FINANCIAL ANALYSIS OF TRACTOR PURCHASE DECISION IN SOUTH SULAWESI, INDONESIA:
A Computer Spreadsheet Template

By

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ABSTRACT

Although most of the rice area in Indonesia is still prepared manually, since the early 1980s the government has promoted tractors for land preparation through subsidized loans. This has increased capital investment in agriculture; and for the farmers, the cost of owning and operating tractor has become an important part of farm costs. By the late 1980s, a rapid increase in the number of tractors intensified competition, reducing capacity utilization below an economically viable level. Thus, many tractor owners defaulted on their loans.

This study investigates the financial profitability of tractor ownership in South Sulawesi, using a computer spreadsheet. The analysis uses input and output data (technical coefficient) collected by the Consequences of Mechanization Project in South Sulawesi in 1980-81, but introduces 1990 costs and prices to assess profitability under current conditions.

The results showed that in 1980, tractors were unprofitable, as indicated by a B-C ratio of 0.87. In 1990, with the 1990 prices applied to the 1975-79 tractor capacity utilization, owners obtained positive net return (as indicated by a B-C ratio of 1.13, an IRR of 27% and a NPV of Rp 1,896,000) when the official contract rates was maintained. Sensitivity analysis showed that changes in critical variables, such as tractor price, contract rates, and interest level result in large changes in B-C ratio, NPV, and IRR. Increasing the initial tractor purchase price by 10%, decreased the B-C ratio to 1.07 (-5%), NPV to Rp 1,246,000 (-34%) and IRR to 23% (-15%). Similarly, reducing the contract rate by 20 percent, reduce the B-C ratio to 0.9 (-20%), NPV to Rp -879,000 (-146%) and IRR to 6.8% (-75%). In addition, increasing the interest rate from 15% to 30%, reduce the B-C ratio to 0.9 (-15%) and NPV to Rp-461,000 (-76%). These results indicate the sensitivity of tractor profitability to parameters controlled by government (subsidized interest rate). Thus, while tractor ownership is certainly profitable, the profitability of future purchasers will depend on government policies at the time of purchase, government willingness to maintain a high contract rate, and farmers willingness to pay this rate.

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CHAPTER I

INTRODUCTION

In most developing countries, national food policy has been geared towards increasing food production through the use of improved technology-including new crop varieties, proper cultural practices, efficient irrigation systems, and farm mechanization.

The introduction of the new high-yielding crop varieties creates a need for improvements in cultural techniques. The shorter duration varieties made possible double or triple cropping where sufficient water was available. To capture the potential of technological changes which made possible multiple cropping, farmers had to reduced the turn-around time between when crops were harvested and when land was prepared for the following crop. In addition to increasing the speed of the work, the use of small tractors allowed farmer to cultivate heavier and more difficult soils, and therefore increase total production.

The introduction of farm tractors in developing countries has generated considerable debate. Proponents argue that tractorization is a necessary element for agricultural modernization because tractor can perform heavy tasks, carry out these operations faster than animals or men, decrease turn-around time, increase cropping intensity, and increase planted area. Opponents of mechanization argue that machines displace labor, shift income from labor to capital owners and worsen the income distribution.

Policy makers in developing countries of South and Southeast

Asia, to varying degrees, believe that the mechanization of part or all crop production processes is an essential element in agricultural development. This is evident in Indonesia where capital at subsidized interest rates has been made available to many farmers to purchase machines.

In Indonesia, the number of tractors, particularly on rice farms, has increased since the early 1970s (Diperta, 1988). The introduction of tractors has raised the level of capital investment in agriculture and the cost of owning and operating them has become an important and rapidly increasing part of farm costs.

Problem

In Indonesia and other developing countries of South and Southeast Asia, about 60 to 70 percent of the rice area is prepared manually by laborers and harvested using knives or sickles (Juares, 1988).

In Indonesia it is estimated that hand land preparation requires a high labor input of approximately 23 labor days per hectare (Dit.Technik Pert., 1974, Morris, 1975 and Consequences, 1981). Because it is the most strenuous activity in rice production,the labor wage rate (in-cash or in-kind) is often substantially higher than that paid for other activities. Consequently, land preparation is a major expense in rice production. Moreover it is argued that, in areas having labor shortages during the peak land preparation period, land preparation and transplanting are often delayed, thus reducing grain yield.

Despite substantial production increases since the mid-1970s, growth in rice supplies has not matched increased demand for rice in Indonesia. During 1950s and early 1960s, rice production remained static while population grew rapidly, resulting in significant food shortages and making Indonesia the world's largest rice importing country from 1973 to 1979 (CBS, 1975 and Birowo, 1982).

Since the early 1970s, the Indonesian government has placed increased emphasis on increasing rice production in order to achieve food self-sufficiency. Measures implemented to attain self-sufficiency in rice production have included increased subsidization of inputs (fertilizer and pesticides), research to develop high-yielding and more pest resistant rice varieties, rehabilitation and extension of irrigation facilities, and farm mechanization. These programs have had a significant impact on rice production. In 1984, the country become self-sufficient, but population growth is expected to threaten future self sufficiency (Erwidodo, 1990).

Since the early 1960s, government has promoted the mechanization of land preparation in Indonesia in several densely populated locations on Java and Bali and the sparsely populated outer island of South Sulawesi. In densely populated areas the government promoted two-wheel tillers. But in sparsely populated areas like South Sulawesi, small four-wheel tractors with 12-15 horse power (HP) were introduced to redress apparent shortage of human and animal power for land preparation that were believed to constrain area expansion, crop intensification and synchronized rice planting. In both areas, farmers used tractors mainly to augment available human and animal power during land preparation.

Government promoted tractors in South Sulawesi, based on the belief that mechanization would (1) raise yields as a consequence of more timely and better quality land preparation, (2) contribute to increasing cropping intensity as a result of more timely land preparation and a shorter turn-around time between crops, (3) permit extensification in areas where a shortage of labor and power results in land being left fallow, (4) increase the profit of the tractor users as a result of lowering land preparation costs, increasing yields, facilitating greater cropping intensity and expanding the area cultivated, and (5) reduce the drudgery of work (Consequences Research Team, 1981, and Opu Sidik, 1984).

Beginning in the early 1970s, small (12-15 hp) four-wheel Japanese tractors were introduced in several districts of South Sulawesi (Gajah Mada University, 1976). The tractor population increased steadily from 25 units in 1974 to 1,658 units in 1981. After 1982 the number started to decrease, with the units still concentrated in only a few districts (Appendix 1). The major factor accounting for increased mechanization was low interest government credit provided to farmers to purchase tractors. Elimination of subsidized credit in 1984 resulted in a decrease in new tractors purchases.

The increase in number and concentration of tractors in South Sulawesi has, however, created concern among economists and policy makers that expanded competition would decrease the hectares serviced by each tractor below the economically viable utilization level. The extend of the market for custom services directly affects the profitability of tractor ownership. Since the tractor owners typically own small farms, they must contract out plowing services to achieve break-even utilization.

The present study uses data from a 1980-81 study of tractor ownership to analyzes financial aspects of tractor ownership and operation, based on the 1990 costs and prices. The analysis is intended to provide guidelines for farmer decision making and future mechanization policy.

Objectives

The general objective of the study is to investigate the current private profitability of tractor use in South Sulawesi, based on technical coefficients estimated in 1980-81 and 1990 prices. The four specific objectives are to:

1. Review tractor mechanization field studies in Asia and Indonesia (particularly in South Sulawesi) to better understand factors associated with the success and failure of mechanization.
2. Develop a spreadsheet to estimate tractor operating and financing costs.
3. Estimate average private tractors costs and return for paddy cultivation in 1990.

4. Illustrate the use of a spreadsheet to provide information to potential tractor buyer, including: (1) break-even cultivated area, and (2) sensitivity analysis of major variable that determine private profitability.

CHAPTER II
REVIEW OF LITERATURE

Mechanization is an important input for the production and preservation of food crops. Hall (1973) argues that mechanization can increase food production through the improvement of water control, better soil preparation for planting, more efficient weed and insect control and the proper harvesting, handling, drying, storage and processing of food and fiber crops. Timeliness in all of these operations enhances yields of individual crops and maximizes the efficient use of each unit area of land throughout the growing season.

There are four ways in which the mechanized farmer can fully realize the working capacity provided by the tractor. First, tractors can enable farmers to increase their annual cropped area by facilitating multiple cropping, thus increasing their cropping intensity. Second, if the tractors' working capacity cannot be fully utilized by the tractor owner due to his/her very small farm size, the owner may hire out the machine to non-mechanized farmers. In this way, the tractor's capacity may be spread over a sufficiently large land base to be economically viable and can increase land use intensity. Third, if a land constraint does not exist, tractor owners can spread the tractor capacity to increase land area farmed by reclaiming fallow land. Finally, tractorization may reduce the financial cost of land preparation, compared to alternative existing technologies (McInerney and Donaldson, 1975). Tractor mechanization is also of vital importance in reducing human drudgery and raising labor productivity.

The potential contributions of tractor mechanization relate to three parts of the production cycle: land preparation and planting, crop growing, and harvest and postharvest operations. Although some researchers hypothesize a positive relationship between land preparation by tractors and yields due to better tillage, empirical studies have shown little or no contribution of tractors to yield increases (Stevens and Jabara, 1988 p 235, Binswanger, 1978).

Saegusa (1975) argued that the general purpose of farm mechanization is to replace human and animal power and thereby: (a) increase the labor productivity and income of agricultural workers[1] and, (b) change the character of farm work--to emancipate the farmer from heavy and arduous labor. As a farmer power unit, man is limited to producing about 0.1 horsepower (hp) of continuous output. In Indonesia, 20 or more workers using hand tools are required to till one acre (about 0.4 ha) in a day. A man riding a 20 - 30 hp tractor has the power under his control equal to about 100 men and easily plows one acre in two to three hours.

