

COMPARATIVE EVALUATION OF TRACTOR AND CARABAO USE IN RICE LAND PREPARATION, NUEVA ECIJA, PHILIPPINES, 1980

Celerina L. Maranan

INTRODUCTION

Tractor use on the farm, when properly applied, can improve overall efficiency, maximize both land and labor productivity and lead to increased economic returns for the farmer. Moreover, it reduces drudgery, improves the farmer's social status and allows him more time to pursue other productive activities and have leisure. However, the mechanization of small rice farms, despite its potential advantages, is not being fully adopted. There are still many farmers in some areas of the Philippines who do not use tractors. Among other reasons, lower operating costs which encouraged tractor use in the past have been affected by rising fuel and oil prices, which, in turn, have led to higher custom rates, making some farmers hesitant to fully adopt tractors. These farmers retain draft animals and continue to use them for all or part of their land preparation operation instead of fully mechanizing. Many factors hinder tractor adoption among small rice farmers. Among these is the lack of cash to purchase or hire tractor services. In addition, small parcels and the prevalence of small farms also make tractor use uneconomical since both two- and four-wheel tractors are indivisible capital-intensive investments. This reason also explains the proliferation of service activities engaged in by tractor owners to ensure that the tractor is a self-liquidating investment.

Research Assistant, IRRI Agricultural Engineering Department, Los Baños, Laguna. Paper presented at the Workshop on the Consequences of Small Rice Farm Mechanization Project, December 1-2, 1983, Development Academy of the Philippines (DAP), jointly sponsored by the National Economic and Development Authority (NEDA), Philippine Institute for Development Studies (PIDS), Ministry of Agriculture (MA), and International Rice Research Institute (IRRI).

The Study

This study conducted in the province of Nueva Ecija, Philippines, involved a farm-level survey of tractor owners, operators and contractors, carabao owners, and non-owner-users employing a precoded interview schedule. A list of tractor owners was obtained from machine dealers, village officials and rural banks located in the province. This list was stratified into two- and four-wheel tractor owners. Seventy-five respondents were drawn randomly from the four-wheel category and 50 from the two-wheel category. In addition, tractor hirers and potential hirers, comprising 25 each from two- and four-wheel tractor users, 50 carabao owners and 25 carabao users were interviewed. The respondents were randomly selected from the various lists provided by the village and town officials. The inclusion of non-owner-users aimed to provide a demand-oriented complement to information obtained from tractor and carabao owners.

This paper is a sequel to the earlier ones written on the analysis of two- and four-wheel tractor owners (See Maranan 1981; Maranan, Duff and Wicks 1980), and aims to compare tractor ownership characteristics with those for carabao.

The objectives of this paper are:

1. To identify activities requiring tractor and/or carabao use and to measure their relative performances;
2. To evaluate the arrangements used by contractors to secure work and to assess the changes which have occurred over time in the provision of contract services;
3. To assess the benefits and costs of tractor ownership compared to nonownership and hiring;
4. To identify the effects of increased operating costs on the utilization of tractors.

Survey Results and Discussion

The farmer. Some selected background information on the farmer respondents is presented in Tables 1a and 1b. The tractor owning and the nonowning groups do not vary much in age which ranges from 45 to 50 years. With regard to the level of educational attainment, there was no significant variation between groups except for the four-wheel tractor owners where 35 out of 75 respondents reached or finished college level. The majority among all groups had

completed elementary schooling. The farmer respondents had, on the average, been farming for 23 years with the carabao owners having the most farming experience.

TABLE 1a
GENERAL INFORMATION, 125 NON-TRACTOR OWNERS,
NUEVA ECIJA, PHILIPPINES, 1980

<i>Item</i>	<i>Carabao owners</i>	<i>Carabao users</i>	<i>Tractor users</i>
Total no.	50	25	50
A. The farmer			
Average age (years)	49	45	46
Average educational attainment (years)	4	6	5
		<i>No. reporting</i>	
No education	12	2	1
Elementary (1-6)	30	13	40
Secondary (7-10)	5	9	5
Collegiate (11 & over)	2	1	1
Not reporting	1	—	3
Total	50	25	50
Average no. of years in farming	29	23	24
<i>Tenure status (by parcel)</i>			
		<i>No. reporting</i>	
Owner	15	7	10
Lessee	37	14	32
Amortizing owner	18	12	19
Share tenant	2	2	4
Total	72	35	65
B. The farm and farm practices			
Total no. of parcels cultivated	72	35	65
Ave. area cultivated (ha.)	2.6	2.4	2.6

Table 1a (Continued)

<i>Item</i>	<i>Carabao owners</i>	<i>Carabao users</i>	<i>Tractor users</i>
<i>Water source (by parcel)</i>			
	<i>No. reporting</i>		
Rainfed	17	23	7
Pump	16	5	12
Gravity	38	6	45
Combination	1	1	1
<i>Cropping pattern (by parcel)</i>			
Rice-rice	45	12	51
Rice-fallow	20	21	12
Rice-vegetables/rice-corn	5	2	—
Rice-rice-rice	1	—	2
Corn only/vegetable only	1	—	2

TABLE 1b
GENERAL INFORMATION, 125 TRACTOR OWNERS,
NUEVA ECIJA, PHILIPPINES, 1980

<i>Item</i>	<i>Tractor type</i>		
	<i>Two-wheel (50)</i>	<i>Four-wheel (75)</i>	<i>All (125)</i>
A. The tractor owner			
Average age (years)	46	50	48
Average educational attainment (years)	5	10	8
	<i>No. reporting</i>		
No education	3	2	5
Elementary (1-16)	35	24	59
Secondary (7-10)	7	15	22
Collegiate (11 and over)	4	33	37
No reporting	1	1	2
Total	50	75	125

