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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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THE IMPACT OF MECHANIZATION ON AGRICULTURAL PRODUCTION IN SELECTED IRRIGATED VILLAGES OF SUPHANBURI PROVINCE, THAILAND

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By

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The Impact of Agricultural Mechanization on Agricultural Production in Selected Irrigated Villages of Suphanburi Province, Thailand[1]

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Introduction

Agricultural mechanization has been the focus of much debate and controversy for a long time. Now that mechanization is well established in some areas, such as Suphanburi Province, the debate has switched to the appropriateness of the different types of machines that are currently available. However, many of the issues remain the same and the problem for the policy maker is still remains - as to what mechanization strategy should be followed?

As in the original debate over mechanization itself, it is still difficult to form definite conclusions, since data is either not available or is site specific and hence not readily generalizable. The aim f this paper is to set out the differences if any, in yields, inputs, cropping intensity, and cost and returns for the two alternative machines used in land preparation in Suphanburi - the 2-wheel tractor and the small 4-wheel trailer.

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[1] Paper presented at the Workshop on Consequences of farm Mechanization in Small Rice Farms held in Bangkok, Thailand, November 10-11, 1983.

[2] ODA Research Fellow, Economics Section, Agricultural Engineering Department, IRRI.

The Consequences of Mechanization study aimed to collect data on four sites in Southeast Asia where mechanization was either well established, or nearly so, in order to provide the sort of quantitative background data which is required for policy interventions.

In Thailand, the area chosen for the survey was Suphanburi Province in the Central Plains. The area is largely irrigated and tractorization is the dominant technique for land preparation. Five villages were purposively selected in order to give a large enough sample of 2-wheel and 4-wheel tractor users and within these villages households were randomly selected.

The survey was carried out in crop year 1981/82 and made use of the FAO Farm Management Data Collection and Analysis System (FMDCAS) together with supplementary questionnaire providing detailed information on machine use, as well as historical information about the cause and consequences of the change in the land preparation technique.

The majority of farm households in the area used either 2 wheel or small 4 wheel tractors. Only 5 out of the total cultivating sample of 250 were totally reliant on animal power for land preparation and this was an insufficient number to be statistically significant.

The analysis therefore focuses on the differences between 2 and 4 wheel tractor users, which have been further disaggregated into owners and hirers. The number of households in each classification group is given in Table 1. The classification system was based on land preparation techniques.

Background

The major crop in the area is rice, with over 90 percent of the cultivated area included in the survey planted to modern varieties, the dominant of which were RD 7 and RD11 (Table 2). This was true for all groups.

Transplanting was also the norm in the area, and most of the 25 percent of farmers broadcasted had large farm sizes of over 3 hectares (Table 3).

Nearly all the households were irrigated although the quality of distribution varied with the distance from the main canal. However, irrigation in general has been installed for some time now. The process of mechanization, was rapid from about 1965 and, for the household in our sample, was nearly complete by 1978 (Figure 1). The growth of 2-wheel and 4-wheel tractors was indistinguishable having virtually the same slope throughout this period.

The mean number of draft animals per farm was surprisingly high suggesting that draft animals were kept as a form of insurance especially for households having machines (Table 4). If these animals are not replaced after their working lives then the mechanization process will be irreversible.

The age distribution of draft animals is shown in Table 5. This suggests that for the two-wheel tractor user, the draft animal population is at least not totally depleted and that there is still investment in new draft stock.

Socio-economic background

The age and educational background of all the surveyed farmers were similar, with a mean age of 47 years and average schooling of just over 3 years (Table 3). Average family size was about 6 although households hiring tractors had smaller family sizes than tractor owners.

The area owned by each group differed. As expected 4-wheel tractor users both managed larger farms and owned a larger share of the farm than 2-wheel tractor users. Owners and hirers owned roughly a similar share of the land that they manage but tractor-owners managed farms which were about twice as large as those of tractor hirers.

The wealth position of the survey farmers is difficult to assess since the value of assets such as land (which may never have been purchased) is very subjective. However Table 6 shows that for all farmers, land was the dominant asset. Since hirers have smaller farm sizes, land accounted for a smaller proportion of their total assets. Although mechanical assets accounted for a relatively high proportion of total assets for the hiring class, this was small in absolute terms. For hirers, animals particularly the productive animals were an important asset, and in absolute terms were greater than for the other groups.

Area cultivated

The mean planted area of 4-wheel tractor farms was 3.68 ha in the wet season (Table 7). This was 30 percent larger than for 2-wheel tractor using farms. The mean in the dry season was 3.43 ha which is also nearly 30 percent larger than for the 2-wheel tractor using farms. These differences are more noticeable when owners and hirers are compared with owners having mean cultivated areas roughly double that of hirers in both the wet and the dry season.

In the largest area class, farms greater than 5.0 ha, do not have any hirers and only very few 2-wheel tractor users. The issue of farm size and choice of machine is an important one which needs further analysis. Maranan et. al.[1] calculated that the breakeven point for 2-wheel tractors was about 3 ha and for 4-wheel tractors, 5 ha.

Cropping intensity

If there are power or time constraints which will limit the amount of land farmers can bring into cultivation in the dry season, then it would be expected that the larger tractors, with greater speed and horsepower, would overcome these constraints and enable farmers to increase land use in the dry season. Results from the study, however showed that there were no significant differences in the rice cropping intensity between 2-wheel and 4-wheel tractor users, both with a mean of 181 percent (Table 7).

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[1]Maranan, C. et. al. The Economics of Mechanical Land Preparation: An Evaluation of Evidence from Suphanburi Province, Thailand.

Owners had a higher intensity than hirers although the difference was very small. This is to be expected since the area was largely irrigated and from Table 8, it can be seen that some farmers did not cultivate a second rice crop. Hence the lower cropping intensity was due mainly to a reduction in the area cultivated by each farmer.

