A SURVEY ON THE UTILIZATION OF AGRICULTURAL MACHINERY

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ABSTRACT

This study was carried out in order to find out an effective machinery utilization strategy by conducting a survey on utilization and maintenance of agricultural machinery.

The survey showed that the no. of utilization hours for power tiller in a year was 190.2hrs, 208.6hrs for tractor, 59.1hrs for rice transplanter, 74.0 hrs for combine, 44.6 cultivator and 254.4hrs for 4.4hrs for grain dryer. The period covered the time the machine was until it became unserviceable.

The results are as follows: 10.0yrs for power tiller, 7.5yrs for tractor, 7.4yrs for rice transplanter and 5.4yrs for combine. This indicate that the actual period of use for power tiller and rice transplanter was longer than the expected period of duration years so there is a need for adjustment. The factors considered by the farmers for purchasing agricultural machine were: farm size(32%), machine operation (26.0%), performance(14.0%) and post or after sales service(12.6%), according to the survey. It showed that repair cost rate in a year was classified into major agricultural machine; 4.8% for combine; 3.9% for tractor; 3.5% for rice transplanter; 2.0% for power tiller; 1.6% for grain dryer; and 1.2% for cultivator. The reasons for poor maintenance were insufficient after sales service(25%) and difficulty in buying parts(75%) because of the unavailability of parts in local shops(55%), imported models(30%) and outmoded model(15%).

Key words : Agricultural Machinery, Utilization history, Breakdown & repair, Agricultural mechanization

INTRODUCTION

Recently, the utilization status of major farm machinery is changing greatly because of the changing farming pattern the participation of older persons and women in farming. It is now difficult to do farming operations without agricultural machinery, so the demand for agricultural machinery in farming is rising continuously. With the change internal and external environmental conditions, the agricultural mechanization policy has also been shifted from supporting system to loan system since the late 1990's.

It is thus necessary to promote efficient utilization strategies for farm machinery.

At the end of 1998, the number of power tiller was 3,349 thousands, an average of 2.37 machines per farm household. But, major machines such as tractor, combine, and grain dryer etc. showed low supply ratio of about 10%. Furthermore, with the farmers' desire for convenient farming using large and riding type machines and the projected change in purchasing and utilization pattern in near future, efficient utilization and maintenance of farm machines should be widely promoted.

The basic information needed in promoting efficient utilization strategies and policies could be obtained from the survey results such as data on farming coverage area, ownership status, utilization pattern, break down and repair results.

This study was conducted to find out the efficient utilization and repair & maintenance strategies through survey and analysis of various information mentioned above on the 6 major machines namely: power tiller, farm tractor, rice transplanter, combine, cultivator, grain dryer etc.

Survey and Analysis Method

In order to obtain the utilization and break down & repair status for the major farm machinery, sample farm households were surveyed from 24 cities and counties in 8 provinces.

The stratified random sampling method was used in the selection of the farm households to be surveyed. List of surveyed regions and the number of samples by region are represented on Table 1 and Table 2, respectively.

Table 1. List of investigated regions

Items	Kyonggi	Kangwon	Chung-buk	Chung-nam	Chun-buk	Chun-nam	Kyong-buk	Kyong-nam	Total
Plain area	Hwasung	Chorwon	Chechon	Hongsong	Iksan	Haenam	Songju	Haman	8Counties
Middle area	Yoju	Hongchon	Chinchon	Poryong	Kochang	Chang-song	Kyongju	Miryang	8Counties
Mountainous area	Yangju	Yongwol	Poun	Kongju	Namwon	Kurye	Kunwi	Hamyang	8Counties

In determining the number of power tillers, tractors, rice transplanters, combine, cultivators, and grain dryers by the end of 1998, the size of samples of 100 machines were identified based on reliance level of 95% and allowable possible error of ±10%. The different size of samples was surveyed considering the ownership and the number of machines for the surveyed regions.