Table 1b (Continued)

<i>Item</i>	<i>Tractor type</i>		
	<i>Two-wheel (50)</i>	<i>Four-wheel 75)</i>	<i>All (125)</i>
	<i>No. reporting</i>		
Main occupation			
Custom operator	—	3	3
Landlord	—	4	4
Farmer	50	68	118
Total	50	75	125
B. The farmer			
No. of years in farming (ave.)	25	23	24
Tenure status (by parcel)	<i>No. reporting</i>		
Owner	10	89	99
Lessee	39	27	66
Amortizing owner	25	21	46
Share tenant	—	9	9
Total	74	146	220
Area cultivated <i>before</i> tractor use (ha.)	3.5	11.4	8.1
Area cultivated <i>after</i> tractor use (ha.)	3.1	9.1	6.9
% rice cropping intensity	196	170	181

Farm characteristics. The majority of the rice farm parcels cultivated were leased and amortized with the exception of those cultivated by the four-wheel tractor owners, who also mainly owned their land. Both the carabao owning and tractor using group had an average farm area of 2.6 ha. while carabao users had 2.4 ha. on the average. The two- and four-wheel tractor owners, on the other hand, had an average of 3.1 ha. and 9.1 ha., respectively. The majority of the parcels cultivated by carabao owners and tractor users were pump-and gravity-irrigated while most carabao-non-owners-users cultivated rainfed farms. Availability of water also affected the

cropping intensity. Rainfed areas had only one rice crop per year while farms with pump and gravity irrigation were able to plant two crops.

Farming practices. Farming practices within the province of Nueva Ecija vary among municipalities. Such variations can be mainly attributed to different farming conditions, primarily the availability of irrigation facilities, which determine the type of power used, the paddy varieties planted, and the cropping patterns and intensities. For instance, in some predominantly rainfed areas such as Guimba, and even in a few pump and gravity-irrigated farms, draft animals are still the most prevalent source of power for land preparation. For rainfed farms, after plowing the field the farmers usually wait for the rain before harrowing; thus, timing is important. Too long an interval may mean another plowing before harrowing and, hence, additional costs to the farmers.

On the other hand, for some irrigated areas like Talavera, the common practice is rotavation with a four-wheel tractor followed by harrowing with a hand tractor or carabao. Carabaos are usually borrowed from other farmers; very few hire them out; and where they are hired out, fees range from ₱15 to ₱40 per day. This fee includes the cost of hiring both the carabao and the operator. Meals and snacks, averaging ₱11.00, are usually provided by the customers, thereby lowering the fee compared to that paid by those who do not provide food. Different contractual arrangements also exist. The fee for tractor services is either on a per hectare or on a per day basis; this may or may not include the cost of fuel. Also, the customer may or may not provide meals for tractor operators who usually come in pairs.

In Sta. Rosa, another predominantly irrigated area, around 50 percent of the farmers still use carabaos, usually only for border cultivation purposes. Four-wheel tractors are no longer used continuously by farmers in fully irrigated areas because they deepen the hardpan, making it difficult for the farmers and the carabao to subsequently work the plots (Kuether 1978). Tractors also get stuck frequently. Other tillage systems include use of the four-wheel tractor for rotavation followed by carabaos for harrowing, levelling and border cultivation.

Table 2 indicates some additional characteristics of the non-tractor owners. Access to irrigation took place mainly in the 1970's when 64 percent of the carabao owners, 20 percent of the carabao

TABLE 2
FARM CHARACTERISTICS, 125 NONTRACTOR OWNERS,
NUEVA ECIJA, PHILIPPINES, 1980

<i>Item</i>	<i>Carabao owners</i>	<i>Carabao users</i>	<i>Tractor users</i>
	n = 50	n = 25	n = 50
	<i>% reporting</i>		
1. Irrigation facilities:			
— no irrigation	16	68	10
— irrigation before 1950's	—	—	4
— irrigation in 1950's	12	4	6
— irrigation in 1960's	8	8	6
— irrigation in 1970's	64	20	74
Total reporting	100	100	100
2. Year modern varieties first used:			
— never used	8	12	6
— before 1964	2	12	2
— 1965-69	10	16	6
— 1970-74	54	36	42
— 1975-79	26	24	44
Total reporting	100	100	100
3. Year tractor first used:			
— never used	24	60	—
— before 1964	8	4	4
— 1965-69	12	8	6
— 1970-74	20	8	36
— 1975-79	36	20	54
Total reporting	100	100	100
4. Type of tractor first used:			
— 2-wheel	10	4	12
— 4-wheel	62	36	82
— both	4	—	6
— no answer	24	60	—
Total reporting	100	100	100

users, and 74 percent of the tractor users first had irrigation. In 1980, 16 percent, 68 percent and 10 percent, respectively, remained unirrigated. Sixty percent of the carabao users and 24 percent of the carabao owning group had never used a tractor on their farms. All tractor users interviewed, however, had used tractors for some time, some before 1964. The majority first used tractors during the periods 1970-74 and 1975-79, with the four-wheel tractor as the predominant type.

Not all respondents used tractors continuously after the initial period of use (Table 3). Some reverted back to carabaos or used a combination of tillage components, while others who owned a carabao preferred its use. Others maintained that the tractor custom rate was too expensive or that they lacked sufficient cash to pay the contract charge. For this group, tractors were used only to prevent delays in farm operations to enable timely planting. Conversely, the majority of farmers used tractors continuously after the initial introduction. Reasons given for their adoption were that carabaos could not finish land preparation on time; the tractor was faster and easier; and the machine provided a better quality of tillage, especially when the field was badly infested with weeds. Respondents also believed rotavation to be better with a four-wheel tractor. Farmers, particularly small operators, usually use both the tractor and draft animals. Many still retain their carabaos for operations such as tilling field borders, dike edges and field levelling.