Timeliness

In addition to quantative differences, there may also be qualitative differences between farm types due to more optimum timing and faster operating hours, and these may be equally important. However, some of these factors, visible at the level of the individual activity or parcel, were smoothed out at the level of household data subject as it is to a myriad of non-technical, socio-economic forces (as well as data aggregation). According to Lingard .... "Such factors as 'timeliness' and 'turnaround times' are extremely elusive concepts, difficult to define, observe and measure and impossible to relate to the broader aggregates found in farm survey data".[2]

Figure 2.3 shows that in the wet season there was little difference in the date of planting between 2-wheel and 4-wheel tractor users and between owners and hirers. However, in the dry season, the 4-wheel tractor farmers prepared their land faster than the 2-wheel tractor users (Figure 3.4). Four-wheel tractor users were roughly 3 weeks faster in preparing the first 60 percent of the land area. This suggests that turnaround times were faster for 4-wheel tractor users, although as to whether this contributes to the small yield difference in favor of 4-wheel tractors during the dry season is debatable.

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[2] Lingard J. "Measuring the Impact of Mechanization on Output". Working Paper No. 55. Consequences of Small Rice Farm Mechanization Project.

Seasonal movement in classification

Majority of the households used the same machine type for land preparation in both season, except for households who rented 4-wheel tractors in the wet season (Table 8). This group split in the dry season, with the majority continuing to hire 4-wheel tractors but a sizeable majority switching to 2-wheel machines. However, this is not surprising since the rental rate the same for 2-wheel and for 4-wheel tractors and land preparation was easier at the start of the dry season. This would suggest a considerable degree of substitutability between 2-wheel and 4- wheel tractors. The choice of machine used for land preparation does not rest solely on technical constraints but will also depend on other factors.

Yields and inputs

In the wet season, per hectare yields were about 12 percent higher on 2-wheel tractor using farms than on 4-wheel tractor using farms although the difference was not statistically significant (Table 9). Fertilizer use was also lower as was total labor input but neither were significantly different.

In the dry season, 4-wheel tractor users obtained the highest yields by a difference of 6 percent. Inputs of seed and fertilizer are similar for all groups.

Likewise there were no significant difference between hirers and owners, for either season, although hirers had 11 percent higher yields in the wet season and 4 percent lower in dry season. Hirers also made

more use of animals in land preparation and had much higher total labor inputs. The extra labor is almost entirely household labor since hired labor is about the same for hirers and owners, at around 36 mandays per season. This extra use of household labor is made possible by the smaller farm size that are found in the 'hiring' group.

Yields and Farm Size

The inverse relationship between productivity and farm size seemed to be roughly consistent with the yield data for small, medium and large farms in Tables 11 and 12. However, although mean yields were lower for large area classes the differences were more pronounced in the wet than in the dry season (about 33 percent lower in the wet season and 12 percent lower in the dry season). The wet season drop in per hectare yields as farm size increase were statistically significant and have important implications.

On the basis of this relationship the overall yield of a given land area is expected to be lower if farmed by larger rather than smaller farms. The danger of land accummulation by larger farms, which is often associated with mechanization and may lead to lower per hectare yields, therefore requires a lot of consideration. However, in a rice exporting country such as Thailand, the issue is not solely one of yield per unit area but also of the marketable surplus above home consumption per unit

area. This can be expected to be higher on larger, and more commercial farms.

Costs and returns analysis

Within the framework of a household analysis, decisions were made on the basis of economic values although these costs and return were based on the yield and input levels discussed previously.

Variable costs

Total variable costs were calculated by summing material costs, power costs, labor costs and other miscellaneous expence and by imputing a value for family labor (Tables 13 and 14). The value of family labor is not easy to quantify but given the different levels of family labor used by each group, especially the small 2-wheel tractor users, it would be misleading not to attempt to value this labor. This was therefore done by calculating the mean cost of labor for all farms, all activities and for all sources and using this value (40 baht per day) to compute a value for household labor. As a result there was no significant differences in variable costs between 2-wheel and 4-wheel tractor users and although the difference was greater for hirers than owners, this was not statistically significant.

Power costs for hirers were computed using actual rental rates and it included all mechanical equipment that was hired, such as tractors and threshers.

Own costs, however, do not include any imputed depreciation or interest and since this was also not recorded as an overhead, the costs for owners was understated.

Material costs were similar for all groups. This is a more reliable indicator of the value of fertilizer than the weight in kg (since the NPK composition of some types of fertilizer could not be determined).

The 'hirer' class spent a lower proportion of total pesticide cost on herbicides and consequently a very high labor input for weeding was required. However, there was very little variation across tractor groups in both wet and dry season, in either total variable cost or in its components. Dry season costs were about 10 percent lower than the wet season.

Returns

There was very little difference in price between 2-wheel and 4-wheel tractor users in the wet season and since yields were similar, the value of output were roughly the same (Table 15). In the dry season, 2-wheel tractor users obtained a lower price and with a corresponding low yield, their returns were lower compared to the 4-wheel tractor group. The reason for the low price was not clear but may be related to the

longer turnaround times mentioned earlier, resulting in delayed sales at lower prices.

Overhead costs

Overhead costs were almost entirely rent and no attempt was made to apportion interest on outstanding loans, taxes, etc. on a per hectare basis. The high degree of land ownership for 4-wheel tractor users was reflected in the lower rent during the wet season. Likewise, reduced cropping intensity could be a result of not renting-in land, since rents during the dry season were markedly lower than in the wet season.

Productivity

Productivity is an index measuring the average return to a particular input. It can be expressed in physical quantity or monetary values.

Land productivity was measured in terms of yield per hectare. Results of the study showed no significant differences in yield per hectare between 2-wheel and 4-wheel tractor users (Tables 17 and 18). Yield per hectare was higher in the dry than in the wet season.

