.3	14.1	17.7	22.5	39.5
	73/74	24,683	8.0	12.5	15.7	19.5	44.4
8	68/69	24,578	8.3	12.9	19.1	24.0	35.7
	73/74	34,860	4.6	13.5	18.0	23.8	40.1

Table A.22. Growth and distributional percentage trends of net returns from all sources, 240 farms, 8 villages, Central Java, from 1968/1969 to 1973/1974 at 1968/1969 prices

			Relative shares (%) of aggregate net returns from all sources received by various quintile groups of farmers				
Village number	Year	Average net returns from all sources (Rp)	First (bottom) 20%	Second 20%	Third 20%	Fourth 20%	Fifth (top) 20%
1	68/69	13,764	0.9	6.8	15.1	21.5	55.8
	73/74	48,571	5.6	11.1	14.5	19.0	49.8
2	68/69	25,851	5.8	8.2	14.5	21.8	49.7
	73/74	97,273	7.2	11.1	13.1	18.6	50.0
3	68/69	25,102	1.6	7.0	12.3	23.3	55.8
	73/74	92,230	3.3	6.4	11.0	18.7	60.6
4	68/69	43,021	1.4	9.2	16.4	25.9	47.1
	73/74	119,384	2.8	8.0	17.6	28.2	43.4
5	68/69	74,240	1.8	4.8	8.7	17.2	67.5
	73/74	96,664	4.5	7.4	13.4	24.6	50.0
6	68/69	35,493	4.1	9.9	15.0	26.2	44.8
	73/74	40,949	5.6	11.7	17.4	26.4	38.9
7	68/69	22,393	8.0	13.2	17.5	20.9	40.5
	73/74	34,590	8.4	11.3	14.1	20.6	45.6
8	68/69	25,897	8.6	12.6	20.1	22.9	35.8
	73/74	36,701	6.1	13.7	18.1	23.3	38.7

Table A.23. Changes in distributional indices of net returns per farm from paddy, 240 farms 8 villages, Central Java, from 1968/1969 to 1973/1974 at 1968/1969 prices

Village number	Indices of income distribution[a]									
	GR		ES		CV			SD		
	68/69	73/74	68/69	73/74	68/69	73/74	F-test	68/69	73/74	F-test
1	0.664	0.474	0.900	0.800	188.1	110.6	-	1.2915	0.5633	-
2	0.575	0.485	0.833	0.833	127.7	133.1	-	0.7743	0.3509	-
3	0.616	0.556	0.867	0.867	140.0	139.1	- ns[b]	0.9262	0.4440	-
4	0.528	0.477	0.800	0.767	98.3	87.2	- ns	1.4002	0.5566	-
5	0.693	0.561	0.900	0.833	183.9	112.5	-	0.7040	0.9892	-
6	0.501	0.434	0.800	0.767	94.9	85.3	- ns	0.9264	0.4157	-
7	0.447	0.399	0.767	0.767	105.6	86.6	- ns	0.4440	0.3508	- ns
8	0.300	0.374	0.667	0.733	53.6	70.4	+ ns	0.3237	0.3645	+ ns

[a]See footnote Table 5.2.

[b]Nonsignificant.

Table A.24. Changes in distributional indices of net farm returns, 240 farms, 8 villages, Central Java, from 1968/1969 to 1973/1974 at 1968/1969 prices

Village number	Indices of income distribution[a]									
	GR		ES		CV			SD		
	68/69	73/74	68/69	73/74	68/69	73/74	F-test	68/69	73/74	F-test
1	0.563	0.485	0.833	0.833	151.5	115.6	- ns[b]	0.9194	0.5743	-
2	0.548	0.477	0.833	0.833	122.8	128.7	-	0.6196	0.3441	-
3	0.580	0.555	0.833	0.867	122.1	138.4	-	0.9582	0.4434	-
4	0.525	0.465	0.800	0.767	99.8	84.9	- ns	1.2380	0.5394	-
5	0.683	0.536	0.900	0.833	181.6	108.0	-	0.6575	0.4946	- ns
6	0.405	0.414	0.733	0.767	75.0	80.4	-	0.3920	0.3908	-
7	0.324	0.351	0.700	0.733	72.7	87.2	-	0.2822	0.2672	-
8	0.284	0.340	0.667	0.700	61.9	62.3	+ ns	0.2355	0.3569	+

[a]See footnote Table 5.2.