On the other hand, Sutter (1974) stated that the introduction of mechanization on small farms in Southeast Asia, without consideration of local custom and economic conditions, is likely to be ineffective and may often have a negative effect. Since market stability and an effective spareparts distribution system are essential for success, utilization of machinery in agricultural production is not feasible without these complementary facilities. Therefore, it is important to

[1] This argument fails to take into account the fact that in much of Asia, landless labor supplies land preparation labor.While mechanization increases labor productivity, it necessarily reduces total labor demand.

carefully study the consequences of mechanization and identify the major factors that affect the impact of mechanization, if policy decisions are to be effective and socially efficient.

Binswanger (1978) concluded that based on tractor surveys in India, Pakistan and Nepal, there is no evidence that tractor are responsible for substantial increases in intensity, yield, timeliness and gross returns. Tractor benefits may exist, but are so small that they cannot be detected.

The results of tractor studies in the Philippines provided disparities based on the timeframe and type of tractor. Alviar (1979) found that 60 percent of the respondents in her study indicated that the main reason they purchased a tractor was due to problem encountered in maintaining carabaos. Also, a smaller number indicated a saving in time and prestige associated with owning a tractor. The average farm area of the tractor-operated farms was twice that of carabaos cultivated farms--ranging from 0.7 to 25 hectares, with an effective crop area ranging from 1.4 to 13 hectares for the carabaos.

Antiporta and Deomampo (1977) noted that the use of hand tractors or power tillers in the Philippines appears to have had overall positive effects, compared to four-wheel tractors. Small power tiller have a positive effect on labor, employment and income. They argue that large tractors, which required huge foreign exchange outlays and incurs high maintenance costs, should be adopted only on large farms. However, mechanization policy in developing countries with surplus labor and small farm size should be approached with caution.

On the other hand, Maranan's (1981) study of tractor contract operations in Nueva Ecija, Philippines, concluded that ownership of two-wheel tractors is not financially profitable. Owners used the machines mainly on their own farms and annual utilization levels were below the break-even point. The four-wheel tractor was a profitable enterprise in 1972 with a benefit-cost ratio of 1.24, but decline in 1980 to 0.89. In contrast, the benefit-cost ratio for two-wheel tractors remained constant over the period, at approximately 0.66. The decrease in the B-C ratio for four-wheel tractors was due to decreased utilization levels and frequent breakdowns. These results also showed that contract rates increased steadily to match rising operating costs. She further suggested that tractor owners have two alternatives, if they intend to stay in business: they can increase utilization and/or increase contract rates.

In another study, Maranan, (1985) reported that the farmer's decision to use a tractor in his farm is affected by his financial capacity, water supply conditions on the farm, and the availability of tractor for hire in the area.

The introduction and adoption of agriculture mechanization in Indonesia, particularly tractor for land preparation, has created considerable controversy. The possibility to increase cropping intensity through the introduction of high-yielding crops varieties, rehabilitation of irrigation, better water management, and integrated pest control created a need to synchronized planting over a relatively wide area. Mechanization proponents argued that sufficient manual and animal power was not available to achieve this objective. Thus, a shortage of labor and the need for extra power in the form of tractor become the main rational for mechanization. This recommendation is opposed by many social scientists, who argued that there exists a surplus of rural labor for land preparation. Thus, the introduction of tractors into densely populated areas is not justified and will increase rural unemployment among the landless (Bernsten and Sinaga, 1979, and Sinaga, 1971).

Morris (1975) estimated that land preparation costs (financial) in Indonesia were higher using animals (carabaos) than power tillers. With the power tiller (12 hp), the time required for field preparation (two passes with the rotovator) was 17 - 24 hours per hectare, including travel time; compared to 160 hours by animal and 440 man-hours using manual methods. In the typical eight-week land preparation period, assuming an eight-hour day and a six-day week, about 16 hectares could be prepared using the power tiller, but only 2.4 and 0.9 hectares by animal and manual methods, respectively.

Sinaga's (1977) study in densely-populated West Java indicated that one tractor in normal use (65 ha per year) replaces 2,210 man-days of human labor per year, if replacing hoe cultivation, or 650 man-days per year if replacing a combination of animal plowing and hoe cultivation. This represented a potential shift of more than Rp.1 million per tractor per year from the pocket of laborers to tractor owners (in the form of rents), to tractor renters (reduce cultivation costs), to tractor dealers and fuel suppliers, to the government (import duties and interest) and to tractor manufacturers (foreign) and their employees.

Bunasor (1981), in his study of two-wheel tractor in densely-populated West Java, concluded that using net revenue (the difference between total revenue and variable costs) as a criterion, both the diesel and gasoline tractors were markedly profitable (financially). His benefit-cost analysis showed that using 1979 prices both types are profitable, as indicated by a positive net present value. B-C ratios were greater than unity and the internal rate of return (IRR) higher than the opportunity cost of capital (based on the average tractor purchase price for the sample).

However, at 1981 investment costs (tractor price) both tractor types were unprofitable. Based on the 1981 custom rate of Rp. 11,000/ha, the break-even area served by the gasoline tractor (now costing Rp.1,500,000) required 42.7 ha/ year to break-even, compared to only 22.3 ha/year at the 1979 purchase price of Rp 783,600. Similarly, in 1981 the diesel tractor required a break-even area of 25.1 ha at a purchase price of Rp 1,360,179 and 55.4 ha at a purchase price of Rp 3,000,000.

There is no land preparation technique which is consistently optimum from all points of view. From the private farmer's (land owner) point of view, the most important factor in determining the optimum technique is its impact on net return. If tractor land preparation increases net returns, compared to hand and animal land preparation, he will adopt it. From the society's point of view, the effects to each technique on employment and income distribution must also be considered in determining the optimum technique (Nehen and Wills, 1986). Furthermore, the population density in an area is a critical factor in determining the social impact. In high population density areas like Java and Bali, mechanization is more likely to displace labor, compared to low population density areas like South Sulawesi where most labor is supplied by the family.

A study conducted on the Consequences of Mechanization in Indonesia (West Java and South Sulawesi) raised considerable doubt regarding the contribution of two-wheel tractors in land preparation to increasing yield, employment, cropping intensity, area expansion and timeliness (Consequences Research Team, 1981). This study revealed that at existing levels of capacity utilization and contract plowing rates, individuals who invested in tractors did not cover their fixed costs and, as a result, earned negative profits.

In South Sulawesi, Arifin (1984) noted that the local government guidelines for simultaneous planting in irrigated areas have reduced the time available for land preparation. This means that available labor must be spread over a wide area. For South Sulawesi, Opu Sidik (1984) argued that an increase in tractor numbers would further stimulate small local repair and spare part industries, and provide work for unemployed youths.

Results from the Consequences of Small Farm Mechanization study in low population density Pinrang and Sidrap districts of South Sulawesi in 1979-1981 showed that farmers using mini-tractors achieved higher yields than non-users, but they also applied more inorganic fertilizer. Thus a yield impact did not exist, as a consequence of mechanization per se. In terms of labor demand, non-mechanized farms used more family labor than mechanized farm. Family labor in mechanized irrigated farms was replaced by tractors.

On the other hand, mechanized farms in Sidrap and Pinrang used more hired labor than non-mechanized farms in both irrigated and rainfed areas (Maamun, 1984).

A related study of mini-tractor owners (Hafsah and Maamun, 1984) showed that most of the tractors were purchased through credits (94%). The owners bought their tractors to used in their own farms (55%) and to rent out (45%). Finally, frequent breakdowns--due to lack of maintenance and poor operator skills--shorter the economics life of the tractors.

Despite the increased demand for tractor services in South Sulawesi, spare parts were scarce, and tractor distributors are becoming less responsible (Saleh, 1984). Due to the scarcity of spare parts and permanent repair shops, 45% of the tractors in the five districts with the largest number of tractors were damaged and not fully utilized.

CHAPTER III

RESEARCH METHODOLOGY

Data Collection

The primary data on tractor utilization used in this study were taken from the Tractor Ownership study that was a part of the Consequences of Small Rice Farm Mechanization research project, conducted in South Sulawesi, Indonesia. The research was carried out as a joint project between The International Rice Research Institute (IRRI), Maros Research Institute for Food Crops (MORIF), Agricultural Extension Service (DIPERTA) and Hasanuddin University, during 1979 - 1981.

The original data set included information on tractor earnings, costs of operation, and tractor capacity utilization. The present study uses the technical coefficients from the original study in combination with the 1990 data on costs and prices[2] to estimate current net income to tractor ownership.

The Study Area

The research area was in South Sulawesi, one of the 27 provinces in Indonesia. It consists of 23 districts, 169 sub-districts and 1,170 villages. The province is the fourth most important area (in terms of rice production) in the country, after West Java, East Java,

[2] In 1990 additional data were collected on the number of tractors, current contract rates, wages, fuel and oil prices in the study area (MORIF, 1990).

and Central Java (CBS, 1986). South Sulawesi is the major rice surplus area in the country. It has a low population density (91/sq. km), compared to 650/sq.km in East Java or 755/sq.km of Java.

Among the 23 districts in this province, two districts (Pinrang and Sidrap) were were the leading areas in terms of irrigated lowland and rice production (Agric. Extension, S.Sul.1986). Those districts were selected as research sites (Figure 1) for two reasons. First, tractors have been used in the area for many years beginning in 1969 (four years after BIMAS[3] program was introduced). The total tractor population increased and reached its peak of 628 in 1981, representing 38 percent of the total tractor population in South Sulawesi. Second, the districts are adjacent, are predominantly rice areas with a good irrigation system and most farmers have adopted high-yielding rice varieties (HYV).

The sub-districts and villages were selected that had a large (more than ten) population of tractors. In each district, three sub-districts with more than five tractors were selected. Then, eight villages were randomly selected from the list, four in each district (Table 1). The eight sample villages cultivated 15,996 ha of farm land, of which 85 percent was irrigated lowland. There were three sources of gravity irrigation water: Saddang, Bulu-Cenrana, and Bulo irrigation systems.