Labor productivity in terms of total labor use was the same for 2-wheel and 4-wheel tractor users in the wet season but much better for 4 wheel users in the dry season. This was due more to lower labor use than to higher yields. However, since the productivity of hired labor was

roughly the same in the dry season, reduced family labor had resulted in this higher productivity. The reverse was true for hirers, who contributed more family labor in the wet season. For both seasons, hired labor ratios were similar.

Tractor productivity in the wet season was slightly better for 2-wheel than 4-wheel tractors. However, in the dry season, 2-wheel tractor users incurred about 25 percent higher productivity than farms using 4-wheel tractors.

Comparing owners and hirers in both seasons, tractor owners had higher productivities, the difference being more distinct in the dry season. The reason for this was not clear but since yields were roughly the same, the main variation could be from the tractor hours in land preparation. This suggests that reduced hours of land preparation by farmers hiring tractors is not a technical constraint to higher yields in the dry season.

Value productivities

All the value productivity ratios were similar between 2-wheel and 4-wheel tractor users in the wet season except for the value of output per power cost, which was higher for 2-wheel tractor users (Tables 19 and 20). In the dry season, the value of output for power cost for 4-wheel tractor users was much closer to that of the 2-wheel tractor users. Since yields were not very different, this may be due to the differences

in the price of rice. Since 4-wheel tractor users planted earlier than users of 2-wheels, the reduced turnaround period may be a significant factor. However, as was noted earlier there were complex and elusive relationships that were difficult to quantify. In the dry season, returns per total costs and per variable costs were all better for four wheel tractor users although the difference were not statistically significant.

The value ratios were all roughly the same for owners and hirers, suggesting that custom rates were set close to the free market rates.

Conclusion

In this preliminarly analysis, few if any significant differences in output or input, have been observed between 2-wheel and 4-wheel tractor users. A more detailed analysis is required to look into the effects of farm sizes and costs of operating the machines. This lack of variation within the area studied suggests that some sort of equilibrium has been attained and that the acquisition of skills and knowledge associated with the new technology is available to and has been assimiliated by all farmers.

However, there may be advantages associated with earlier planting and subsequently higher prices. In this regard, 4-wheel tractors may be more efficient and faster thus enabling more land to be prepared in a shorter time.

Table 1. Distribution of households among classification groups for wet season 1981/82 and dry season 1982.

(a) Wet Season 1981/82

Classification	Animal	2 WT	4 WT	Ownership status
Owners	5	100	54	159
Hirers	-	63	32	95
Mechanization type	5	163	86	254

(b) Dry Season 1982

Classification	Animal	2 WT	4 WT	Ownership status
Owners	2	96	53	151
Hirers	-	69*	27	96
Mechanization type	2	165	80	247
Did not cultivate/moved		-	-	11

* Including 2 landless households from wet season 1981/82 who cultivated in dry season 1982.

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 2. Percentage of area planted with different varieties in selected irrigated villages, Suphanburi Province, Thailand, wet season 1981/82.

Varieties	2 WT	4 WT	Own	Hire
		percent		
HYV				
RD 7	70	64	67	69
RD 11	17	28	24	16
Others	5	3	3	7
Total	92	95	94	92
Local	8	5	6	8
Total planted area (ha)	457	318	599	181

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 3. Percentage of area planted by method of planting in selected irrigated villages, Suphanburi Province, Thailand, wet season, 1981/82.

Method	2 WT	4 WT	Own	Hire
		percent		
Broadcasting	19	33	26	23
Transplanting	81	67	74	77
Total planted area (ha)	457	318	599	181

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 4. Characteristics of farmer and farmholdings in selected irrigated villages of Suphanburi Province, Thailand, wet season 1981/82.

Item	2 WT	4 WT	Owner	Hirer
Farmer's age (year)	47	48	47	47
education (year)	3.3	3.0	3.2	3.2
Family size	6.1	6.0	6.5	5.3
Land managed (ha)	2.95	3.80	3.98	1.93
Percentage of managed land which is owned	65%	104%	84%	77%
No. of draft animals per farm	0.58	0.55	0.48	0.90
No. of tractors per farm	0.83	0.91	1.28	0.10
No. of farmers in sample	163	86	159	95

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 5. Percentage distribution of draft animals by sex for 2-wheel and 4-wheel tractor users in selected irrigated villages, Suphanburi Province, Thailand, wet season 1981/82.

Age	2 WT		4 WT	
	Male	Female	Male	Female
	percent			
less than 6 months	9	-	-	-
6 months - 1 year	14	12	7	5
1 - 3 years	32	27	31	35
over 3 years	45	61	62	60

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 6. Mean assets and percentage composition of farm households in selected irrigated villages of Suphanburi Province, Thailand, wet season 1981/82.

Item	2 WT	4 WT	Own	Hire
Total assets	165,000	250,000	250,000	105,000
Of which:				
land	67	78	81	53
machinery	22	12	12	28
draft animals	3	4	3	6
productive animals	8	7	4	13

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 7. Average level of cropping intensity of rice land for 2-wheel and 4-wheel tractor users, owners and hirers in selected irrigated villages in Suphanburi Province, Thailand, crop year 1981/82.

Item	2 WT	4 WT	Owner	Hirer
Cultivated area (ha)				
Wet season	2.82	3.68	3.82	1.90
Dry season	2.70	3.43	3.67	1.81
Cropping intensity	1.81	1.81	1.84	1.77
Sample size	162	86	153	95

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 8. Movement of households in percentage farm types between wet season 1980/81 and dry season 1982 in selected irrigated villages in Suphanburi Province.