[b]Nonsignificant.

Table A.25. Changes in distributional indices of net returns from all sources, 240 farms, 8 villages, Central Java, from 1968/1969 to 1973/1974 at 1968/1969 prices

Village number	Indices of income distribution[a]									
	GR		ES		CV			SD		
	68/69	73/74	68/69	73/74	68/69	73/74	F-test	68/69	73/74	F-test
1	0.548	0.418	0.833	0.767	144.0	99.0	-	0.9269	0.3255	-
2	0.433	0.409	0.767	0.767	92.3	101.2	-	0.3452	0.2966	-
3	0.531	0.542	0.800	0.833	109.9	122.0	- ns[b]	0.9439	0.4590	-
4	0.459	0.422	0.767	0.733	90.9	76.1	- ns	0.9522	0.4531	-
5	0.634	0.455	0.900	0.767	167.0	87.9	-	0.6039	0.3878	-
6	0.413	0.341	0.767	0.700	78.1	62.4	- ns	0.3782	0.3066	- ns
7	0.315	0.365	0.700	0.733	68.3	92.6	-	0.2634	0.2609	-
8	0.279	0.315	0.667	0.700	59.5	57.8	-	0.2291	0.3086	-

[a]See footnote Table 5.2.

[b]Nonsignificant.

Table A.26. Simple correlation matrix of 1968/1969 relative variance regression

X_1	X_2	X_3	X_4	
1.00000	0.25969	0.38273	0.46067	X_1
	1.00000	-0.26366	-0.19027	X_2
		1.00000	0.95416	X_3
			1.00000	

Table A.27. Simple correlation matrix of 1973/74 relative variance regression

X_1	X_2	X_3	X_4	
1.00000	0.25969	0.38273	0.46067	X_1
	1.00000	-0.26366	-0.19027	X_2
		1.00000	0.95416	X_3
			1.00000	

Table A.28. Simple correlation matrix of absolute-change regression

X_1	X_2	X_3	X_4	
1.00000	0.17127	0.48310	0.66277	X_1
	1.00000	-0.47689	-0.07082	X_2
		1.00000	0.85868	X_3
			1.00000	X_4

Table A.29. Simple correlation matrix of relative-change regression

X_1	X_2	X_3	X_4	
1.00000	0.26610	0.50959	0.58586	X_1
	1.00000	-0.52759	-0.00401	X_2
		1.00000	0.55615	X_3
			1.00000	X_4

Table A.30. Farm income received, numbers of all-HYV adopters and expenditures on seed, fertilizers and pesticides, 1968/1969 and 1973/1974, 240 paddy farms, 8 villages, Central Java[a]

Farm income categories	Income received (Rp)[b]		Number of adopters[c]		Expenditure on seed, fertilizers and pesticides (Rp)	
	1968/1969	1973/1974	1968/1969	1973/1974	1968/1969	1973/1974
Bottom 20%	125,267	474,937	13	23	204,721	308,037
Bottom 40%	549,783	1,516,227	21	50	446,908	590,571
Top 40%	5,623,098	11,088,949	17	56	1,124,413	2,745,977
Top 20%	4,210,364	8,366,805	9	22	757,904	2,130,852

[a]Incomes and expenditures in 1973/1974 were made comparable to those in 1968/1969 by using, respectively, paddy prices and corresponding input prices as deflators. See Table A.19 for details about deflators.

[b]Defined as the sum of net return from paddy cropping, value of house garden products and other farm products.

[c]Including only adopters of pure HYV planted on all plots of their irrigated lands.

