RESOURCE UTILIZATION EFFICIENCY OF RICE PRODUCTION IN SOUTH SULAWESI

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Abstract

Introduction

The problems of increasing agricultural production per unit of land or any other resource were described in the Neoclassical theory of production. First, by shifting the production function upwards, and second, by moving along the existing production surface such that each factor yields its optimum potential productivity.

Shifting production function upwards is one of the strategies adopted by many countries to generate "Green Revolution". Advances in technology are needed for which costly research and extension activities are needed. The second approach suggests that with a given technology a higher level of productivity can be attained by changing the allocation of variable resources. This implies a relatively low cost alternative for achieving a higher level of production in a short period of time. The question arises whether such an adjustment on the existing production function is possible.

Policy makeds and implementing bodies need to know how efficiently, in economic terms, resources are being utilized in peasant agriculture, for which this study is designed with the objective to evaluate the economic efficiency of resource allocation in irrigated small rice farms in South Sulawesi.

Methodology

Data Source. The data used are cross sectional sample survey data collected during the wet season 1980 in South Sulawesi (Study on the Consequences of Small Farm Mechanization).

Study Area. Two districts, Pinrang and Sidrap, were selected among 23 districts in the province. The districts are adjacent, have the same climate, and were the leading areas in terms of irrigated lowland and rice production (Agricultural Extension Service South Sulawesi, 1978). The new rice technology through

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the mass guidance (BIMAS)[1] package was introduced for the first time in the study area in 1965. Consequently, the rice farming system in the area has undergone many changes over time and hence can be regarded to be a representative of a transforming agriculture. Most of the farmers grow one to two crops of high yielding rice varieties each year.

Sample. Three hundred farmers were randomly selected in eight villages of the two districts. The farmers were classified into two different environments (irrigated and non-irrigated farms) and two different power classes (mechanized and non-mechanized farms). A mechanized farm used tractors either alone or in combination with animal or manual power. A non-mechanized farm did not use tractors. This paper concern only the mechanized irrigated farm stratum. The forty farmers selected for this analysis belong to a sub-stratum of owner-operators, with rice-based farming systems using HYV, fertilizer/pesticides, and transplanting practice (not direct seeding). This procedure was adopted to minimize technological and institutional differences within the sample.

Analytical Procedure. The analysis involved in the study consists of two main stages:

1. Estimation of rice production function using the available cross sectional data.
2. Estimation of an efficiency index, using estimated parameters of the production function, mean level of resources used and the average prices prevailing during the season of the study.

The Cobb-Douglas production function is used in unrestricted form of the estimation. Selection of the Cobb-Douglas functional form is based on the following criteria.

a) **Economic criteria:** If farmers allocate their resources in a rational manner, according to neoclassical theory they will not be operating in either the increasing marginal product or negative marginal product stage of the production function, unless there is a strong a **priori** justification for such behavior. (Heady and Dillon, 1964). Since there is no reason to suppose that South Sulawesi farmers have such a justification, the Cobb-Douglas function, which can show only the decreasing but positive marginal product, is suitable.

b) **Statistical criteria:** As the sample size is limited to 40, the other functional forms that cause greater losses of degrees of freedom are considered less appropriate. An attempt is made to keep error degrees of freedom above 30 in order to maintain the reliability of the statistical test involved (Koutsoyiannis, 1977).

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[1] A package of practices including High Yielding Variety (HYV) fertilizer, insecticide, water control and cultural practices.

The Cobb-Douglas function estimated in natural form is:

$$Y = A \prod_{i=1,2,\ldots,n}^{n} X_i^{b_{ie}\,u} \qquad X_i^{b_{ie}\,u}$$

where Y = total production as the dependent variable in kilogram of paddy per farm.

X = independent variable, including:

a) total rice land in hectares cultivated by farmers (LD)
b) urea used in kg per farm (UR)
c) cost of chemical weeding in rupiah (CHW)
d) total cost of weeding in rupiah (TCW)
e) cost of insecticide in rupiah (CINS)
f) cost of land preparation in rupiah (CLP)
g) total hired labor except harvest in man working hours (HLEH)
h) cost of material input including urea, insecticide and herbicide in rupiah (CM)
i) total labor used in man working hours (TL)
j) total hired labor in man working hours (THL)
k) total labor used in hand weeding (LHW)