Farm class in wet season	Farm class in dry season 1980							Landless	Total no. of cases
	Animal	2 WT		4 WT		Did not cultivated			
		Owner	Hirer	Owner	Hirer	Remained	Moved		
					percent				
Animal	40	20	20	-	-	20	-	-	5
2 WT owner	-	92	3	3	2	-	-	-	100
2 WT hirer	-	3	75	2	11	10	-	-	63
4 WT owner	-	2	6	89	2	2	-	-	54
4 WT hirer	-	41	3	53	3	-	-		32
Landless	-	-	11	-	-	-	11	78	18
Total	2	96	69	53	27	9	2	14	272

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 9. Yield and inputs in rice production for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated villages of Suphanburi Province, Thailand, wet season 1981/82.

Item	Type of tractor		Ownership	
	2 WT	4 WT	Owner	Hirer
	per hectare			
Yield (kg)	3604	3178	3311	3643
Material inputs (kg)				
Seeds	121	197	155	132
Fertilizer	286	233	270	267
Power inputs				
Animal	3	7	4	10
Tractor	49	49	52	44
Labour inputs				
Total (mds)*	81	74	76	91
Hired (mds)	34	37	34	36
Hired (%)	(41)	(50)	(46)	(40)

* One manday = 8 hours.

Table 10. Yield and inputs in rice production for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated villages of Suphanburi Province, Thailand, dry season 1982.

Item	2 WT	4 WT	Owners	Hirers
		per hectare		
Yield (kg)	3647	3861	3772	3609
Material inputs (kg)				
Seeds	117	130	122	119
Fertilizer	292	290	295	286
Power inputs				
Animal	2	0	1	3
Tractor	49	53	49	52
Labor inputs				
Total (mds)*	76	67	68	82
Hired (mds)	33	36	33	35
Hired (%)	(43)	(54)	(49)	(43)
No. of respondents	165	80	149	98

* One manday = 8 hrs.

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 11. Mean yield by area class for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated villages in Suphanburi Province, Thailand, wet season 1981/82.

Area group	2 WT	4 WT	Owner	Hirer
		kg per hectare		
< 2.0 ha	3965 (64)	3864 (22)	4098 (24)	3877 (62)
2.0 - 5.0 ha	3204 (80)	3099 (41)	3289 (90)	2820 (31)
≥5.0 ha	2941 (18)	2664 (23)	2834 (39)	1845 (2)
All	3604 (162)	3178 (86)	3311 (153)	3643 (95)

Figures in parenthesis give the number of farms in each area group.

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 12. Mean yield by area class for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated villages in Suphanburi Province, Thailand, dry season, 1982.

Area group	2 WT	4 WT	Owner	Hirer
<2.0 ha	3713 (69)	3867 (23)	3845 (27)	3713 (65)
2.0 - 5.0 ha	3468 (85)	3905 (42)	3745 (94)	3236 (33)
> 5.0 ha	3254 (14)	3470 (15)	3417 (28)	1941 (1)
All	3647 (168)	3861 (80)	3772 (149)	3609 (99)

Figures in parenthesis give the number of farms in each area group.

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 13. Variable costs per hectare for rice production for 2 wheel and 4 wheel tractor users and owners and hirers in selected irrigated villages of Suphanburi Province, Thailand, wet season 1981/82.

Item	2 WT	4 WT	Owners	Hirers
Material costs (baht)		per hectare		
Seeds	420	652	544	423
Fertilizer	1661	1551	1581	1694
Pesticides	321	315	299	344
of which:				
insecticides (%)	71	65	67	72
fungicides (%)	2	3	2	1
rodenticides (%)	9	7	8	10
herbicides (%)	18	25	23	17
Total	2402	2528	2424	2461
Power costs				
- hired	681	655	267	1315
- own	796	1219	1425	135
Total	1477	1874	1692	1450
Labor costs				
- hired	1359	1544	1459	1318
- household*	1731	1221	1194	2247
Total	3090	2765	2653	3565
Other costs:	24	17	28	11
Total variable costs	6993	7184	6797	7487

*Imputed at overall mean cost of labor for all types, sources and for all activities.

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 14. Variable costs per hectare in rice production for 2-wheel and 4-wheel tractor users and owners and hirers in selected irrigated villages of Suphanburi Province, Thailand, dry season 1982.

Item	2 WT	4 WT	Owners	Hirers
	per hectare			
Material costs				
Seeds	295	346	304	320
Fertilizer	1644	1586	1617	1631
Pesticides	222	167	200	206
of which:				
- insecticide (%)	63	63	65	61
- fungicides (%)	3	2	2	3
- rodenticides (%)	10	10	7	14
- herbicides (%)	24	25	26	22
Total	2161	2099	2121	2157
Power costs				
- hired	558	538	276	965
- own	423	777	774	172
Total	981	1315	1050	1137
Labor costs				
- hired	1309	1689	1524	1268
- household*	1764	1331	1498	1887
Total	3073	3020	3022	3155
Other costs	7	13	14	1
Total variable costs	6222	6447	6207	6450

*Imputed at overall mean cost of labor for all types, sources and for all activities.

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 15. Costs and returns summary for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated villages of Suphanburi Province, Thailand, wet season 1981/82.

Item	Type		Ownership	
	2 WT	4 WT	Owner	Hirer
	baht per hectare			
Value of output	11,371	10,784	10,885	11,488
Price of paddy	3.30	3.28	3.36	3.19
Total costs	8,591	7,925	7,900	9,153
overheads*	1,598	741	1,203	1,666
variable	6,993	7,184	6,797	7,487
Paid out costs**	6,860	6,704	6,706	6,906
No. of respondents	158	85	156	91

* Mostly rent.

** Excluding imputed cost of family labor.

Table 16. Costs and returns summary for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated villages of Suphanburi Province, Thailand, dry season 1982.