Table A.31. Simple correlations matrix of Cobb-Douglas model for 1968/1969

X_1	X_2	X_3	
1.00000	0.80295	0.93278	X_1
	1.00000	0.71962	X_2
		1.00000	X_3

Table A.32. Simple correlations matrix of Cobb-Douglas model for 1973/1974

X_1	X_2	X_3	
1.00000	0.88446	0.93877	X_1
	1.00000	0.86941	X_2
		1.00000	X_3

XII. APPENDIX B. TEST OF NORMALITY OF FARM INCOME DISTRIBUTION, 1968/69 - 1973/74

The objective is to test whether the 1968/69 and 1973/74 net returns from paddy per farm in Central Java are normally distributed or log-normally distributed. The Chi-square test of goodness of fit will be employed to test the null hypothesis:

$$f_i = fP_i,$$

where f_i is the observed frequency of the i-th cell and fP_i is the corresponding expected frequency.

The test criterion is defined as [63, p. 350]:

$$X^2 = \frac{(f_i - fP_i)^2}{fP_i},$$

with the degree of freedom given by the number of cells minus one and the number of parameters estimated (i.e. the mean and the variance). The results of the null hypothesis testings are given below.

Apparently, the results of testings indicate that both the original and the log-transformed data for per-farm net returns from paddy are not normally distributed. However, the log-transformed income data are relatively closer to the normal distribution, as estimated X^2 values are relatively smaller than those of the original data distribution.

Sample income distribution	Number of observations	Degrees of freedom	X^2 value [1]
(1) 1968/69 net return from paddy, original data	240	9	442.3**
(2) 1973/74 net return from paddy, original data	240	24	549.7**
(3) 1968/69 net return from paddy, logarithmic transformation	232[2]	6	50.7**
(4) 1973/74 net return from paddy, logarithmic transformation	239[3]	4	13.4**

[1]Values of critical X^2 at 1 percent level of significance:

d.f.	X^2
4	13.3
6	16.8
9	21.7
24	43.0

[2]Eight sample farms were taken out because of negative income figures.

[3]One sample farm was excluded because of a negative income figure.

XIII. APPENDIX C. SELECTION OF SAMPLES FOR THE RICE INTENSIFICATION STUDY, AGRO ECONOMIC SURVEY (AES), 1968[1]

To carry out the research, the AES decided to interview paddy farmers in the important rice producing areas on the islands of Java, Sumatra and Sulawesi. Trying to draw a representative sample of rice farmers for these areas is almost impossible. What the AES tried to do was to reduce the area coverage of the study.

First, only areas with adequate irrigation were included which was based on the concept of technically or semi-technically irrigated areas used by the Department of Public Works.[2] In a few places, e.g., kabupaten Cianjur,[3] village rain-fed irrigation was considered to be adequate for good water control. To cover the important rice areas the decision was made to include the provinces of North Sumatra, West Sumatra, Lampung, West Java, Central Java, East Java, Bali and South Sulawesi, which can be seen from Table C.1 below. Their geographical locations are found in Figure 3.1.

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[1]Adapted from [8].

[2]"Technically irrigated" means that the water flow can be controlled (regulated) and measured according to the need. "Semi-technically irrigates" means that the water flow can only be controlled, but no measuring device is used.

[3]In Indonesia the government administrative areas are organized, from top to bottom, as follows: Central agencies → Provinces → Kabupaten (district) → Kacamatan (sub-district) → Desa (village). A village is the smallest administrative unit, although for practical reasons it is divided into some twenty pedukuhan (hamlets).

Second, each province was divided up into some comparable distinct producing areas, thus making a population of nineteen irrigated rice producing areas. In each distinct area one kabupaten was randomly chosen, except for North Sumatra, where the areas are not so homogeneous with respect to soil types, two kabupatens were selected at random. In all, there are 20 kabupatens samples which are listed in Table C.1.