$$n \geq \frac{N}{(\frac{e}{k})^2 \frac{N-1}{P(1-P)} + 1} \quad \cdots\cdots\cdots\cdots \text{Eq. (1)}$$

n : size of sample

e : maximum allowable possible error (±10%)

N : size of population

P : expected rate of population (50%)

k : % point (=1.96) of standard distribution corresponding to reliance level

Table 2. Number of samples

Items	No. of farms (households)	No. of samples investigated (unit) †					
		Power tiller	Farm tractor	Rice transplanter	Combine	Cultivator	Grain dr
Plain area	89	52	57	48	43	33	55
Middle area	70	67	47	55	34	31	28
Mountainous area	38	39	23	25	16	26	10
Total	197	158	127	128	93	90	93

† : Ownership of machines of 197 farm households.

The survey was conducted for 6 months from April to September 1999, thru personal interviews with farmers at each farm household.

RESULTS AND DISCUSSION

1. General status of the surveyed farm households

The age distribution of the sampled farmers was highest for yhe 40~50age group. The average farming area of the surveyed farmers was 3.79ha per household, which was larger than the national average of 1.35ha per household (Table 3 and Table 4).

Table 3. Distribution rate of farmers by age groups

Items	30's	40's	50's	over 60's	Total
Rate(%)	16.3	34.0	34.5	15.2	100

Table 4. Farm households by size of cultivated land

(unit: ha/households)

Items	Paddy field	Upland	Total	Remarks
Plainarea	3.60	1.06	4.66	cultivation of rice+upland : 116farm households
Middlearea	2.99	0.69	3.68	cultivationofrice+orchard : 24farm households
Mountainous Area	2.33	0.70	3.03	cultivation of rice+livestock : 33farm households
Average	2.972.97	0.820.82	3.793.79	cultivation of rice+greenhouse : 24farm households

2. Working results by the machinery

The annual coverage areas, annual working hours, and annual working days of the major farm machinery were surveyed and analyzed by regions and type or nature of work. As shown in Table 5, the annual coverage areas, annual working hours, and annual working days of the power tiller were 0.67ha, 190.2hrs, and 54.2days.

Table 5. Annual coverage of power tiller

Items	Plowing	Land preparation	Pest control†	Pumping	Convey-ance‡	Others	Total
○Coverage area (ha/yr)	0.31	0.32	-	-	-	0.04	0.67
- Plain area	0.34	0.21	-	-	-	-	0.55
- Middle area	0.30	0.37	-	-	-	0.04	0.71
- Mountainous area	0.27	0.36	-	-	-	0.09	0.72
○Working hours(hr/yr)	6.4 (3.4)	6.5 (3.4)	38.7 (20.4)	32.4 (17.0)	102.3 (53.8)	3.9 (2.0)	190.2 (100)
- Plain area	6.3	4.4	32.1	24.0	92.5	0.9	160.1
- Middle area	6.5	7.0	42.1	18.3	90.5	5.6	170.0
- Mountainous area	6.5	8.4	41.8	67.6	135.9	4.7	264.9
○Working days(days/yr)	1.3 (2.5)	1.2 (2.2)	8.6 (15.9)	4.4 (8.1)	38.0 (70.1)	0.7 (1.3)	54.2 (100)
- Plain area	1.4	0.9	7.1	5.2	39.4	0.2	54.1
- Middle area	1.5	1.3	10.1	3.0	35.5	1.0	52.5
- Mountainous area	0.9	1.2	8.1	5.7	40.4	0.7	57.0

† : Coverage area(ha)×Times of pest control(times)

‡ : Utilization other than in farming operation.

Power tiller was mainly used for pest control and conveyance, but used less than 10% for plowing & land preparation. This means that power tiller is mainly used for power source instead of being used for plowing & land preparation.

The annual coverage area and working days by regions showed almost similar status, but the annual working hours showed more hours in mountainous (1.6 to 1.7 times) than in plain and areas. Power tiller is still used more frequently in the mountainous area.