Eighty-eight percent of the tractor users interviewed reported that tractor use greatly reduced the labor required for land preparation (Table 4). The actual family labor required was reduced by 76 percent while hired labor was decreased by 85 percent. Sixty-nine percent of the respondents reported that the family labor time saved by using tractors was used to clean and repair dikes and levees. In addition, 45 percent used the extra time to plant crops earlier. Similarly, 88 percent and 76 percent of the two- and four-wheel tractor owners, respectively, reported a reduction in labor. Family labor was reduced by 63 percent to 71 percent for two- and four-wheel tractor owners, while hired labor was reduced by 68 percent for two-wheel and 62 percent for four-wheel tractors.

Field capacity. Table 5 shows the respective field capacities of the different power types. A two-wheel tractor can finish plowing a hectare of land in 11.3 hours, on the average, and harrowing in 8.6 hours for one pass operation. For the same land area, a four-wheel

TABLE 3
REASONS FOR USING/NOT USING TRACTOR FOLLOWING INITIAL
INTRODUCTION, 125 RESPONDENTS, NUEVA ECIJA,
PHILIPPINES, 1980

<i>Item</i>	<i>Carabao owner</i>	<i>Carabao user</i>	<i>Tractor user</i>
<i>Percent</i>			
A. Those reporting continuous use after initial introduction	71	58	88
B. Those reporting discontinuous use after initial introduction	29	42	12
<i>Reasons for continuous use</i>			
1. Carabao cannot finish land preparation on time/tractor; does land preparation faster	44	29	41
2. Tractor eases land preparation	22	12	27
3. Farmer owns a tractor	15	14	11
4. Better quality land preparation with tractor especially on weedy fields	37	14	34
5. Rotavation possible only with tractor	11	14	4
<i>Reasons for not continuing use of tractor</i>			
1. Owns a carabao	27	60	33
2. Expensive tractor rate	27	20	33
3. Lack of cash for contract fee	18	20	—
4. Tractor used only to prevent delays in farm operations	9	—	—

TABLE 4
REDUCTION IN LABOR REQUIREMENTS FOR LAND PREPARATION
WITH USE OF TRACTORS, 175 RESPONDENTS, NUEVA ECIJA,
PHILIPPINES, 1980

<i>Item</i>	<i>Tractor users</i> n = 50	<i>Tractor owners</i>	
		<i>Two-wheel</i> n = 50	<i>Four-wheel</i> n = 75
No. reporting labor reduction	44	44	64
Actual family labor reduction (%)	76	63	71
Actual hired labor reduction (%)	85	68	62
No. reporting no labor reduction	1	6	11
<i>Common uses of family labor time saved due to tractor use</i>			
		<i>% reporting^a</i>	
1. Cleaning/repairing dikes, levees		69	—
2. Planting rice earlier		45	—
3. Do other farm chores		2	—

a. Some respondents gave more than one answer, some did not comment.

tractor does plowing in 5.3 hours while one harrowing is done in 3.6 hours. Harrowing is usually done twice with at least a day interval a further pass which is known as levelling then takes place. Rotavating a hectare take 12.3 hours by a two-wheel tractor while a four-wheel unit finishes it in 4.3 hours.

Carabaos, on the other hand, plow a hectare in an average of 44 hours, harrow in 36 hours, level in 14 hours, and side cultivate in 3 hours. A two-wheel tractor plowing and harrowing a hectare of land takes a total of 37.1 hours or 4.65 days, while plowing and then rotavating takes only 3 days. A four-wheel tractor, on the other hand, is able to prepare a hectare in 16.1 hours (plowing plus harrowing) or 9.6 hours (plowing plus rotavating), that is, in either 2.1 days or 1.2 days. In the case of a carabao, land preparation takes 133 hours or 16.6 days if the carabao works 8 hours a day or 22 days if it works only 6 hours a day. Needless to say, the farmer can always employ as many carabao/men teams as he wants to finish the task as early as possible.

TABLE 5
COMPARATIVE FIELD CAPACITY BY POWER TYPE AND OPERATION,
NUEVA ECIJA, PHILIPPINES

Operation	Power type		
	Two-wheel tractor	Four-wheel tractor	Carabao
	hours/ha.		
Plowing	11.3	5.3	44
Harrowing (1 pass operation) ^a	8.6	3.6	36
Rotavating	12.3	4.3	—
Levelling	8.6	3.6	14
Side cultivation	—	—	3
Total			
Plowing + harrowing	37.1	16.1	133
Plowing + rotavating	23.6	9.6	—

a. Harrowing is normally done twice after plowing plus one final harrowing (or levelling); thus, 8.6 hr. \times 3 = 25.8 hours. This is true for both two- and four-wheel tractors.

Contract service rates. Within the period 1972 to 1983, the custom fee for the use of carabao in each land preparation activity increased by about 118 percent to 169 percent, from ₱13 to ₱40/day for plowing, ₱15 to ₱35/day for harrowing, and ₱16 to ₱35/day for levelling. However, not much difference is noted between operations.

Contract rates for two-wheel tractors were on both a per hectare and a per day basis, with the fuel expenses shouldered by either the tractor owner or by the farmer-customers. However, for the four-wheel tractors, the arrangements were all on a per hectare basis with the fuel provided by either the tractor owner or by the customer.