[3] BIMAS is the Government of Indonesias' "Mass Intensification Program", through which new technology and credit is provided to farmers.

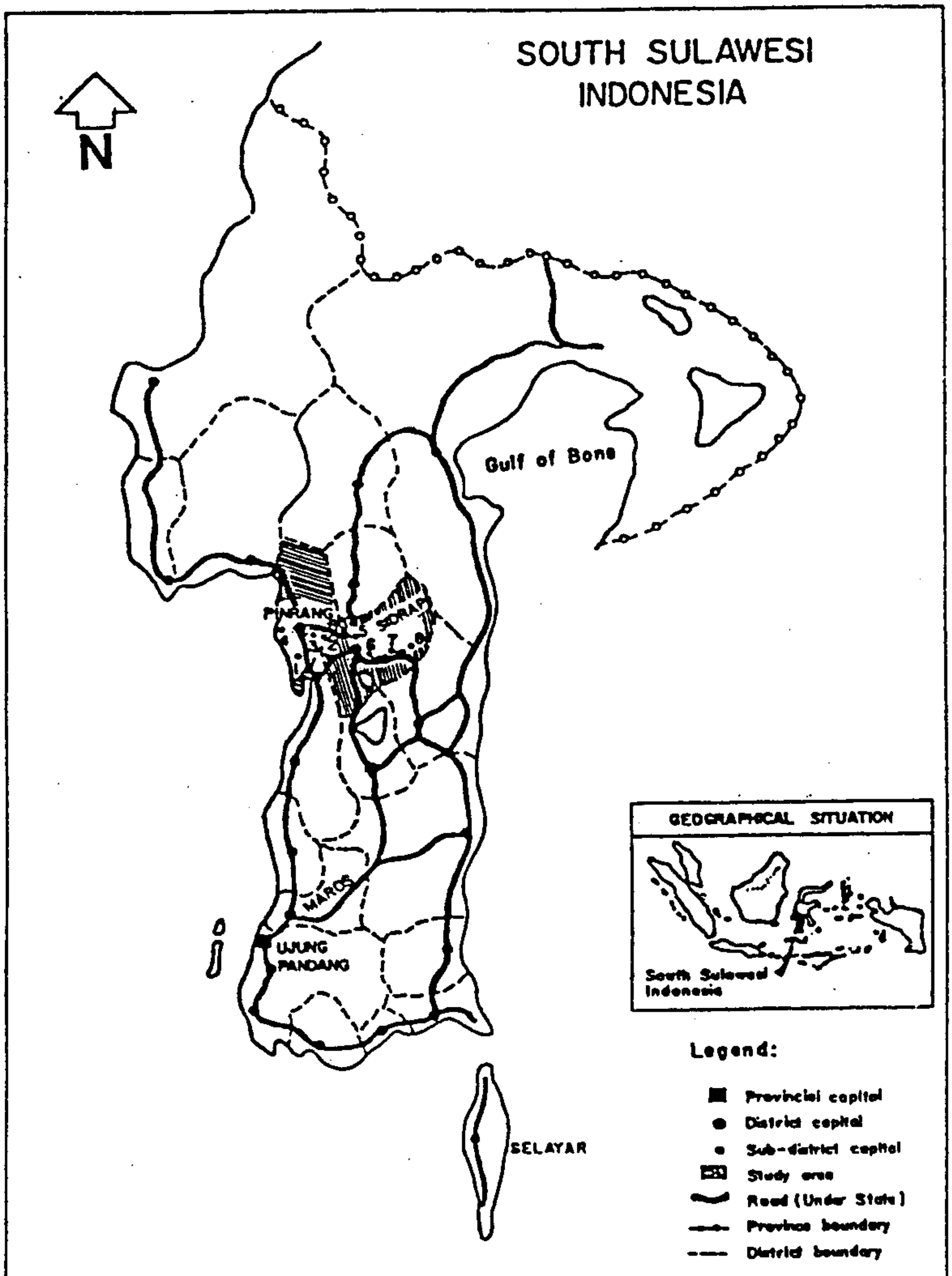

Figure 1. Location of survey area South Sulawesi, Indonesia.

Table 1. Districts, sub-districts and villages sampled in the tractor study, South Sulawesi, Indonesia.

District	Sub-district	Village
Pinrang	1. Mattirobulu	a. Padakkalawa
	2. Mattiro Sompe	b. Mattongang-tongang
	3. Watang Sawitto	c. Temmassarange
		d. Mattiro Deceng
Sidrap	1. Panca Rijang	a. Rappang
	2. Maritenggae	b. Wt.Sidenreng
	3. Dua Pitue	c. Lancirang
		d. Tanru Tedong

Source: Consequences of Mechanization Study, S.Sulawesi

Samples

First, all 149 tractor owners in the eight villages were enumerated (census) to obtain data on year of purchase, model and horse-power. Second, these tractors were stratified into five year-of-purchase vintage groups (i.e. 1975 through 1979). Finally, a random sample of 10 tractor owners were selected to represent each purchase year, resulting in a total sample of 50 owners. The 1990 data on costs and prices were collected by staff of the Maros Research

Institute for Food Crops and were combined with the original tractor survey data to estimate the profitability of tractor ownership under current prices.

Analytical Procedure

Break-even Analysis (Financial)

Break-even analysis (BEA) indicates the level at which an investment incurs neither a loss nor produces a profit. For the farmer who invests in a piece of farm equipment, this is the level of equipment use at which the total annual costs are covered by its earnings. In the case of a tractor, the earnings from total hectares of land cultivated is usually used as the basis for calculating benefit-cost.

Fixed and Variable Costs.

In this analysis, tractor costs are divided into two major categories: fixed and variable costs.

Fixed costs include depreciation and interest[4] on capital investment. The straight line method is used to calculate depreciation.

The variable costs consisted of fuel, oil, driver, and repair & maintenance costs.

[4] Tractor are often purchase on credit, with money borrowed from the bank or other lending agencies. For farmer purchasing with cash, an interest charge equal to the bank rate was charged because the farmers' saved money also has an opportunity cost.

Formula

The tractor break-even analysis is carried out using the following formula (Wattanutchariya and Pakuthai, 1981):

$$CR\ (X) = AFC + AVC\ (X)$$

$$CR\ (X) - AVC\ (X) = AFC$$

$$X\ (CR - AVC) = AFC$$

$$BE_{ha} \text{ or } X = \frac{AFC}{CR-AVC}$$

where :

BE_{ha} = break-even hectares

X = Break-even hectares i.e. the require hectares needed to cover the total annual cost of tractor use.

CR = custom or contract rate in Rupiah/hectare.

AFC = average fixed cost/year is the sum of depreciation (D) and interest on capital investment (I)

AVC = average variable cost in Rupiah per hectare, as previously defined.

A Graphic Representation

Under diminishing cost, the break-even point can be calculated by using the average cost function. The average cost curve is shown in Figure 2.

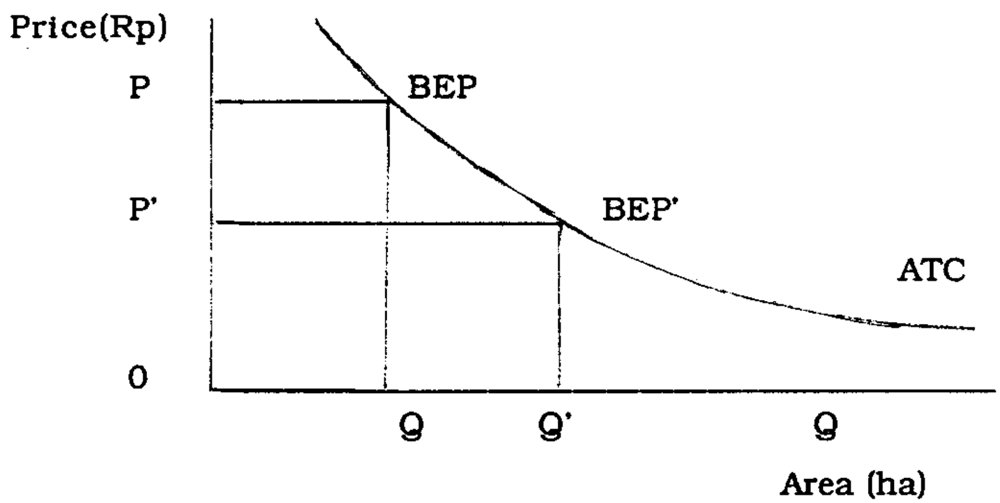

Figure 2. Break-even point under diminishing cost.

If the custom rate is OP, the break-even point (BEP) will be at OQ. If the custom rate falls to OP', the break-even point will be at OQ'.

Assumptions

The assumptions underlining the analysis are as follows :

1. The expected economic life of the tractor is five years.
This estimate is based on the owners' observations (made during the initial survey) that after five years of use (10 seasons), most tractors broke down frequently and are no longer operable in the sixth year.

2. After five years of use, the salvage value of the tractors is estimated at 10 percent of the initial capital investment.

3. The nominal interest rate of capital is 15 percent per annum (1990), based on the rate charged for credit by government banks.

4. The flows of benefits and costs are based on observed receipts and expenses for the tractors in the original sample (1979), adjusted for 1990 prices.