Item	2 WT	4 WT	Owner	Hirer
		baht per hectare		
Value of output	8579	10,406	8865	9581
Price of paddy	2.50	2.58	2.53	2.53
Total costs	6733	6984	6687	7015
overhead*	511	537	480	656
variable	6222	6447	6207	6450
Paid out costs**	4969	5653	5189	5128
No. of respondents	155	80	149	98

* Mostly rent.

** Excluding imputed cost of family labor.

Table 17. Productivity ratios for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated village, Suphanburi Province, Thailand, wet season 1981/82.

Item	2 WT	4 WT	Owner	Hirer
Yield				
per hectare (kg)	3604	3178	3311	3643
per total labor (md)	44	43	62	40
per hired labor (md)	106	86	97	101
per tractor hour (land preparation)	93	89	81	113
No. of respondents	158	85	156	91

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 18. Productivity ratios in rice production for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated villages in Suphanburi Province, Thailand, dry season 1982.

Item	Machine type		Ownership	
	2 WT	4 WT	Owner	Hirer
Yield (kg)	3647	3861	3772	3609
per hectare				
per total labor (md)	48	58	55	44
per hired labor (md)	111	108	114	103
per tractor hour (land preparation)	141	112	101	176
No. of respondents	165	80	149	98

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 19. Productivity ratios in rice production for 2-wheel and 4-wheel tractor users and for owners and hirers in selected irrigated village of Suphanburi Province, Thailand, wet season 1981/82.

Item	2 WT	4 WT	Owner	Hirer
		baht per hectaare		
Value of output:				
per hectare	11,371	10,784	10,885	11,488
per total cost	1.32	1.36	1.38	1.26
per variable costs	1.63	1.50	1.60	1.53
per paid out cost	1.66	1.61	1.62	1.66
per fertilizer cost	6.8	6.8	6.9	6.8
per power cost	7.7	5.8	6.4	7.9
No. of respondents	158	85	156	91

Source: Consequences of Small Rice Farm Mechanization in Thailand.

Table 20. Productivity ratios inrice production for 2-wheel and 4-wheel tractor users and for owner and hirer in selected irrigated villages of Suphanburi Province, Thailand, dry season 1982.

Item	Type		Ownership	
	2 WT	4 WT	Owner	Hirer
	baht per hectare			
Value of output:				
per hectare	8597	10,406	8865	9581
per total cost	1.28	1.49	1.33	1.37
per variable cost	1.38	1.61	1.43	1.49
per paid out cost	1.73	1.84	1.71	1.87
per fertilizer cost	5.2	6.6	5.5	5.9
per power cost	8.8	7.9	8.4	8.4
No. of respondents	155	80	49	98

Source: Consequences of Small Rice Farm Mechanization in Thailand.