Table 6 shows the trend in two-wheel and four-wheel tractor service rates from 1972 to 1980. For two-wheel tractors the price has risen from an average of ₱100/ha. to ₱275/ha. for rotavation. Other operations such as plowing and harrowing were reported from 1977 on a per hectare rate with fuel provided by the tractor owner. Plowing operations, with fuel provided by the customers, averaged ₱55/ha. in 1975 and ₱75/ha. in 1980. Contract rates for harrowing,

which consisted of three passes at different time intervals, were the same from 1975 to 1977 at ₱150/ha. The rate was a bit higher in 1978 and 1979 at ₱170/ha. and increased further to ₱205/ha. in 1980.

There was no significant difference in the costs for daily hire between those with fuel provided by the customers and those by the tractor owners. It may not be conclusive but this suggests that customers who were providing fuel were actually spending more than those who did not provide fuel. The rate for four-wheel tractor services with fuel provided by the tractor owners was ₱110/ha. in 1972, rising to ₱225/ha. in 1980, an increase of 104 percent. Aside from plowing, rotavating was the other major operation done by four-wheel tractors. However, there were a few respondents who reported doing harrowing jobs. In 1974 and 1975, the rate was ₱230/ha., increasing to ₱380/ha. in 1980.

TABLE 6
CONTRACT RATES^a FOR TRACTOR CUSTOM SERVICES BY TRACTOR
TYPE AND OPERATION 125 TRACTOR OWNERS,
NUEVA ECIJA, PHILIPPINES, 1972-1980

Year	Operation	Tractor Type		
		Two-wheel		Four-wheel
		Per ha	Per day	Per ha ^b
1972	Plowing	65	—	110 (5) ^c
	Harrowing ^d	—	—	—
	Rotavating	100 (2) ^c	—	152 (11)
1973	Plowing	—	—	116 (5)
	Harrowing	—	—	—
	Rotavating	115 (2)	—	158 (14)
1974	Plowing	—	—	131 (8)
	Harrowing	—	—	230 (2)
	Rotavating	117 (3)	—	173 (20)
1975	Plowing	—	—	137 (10)
	Harrowing	—	—	230 (2)
	Rotavating	128 (4)	—	178 (32)

Table 6 (Continued)

Year	Operation	Tractor Type		
		Two-wheel		Four-wheel
		Per ha	Per day	Per ha ^b
1976	Plowing	—	—	137 (17)
	Harrowing	—	60(1) ^c	250 (2)
	Rotavating	188 (8)	—	187 (44)
1977	Plowing	128 (4)	62 (4)	160 (21)
	Harrowing	210 (4)	62 (4)	267 (3)
	Rotavating	219 (10)	—	213 (49)
1978	Plowing	150 (4)	65 (5)	183 (21)
	Harrowing	242 (5)	65 (5)	275 (4)
	Rotavating	233 (11)	—	238 (55)
1979	Plowing	153 (5)	74 (5)	215 (23)
	Harrowing	304 (7)	71 (7)	332 (5)
	Rotavating	266 (13)	—	275 (63)
1980	Plowing	206 (8)	74 (5)	225 (25)
	Harrowing	319 (11)	74 (5)	380 (8)
	Rotavating	275 (13)	—	297 (66)

a. Fuel expenses paid by tractor owners.

b. There was no per day contract rate arrangement for four-wheel tractors

c. Figures in parentheses are number of respondents reporting.

d. Three passes for harrowing per hectare, i.e., 2 regular harrowings and 1 final operation which is also called "levelling".

Type of power used. For a number of reasons, tractor hirers used more than one type of power source for tillage, i.e., draft animal, two-wheel tractor, four-wheel tractor or combinations. They believed tractors were better for specific operations such as rotavation while draft animals were best for levelling and for field corners and dike edges. They also mentioned that tractor use resulted in reduced weed population compared to carabao use. In addition, carabaos were sometimes scarce and farmers had no alternative to tractors. Several farmers felt that it would be more costly to rely continuously on the use of a tractor for land preparation.

Tables 7 and 8 indicate the change in source of power used by farmers from 1972 to 1979. For plowing, the shift from carabao or draft animal to two-wheel and four-wheel tractors was significant for both wet and dry seasons. Harrowing showed a different trend. The use of a carabao for harrowing was the prevailing method but a slightly decreasing use was evident. In contrast, there was a gradually increasing trend in two-wheel tractor utilization as well as in the combination of two-wheel tractors and carabaos. The use of the four-wheel tractor increased from 1972 to 1975 in both seasons, after which a gradual decline resulted. Some farmers also reported the use of a combination of four-wheel tractors and animal power for harrowing. Four-wheel tractors were used primarily for rotavating while a considerable number of the respondents employed combinations of two-wheel tractors and carabaos or four-wheel tractors and carabaos. During the second cropping season (dry season), a similar trend was evident in the types of power used for land preparation. A majority of the farmers paid cash for tractor services immediately. Only a few deferred payment. Some respondents paid in kind or with a combination of cash and kind.

Carabao ownership and use. Most farmers retain carabos for land preparation operations to supplement tractors, either for harrowing or to reach portions of the field which the tractor cannot till. Carabaos are also utilized for transport of farm products. Table 9 shows that only 6 percent of the carabao owners reported hiring out their carabaos at an average fee of ₱35/day, with the farmer accompanying his carabao. Care and feeding of carabaos is relatively easy since the feed is gathered directly from the field. Some supplemental medicine is provided by municipal agricultural offices especially when there are threats of epidemics. A problem arises, however, during the dry season when feed and grazing areas are scarce. Some chemical applications can also poison the animals. Carabaos are usually maintained by the farmer, a son, another member of the family, or a regular farm help employed for the job. Maintenance requires an average of 3.5 hours per day. Carabaos are used in the field for an average of 5 hours daily for plowing and less than 7 hours per day for harrowing.