Sensitivity Analysis

Sensitivity analysis is the most common method to evaluate risk associated with an investment (Levy and Sarnat, 1982). Sensitivity analysis measures the effect of changes in the variable of interest on changes in other variables (DeGarmo, 1979). A sensitivity analysis is done by varying one element or a combination of elements and determining the effect of that change on the outcomes (Gittinger, 1982)

This study analyzes the effect of changes in four independent variables on the profitability of tractor purchase decision. The variables in the present analysis include: a) tractor capacity (hectares plowed per year. b) initial investment cost. c) contract rate (Rp/ha). and d) economic life of the machine (year).

a. Sensitivity to Capacity Utilization

As illustrated in Table 2, tractor revenue (1a) and variable costs (2b) vary in direct proportion to capacity utilization.

b. Sensitivity to Tractor Price

Changes in the tractor price will affect the depreciation and salvage value. Assuming the tractor cultivates the same number of hectares each year, revenues and variable costs will remain unchanged, regardless of purchase price.

c. Sensitivity to Contract Rate

Changes in the tractor contract rate will not affect variable under group 2a and 2b (Table 2), except tractor drivers' wage. Tractor revenue will vary in direct proportion to the contract rate.

d. Sensitivity of the Economic Life of the Machine

Changes in the economic life of the machine affect annual depreciation and interest charges on the investment.

Table 2. Variables used for sensitivity analysis

No	Variables	
1.	Revenue	
	a. Revenue = cap.util.(ha served x custom rate(Rp/ha)	= R_1
	b. Salvage value = 10 percent of initial cost	= R_2

		TR
2.	Cost	
	a. Fixed cost (initial cost)	= C_1
	b. Variable cost	
	Fuel = liter/ha x price(Rp/l)x area served(ha/yr)	= C_2
	Oil = liter/ha x price(Rp/l)x area served(ha/yr)	= C_3
	Driver = wage(Rp/ha) x area served(ha/yr)	= C_4
	Repair & Maintenance = cost(Rp/ha) x area served (ha/yr)	= C_5

		TC
3.	Profit (Net benefit)	
	Profit (π) = Total Revenue (TR) - Total Cost (TC)	

CHAPTER IV

ASPECTS OF LAND PREPARATION IN SOUTH SULAWESI

Power Sources Alternatives.

Manual, animal and mini-tractors were the main sources of power for land cultivation in this areas. Since the mid-1970s, the demand for tractors[5] for land preparation has increased rapidly, as indicated by their growing population. The total number of mini-tractors in the two districts increased from 18 units in 1974 to 628 units in 1981. From 1982 to 1989 the number fluctuated and in 1989 it decreased to 489 units. The number of tractors in the eight villages also increased during the same period, from 4 units in 1974 to 190 in 1981 (no data available for 1989).

As alternative types of power for land preparation, farmers also used animals (cows and buffaloes) and manual labor (hoe). Horses were seldom used for land preparation, but frequently for transportation. The household census data (1979) showed that the farmers have gradually shifted from using manual and/or animal power to combinations of manual + tractor and manual + animal + tractor (Maamun, 1983). One advantage of tractor land preparation is that it can complete the job almost ten times faster than manual, or 2.4 faster than animals.

Relative Costs.

In 1980, tractor land preparation was less costly than manual and slightly more expensive than owned-animal land preparation (Table 3).

[5] Throughout the text, the term tractor refers to 4-wheel mini-tractor at 12-16 hp.

Table 3. Cost of land preparation by power type, South Sulawesi, Indonesia, 1980 and 1990.

Item		Power types			
		Manual (hired)	Animal(a pair) Owned	Animal(a pair) Hired	Tractor
Time required[a]					
Hours/ha		182	48		20
Days/ha		23	6		2.5
Cost components (Rp/ha)					
Driver[b]	(1990)	na	15,000	15,000	na
	(1980)	na	6,000	6,000	
Herdsmen[c]	(1990)	na	24,500	24,500	na
	(1980)	na	11,200	11,200	na
Animal[d]	(1990)	na	na	63,000	na
	(1980)	na	na	28,800	
Total	(1990)	57,500[b]	39,500	102,500(75,000)[e]	80,000
Custom rate	(1980)	23,000	17,200	46,000	19,000[f]

na = indicates not applicable

[a]Sources : Direktorat Tehnik Pertanian, Jakarta. 1974; Morris, R.A. 1975; and Consequences of Mechanization Survey, 1979.

[b]Manual and animal driver wages in 1990 and 1980: Rp 2,500 and Rp1,000/day including meals, respectively.

[c]Herdsman cost: 350 kg paddy/pair/season.A pair of draft animal can serve 2.5 ha, per season = 140 kg/ha/pair/season, equivalent to Rp.11,200 (price of paddy Rp.80/kg) in 1980, and Rp.24,500 (price of paddy Rp175/kg) in 1990.

[d]Animal hired = 900 kg paddy/pair/ season.For 2.5 ha/season area served = 360 kg/ha, equivalent to Rp 28,800(1980) and Rp 63,000 (1990).

[e]Figures in parenthesis are based on contract arrangement.

[f]This figure represents the1980 official rate, while the break-even analysis used the average actual rate.

The exchange rate were US $ 1=Rp 625 (1980) and Rp1,825(1990), respectively.

From 1980 to 1990, the nominal cost of land preparation per hectare increased by 150, 129, 123, and 321 percent; for manual, animal owned, animal hired, and tractor, respectively. Thus, in 1990 tractor land preparation was significantly more expensive than manual or animal land preparation.

Tractor utilization.

Table 4 shows tha tractor utilization pattern (mean hectares plowed on-farm and as custom work, by season) for units purchased in 1975 through 1979[6].

Four aspects of the utilization pattern stand out. First, owners only used their tractors for land preparation, but never for transportation. Second, owners plowed more hectares (60-70%) during the wet than during the dry season. Third, the average annual hectarage cultivated (based on season of own farm and custom work use) declined from 60.7 in the first year to 17.0 hectares in the fifth year. This was probably due to declining capacity utilization (associated with age and poor maintenance) and the increasing number of tractors in the area which made competition keen. Consequently, over the five-year working life of the tractors, each unit prepared an average of only 51.7 hectares annually. Fourth, in all years the own-farm area plowed was much smaller than the area of custom work, with only 13 percent of the cultivated area on own-farm and 87 percent off-farm. This was because, given their small farm sizes, owners could not fully utilize the tractor's work capacity and had to hired out tractor services to neighboring farms (Hafsah and Maamun, 1984).

[6] Since the data were collected in 1980, complete data (fine years) was only available for unit purchased in 1975.

Table 4. Tractor utilization pattern (hectares per tractor) by season, year and year of purchase 1975 - 1979, South Sulawesi, Indonesia.

Year Purchase		Year 1st WS	1st DS	2nd WS	2nd DS	3rd WS	3rd DS	4th WS	4th DS	5th WS	5th DS	Mean
Observations.		50		40		30		20		10		
1975	OF	4.4	4.2	2.3	2.3	3.4	3.4	3.3	2.3	2.8	1.6	6.0
	CW	32.0	29.8	30.8	23.7	28.6	17.4	16.0	11.1	7.7	4.9	40.4
1976	OF	5.5	4.5	5.4	5.1	5.0	4.7	3.4	0.5	-	-	8.5
	CW	31.5	29.9	29.3	26.4	24.3	17.2	21.6	2.9	-	-	45.8
1977	OF	5.3	2.4	5.1	2.0	4.1	2.2	-	-	-	-	7.0
	CW	36.2	27.8	33.2	13.5	20.1	8.8	-	-	-	-	46.5
1978	OF	3.9	2.4	3.9	2.9	-	-	-	-	-	-	6.5
	CW	35.8	18.0	20.5	10.3	-	-	-	-	-	-	42.3
1979	OF	3.6	2.5	-	-	-	-	-	-	-	-	6.1
	CW	37.3	24.9	-	-	-	-	-	-	-	-	62.2
Ha/T/	OF	4.5	3.2	4.2	3.0	4.2	3.4	3.3	1.4	2.8	1.6	
Season	CW	34.6	26.1	28.4	18.5	24.3	14.5	18.8	7.0	7.7	4.9	
Total		39.1	29.3	32.6	21.5	28.5	17.9	22.1	8.4	10.5	6.5	
	OF	7.7		7.2		7.6		4.7		4.4		6.9
Year	CW	60.7		46.9		38.8		25.8		12.6		44.8
Total		68.4		54.1		46.4		30.5		17.0		51.7

WS = wet season, DS = dry season, T = tractor, OF = own farm, CW =custom work, Ha = hectare.

Source: Consequences of Mechanization Study, S. Sulawesi.

Credit Policy.

In Indonesia, tractor purchases have been subsidized through institutional credit. Some rich farmers, owing to a lack of alternative sources of investment, may have overinvested in tractor. In some cases, they may have been encourage by the status symbols value of being an owner.

Data on loans advanced by banks to farmers to purchase tractors showed that up to 1980, 79 percent of all machines in the sample were acquired through subsidized credit (Maamun, 1983). The nominal rate of interest charged was 12 percent (1980-1984), much lower than the rate charged (20-30%) for similar long-term loans by non-government lending agencies. From 1984 up to the present (1990), government banks charged a nominal rate of interest of 15 percent, compared to 30 to 35 percent by private lending agencies. This implies the availability of capital at low interest rates still constitutes an incentive for tractorization.

The fact that 79 percent of the tractor were purchased through subsidized bank loans indicates that subsidies substantially increased the number of tractors purchased from 1975 to 1979 (Table 5).

Repair and Maintenance Problems.

The cost of tractor repair and maintenance depends on the frequency of tractor breakdowns. Data from the tractor owner samples (Hafsah and Maamun, 1984) indicated that the most frequent breakdowns were due to problems affecting the transmission (34%), implements (29%), and the engine (25%). Frequent damage to the transmission was due to frequent stopping and starting under load.

Table 5. Tractor purchases, by sources of credit for the eight sample villages, South Sulawesi, Indonesia.