The annual coverage area, annual working hours, and working days for the tractor, as shown in Table 6, were 27.5ha, 208.6hrs, and 36.4days. Tractor was mainly used for plowing & land preparation (over 90%) in contrast with power tiller. So, the machines used for plowing & land preparation has been shifted from power tiller to tractor.

For the annual working hours, 65% of the machinery them was used for plowing and land preparation. Implements suitable for various farming operation, other than plow and rotary, should be developed and attached to the tractor to maximize the working hours. The survey showed that the working hours for other farming operation; (except for plowing & land preparation) was very long. The working results by the regions showed similar status.

Table 6. Annual coverage of farm tractor

Items	plowing	Land prepar-ation	fertilizer applica-tion	ridging	pest control†	mulch-ing	convey-ance‡	loader	baler	others	Total
Coverage area (ha/yr)	8.61 (31.3)	16.67 (60.6)	1.93 (7.0)	0.26 (0.9)	- (-)	- (-)	- (-)	- (-)	- (-)	0.02 (0.1)	27.49 (100)
Plain area	8.28	18.29	2.50	0.22	-	-	-	-	-	0.04	29.29
Middle area	8.16	14.36	2.15	0.44	-	-	-	-	-	-	25.11
Mountainous area	10.36	17.19	0.05	-	-	-	-	-	-	-	27.60
Working hours (hr/yr)	34.4 (16.5)	100.8 (48.3)	1.8 (0.9)	1.2 (0.6)	0.5 (0.2)	0.2 (0.1)	45.4 (21.8)	20.5 (9.8)	3.6 (1.7)	0.2 (0.1)	208.6 (100)
Plain area	30.5	106.1	2.3	0.7	0.5	0.4	45.3	12.2	5.1	0.4	203.5
Middle area	38.6	93.2	1.9	2.5	-	-	48.1	29.8	2.2	-	216.3
Mountainous area	35.8	102.9	0.1	-	1.2	-	40.3	22.8	2.4	-	205.5
Working days (days/yr)	4.3 (11.8)	12.6 (34.6)	0.2 (0.5)	0.3 (0.8)	0.1 (0.4)	0.02 (0.1)	13.0 (35.7)	5.3 (14.6)	0.5 (1.4)	0.03 (0.1)	36.4 (100)
Plain area	3.8	13.3	0.3	0.3	0.2	0.1	13.0	2.9	0.6	0.1	34.5
Middle area	4.8	11.6	0.2	0.4	-	-	13.4	8.1	0.3	-	38.8
Mountainous area	4.5	12.9	0.01	-	0.3	-	12.2	5.7	0.5	-	36.1

† : Coverage area(ha)×Times of pest control(times)

‡ : Utilization other than in farming operation.

As shown in Table 7, the annual coverage area, annual working hours, and annual working days of rice transplanter were 6.55ha, 59.1hrs, and 7.3days, respectively. And the coverage area occupied almost same portion for personal labor and hired labor.

The annual coverage area, annual working hours, and annual working days of combine were 14.47ha, 74.0hrs, and 9.3days, respectively, and the annual coverage area, annual working hours, and annual working days of grain dryer were 9.35ha, 254.4hrs, 16.4days (Table 7).

Rice transplanter and combine were used only less than 10days, and also used for 8.1hours and 8.0hours per day, respectively. In comparision with the 20-day expected annual working days for rice transplanting and harvesting operation, the results showed that the annual working days was reduced because enhanced performance of the higher-powered and multi-rows machines.

The annual coverage area of grain dryer at the mountainous area was only 50% compared with the plain area.