Tractor/carabao hiring characteristics. Table 10 provides the responses of the 50 tractor users and the level of services they received. Thirty percent hired the same contractors each year,

TABLE 7
POWER SOURCE BY OPERATION WET SEASON, 50 TRACTOR USERS,
NUEVA ECIJA, PHILIPPINES, 1972-1979

Operation/ Year	Tractor			Two-wheel tractor +	Two-wheel	Four-wheel
	Two-wheel	Four-wheel	Carabao	4-wheel tractor	tractor + carabao	tractor + carabao
	<i>percent</i>					
<i>Plowing</i>						
1979	54	36	4	4	—	—
1978	48	38	10	5	—	—
1977	35	55	5	5	—	—
1976	32	41	23	4	—	—
1975	23	36	32	4	4	—
1974	16	12	68	4	—	—
1973	12	15	69	4	—	—
1972	11	15	70	4	—	—
<i>Harrowing</i>						
1979	32	4	52	—	10	2
1978	26	6	55	—	10	2
1977	26	6	57	—	8	2
1976	27	7	57	—	9	—
1975	26	7	60	—	7	—
1974	13	5	79	—	3	—
1973	11	5	81	—	3	—
1972	8	3	87	—	3	—
<i>Rotavation</i>						
1979	7	62	—	—	21	10
1978	7	63	—	—	20	10
1977	7	62	—	—	21	10
1976	8	60	4	—	16	12
1975	10	62	—	—	14	14
1974	8	54	—	—	15	23
1973	9	45	—	—	18	27
1972	—	50	10	—	1-	30

TABLE 8
POWER SOURCE BY OPERATION DRY SEASON, 50 TRACTOR USERS,
NUEVA ECIJA, PHILIPPINES, 1972-1979

Operation/ Year	Tractor			Two-wheel tractor +	Two-wheel tractor +	Four-wheel tractor +
	Two-wheel	Four-wheel	Carabao	4-wheel tractor	carabao carabao	carabao carabao
	<i>Percent</i>					
<i>Plowing</i>						
1979	60	40	—	—	—	—
1978	53	42	5	—	—	—
1977	39	61	—	—	—	—
1976	35	45	20	—	—	—
1975	25	40	30	—	5	—
1974	22	17	61	—	—	—
1973	17	22	61	—	—	—
1972	16	21	63	—	—	—
<i>Harrowing</i>						
1979	38	5	40	2	14	—
1978	32	7	46	2	12	—
1977	31	8	46	3	10	3
1976	32	8	46	—	11	3
1975	31	9	49	3	9	—
1974	14	7	71	4	4	—
1973	15	8	69	4	4	—
1972	12	4	77	4	4	—
<i>Rotavating</i>						
1979	9	68	4	—	18	—
1978	9	70	4	—	17	—
1977	9	68	4	—	18	—
1976	12	65	6	—	18	—
1975	13	67	7	—	13	—
1974	11	56	11	—	22	—
1973	14	43	14	—	29	—
1972	—	50	33	—	17	—

TABLE 9
CARABO OWNERSHIP, CARE AND MAINTENANCE, 50 FARMERS,
NUEVA ECIJA, PHILIPPINES, 1980

<i>Item</i>	<i>Carabao owners</i>
1. Average purchase price of carabao/unit	₱ 1,794
Average present price of carabao/unit	3,310
2. No. of working carabaos owned	62
— male	31
— female	31
3. Carabao owners hiring out animals (%)	6
Carabao owners not hiring out animals (%)	94
4. Average care and maintenance expenses (₱/farmer/year)	
— medicine (<i>N</i> = 4)	43.75
— special feeds (<i>N</i> = 4)	189.00
5. Ave. time devoted to carabao care and maintenance (h/day)	
— peak season	3.5
— off season	3.6
6. Who cares for animal (no. reporting)	
— farmer	36 (72%)
— son	5 (10%)
— regular helper	3 (6%)
— farmer and family	6 (12%)
Total	50 (100%)
7. Average hours per day carabao works	
a) plowing : 1st crop	5
2nd crop	5
b) harrowing: 1st crop	7
2nd crop	7

TABLE 10
TRACTOR HIRING AND SERVICE CHARACTERISTICS, 50 RESPONDENTS
NUEVA ECIIJA, PHILIPPINES, 1980

<i>Item</i>	<i>No. reporting</i>
A. Hiring characteristics	
1. No. hiring same contractor each year	15
2. No. hiring different contractor each year	35
3. Reasons for hiring same contractor:	
3.1 Tractor provides good service performance	4
3.2 Tractor owner is a relative	3
3.3 Tractor owner lives in area	3
3.4 Regular contractor	2
3.5 The tractor is always available/no other alternative/gives discount to customers	3
4. Reasons for not hiring same contractor:	
4.1 Unavailability and lack of timing	35
B. Service characteristics	
1. Checking quality of tractor services before hiring	
Yes	42
No	8
2. Punctuality of contractor	
Yes	35
No	8
Sometimes	7
3. Satisfied with work of contractor	
Yes	45
No	5

primarily because of good service. Another common factor is that the tractor owner is a relative or that the operator resides in the area. Seventy percent changed contractors every year because they required the machine immediately for timely cultivation.

Both tractor and carabao users reported using different methods to secure contractors. Eighty-eight percent contracted the tractor owner himself while a few worked through tractor agents who arranged farm services. Eight percent of the carabao contractors contracted the farmers to offer their services. Farmers were cautious in choosing contractors. They usually checked the quality of the contractor's services on other farms before hiring a contractor. This observation was reported by 80 percent of the tractor users. Seventy percent of the respondents reported that contractors were punctual in coming to the farm. Ninety percent were satisfied with the contractor services.