Year purchased	Cash	Source of loan		Total
		Dealer	Bank	
1974	1	3	0	4
1975	0	4 (1)	11 (9)	15 (10)
1976	5 (1)	6 (3)	28 (6)	39 (10)
1977	2 (1)	6 (4)	12 (5)	20 (10)
1978	2 (1)	2 (1)	8 (8)	12 (10)
1979	0	0	59 (10)	59 (10)
Total	10 (3)	21 (9)	118 (38)	149 (50)
%	7 (6)	14 (18)	79 (76)	100 (100)

Figures in parentheses refers to the tractor sample
Source: Consequences of Mechanization study, South Sulawesi.

High implement damage (especially to rotary-blades) resulted from the inferior quality of replacement parts. Engine damage (especially the piston) was due primarily to delayed oil changes and continues operation beyond the recommended hours. These explanations are consistent with the owners' observations that the main factors associated with breakdowns were poor maintenance by the driver (34%), followed by the drivers' inexperience (22%), frequent turnover of drivers (19%), distance and poor service of the repairshops (16%) and low quality of equipment (9%). Consequently, it appears that tractor breakdowns could be reduced through better driver training and supervision (Hafsah and Maamun, 1984).

Delays in repair were due to difficulties in obtaining spare parts. Tractor owners complained of long delays due to spare parts shortages at the repair shops, at the dealerships and in the central store. Farmers reported that spare parts were not always available when needed (43%), they had to travel long distances to the repair shops (24%), they did not have time to travel long distances to the shop (20%), and they had a shortage of cash to pay for repairs (12%).

Fixed and Variable Costs.

Changes in the fixed and variable cost shares of total costs were examined by comparing the costs in 1980 to 1990. Table 6 shows that in 1980, fixed costs represented a larger share (64%) of total costs than in 1990 (49.5%) -- due to relative greater cost increase for variable inputs (402%), compared to fixed cost (179%).

Table 6. Cost components (Rp/ha) of tractor utilization 1980 and 1990, South Sulawesi, Indonesia.

Costs	1980		1990		Change(%)	
	Rp/ha	%	Rp/ha	%	Rp/ha	Share
Fixed						
Depreciation	7,980	43.6	20,615	31.2	158	-28
Interest	3,737	20.4	12,067	18.3	222	-10
Sub-total	11,717	64.0	32,682	49.5	179	-23
Variable						
Fuel	1,335	7.3	6,600	9.9	394	36
Oil	380	2.0	2,025	3.1	432	55
Driver	2,500	13.7	12,800	19.4	412	42
Repair & Maint.	2,383	13.0	12,000	18.1	404	39
Sub-total	6,598	36.0	33,425	50.5	402	40
Total	18,315	100.0	66,107	100.0	261	na

na indicates not applicable

Characteritics of Tractor Owners.

The tractor owners were mainly middle aged (40 years), had minimal formal education (4.6 years), and had seven household members. In addition to farming as their main occupation, some earned income as traders. They owned 7 ha of lowland (valued at

Rp. 10.5 million), in addition to cattle, animals, buildings and other assets. Their combined total asset value was approximately Rp 14.195 million (Consequences Team, 1981). Their tractor experience ranged from one to five years, and several had operated other machinery such as rice mills and power sprayers.

Compared to the tractor ownwer, the non-owner and/or non-mechanized farmers included in the larger "Consequences Survey " were similar in age (41 years old), and number of household members (7), but were less educated (3.8 years) and had fewer assets, especially lowland (owning or cultivating only 1.34 ha of land).

The owners gave several reasons for purchasing a tractor. Since most owners were also large land owners, it is consistent that the most common reason was "to cultivate their own land" (44%). Only 26 percent expected to earn money by renting out the tractor to neighboring farmers (particularly when pressed to meet repayments). Seventeen percent purchased because credit was available and only six percent because it enhanced their social prestige.

With respect to the benefits associated with tractor ownership, the respondents noted the most important benefit was the potential for timely planting (29%), followed by more thorough land preparation (25%), and reduced hired labor requirements (25%). Only 10 percent reported that the tractor increased yield and/or reduced drudgery (Maamun, 1984).

These responses were different than those given by farmers hiring custom services. The most important reasons for those hiring tractors was better land preparation (41%), more timely planting

(28%), with less emphasis on reducing hired labor requirements and drudgery.

Characteristics of Tractor Operators

To operate the 50 sample tractors, 70 operators/drivers were employed. Sixty-nine percent had a primary education, 17 percent had completed secondary/high school, three percent had attended college, and the remaining 11 percent had no formal education. In terms of experience with tractor land preparation, 64 percent had 1-2 years, 32 percent had 3-4 years and only 4 percent had 5-6 years experience.

Operators/drivers had only minimal formal training in how to operate the tractors. Eighty-three percent had never attended any formal training in tractor use, 16 percent had attended one course and one percent went twice. For those receiving some training, 42 percent were only taught how to drive, 25 percent reported they had been trained on the fundamentals of the machine, and 33 percent received both types of training.

The most important reasons cited for being an operator were the high wage which can be earned from driving tractors (48%). Several indicated it was a trial or experiment (27%) and some said it increased social prestige (25%). Most were engaged in agriculture (88%), but some were employed in the service sector(12%), in addition to being an operator.

CHAPTER VI

TRACTOR INVESTMENT DECISIONS USING A COMPUTER SPREADSHEET TEMPLATE

Tractor Investment Template.

A tractor investment template is a spreadsheet that includes the technical coefficients and formulas required to evaluate tractor investment decisions. With slight modification, this template could be used to evaluate investment decisions for other farm machines such as rice mills and water pumps .

"Microsoft Excel", which runs on IBM compatible and Macintosh microcomputers, was the software program used for this purpose. Excel is a very powerful tools for manipulating data which are entered into the cells. Calculations on the spreadsheet are obtained by using the "menu" that appears on the top of the work-sheet. The menu consists of the following options: File, Edit, Formula, Format, Data, Options, Macro and Window. Each menu contains several sub-menus. For example: under Formula, we can select SUM to do summation, AVERAGE to calculate the mean and so on.

In using Excel, the first task is to create a worksheet that can be used as a database. Excel worksheet has 16,384 rows and 256 columns. The columns are labeled from left to right, beginning with A through Z. After Z, labeling continues with AA through AZ, then BA through BZ, and so on to column IV. The monitor displays only a portion of the worksheet at any one time. To see all the rows and columns, the user must scroll the worksheet within the window. In the worksheet, the first active cell, column A and row 1, is refered to as A1. To enter data or a formula into a cell, first select the cell to work with, then type in the desired data/formula.

Table 7 presents the Baseline estimate of the costs and returns to the tractor investment. The table is divided nine sections. Section I - III presents the data (technical coefficients) obtained from the farmers/tractor owners (hectares cultivated, other tractor uses, the custom rate, fuel and oil used and its prices, and costs for driver and repair/maintenance) and variable costs estimates, based on these data. Section IV and VII present the calculated cost of owning the tractor (fixed cost) and the net returns or losses from tractor ownership, based on the information from section I through III. Section VIII presents the capital and interest computations and Section IX presents methods of computation and explanations.

Break-Even Analysis (financial results)

The break-even analysis is used to estimate the custom rate (or ha plowed) required to cover annual fixed and variable cost. Variable costs include annual cost for fuel, oil, operator/driver wage, repair and maintenance, assuming a five-year working life for the tractors. Fixed cost include annual depreciation (capital cost) and interest, assuming a five-year working life for the tractors. The straightline method was used to compute depreciation. Interest rates of 12% and 15% per year were charged for the tractor pooled-group (1975-79) and units bought in 1990, respectively.

	A	B	C	D	E	F	G	H	I
1									
2									
3									
4									
5		**Table 7. Baseline estimate of tractor investment (Template)**							
6			(See Notes and Computation Methods in IX)						
7									
8	I	**Farmers Data**							
9			First yr	Second yr	Third yr	Fourth y	Fifth yr	Ave(75-79)	1990 prices
10									
11		No.of Observation	50	40	30	20	10	150	150
12		Hectares cultivated	68.4	54.1	46.4	30.5	17	51.71	51.71
13		Other tract.use(km)	0	0	0	0	0	0	0
14		Price of fuel(Rp/l)	37.15	37.80	43.68	42.94	45.38	39.95	200
15		Price of oil(Rp/l)	396.60	388.19	445.51	464.09	481.44	418.79	2250
16		Av.Custom Rate(Rp/h	14172	14470	17271	18564	22059	15983	80000
17		Av.Other use(Rp/km)	0	0	0	0	0	0	0
18									
19									
20									
21	IIa	**Av.Fuel & Oil use**							
22		Fuel (l/ha)	28.88	28.30	34.10	44.22	46.72	33.004	33.004
23		(l/km)	0	0	0	0	0	0	0
24		Oil (l/ha)	0.85	0.86	0.93	0.97	1.12	0.90	0.90
25		(l/km)	0	0	0	0	0	0	0
26									
27	IIb	**Share of Variable Costs(%)**							
28		Driver for Cult.	0.14	0.14	0.15	0.18	0.23	0.16	0.16
29		Driver for Other	0	0	0	0	0	0	0
30		Rep & Main.(Cult)	0.07	0.10	0.17	0.31	0.23	0.15	0.15
31		Rep & Main.(Other)	0	0	0	0	0	0	0
32									
33									
34									
35	III	**Variable Costs of Operation for Cultivation and Other uses**							
36									
37		Fuel cost (Rp/ha)	1073	1070	1489	1899	2120	1335	6600.8
38		(Rp/km)	0	0	0	0	0	0	0
39		Oil cost (Rp/ha)	337	334	414	450	539	380	2025
40		(Rp/km)	0	0	0	0	0	0	0
41									
42		Driver Cost(Rp/ha)	1967	2097	2527	3274	5148	2500	12800
43		(Rp/km)	0	0	0	0	0	0	0
44		R & M cost (Rp/ha)	930	1390	2965	5777	5093	2383	12000
45		(Rp/km)	0	0	0	0	0	0	0
46									
47		Tot.Var.Cost(Rp/ha)	4308	4891	7396	11400	12901	6599	33425.8
48		(Rp/km)	0	0	0	0	0	0	0
49									
50									