Third, for each of the 20 kabupatens, two kecamatans having the same characteristics as the kabupaten selection were randomly chosen. Then, one village out of the population which have the same characteristics of selection as its kecamatan, was picked up randomly in each selected kecamatan. However, in kabupatens Lampung Selatan, Lampung Tengah and Bone only one village in each kabupaten was chosen because of their being less important rice growing areas. Thus, a total of 37 villages were selected as samples.

Fourth, in each of the 37 villages farmers were grouped into three strata: large, BIMAS and non-BIMAS farmers. The large farmers statistical population was determined by asking the village chief who were the ten farmers with the largest paddy field operation in the village. The BIMAS farmer population consisted of all the farmers in the village who took part in one of the various BIMAS programs in the wet season of 1968/69. The non-BIMAS farmer population was made up of farmers who did not participate in any BIMAS program at that period. Five farmers were randomly selected in the first stratum, fifteen in the second, and ten in the third stratum. Thus, theoretically, in each of the 37 villages a total of 30 farmers were chosen.

Table C.1. The irrigated rice producing areas in the selected provinces and the randomly chosen kabupaten in each of these areas, 1968

Province	Area	Kabupatens included in each area	Selected kabupatens
1. North Sumatra	1. East Cost lowland plain	1. Langkat, Deli-Serdang, Sima-lu lungun, Asahan Labuhan Batu	1. Deli-Serdang 2. Simalungun
2. West Sumatra	1. Lowland plain	1. Padang-Pariaman	1. Padang-Pariaman
	2. Mountain	2. Pasaman, Lima-puluh koto, Tanah Datar, Solok, Sw-Sijun-jung	2. Tanah Datar
3. Lampung	1. Non-transmigration	1. Lampung Selatan	1. Lampung Sel.
	2. Transmigration	2. Lampung Tengah	2. Lampung Timur
4. West Java	1. Northern lowland plain western sector	1. Serang, Tanggerang, Bogor, Lebak, Pandeglang	1. Serang
	2. Northern lowland plain eastern sector	2. Bekasi, Kerawang Indramayu, Subang, Cirebon, Kuningan, Majalengka	2. Subang
	3. Mountains	3. Sukabumi, Cianjur Garut, Tasikmalaya Uiamis, Sumedang, Bandung	1. Cianjur
5. Central Java	1. North Coast plain	1. Brebes, Tegal, Pemalang, Pekalong-an, Batang	1. Pemalang
	2. East lowland plain	2. Kendal, Semarang Demak, Kudus	2. Kendal
	3. South Coast lowland plain	3. Kebumen, Purworejo Kulon Progo, Cilacap	3. Kebumen

Table C.1. Continued

Province	Area	Kabupatens included in each area	Selected kabupatens
	4. Serayu river basin	4. Wonosobo, Banjar-negara, Purba-lingga, Banyumas	4. Banyumas
6. East Java	1. Bengawan Solo river basin	1. Bojonegoro, Tuban Lamongan, Madiun, Magetan, Ngawi, Ponorogo, Pacitan	1. Ngawi
	2. Brantas river basin	2. Surabaya, Sido-arjo, Mojokerto, Jombang, Kediri, Nganjuk, Blitar, Tulungagung, Trenggalek, Malang	2. Sidoarjo
	3. Eastern plains	3. Pasuruan, Probo-linggo, Lumajang, Bondowoso, Pena-rukan, Jember, Banyuwangi	3. Jember
7. Bali	1. Southeastern plain	1. Gianyar	1. Gianyar
8. South Sulawesi	1. Southwest coastal plain	1. Gowa, Takalar, Maros	1. Maros
	2. Northwest coastal plain	2. Pare-pare, Pinrang, Sidenreng-Rappang, Soppeng	2. Pinrang
	3. East coastal plain	3. Luwu, Wajo, Bone	3. Bone

Some villages had only two strata depending on the presence of a BIMAS program that included all the farmers in the village, or the absence of any BIMAS program. In these cases, twenty-five farmers were selected in the second stratum. Often the number of farmers in BIMAS and non-BIMAS strata varied due to sampling difficulties at the village level.