Problems in carabao and tractor ownership and use. The most common difficulties were the fear that the carabaos would become sick or poisoned by chemicals and the apprehension about carabao thieves. Owners also recognized the fact that carabaos could not be used continuously for long hours. A carabao usually works in the field for an average of about 5 to 7 hours per day. Some had difficulty maintaining carabaos due to the lack of feed, especially during the dry season. Others mentioned that their carabaos were old and therefore weak.

Both tractor and carabao users experienced problems in hiring a tractor and/or a carabao (Table 11). Eighty-eight percent of the tractor users interviewed complained of high contract rates and the lack of ready cash to pay contract fees. The latter often caused delays in tractor services. Other problems reported were poor quality of service; unavailability of tractors, especially during peak periods; and unpunctual tractor operators. In the case of carabao users, the most important problem reported was unavailability of animals during peak periods.

Benefit-cost ratio and sensitivity analysis. The cost summary was taken from a previous analysis (see Maranan 1981) with slight modifications such as omission of the tax and insurance cost and inclusion of repairs and maintenance cost as a component of fixed cost instead of variable cost (Table 12). The two- and four-wheel tractors included in the computations of benefit-cost ratios were those involved solely in land preparation. For this cost summary, sensitivity analysis of the prices of oil, fuel and contract rates was done.

The values used were derived as follows: Capital investment was the average tractor purchase price in 1980 as taken from the survey

data. Annual depreciation was computed using the straight-line method with machine life estimated at eight years for two-wheel tractors and 20 years for four-wheel units. Salvage value was assumed at 10 percent of the initial investment.

$$\text{Annual depreciation} = \frac{\text{Initial cost minus salvage value}}{\text{Estimated useful life}}$$

TABLE 11
PROBLEMS ENCOUNTERED IN USING/HIRING TRACTOR
AND CARABAOS, NUEVA ECIJA, PHILIPPINES, 1980

		<i>No. reporting^a</i>
1.	Tractor users	
1.1	No. respondents	50
1.2	Problems	
a.	High tractor fees/financial problem which delays tractor service	44
b.	Work not well done/tractor operator does not perform his job well	9
c.	Unavailability of tractor for hire (first come, first serve basis) especially during peak season	5
d.	Tractor contractors not always on time	4
	Total responses	62
2.0	Carabao users	
2.1	No. respondents	12
2.2	Problems	
a.	Lack of carabaos during peak season	10
b.	Carabaos cannot ford deep rivers (difficult to transport carabaos)	1
c.	Carabao service fees are high	1

a. Some respondents mentioned more than one problem in the case of tractor users. while in the case of carabao users no problems were mentioned.

TABLE 12
BENEFIT COST ANALYSIS FOR TWO- AND FOUR-WHEEL TRACTORS,
NUEVA ECIJA, PHILIPPINES, 1980

Item	Tractor type	
	Two-wheel	Four-wheel
	Pesos	
Capital investment	13,000	192,250
Fixed cost/year		
Depreciation	1,462	8,651
Interest on ave. capital investment	858	12,688
Repair and maintenance	520	10,594
Total fixed cost/year	2,840	31,913
Variable cost/ha.		
Diesel fuel/gasoline	126.54	54.71
Oil, grease	10.38	1.64
Labor	50.16	57.20
Total variable cost/ha.	187.08	113.55
Total variable cost/year	2,743	19,520
Total fixed cost/year	2,840	31,913
Total Cost/Year	5,583	51,433
Annual use (ha.)	14.66	171.91
Average capacity (hr./ha.) ^a	17.6	4.7
Contract rate/ha.	273	286
Total Benefits	4,002	49,166
BCR (undisc.)	0.72	0.96
PBP (years)	(-)	30
BEP (ha.)	33	185

a. Average for any one operation.

Interest on capital investment was charged at 12 percent per annum, the prevailing rate during the year. Repair and maintenance costs were charged at 4 percent per annum for the two-wheel and 5.5 percent for the four-wheel tractors, as taken from the 1980 survey.

Variable costs per hectare were computed using the survey data. Gasoline was the predominant power source for four-wheel tractors and it was valued at ₱4.79/l in 1980 with an average consumption of 1.5 liters per hour. Diesel fuel was the most important fuel for four-wheel tractors, with a consumption of 4.08 liters per hour on average, costed at ₱2.85/l in 1980. Oil and grease were also calculated based on consumption rates obtained from the survey at ₱11.30 per liter and ₱9.00/kg., respectively. Labor costs were taken at 20 percent of the total revenue of the tractors derived from doing land preparation operations. The rates prevailing in the area ranged from 10 percent to 35 percent of the gross custom rate. Labor usually comprises two drivers and sometimes additional helpers. Total costs are computed as total fixed costs per annum plus total variable costs per hectare multiplied by the annual utilization in hectares.

Total revenue was the sum of the annual utilization in hectares multiplied by the custom rate per hectare.

The computed benefit-cost ratios were .72 for two-wheel and .96 for four-wheel tractors. This indicates that investing in tractors is not financially sound at the current utilization level and the prevailing contract rate per hectare. However, this is an average value and will include units not really intended for contractual business but only for own farm use. As a consequence they have a very low total utilization rate. The owners justified their investment by claiming that the tractors were purchased for their own convenience and that custom work would only hasten wear and tear. Repairs were expensive and spare parts were seldom available besides being expensive. This was true for both tractor types. Some tractor owners, however, revealed that they charged as much as ₱450/ha. for rotavation. Others may follow suit if scarcities occur.

The breakeven point for the two-wheel and four-wheel tractor types was also estimated. The two-wheel tractor units would have to operate 33 hectares of land per year in order to break even, while four-wheel units would need 185 hectares. The options facing tractor owners/contractors in order to stay in business are either to increase contract rates or to increase the level of utilization.