Table 7. Annual coverage of Ricetransplanter, Combine& Grain dryer

Items	Coverage area (ha/yr)			Working hours (hr/yr)	Working days (days/yr)
	Personal labor	Hired labor	Total		
Rice transplanter	3.28	3.27	6.55	59.1	7.3
Plain area	3.46	3.88	7.34	62.8	7.8
Middle area	3.42	3.14	6.56	52.6	6.6
Mountainous area	2.60	2.40	5.00	64.0	8.0
Combine†	4.97	9.51	14.47	74.0	9.3
Plain area	5.29	11.56	16.85	83.6	10.4
Middle area	4.62	7.05	11.67	66.9	8.4
Mountainous area	4.85	9.20	14.05	63.2	8.0
Grain dryer ‡	5.06	4.29	9.35	254.4	16.4
Plain area	5.99	4.92	10.91	288.2	18.6
Middle area	4.04	3.97	8.01	231.9	15.0
Mountainous area	2.81	1.73	4.55	131.1	8.5

† ‡ : In case of rice & barley.

The modes of transporting after harvest were surveyed to analyze the correlation between harvesting and drying operation. The results are shown on Table 8. The mode of transportation for harvested grain are as follows: power tiller + trailer (25.6%), truck (22.4%), power tiller + truck (18.9%), tractor + trailer (15.6%), tractor + truck (11.1%). Truck was used for grain transportation by 55.5% of the surveyed farm households. This was higher than the farm households using power tiller and tractor.

The annual working hours for the cultivator was 44.6hrs mainly for ridging, mulching, trenching and covering. The annual working performance of the cultivator was very low, which means that the cultivation area for upland crops is poor (Table 9).

Table 8. Transportation method of grain

Items	PT(T)†	FT(T)‡	Truck	PT(T)+ FT(T)	PT(T)+ Truck	FT(T)+ Truck	PT(T)+ FT(T)+Truck	Total
Rate (%)	25.6	15.6	22.2	3.3	18.9	11.1	3.3	100

† : power tiller + trailer, ‡ : farm tractor + trailer

Table 9. Annual coverage of cultivator

Items	plowing	Land prepara-tion	ridging	mulch-ing	hilling	trench, covering	weeding	others	Total
Coverage area (ha/yr)	0.10 (3.9)	0.31 (12.1)	0.54 (21.1)	0.75 (29.3)	0.30 (11.7)	0.43 (16.8)	0.11 (4.3)	0.02 (0.8)	2.56 (100)
Working hours (hr/yr)	2.2	5.7	11.3	10.9	4.0	8.2	2.2	0.1	44.6
Working days (days/yr)	0.3	0.7	1.4	1.4	0.5	1.0	0.3	0.1	5.7

As shown in Table 10, most farm households owned tractors and combine and hired farm laborers. But a few farm households owned rice transplanter and grain dryer and hired farm laborers. The reason for this could be the availability of rice transplanter, and the common practies of using it in combination with the grain dryer.

Table 10. Percentage of hired labor by major farm machinery

(unit : %)

Items	Farm tractor	Rice Transplanter	Combine	Grain dryer
Percentage of coverage area by hired labor	61.6	49.9	65.7	45.9
Percentage of farm household with hired labor	92.1	69.5	81.7	66.7

3. Life span/serviceable period of the machines

With the increase in supply of farm machinery this year, the skill of farmers in the utilization of advanced and modern machines is also improving.

Table 11. Distribution of operation career of handling

(unit : %)

Items	Ave. no of yrs. of utilization (yr)	1~2	3~4	5~6	7~8	9~10	11~12	13~14	Over 15year
Power tiller	10.0	-		15.7	17.6	33.4	9.8	7.8	15.7
Farm tractor	7.5	-	-	13.3	73.4	13.3	-	-	-
Rice transplanter	7.4	-	15.4	24.6	23.1	24.6	7.7	4.6	-
Combine	5.4	-	33.3	37.5	25.0	4.2	-	-	-

In order to estimate the life span of the machine the period from the time of purchase to the time of deterioration of the machine was surveyed. The average serviceable years, as shown in Table 11, were 10.0years for power tiller, 7.5years for tractor, 7.4years for rice transplanter, and 5.4years for combine. The serviceable years for power tiller showed uniform distribution at 9 to 10 years, and for tractor and rice transplanter the distribution was 5 to 10 years and those for combine 3 to 8 years.