In the Cobb-Douglas function b is interpreted directly as the production elasticity of the itch input, therefore the MPP of the itch input at average X_i can be derived by multiplying b_i by $\bar{Y}/\bar{X}_i$ where the means are geometric means:

$$b_i(\bar{Y}/\bar{X}) = (\gamma\bar{Y}/\gamma\bar{X}_i\ \bar{X}_i/\bar{Y})\ \bar{Y}/\bar{X}_i = \gamma Y/\gamma X_i = MPP_i.$$

Under perfect competition the value of marginal product of the itch resource (MVP_i), given by the product of MPP_i and the price of output, should be equal to the marginal factor cost (MFC) of the itch resource to maximize profit, $MVP_i = MFC_i$ or $MVP_i/MFC_i = 1$.

This equality defines the efficient level of resource use. The resource is underutilized if $MVP_i > MFC_i$ and overutilized if $MVP_i < MFC_i$. The efficiency index (EI) of resource use can be calculated by taking the ratio:

$EI = MVP_i/MFC_i$ $EI = 1$: resource i is utilized efficient

$EI > 1$: resource i is underutilized

$EI < 1$: resource i is overutilized

Results and Discussion

The production functions estimated using different variables are shown in Table 1. In the first two equations, the inclusion of total hired labor (THL) instead of total labor (TL) improves the fit of the function. It can be seen from the increase in the value of F and R^2 without affecting the degree of significance of the coefficients. Thus, the inclusion of family labor in total labor does not significantly sdd to total production.

Segregation of variables (capital is segregated into fertilizer, insecticide, chemical weeding and land preparation) improves the overall fit of the function and the degree significance of the coefficients in the 4.th equation. The inferiority of equation 4 seems to be attributed to the inclusion of land preparation, which has a negative sign and reduces the significance of other coefficients. This may be due to the heavy aggregation of the cost of labor, animal and mechanical power into one cost of land preparation variable, leading to a high degree of commission error in aggregation.

In the fifth equation labor for harvesting is excluded with the belief that only labor used before harvesting could be really important in determining the level of production. However, it does not give a good fit but, in fact, reduces the fit of the function. This implies that harvesting labor is an important factor in delivering the level of production, such as in minimizing losses during harvest.

Total hired labor (THL) was not statistically significant in any of the equations. It means that the elasticity of labor is not significantly different from zero, and may partly be attributed to a very high use of labor compared with the recommended level shown in Table 3. All labor components are aggregated and in this form labor variable seems to be highly erratic in all samples. In equation 7 the inclusion of labor for hand weeding and cost for land preparation does not improve the fit of the function but gives a negative sign.

Equation 6 has been selected as the average production functions for the sample based on its high R^2, t-value and degree of significance of the coefficients. Eventhough equation 3 gives the highest F-value and has higher levels of significance for individual parameter estimates than equation 6, the latter is preferred, because it conforms with *a priori* expectations of the explanatory variables and gives the highest R^2. Besides, a 10% level of significance is assumed to be adequately satisfactory to attest to the reliability of the parameter estimates.

Marginal physical product (MPP) was computed at the geometric means of the input and output. From MPP, the marginal value product (MVP) was calculated to be Rp 125/kg of paddy. Marginal factor cost (MFC) of capital inputs is computed by considering the interest rate of 12% per year. Since only one season

Table 1. Estimated Production Function and Related Information[1].

Regression No.	Constant Term	Independent-Variables					R^2	F
1.	1.6323**	0.4837 LD**	0.0230 TL	0.4130 CM**			0.51	12.53*
	(1.88)	(2.49)	(0.10)	(2.52)				
2.	2.4668**	0.4784 LD**	0.1878 THL	0.3609 CM**			0.54	13.89*
	(2.13)	(2.59)	(1.42)	(2.22)				
3.	2.5691	0.5432 LD**	0.2702 UR*	0.0751 CHW*	0.0871 THL		0.63	14.90*
	(8.83)	(3.45)	(2.74)	(3.12)	(0.67)			
4.	3.4042*	0.5900 LD*	0.2086 UR**	-0.1212 CLP	0.0062 TCW	0.0516 CINS	0.57	8.90*
	(2.88)	(2.88)	(2.95)	(-0.45)	(0.11)	(1.68)		
5.	2.7507	0.5503 LD*	0.2500 UR**	0.0697 CHW*	0.0394 CINS	-0.0099 HLEH	0.65	12.61*
	(8.92)	(3.52)	(2.38)	(2.82)	(1.37)	(-0.07)		
6.	2.5044*	0.5590 LD*	0.1938 UR**	0.0650 CHW***	0.0465 CINS***	0.1380 THL	0.66	13.26*
	(8.79)	(3.65)	(1.85)	(2.71)	(1.76)	(1.07)		
7.	4.1114*	0.6413 LD*	0.2705 UR**	-0.0365 LHW	-0.2668 LHW		0.53	10.06*
	(3.67)	(3.11)	(2.68)	(-0.55)	(-0.55)			