	A	B	C	D	E	F	G	H	I
54									
55									
56									
57			First yr	Second yr	Third yr	Fourth y	Fifth yr	Ave(75-79)	1990 prices
58									
59	IV	**Fixed Cost of Owning of Tractor**							
60									
61		Ann.Cap.cost(Rp/yr)	0	452880	452880	452880	704480	412624	1066000
62		(Rp/ha or km)	0	8371	9760	14849	41440	7980	20615
63		Ann.Int.cost(Rp/yr)	301920	247574	193229	138883	84538	193229	624000
64		(Rp/ha or km)	4414	4576	4164	4554	4973	3737	12067
65		Tot.F.Cost (Rp/yr)	301920	700454	646109	591763	789018	605853	1690000
66		(Rp/ha or km)	4414	12947	13925	19402	46413	11717	32682
67									
68									
69	V	**Calculation of Depreciations and Capital costs (see VIII)**							
70									
71				IC(Rp000)	SV(10%)	Depr(Av)	Cap.Cost	Int.Rate	
72									
73		Av.1975-79		2516	251600	412624	193229	12%	
74		1990		6500	650000	1066000	624000	15%	
75									
76									
77	VI	**Summary of Tractor Costs**							
78			First yr	Second yr	Third yr	Fourth y	Fifth yr	Ave(75-79)	1990 prices
79		Total Var.Costs							
80		Cultivation	4308	4891	7396	11400	12901	6599	33426
81		Other uses	0	0	0	0	0	0	0
82									
83		Total Fixed Cost	4414	12947	13925	19402	46413	11717	32682
84									
85		Total Costs	8722	17838	21320	30802	59313	18316	66108
86									
87									
88	VII	**Return or Loss from Tractor Ownership**							
89									
90		Rev-Cultiva(Rp/ha)	14172	14470	17271	18564	22059	15983	80000
91		-Others(Rp/km)	0	0	0	0	0	0	0
92		Total Revenue(Rp)	14172	14470	17271	18564	22059	15983	80000
93									
94		Cost for Cult.(Rp)	8722	17838	21320	30802	59313	18316	66108
95		Cost for Others(Rp)	0	0	0	0	0	0	0
96		Total Cost (Rp)	8722	17838	21320	30802	59313	18316	66108
97									
98		NR from Cult(Rp/ha)	5450	-3368	-4049	-12238	-37254	-2333	13892
99		NR from Others(Rp)	0	0	0	0	0	0	0
100		Total Return (Rp)	5450.42	-3368.1	-4049.5	-12238	-37254	-2333.28	13891.93
101									
102									

	B	C	D	E	F	G	H	I
103								
104								
105								
106	VIII	**Calculation of Capital cost and Interest Cost**						
107								
108		**Year**	**Init.cost**	**Capital c**	**Remainin**	**Interest**		
109								
110		**Entire group(1975-79) at 12% interest**						
111		Year1	2516000	0	2516000	301920		
112		Year2	2516000	452880	2063120	247574		
113		Year3	2063120	452880	1610240	193229		
114		Year4	1610240	452880	1157360	138883		
115		Year5	1157360	452880	704480	84538		
116			Salvage	251600				
117								
118			Average	412624		193229		
119								
120		**1990 prices at 15% interest**						
121		Year1	6500000	0	6500000	975000		
122		Year2	6500000	1170000	5330000	799500		
123		Year3	5330000	1170000	4160000	624000		
124		Year4	4160000	1170000	2990000	448500		
125		Year5	2990000	1170000	1820000	273000		
126			Salvage	650000				
127								
128			Average	1066000		624000		
129								
130		Note:	Cap.cost/Depreciation= I.Cost-S.Value/lifetime					
131			Salvage Value is 10% of Initial Cost					
132			Remaining Balance (col. O)=Initial Cost(col.M)-					
133				Capital cost(col.N)				
134			Col.P = interest on capital at 12% and 15%					
135								
136								
137	IX	**Methods of Computation**						
138								
139	I, IIa =	Based on actual obsevation						
140	IIb =	Percent of Custom rate or Other uses. Example:C23=C37/C13						
141		The Average value using formula: Hij=(Ci*ni+. . .+Gi*ni)/N						
142	III =	Price * the amount used. Example: C32=C11*C17						
143		Cost for Driver, Repair & Maintenance based on actual observation						
144		TC=SUM(Row 32+34+37+39)						
145	IV =	Row 57: Depreciation based on formula: (I.Cost-S.Value)/Lifetime						
146		Where Salvage Value= 10% of Initial Cost computed at the 5th year						
147		No payment from the first year						
148		Downpayment for the 2nd to 5th year=Cap.Cost+Interest						
149		Nominal Interest rate: 12%(av.1975-79) and 15%(1990)						
150		No separation on cap.cost & interest between cult.and other uses						
151	V =	is used for IIb						
152	VII =	Tractor returns based on cultivation and other uses.						
153		Net Return=Revenues-Costs						
154								

Estimated annual costs for both tractor groups, are shown in Table 8; and the break-even analysis is presented in Table 9, based on the calculation on Appendices 2 and 3. The analysis shows that given the costs and custom rates that existed in 1980, it was necessary to cultivate 64.56 ha to break-even. But, as shown in Table 4, owners averaged only 51.7 hectares per year. Thus, to become economical, given 1980 costs and custom rates, owners would had to increase the area cultivation by more than 12.85 ha or increase the contract rate from Rp 15,983 (the 1980 custom rate) to more than Rp 18,315 per hectare. Tractor owners in 1975-79 did not break-even because a lack of custom work (due to competition), reduced demand, resulting in lower contract rates. In addition, short periods of time for land preparation, and frequent breakdowns were also major problems.

On the other hand, assuming 1990 costs, and custom rate (Rp 80,000) owners would break-even by cultivating only 36.27 hectares. Alternatively, if they plowed 51.7 hectares per year, they could break-even by a custom rate of Rp 66,108 to cover variable and fixed costs.

Table 8. Cost components (Rp) of tractor utilization for break-even analysis, South Sulawesi, Indonesia.

Cost item	Pooled prices (1975-79)	1990 prices
Fixed Cost (Rp/yr.)[a]		
Depreciation	412,624	1,066,000
Interest on capital	193,229	624,000
Sub-total	605,853	1,690,000
Variable Cost (Rp/ha)[b]		
Fuel cost	1,335	6,601
Oil cost	380	2,025
Driver cost	2,500	12,800
Repair & maintenance	2,383	12,000
Sub-total	6,598	33,426
Exchange rate (Rp/$)	625	1,825

[a]This analysis assumes a five year working life.
[b]Derived from Table 7.

Table 9. Break-even area cultivated and contract rate for tractor operation, South Sulawesi, Indonesia.

Item	Pooled prices 1975-1979	1990
No. of observation	150	150
1. Area cultivated (ha/yr.)		
a. Required to break-even	64.56	36.27
b. Actual	51.71	51.71
c. Difference (b-a)	-12.85	15.44
2. Contract rate (Rp/ha)		
a. Required to break-even	18,315	66,108
b. Actual	15,983	80,000
c. Difference (b-a)	-2,332	13,892

Sensitivity Analysis

Based on the baseline capacity level (51.7 hectares per year), a five- year economic life, and a 15 percent discount rate, the benefit-cost ratio (BCR), net present value (NPV) and internal rate of return (IRR) were 1.13, Rp 1,896,000 and 27.07 percent, respectively (Appendix 4). Sensitivity analysis shows the effect of a change in one or more critical variables on decision variables. The critical variables of interest in the present analysis are: capacity utilization, tractor price, contract rate, and a tractor's economic live. Table 10 shows the values

Table 10. Values used in the sensitivity analysis.

Item	Baseline values	Values used Sens. Analy. Value	Change(%)[a]
Capacity utilization (ha/yr.)	51.7	56.9[a]	+10
Contract rate (Rp 000/ha)	80.0	88.0 (64.0)	+10(-20)[b]
Tractor Price (Rp 000)	6,500	7,150	+10
Economic life (yr.)	5	6	+20
Interest (discount) rate (%)	15	30	+50

[a]Change, relative to the baseline value.

[b]Reduction of 20 percent shown in parenthesis.

that were initially used in the baseline break-even analysis; and the values used in the sensitivity analysis.

Sensitivity to Capacity Utilization

Total revenue and variable cost changed in direct proportion to the capacity utilization level. Increasing the capacity utilization by 10 percent to 56.9 hectares, increased the B-C ratio, NPV, and IRR to 1.19, Rp 2,707,000 and 30.74 percent, respectively (Table 11). These changed represent an increased of 5, 43 and 14 percent, respectively, compared to the baseline value.

Sensitivity to Purchase Price

Increasing the initial tractor purchase price greatly reduced the profitability of tractor ownership (Table 11). A 10 percent increase in the purchase price (at the discount rate of 15%), decreased the B-C ratio, NPV and IRR to 1.07, Rp 1,246,000 and 22.93 percent, respectively. These changed represent a declined of 5, 34 and 15 percent, respectively, compared to the baseline value.

Sensitivity to Discount Rate

Increasing the discount (interest) rate from 15 percent to 30 percent reduced the B-C ratio to 0.9 resulted in a negative NPV (-Rp.1,111,000). These changed represent a declined of 20, and 159 percent, respectively, compared to the baseline value.

Sensitivity to the Contract Rate

Reducing the contract rate reduced total revenues in direct proportion to the change. By decreasing the contract rate by 20 percent, the B-C ratio, NPV and IRR declined to 0.9, -Rp 879,000 and 6.75 percent, respectively (Table 11). These changed represent a decline of 20, 146 and 75 percent, respectively, compared to the baseline values.