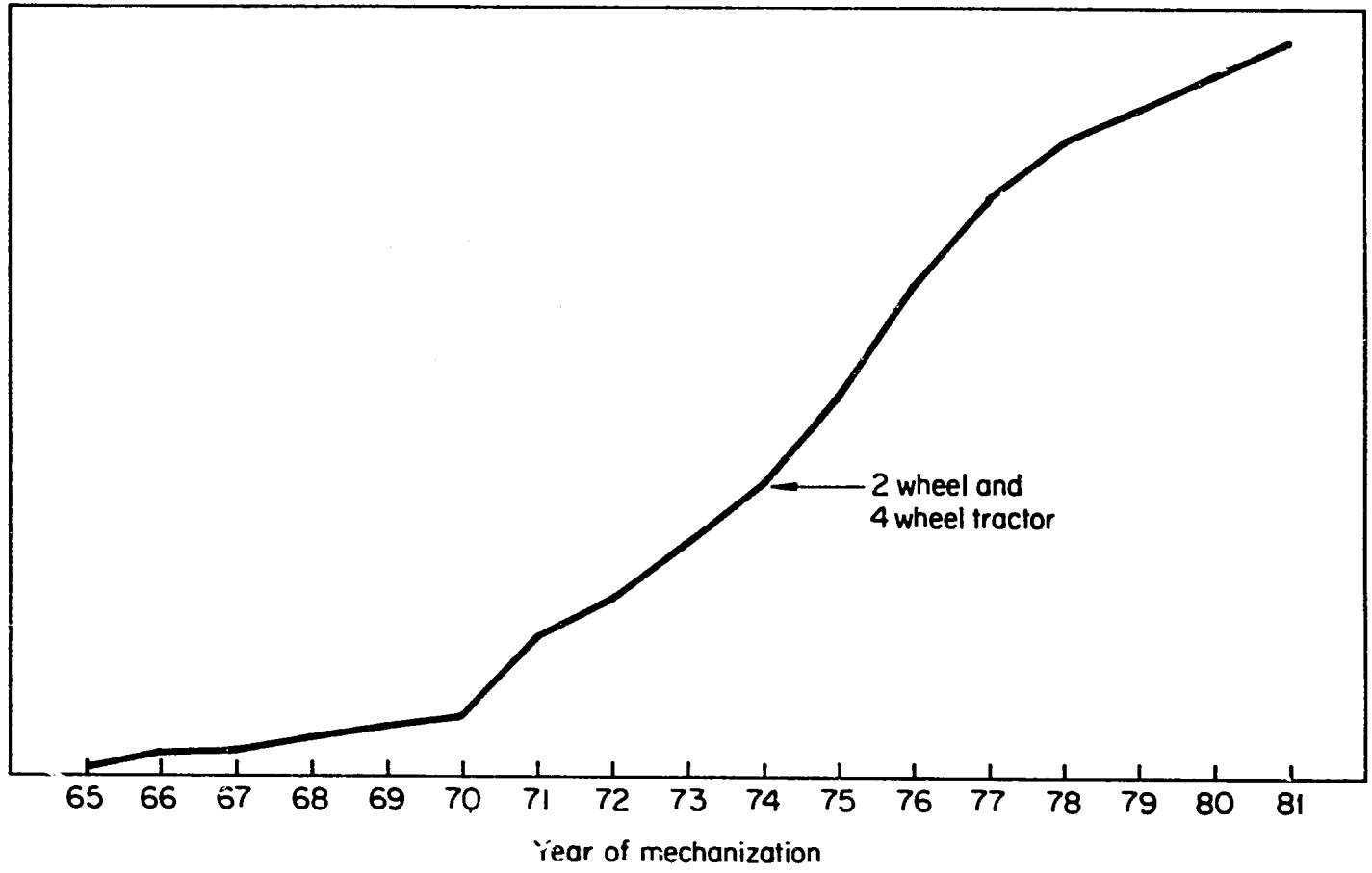

Fig. 1. Cumulative frequency of percentage of mechanized households by year of mechanization for selected irrigated villages of Suphanburi province, Thailand.

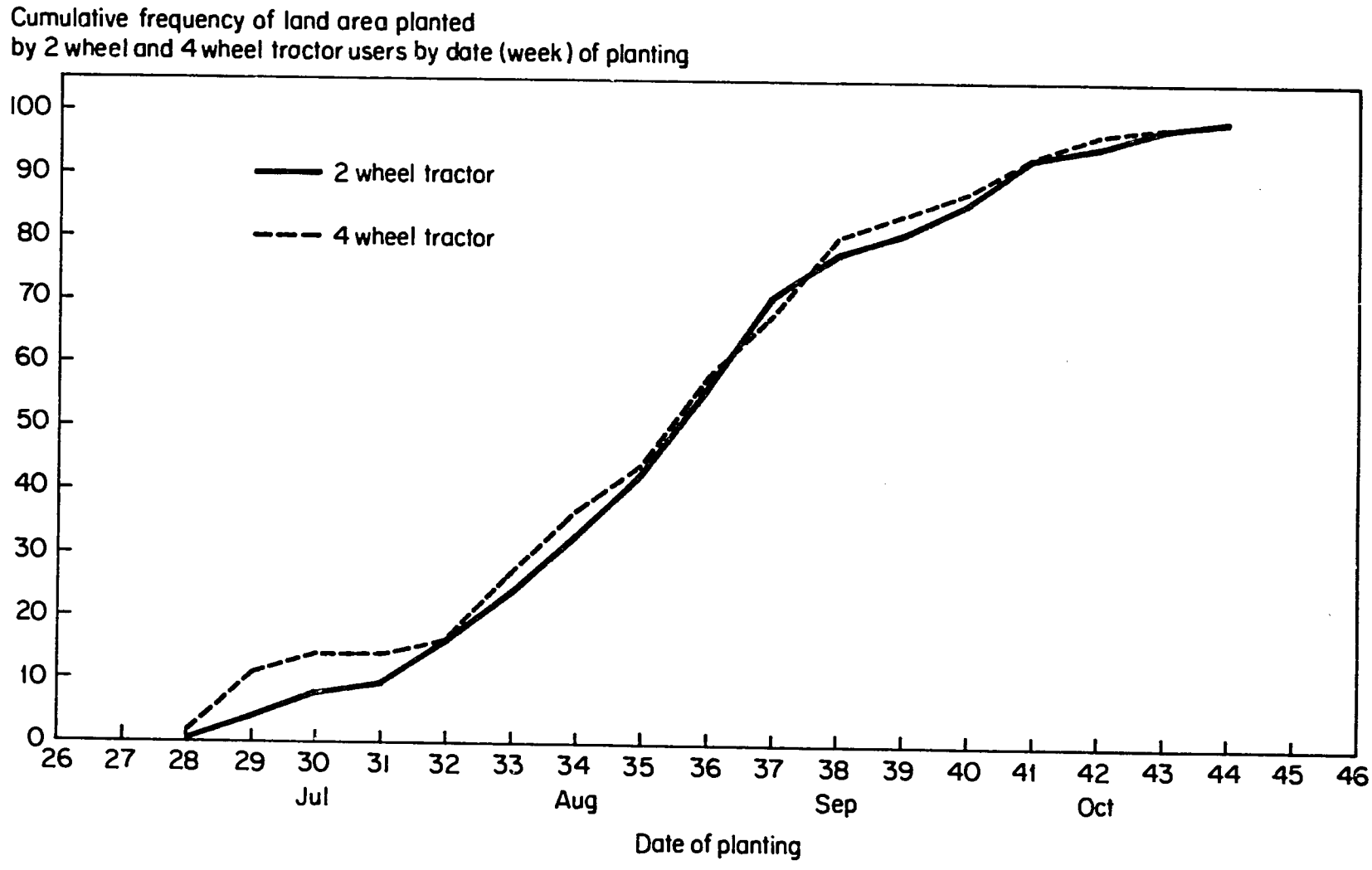

Fig. 2. Cumulative frequency of land area planted by 2 wheel and 4 wheel tractor users by week of planting, in selected irrigated villages of Suphanburi province, Thailand. Wet season, 1981.