The payback period for four-wheel tractors is 31 years. No payback period was estimated for the two-wheel units. The latter was due to total costs composed of total operating costs plus fixed costs components like repairs and maintenance and interest on average investment being greater than total benefits.

Comparative benefit-cost ratios by year of tractor purchase were computed to examine the effects of tractor ages on their 1980 utilization rates. A relationship between age and utilization can be noted with the four-wheel tractor group, starting from 1973 to 1979 (Table 13). As the tractor gets older, utilization decreases. Utilization in 1980, however, declined from 1,041 hr. to 808 hr./ha. The level of capital investment and utilization rate have a great effect on BCR also.

The two-wheel tractor group, however, had very low BCR's, 0.5 at its lowest and .99 at its highest. Utilization levels have been very low since 1972.

In looking at the consequences of the change in operating cost components such as fuel and oil on the profitability of tractor investment, breakeven points, payback period and benefit-cost ratios were computed and shown in Tables 14 to 16. At the prevailing contract rate of ₱273/ha. for two-wheel tractor service and fuel price, the breakeven point is only 33 hectares per year. This increased to 55 and 163 ha. with the 25 percent and 50 percent increases in fuel and oil prices, respectively. Beyond a 50 percent increase, variable costs exceed the custom rate; thus, a breakeven point does not exist. As the contract rate per hectare is increased, the required area to breakeven becomes smaller. Similarly, four-wheel tractors gave the same picture although no negative breakeven point values were estimated.

The effect of changes in oil and fuel price and contract rates on payback period of tractors was also examined. At the prevailing contract rate and fuel and oil prices, two-wheel tractors are unable to self-liquidate. Even with a 25 percent increase in the contract rate, the payback period computed was still beyond the machine's estimated life of only eight years. Four-wheel tractor investment presents a better picture.

Increases in the prices of fuel and oil lower the benefit-cost ratio. Table 16 shows that only a 75 percent increase in the contract rate will make the investment viable. A 50 percent increase in the

price of fuel and oil reverts viability. Four-wheel tractors need a lower increase in contract rate in order to have a benefit-cost ratio of 1.0.

All these sensitivity analyses point out the fact that an increase in fuel price needs a simultaneous increase in contract rate if only to break even. The customers could only afford a certain amount of contract rate. Beyond that, any cheaper alternative would be most welcome. The level of utilization could also be increased but it had to take into consideration the available area, the present tractor supply in the locality, and the machine's capacity.

TABLE 13
COMPARATIVE BENEFIT/COST RATIOS OF TWO- AND FOUR-WHEEL
TRACTORS BY YEAR OF PURCHASE, NUEVA ECIJA,
PHILIPPINES, 1980

<i>Year of purchase</i>	<i>Average capital investment (P)</i>	<i>Average utilization per year (hr.)</i>	<i>Benefit-cost ratio</i>
<i>Four-wheel tractors</i>			
1972	82,834	1,396 ^a	1.39
1973 (5)	74,200	700	1.30
1974 (9)	109,444	747	1.07
1975 (7)	158,686	811	0.88
1976 (5)	151,800	868	0.90
1977 (5)	88,400	1,168	1.69
1978 (5)	225,200	1,595	1.33
1979 (3)	188,000	1,041	1.09
1980 —	192,250	808	0.96
<i>Two-wheel tractors</i>			
1972	8,000	429	0.70
1973	—	—	—
1974	—	—	—
1975 (6)	12,100	292	0.58
1976 (6)	17,883	267	0.56
1977 (11)	10,518	288	0.86
1978 (8)	8,525	258	0.99
1979 (11)	9,304	252	0.92
1980 —	13,000	258 ^b	0.72

Figures in parentheses are the number of samples.

a. Based on Orcino and Duff (1973). Utilization includes threshing activity.

TABLE 14
EFFECT OF CHANGES IN PRICES OF FUEL AND OIL AND CONTRACT
RATES ON BREAKEVEN POINT FOR TWO-WHEEL AND FOUR-WHEEL
TRACTORS, NUEVA ECIJA, PHILIPPINES

Item	Fuel and oil price change					
	Prevailing price ^a	+25%	+50%	+100%	+150%	+200%
<i>Hectare</i>						
Two-wheel tractor						
<i>Contract rate:</i>						
Prevailing rate ^c	33	55	163	b	—	—
+ 25%	21	28	42	—	—	—
+ 50%	15	18	23	53	—	—
+ 75%	12	14	16	26	71	—
+ 100%	10	11	12	17	30	109
Four-wheel tractor						
<i>Contract rate:</i>						
Prevailing rate ^c	185	202	221	275	363	534
+ 25%	139	148	156	184	220	273
+ 50%	111	117	123	138	158	183
+ 75%	93	97	101	111	123	138
+ 100%	80	82	86	92	101	111

a. Prevailing price in 1980: ₱ 4.79/l gasoline; ₱ 2.85/l diesel fuel; ₱ 11.30/l oil.

b. (—) indicates negative value.

c. Prevailing custom rate: TWO-WT = ₱ 273/ha.; FOUR-WT = ₱ 286/ha.