Sensitivity to Economic Life

Analysis of sensitivity to economic life shows that with a six year working life (instead of five), the B-C ratio, NPV and IRR increased to 1.22, Rp 2,894,000, and 30% respectively (Table 11). These changes represented an increase of 8, 53 and 10 percent respectively, compared to the baseline estimates.

	V	W	X	Y	Z	AA	AB	AC
1								
2								
3								
4								
5			**Table 11. Sensitivity Analysis on variables of interest**					
6								
7					**Variable of interest**			
8			Disc.rate	Base Run	Cap.Util(+10%	Tr.Price(+10%)	Cont.rate(-20%)	
9		**Five-year**						
10		BCR	15%	1.13	1.19	1.07	0.90	
11			30%	0.96	1.01	0.90	0.77	
12								
13		NPV	15%	1896000	2707000	1246000	-879000	
14			30%	-461000	128000	-1111000	-2477000	
15								
16		IRR		27.07	30.74	22.93	6.75	
17								
18								
19		**Six-year**						
20		BCR	15%	1.22	1.28	1.17	0.98	
21			30%	1.00	1.06	0.95	0.80	
22								
23		NPV	15%	2894000	3809000	2272000	-239000	
24			30%	-3000	636000	-653000	-2190000	
25								
26		IRR		29.99	33.01	26.65	13.16	
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								

CHAPTER VII

SUMMARY AND RECOMMENDATION

Summary

Tractors have been introduced in several areas of Indonesia to augment manual and animal land preparation, in the belief that tractors would increase yield, increase cropping intensity, and reduce drudgery. Tractors have been promoted in both the most populous areas of Java-Bali since the mid-1960s and in sparsely populated areas of Sulawesi since the early 1970s. The rapid increase in the tractor population, particularly in Java-Bali has created concerns among social scientists that tractorization willi displace labor and increase unemployment.

The objectives of the study were to: 1) review tractor mechanization field studies in Asia, Indonesia, and South Sulawesi in particular, 2) develop a spreadsheet to estimate tractor operating and financing costs, 3) estimate average private tractors costs for cultivation in 1990, and 4) illustrate the use of the spreadsheet to as a tool to provide information to potential tractor buyers regarding the profitability of purchasing.

Data collected under the IRRI research project "The Consequen ces of Small Rice Farm Mechanization in Asia" were used for this study. The original study was conducted in two districts, Pinrang and Sidrap of South Sulawesi. Primary data on tractor ownership and use (tractor earnings and costs) were collected through interviews with the owners, drivers and users in eight villages in the two districts. The tractor data were grouped, based on the year the tractors were purchased, and then pooled for the years, 1975-79. The current analysis a) estimates the profitability of tractor ownership in 1975-79, and b) uses the technical data from the 1975-79 study, and 1990 cost and prices to estimate current tractor profitability in 1990.

Tractor profitability was estimated using a program called "Microsoft Excel" that runs on IBM compatible and Macintosh microcomputers. Profitability was measured using cost-benefit, break-even analysis, and sensitivity analysis.

In 1975-79, tractor ownership was found unprofitable. For the sample of tractor owners, the B-C ratio was 0.87. The break-even analysis showed that in 1975-79, to break-even tractors owners had to plow 64.6 ha/year, compared to the actual capacity utilization level of 51.7 ha/year. Low capacity utilization resulted from competition with alternative power sources, which required tractor owners to set contract rates at Rp 15,983, below the official rate of Rp 19,000. Also, government subsidization of tractor credit led to a rapid expansion of tractors in the area--thereby creating intense competition between tractor owners, who therefore reduce their contract rates.

In 1990, tractor ownership was markedly profitable. At 1990 prices, the B-C ratio was 1.13, the IRR was 27.07 and the NPV was Rp 1,896,000. Sensitivity analysis showed that profitability (B-C ratio) increased substantially when (a) the depreciation period was increased from 5 to 6 years (+ 8%), and (b) capacity utilization was increased by 10% (+ 7.6%). On the other hand, the B-C ratio (a) fell to 0.96 (-15%) when the interest rate was increased from 15 to 30%, (b) fell to 0.77(-14%) when the contract rate was reduced by 20%, and (c) fell to 0.9 (-15.9%) when the tractor price was increased by 10%.

The main factor that explained greater private profitability in 1990 was the high contract plowing rate owners received, which made it possible to break-even by plowing only 36.3 ha in 1990, compared to 64.6 ha in 1975-79. This high rate (39% above the rate for manual and 6.7% above the rate for hired animal land preparation) resulted from a government requirement that tractor owners all charge the official rate of Rp 80,000 and a declined in the availability (supply) of tractors, which reduced competition for plowing services. Farmers continue to hired tractor plowing services at this high rates because tractor plowing allow them to meet the need to plow their fields quickly when irrigation water was available and thereby trans-planting on time.

Recommendations

This study highlight the significant impact of government policies on the private profitability of tractor ownership. Without government subsidization of interest rates and efforts to enforce the official contract rate, private profitability would have fallen below the break-even level. On the other hand, investment in driver training and expanding repair and maintenance services could increase the profitability of tractor ownership by extending the useful life from 5 to 6 years.

Available evidence suggests that in low population areas like South Sulawesi, the introduction of tractors has minimal negative impact on employment, since the farmers hire tractor services to replace family labor. On the other hand, government needs to carefully evaluate the need for a credit subsidy. Resources currently allocated to subsidize tractor owners may be better used to finance alternative investments in agriculture which will increase productivity, such as expanding irrigation facilities. Similarly, maintaining the official contract rate serves to redistribute income from tractor users (who pay a higher than market determined rate) to tractor owners. Finally, from the tractor owners' point of view, investing in a tractor is currently profitable. Yet, this is a risky investment, since profitability is dependent on governments' willingness (and ability) to maintain the official rate, farmers' continued willingness to pay this rate and government's willingness to subsidized tractor credit.

Limitations.

The data used to estimate the benefit and cost of tractors in 1990 was based on the the 1990 costs and prices which were applied to the 1975-79 technical data, since no record keeping data has been collected during the 10 years period. Therefore, these results are valid to the extent that the 1975-79 technical coefficients still reflect conditions in 1990.

Future Research.

There is a need to conduct a record-keeping study of tractor costs, prices and tractor capacity to confirm these finding that were based on 1975-79 data. This will help government set contract rates at a level that gives owners a reasonable profit. In 1990, the contract rate was set too high (Rp 80,000), while tractors owner broke-even at a contract rate of Rp 67,000. In contrast, in 1980 the contract rate was too low to cover fixed and variable costs.

In addition, social studies on the impact of the tractors in the rural community are needed to guide future decision about tractor policy. For example, more information is needed on the direct impact of the tractors on (i) creating agricultural employment and (ii) creating a demand for repair shops and small local manufacturers. Finally, research is needed to assess the impact of tractors on the land tenure system, displacement of labor, and labor exchange systems.

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APPENDICES

Appendix 1. Population of tractors by district, South Sulawesi, Indonesia

District	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Sidrap	165	300	344	361	279	239	181	187	290	280	274	270
Pinrang	138	208	258	267	265	260	220	220	208	212	217	219
Polmas	67	170	203	203	175	143	142	87	153	155	153	152
Soppeng	65	119	148	153	134	124	121	93	112	117	118	118
Luwu	57	128	185	199	76	68	67	100	125	124	120	118
Tator	25	17	24	25	21	17	12	9	23	22	22	22
Maros	22	43	55	60	57	52	48	35	42	44	44	44
Bone	22	58	83	90	68	47	43	40	56	58	58	59
Wajo	15	93	131	131	101	90	86	74	81	84	86	87
Pangkep	12	24	27	29	23	19	16	18	22	22	22	22
U.Pandang	34	40	48	50	32	12	12	7	41	39	38	37
Gowa	17	23	25	25	21	21	13	8	22	22	22	21
Bulukumba	7	18	18	18	17	17	10	10	14	15	15	15
Barru	7	14	19	19	19	19	17	19	13	14	15	15
Takalar	3	10	14	14	12	3	10	14	9	9	9	9
Bantaeng	1	3	6	6	4	3	5	4	3	3	4	4
Jeneponto	1	2	3	3	3	2	3	2	2	2	2	2
Pare-pare	0	1	1	1	1	1	1	1	1	1	1	1
Enrekang	1	1	1	1	1	0	0	1	1	1	1	1
Sinjai	1	1	1	1	1	1	0	0	1	1	1	1
Majene	0	1	1	1	1	0	0	0	1	1	1	1
Mamuju	0	1	1	1	1	0	0	0	1	1	1	1
Selayar	0	0	0	0	0	0	0	0	0	0	0	0
Total	660	1275	1596	1658	1312	1138	1007	929	1221	1226	1223	1219

Source: Agricultural Extension Service, South Sulawesi

Appendix 2. Calculation of break-even area cultivated and contract rate of the tractor pooled group (1975-79), South Sulawesi, Indonesia.

---

1. BE_{ha} = area (ha) cultivated based on the actual contract rate of Rp 15,983/ha

The formula used:

$$CR (X) = FC + VC (X)$$

$$\text{or } X = \frac{FC}{CR-VC}$$

where: X = breakeven area (ha)

FC = fixed cost/year (Rp)

VC = variable cost/ha(Rp)

CR = contact rate (Rp/ha)

$$X = \frac{605,853}{15,983-6,599} = 64.56 \text{ ha}$$

2. BE_{cr} = contract rate (Rp/ha) charged based on the actual area cultivated of 51.77 ha/year.

The formula used :

$$CR_{bep}(X) = FC + VC (X)$$

$$CR_{bep}(51.71) = 605,853 + 6,599 (51.71)$$

$$CR_{bep} = 18,315 \text{ rupiah}$$

Appendix 3. Calculation of break-even area cultivated and contract rate of the tractor pooled group using 1990 prices.