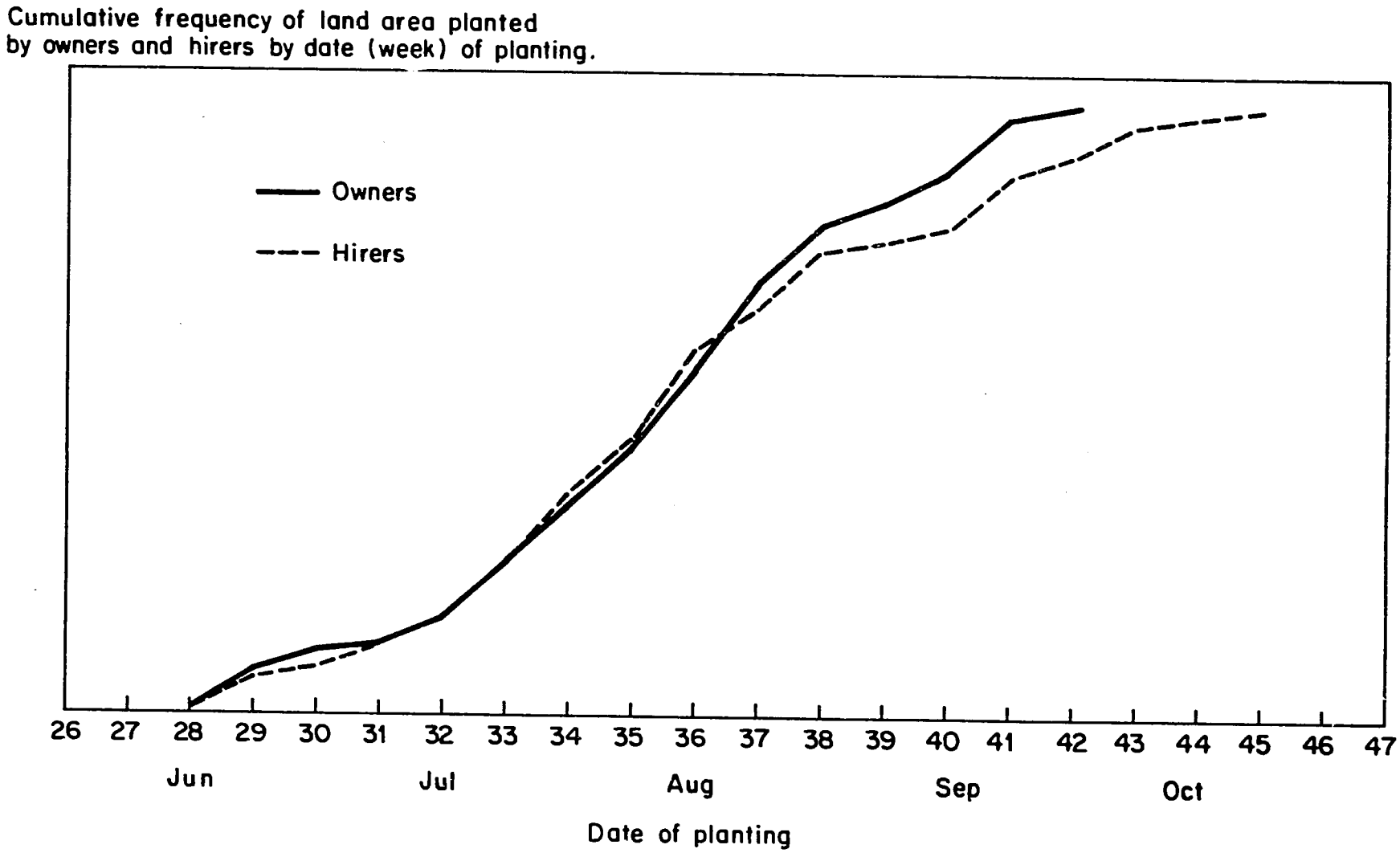

Fig. 3. Cumulative frequency of land area planted by owners and hirers by week of planting, in selected irrigated villages, Suphanburi province, Thailand, wet season 1981.