Table 12. Pattern in life span and number of working hours of farm machinery

Item	'80~'86		'87~'95		After '96	
	Serviceable year's(yr)	Working hours(hr/yr)†	Serviceable year's(yr)	Working hours(hr/yr)†	Serviceable year's(yr)	Working Hours(hr/yr)†
Power tiller	8	323 ('84)	7	294 ('93)	6	190 ('98)
Farm tractor	10	379 ('84)	8	210 ('93)	8	209 ('98)
Rice transplanter	6	69 ('80)	6	44 ('93)	5	59 ('98)
Combine	8	103 ('81)	7	92 ('93)	5	74 ('98)
Cultivator	-	-	6	-	5	45 ('98)
Grain dryer	8	-	8	232 ('93)	8	254 ('98)

† : Annual report of NAMRI

These results showed that the major farm machinery was used longer than the expected Serviceable period.

As the supporting information for adjusting the serviceable period, the recommended change in life span & working hours of farm machinery was shown on Table 12. In reducing the span of annual working hours of the machinery, the serviceable period for some of the machinery should be adjusted. It is suggested in this study that the serviceable period for power tiller should be adjusted to 8years from 6years and 7years from 5years (Table 13).

Table 13. Adjustment of serviceable period of farm machinery

Items	Ave. year of use By farm household(yr)†	RFDP(%) ‡	Serviceable period of current(yr)	Adjustment of serviceable period(yr)
Power tiller	10.0	81.3	6	8
Farm tractor	7.5	53.3	8	(8)
Rice transplanter	7.4	84.8	5	7 (working type)
Combine	5.4	68.0	5	(5)

† : Average years of use farm machinery based on farmer's experience.

‡ : Rates of farm households usage more than the recommended serviceable period.

4. Possession status by the machinery

As shown on Table 14, most farmers want to own more and convenient machinery in future. The average output of the currently owned tractor is 42.9ps, but the desired machinery has to have 55.1ps.

The supply for rice transplanter of 6rows and combine with 4rows will be increased continuously, especially the combine large scale type. Most farmers want to own a grain dryer similar with the current type with a capacity corresponding to the working area(personal + hired labor) of the farmers (Table 15).

Table 14. Distribution of ownership of tractor, rice transplanter, combine

Items		current working machinery	desired machinery in future	machinery previously owned
Farm tractor	lessthan 40ps	28.9	8.6	82.4
	40~59ps	52.1	64.5	17.6
	over 60ps	19.0	26.9	-
	Total	100	100	100
	[average output(ps)]	(49.6)	(55.1)	(37.8)
Rice Transplanter	4rows(working type)	78.7	65.8	88.8
	6rows(riding type)	21.3	34.2	11.2
	Total	100	100	100
Combine	2 rows	5.4	-	33.3
	3 rows	37.6	15.7	43.1
	4 rows	57.0	84.3	23.6
	Total	100	100	100

Table 15. Ownership distribution of grain dryer

Items	desired model purchasing in future (%)				Remarks (rate of purchasing same model)
	Level of 30suk	Level of 40suk	Over50suk	Total	
Level of 30suk farm household	77.8	13.9	8.3	100	77.8%
Level of 40suk farm household	-	80.0	20.0	100	50.0
More than 50suk farm household	-	-	-	100	80.0

5. Number of repair and annual repair cost of the machinery

The combine showed the highest annual repair cost of 1,079 thousands won and the frequency of repair (6.2times per year). The combine has to replace the disposable parts such as cutting knife, belt, chain etc., and most machines required total repair and service.

The tractor has the second highest annual repair cost at 779thousands won. The frequency of repair for tractor was 2.0times per year, which was the same with rice transplanter. The percentage of repair for owned tractor was very low (21.1%) compared with rice transplanter. The repair cost for tractor was higher than the rice transplanter due to higher cost of machine parts and manual service charge.