CONCLUSION

The farmer's decision to adopt tractor use on his farm is affected by his financial capacity, by water supply conditions on the farm, i.e. rainfed or nonirrigated, and the availability of tractors for hire in the area. Although most farmers surveyed had tried tractors, not all of them used them continuously. Many shifted between different power

TABLE 15
EFFECT OF CHANGES IN PRICES OF FUEL AND OIL AND CONTRACT
RATES ON PAYBACK PERIOD FOR TWO- AND FOUR-WHEEL TRACTORS,
NUEVA ECIIJA, PHILIPPINES

<i>Item</i>	<i>Fuel and oil price change</i>					
	<i>Prevailing price^a</i>	<i>+25%</i>	<i>+50%</i>	<i>+100%</i>	<i>%150%</i>	<i>+200%</i>
Two-wheel tractor		<i>Years</i>				
<i>Contract rate:</i>						
Prevailing rate ^b	—	c	—	—	—	—
+ 25%	21	113	—	—	—	—
+ 50%	9	14	31	—	—	—
+ 75%	6	8	11	62	—	—
+ 100%	4	5	6	13	—	—
Four-wheel tractor						
<i>Contract rate:</i>						
Prevailing rate ^b	30	48	125	c	—	—
+ 25%	12	14	17	29	114	—
+ 50%	7	8	9	12	17	29
+ 75%	5	6	6	7	9	12
+ 100%	4	4	5	5	6	7

a. Prevailing price in 1980: ₱4.79/l gasoline; ₱2.85/l diesel fuel; ₱11.30/l oil.

b. Prevailing rate: TWO-WT = ₱273/ha.; FOUR-WT = ₱286/ha.

4 WT = ₱286/ha.

c. (—) means negative value.

types for land preparation operations, i.e., between use of two-wheel tractor, four-wheel tractor, carabao and combinations of all three. For upland conditions, use of four-wheel tractor and/or a carabao is the most appropriate, whereas for a fully irrigated area, continuous use of a four-wheel tractor can deepen the hardpan, making it difficult for the farmer and his carabao and even for the tractor itself to work on the same field at a later date.

TABLE 16
EFFECT OF CHANGES IN FUEL AND OIL PRICE AND CONTRACT RATES
ON BENEFIT-COST RATIOS FOR TWO- AND FOUR-WHEEL TRACTORS,
NUEVA ECIJA, PHILIPPINES

<i>Item</i>	<i>Fuel and oil price change</i>					
	<i>Prevailing price^a</i>	<i>+ 25%</i>	<i>+ 50%</i>	<i>+100%</i>	<i>+150%+200%</i>	
Two-wheel tractor						
<i>Contract rate:</i>						
Prevailing rate ^b	.72	.66	.61	.53	.47	.42
+ 25% increase	.86	.79	.73	.64	.56	.51
+ 50% increase	.99	.92	.85	.74	.69	.62
+ 75% increase	1.12	1.04	.96	.84	.76	.68
+ 100% increase	1.24	1.15	1.07	.95	.85	.76
Four-wheel tractor						
<i>Contract rate:</i>						
Prevailing price ^b	.96	.91	.87	.80	.75	.69
+ 25% increase	1.14	1.09	1.05	.97	.90	.84
+ 50% increase	1.31	1.25	1.21	1.12	1.04	.97
+ 75% increase	1.46	1.41	1.35	1.26	1.17	1.10
+ 100%	1.61	1.56	1.52	1.42	1.28	1.22

Carabaos are considered important for the farmer despite their slow and tedious pace in the field. Animals are used for many purposes such as tilling areas of the field which are inaccessible to the tractor, and also for transporting farm products. Renting out of carabaos is no longer a common practice in the province of Nueva Ecija. A more common practice is the lending of a carabao to other farmers free of charge as an act of kindness and even kinship. Farmers also return favors to one another through the exchange of man and animal labor. Two-wheel tractor owners are unwilling to do much custom work due to the fear of expensive repairs and spare parts in case of tractor breakdown. The purchase of most tractors,

especially two-wheel units, was mainly for convenience rather than for income generation through hiring out. Low utilization rates support this view. The breakeven points for two- and four-wheel tractors were 33 ha. and 185 ha., respectively, well above current average rates worked. Increases in oil and fuel prices exacerbate the situation. Recent communications with some farmers in the survey area indicate that with increased costs for fuel and oil and higher contract rates farmers, particularly the small farm operators, tend to shift back to carabaos. Some farmers owning larger farms, however, find it hard to use carabaos for timely land preparation operations. Clearly, these are adjustments towards a financially viable equilibrium state in the competitive tractor hire market.

REFERENCES

- Barker, R.; Johnson, S.; Alviar, N.; and Orcino, N. "Comparative Economic Analysis of Farm Data on the Use of Carabao and Tractor in Lowland Rice Farming." Paper presented at the Farm Management Seminar with Focus on Mechanization. U.P. Institute of Small-Scale Industries, Manila, February 24 – March 1, 1969.
- Bautista, F., and Wickham, T. "The Tractor and the Carabao." IRRI Saturday Seminar, July 27, 1974.
- Kuether, D.O. "Soil Compaction and Wetland Rice Tillage Systems." *Journal of the Philippine Society of Agricultural Mechanization in Asia*. IX (1978).
- Maranan, C.L. "A Comparative Analysis of Tractor Contract Operation in Nueva Ecija, Philippines." Paper presented at the workshop on the Consequences of Small Rice Farm Mechanization Project, Los Banos, 1981.
- Maranan, C.; Wicks, J.; and Duff, B. "The Profitability of Two- and Four-Wheel Tractor Ownership in Nueva Ecija, Philippines, 1980." IRRI Saturday Seminar, May 16, 1981.
- Monge, V. S. "Analysis of Factors Affecting the Demand for Tractor and Power Tiller Services in Nueva Ecija, Philippines." Master's thesis, University of the Philippines, Los Banos, Laguna, 1980.
- Orcino, N. "Economic Aspects of Hand Tractor Ownership and Operation." IRRI Saturday Seminar Paper, September 22, 1970.
- Orcino, N., and Duff, B. "Technical and Economic Characteristics of Tractor Contract Operations in Central Luzon." IRRI Saturday Seminar Paper, June 30, 1973.