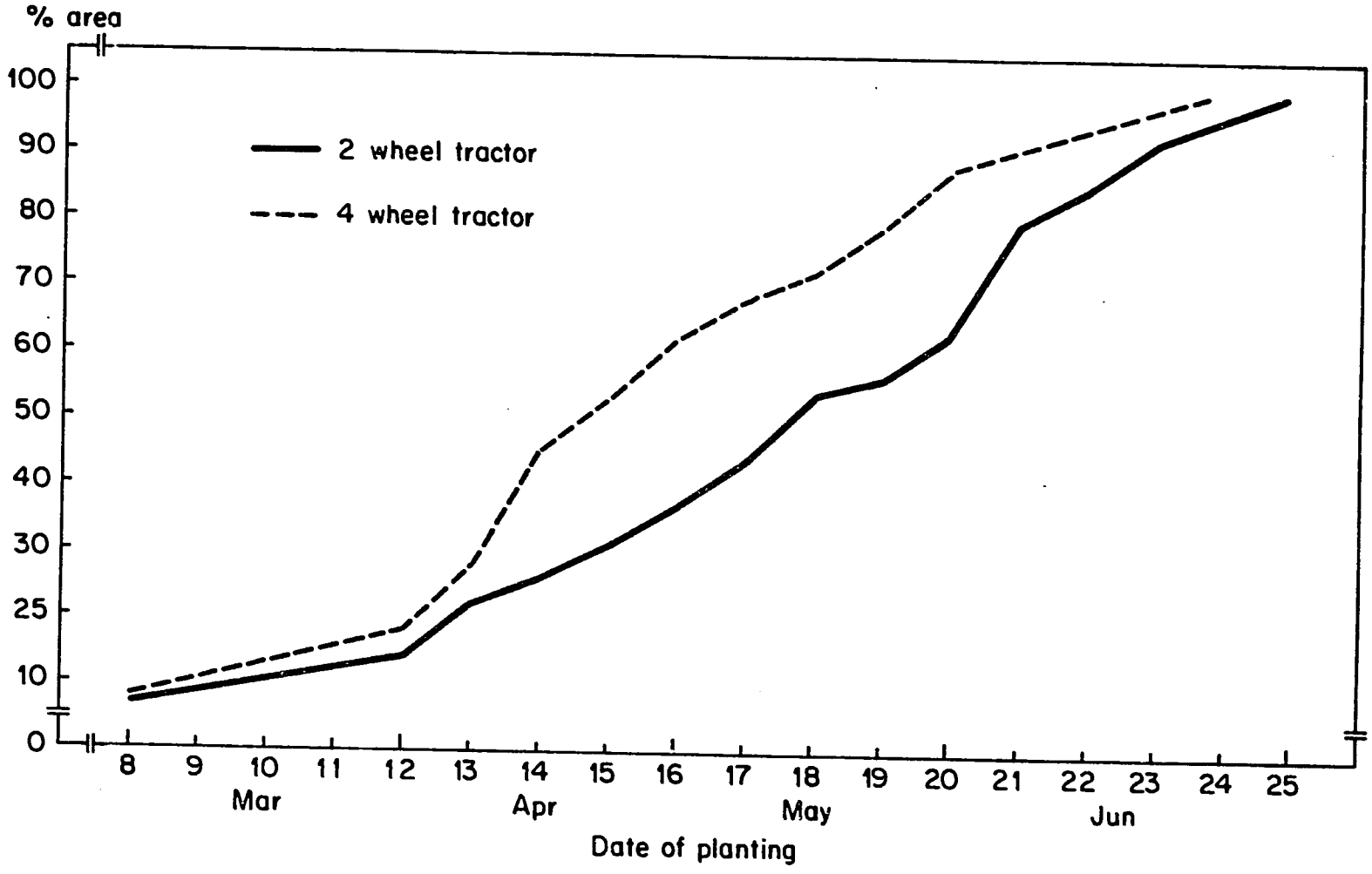

Fig. 4. Cumulative frequency of land area planted by 2-wheel and 4-wheel tractor users by week of planting, in selected irrigated villages of Suphanburi province, Thailand, dry season, 1981.

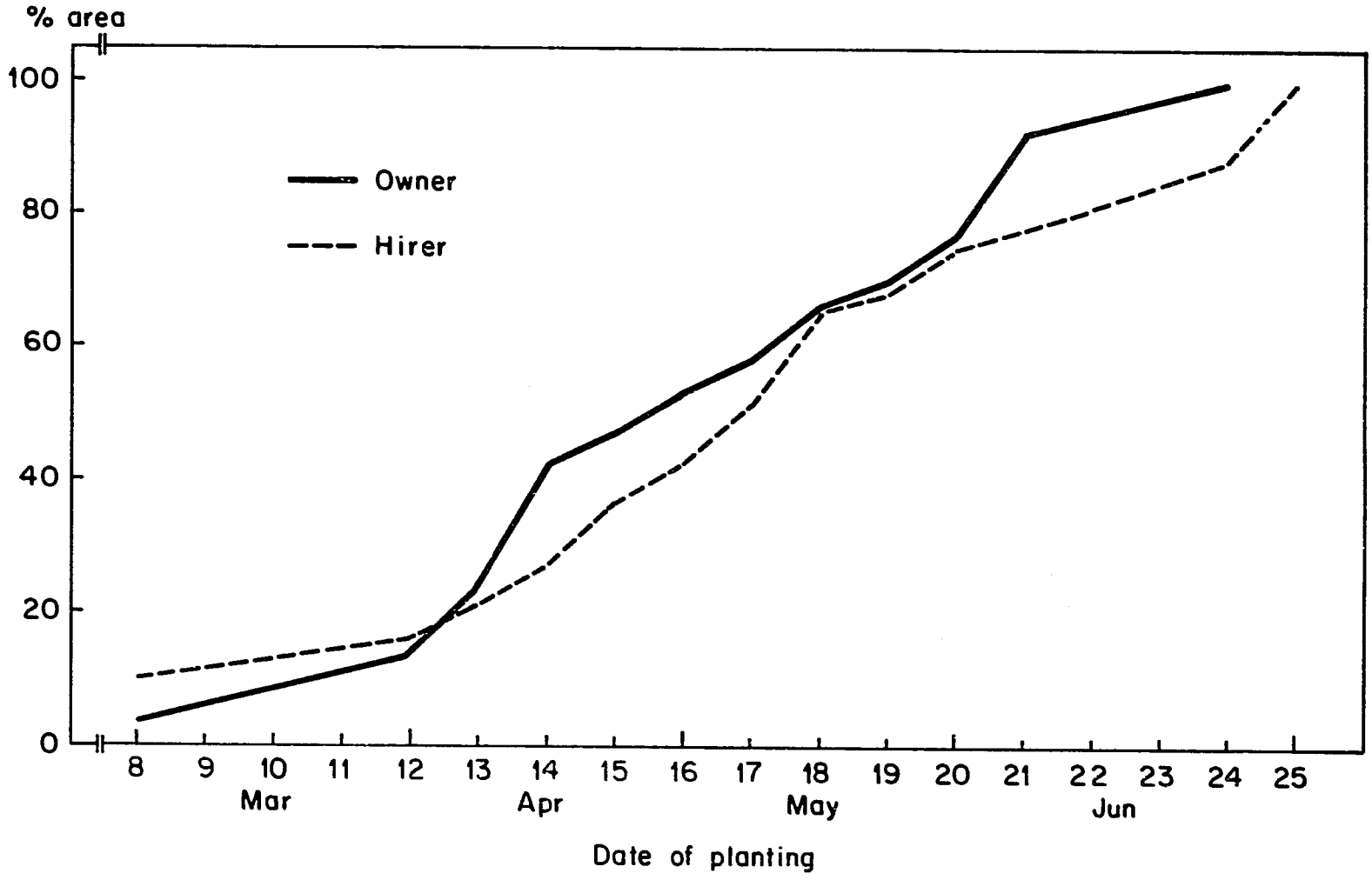

Fig. 5. Cumulative frequency of land area planted by tractor owners and hirers by week of planting, in selected irrigated villages, Suphanburi province, dry season, 1981.