---

1. BE_{ha} = area (ha) cultivated based on the actual contract rate of Rp 80,000

The formula used:

$$CR\,(X) = FC + VC\,(X)$$

$$\text{or } X = \frac{FC}{CR-VC}$$

where: X = breakeven area (ha)
FC = fixed cost/year (Rp)
VC = variable cost/ha(Rp)
CR = contact rate (Rp/ha)

$$X = \frac{1{,}690{,}000}{80{,}000-33{,}426} = 36.27 \text{ ha}$$

2. BE_{cr} = contract rate (Rp/ha) based on actual area cultivated of 51.77 ha/year. The formula used :

$$CR_{bep}\,(X) = FC + VC\,(X)$$

$$CR_{bep}\,(51.71) = 1{,}690{,}000 + 33{,}426(51.71)$$

$$CR_{bep} = 66{,}108 \text{ rupiah}$$

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2												
3												
4		**Appendix 4. Cost-Benefit Analysis of a tractor, Base Run using1990 prices, S. Sulawesi, Indonesia.**										
5												
6	Yea	Cost (Rp)	Benefit (R	Net Benef(R	D.Facto	PV of Cos	PV.of Bene	Net P.Valu	D.Fact	Net P.Value	PVC	PVB
7					15%	15%	15%	15%	30%	30%	30%	30%
8	0	6500000	0	-6500000	1	6500000	0	-6500000	1	-6500000	6500000	0
9	1	1728448	4136800	2408352	0.8696	1503007	3597237	2094231	0.769	1852022.7	1329176.512	3181199
10	2	1728448	4136800	2408352	0.7561	1306949	3128000	1821051	0.592	1425744.4	1023241.216	2448986
11	3	1728448	4136800	2408352	0.6575	1136489	2720029	1583540	0.455	1095800.2	786444	1882244
12	4	1728448	4136800	2408352	0.5718	988240	2365215	1376975	0.350	842923	604957	1447880
13	5	1728448	4136800	2408352	0.4972	859350	2056734	1197384	0.269	647847	464953	1112799
14		S.Value	650000	650000	0.4972		323180	323180	0.269	174850		174850
15												
16	Tot	15142240	21334000	6191760		12294034	13867215	1896361		-460812.9	10708770.88	10247958
17												
18	6	1728448	4136800	2408352	0.432	746690	1787098	1040408	0.207	498529	357789	856318
19		S.Value	650000	650000	0.432		280800	280800	0.207	134550		134550
20												
21	Tot	16870688	25470800	8600112		13040724	15935113	2894389		-2584	11066559.62	11063976
22												
23												
24		**BC.Ratio**	**5-year**	**6-year**								
25		Undisc.	1.41	1.51								
26		Disc.(15%	1.13	1.22								
27		Disc.(30%	0.96	1.00								
28						IRR = r' + (r"-r')*NPV'/(NPV'-NPV")						
29		**NPV(Rp.1000)**										
30		Undisc.	6192	8600		where: r' =lower discount rate						
31		Disc.(15%	1896	2894		r" =higher discount rate						
32		Disc.(30%	-461	-3		NPV' =NPV at lower discount rate						
33						NPV" =NPV at higher discount rate						
34		**IRR (%)**	27.07	29.99								
35												

	A	B	C	D	E	F	G	H	I	J	K	L
72												
73		**Appendix 5. Cost-Benefit Analysis of a tractor assuming a 10% increase in capacity utilization**										
74												
75	Yea	Cost (Rp)	Benefit (R	Net Benefit(	DF(15%	PV of Cos	PV.of Bene	Net P.Valu	DF(30%	Net P.Value	PVC	PVB
76								15%		0.30		
77	0	6500000	0	-6500000	1	6500000	0	-6500000	1	-6500000	6500000	0
78	1	1901939	4552000	2650061	0.8696	1653869	3958283	2304413	0.769	2037896.6	1462591.399	3500488
79	2	1901939	4552000	2650061	0.7561	1438132	3441949	2003817	0.592	1568835.9	1125948.125	2694784
80	3	1901939	4552000	2650061	0.6575	1250563	2993031	1742468	0.455	1205778	865382	2071160
81	4	1901939	4552000	2650061	0.5718	1087434	2602606	1515172	0.350	927521	665679	1593200
82	5	1901939	4552000	2650061	0.4972	945606	2263163	1317557	0.269	712866	511622	1224488
83		S.Value	650000	650000	0.4972		323180	323180	0.269	174850		174850
84												
85	Tot	16009697	23410000	7400303		12875605	15259032	2706607		127748	11131222.44	11258970
86												
87	6	1901939	4552000	2650061	0.432	821638	1966464	1144826	0.207	548563	393701	942264
88		S.Value	650000	650000	0.432		280800	280800	0.207	134550		134550
89												
90	Tot	17911636	27962000	10050364		13697243	17506296	3809053		636010	11524923.89	12160934
91												
92												
93		**BC.Ratio**	**5-year**	**6-year**								
94		Undisc.	1.46	1.56								
95		Disc.(15%	1.19	1.28								
96		Disc.(30%	1.01	1.06								
97						IRR = r' + (r''-r')*NPV'/(NPV'-NPV'')						
98		**NPV(Rp.1000)**										
99		Undisc.	7400	10050		where: r' =lower discount rate						
100		Disc.(15%	2707	3809		r'' =higher discount rate						
101		Disc.(30%	128	636		NPV' =NPV at lower discount rate						
102						NPV'' =NPV at higher discount rate						
103		**IRR (%)**	30.74	33.01								
104												

	A	B	C	D	E	F	G	H	I	J	K	L
38												
39		Appendix 6. Cost-Benefit Analysis of a tractor assuming a 10% increase in tractor price										
40												
41	Yea	Cost (Rp)	Benefit (R	Net Benefit(	DF(15%	PV of Cos	PV.of Bene	Net P.Valu	DF(30%	Net P.Value	PVC	PVB
42								15%		30%		
43	0	7150000	0	-7150000	1	7150000	0	-7150000	1	-7150000	7150000	0
44	1	1728448	4136800	2408352	0.8696	1503007	3597237	2094231	0.769	1852022.7	1329176.512	3181199
45	2	1728448	4136800	2408352	0.7561	1306949	3128000	1821051	0.592	1425744.4	1023241.216	2448986
46	3	1728448	4136800	2408352	0.6575	1136489	2720029	1583540	0.455	1095800	786444	1882244
47	4	1728448	4136800	2408352	0.5718	988240	2365215	1376975	0.350	842923	604957	1447880
48	5	1728448	4136800	2408352	0.4972	859350	2056734	1197384	0.269	647847	464953	1112799
49		S.Value	715000	650000	0.4972		355498	323180	0.269	174850		192335
50												
51	Tot	15792240	21399000	5541760		12944034	13867215	1246361		-1110813	11358770.88	10265443
52												
53	6	1728448	4136800	2408352	0.432	746690	1787098	1040408	0.207	498529	357789	856318
54		S.Value	715000	650000	0.432		308880	308880	0.207	134550		148005
55												
56	Tot	17520688	25535800	8015112		13690724	15963193	2272469		-652584	11716559.62	11077431
57												
58												
59		**BC.Ratio**	**5-year**	**6-year**								
60		Undisc.	1.36	1.46								
61		Disc.(15%	1.07	1.17								
62		Disc.(30%	0.90	0.95								
63						IRR = r' + (r"-r')*NPV'/(NPV'-NPV")						
64		**NPV(Rp.1000)**										
65		Undisc.	5542	8015		where: r' =lower discount rate						
66		Disc.(15%	1246	2272		r" =higher discount rate						
67		Disc.(30%	-1111	-653		NPV' =NPV at lower discount rate						
68						NPV" =NPV at higher discount rate						
69		**IRR (%)**	22.93	26.65								
70												

	A	B	C	D	E	F	G	H	I	J	K	L
106												
107		**Appendix 7. Cost-Benefit Analysis of a tractor assuming a 20% decrease in contract rate.**										
108												
109	Yea	Cost (Rp)	Benefit(Rp	Net Benef(R	DF(15%	PV of Cos	PV.of Bene	Net P.Valu	DF(30%	Net P.Value	PVC	PVB
110								15%		30%		
111	0	6500000	0	-6500000	1	6500000	0	-6500000	1	-6500000	6500000	0
112	1	1728448	3308800	1580352	0.8696	1503007	2877233	1374227	0.769	1215290.7	1329176.512	2544467
113	2	1728448	3308800	1580352	0.7561	1306949	2501916	1194967	0.592	935568	1023241	1958810
114	3	1728448	3308800	1580352	0.6575	1136489	2175602	1039113	0.455	719060	786444	1505504
115	4	1728448	3308800	1580352	0.5718	988240	1891806	903566	0.350	553123	604957	1158080
116	5	1728448	3308800	1580352	0.4972	859350	1645069	785719	0.269	425115	464953	890067
117		S.Value	650000	650000	0.4972		323180	323180	0.269	174850		174850
118												
119	Tot	15142240	17194000	2051760		12294034	11091627	-879227		-2476993	10708770.88	8231778
120												
121	6	1728448	3308800	1580352	0.432	746690	1429402	682712	0.207	327133	357789	684922
122		S.Value	650000	650000	0.432		280800	280800	0.207	134550		134550
123												
124	Tot	16870688	20502800	3632112		13040724	12801829	-238895		-2190160	11066559.62	8876400
125												
126												
127		**BC.Ratio**	**5-year**	**6-year**								
128		Undisc.	1.14	1.22								
129		Disc.(15%	0.90	0.98								
130		Disc.(30%	0.77	0.80								
131						IRR = r' + (r"-r')*NPV'/(NPV'-NPV")						
132		**NPV(Rp.1000)**										
133		Undisc.	2052	3632		where: r' =lower discount rate						
134		Disc.(15%	-879	-239		r" =higher discount rate						
135		Disc.(30%	-2477	-2190		NPV' =NPV at lower discount rate						
136						NPV" =NPV at higher discount rate						
137		**IRR (%)**	6.75	13.16								
138												