[1]Derived from the computer output.
* Significant at 1% level
** Significant at 5% level
*** Significant at 10% level
Figures in parentheses are t-values

VARIABLES:
LD = Land
THL = Total Hired Labor
CLP = Cost of Land Preparation
HLEH = Total Hired Labor Except Harvest
CM = Cost of Material Inputs
CHW = Cost of Material Weeding
LHW = Total Labor Used in Hand Weeding
TCW = Total Cost of Weeding
TL = Total labor
UR = Urea Used
CINS = Cost of Insecticide

is considered in the study, 6% interest is used, so that Rp 0.06 is added to each rupiah cost. There is no exclusive cost for land; the predominant 50-50 sharing basis is used to determine its marginal factor cost using the formula:

$$\text{MFC}_{\text{Land}} = \frac{\text{Average yield in kg/ha}}{2} \times \text{price of paddy/kg.}$$

The result of the computation of MPP, MVP, MFC and the Efficiency Index (EI) of resource use, is presented in Table 2. The EI for land is 1.19, implying that land as an input variable is being used efficiency since the value is almost equal to one. All other inputs are underutilized since their efficiency index values are greater than one. This is further demonstrated in Table 3, where the actual level of inputs are shown below the recommended level.

Table 2. Efficiency Index of Resource Use and Related Information.

Input per Farm	Geometric Mean	Marginal Physical Product (kg)	Marginal Value Product (Rp)[1)]	Marginal Factor Cost (Rp)	Efficiency Index (MVP/MFC)
Land cultivated (ha)	0.9446	1577	197.225	165.988	1.19
Urea applied (kg)	97.53	5.28	660	70	9.43
Cost of chemical weeding in rupiah	44.74	3.87	482.50	1.06	455.2
Cost of insect control in rupiah	264.322	0.47	58.75	1.06	55.42

[1)] Computed at the rate of Rp 125/kg of paddy.

Table 3. Actual and Recommended Levels of Input per hectare.

Items	Actual Level			Recommended Level[1]
	Arithmetic Mean	Minimum	Maximum	
Total product (kg/ha)	2,929	151	9243	—
Land (ha)	1.0	0.17	4.20	—
Urea (kg/ha)	133	0	882	250
Cost of material input (Rp)	18,957	1563	114706	32780
Cost of chemical weeding (Rp)	694	0	3025	1500
Total cost of weeding (Rp)	5,254	0	18277	20000
Cost of insecticide (Rp)	1,989	0	7353	2500
Cost of land preparation (Rp)	21,214	6723	75630	—
Total hired labor (MH)	254	15	583	245
Total hired labor except harvest (MH)	135	11	586	198
Total labor (MH)	408	127	725	680

Rp = Rupiah, Indonesian Currency.
MH = Man hour.

[1] Based on BIMAS package.

Lack of capital may be one explanation for the farmer's underutilization of inputs. Another possible reason is the presence of risk and uncertainty in farm operations. It should be noted that the farmers are all owner operators, that means they have no landlord to shoulder the expenses brought about by unfavorable future outcomes. They limit their use of inputs so as to lessen their loss in case of crop failure.

The equations were tested for homoscedasticity using Spearman Paule Correlation between residuals and the variables. It is found that equation 1 is homoscedastical between residual and land (LGLD).

Heteroscedasticity is found on total labor (LGTL) in equation 1 and variable cost of chemical weeding (LGCHW) in equation 3. No hereroscedasticity is found for other variables in this equation.

Summary

Farmers underutilized all farm inputs except for land. Capital inputs are not used at an optimum level, that means there is further scope for increasing production.

Lack of capital may be a strong possible constraint. Farmers could not reach the most efficient level of resource use due to limited capital and have to operate at a sub optimal level. Another possibility is the risk and uncertainty of farming. Securing loans for the acquisition of inputs would simply aggregate future problems in case of crop failure.

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