For power tiller, rice transplanter, cultivator, and grain dryer, the frequency of repair per year was relatively low (less than 2.0times) and the percentage of repair by owners was higher for simple disposable machine parts (Table 16).

Table 16. No. of repair and repair cost of the major agricultural machine in a year

Item	Power tiller	Farm tractor	Rice trans planter	Combine	Cultivator	Grain dryer
No. of repair (times/yr)	1.4	2.0	1.9	6.2	1.7	1.4
Repairing by owner (%)	37.2	21.1	62.9	52.5	54.2	64.3
Repair cost (thou. won/yr)	33	779	123	1,079	26	77

6. Repair cost rate

(1) Annual repair cost rate

As shown on Table 17, the annual repair cost rates were estimated by machinery namely: for combine 4.8%, tractor 3.9%,, rice transplanter 3.5%,, power tiller 2.0%, grain dryer1.6%, and cultivator 1.6% were respectively.

In Korea, the repair cost rate of the machinery is not standardized. Generally, the repair cost rate adopted 6% regardless of the kinds of machinery. However, as shown on Table 17, the repair cost rate by the machinery has a great difference.

Table 17. Repair cost rate of the major agricultural machine in a year

(%/yr)

Power tiller	Farm tractor	Rice transplanter	Combine	Cultivator	Grain dryer
2.0	3.9	3.5	4.8	1.6	1.6

(2) Repair cost rate according to span of period of utilization

The regression on the repair cost rate according to period of utilization for major farm machinery was shown Fig. 1. As the period of utilization increases the repair cost rate also increases. For combine, rice transplanter, and tractor, the repair cost rate increased greatly with increase in years of utilization but for power tiller, cultivator, and grain dryer, the increase was gradual.

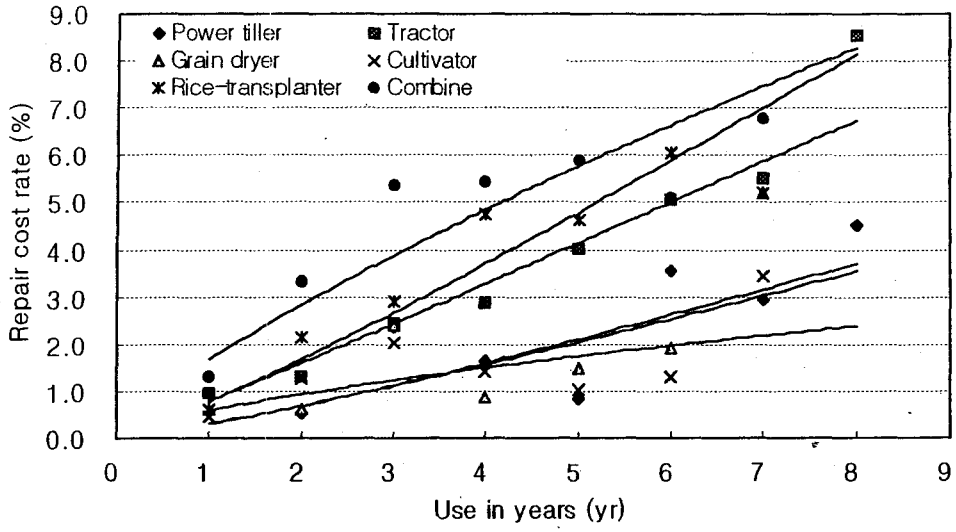

Fig1. Repair cost rate by age of the major agricultural machine in a year

The regression equations related to Fig. 1 are shown on Table 18. These regression model equations indicate lower pair cost rate in early age, but show exponentially increasing rate by with the increase in age.

The correlation coefficients show higher values for tractor, rice transplanter, and combine as 0.9232, 0.9638, and 0.9232, respectively, but relatively low values for power tiller, cultivator, and grain dryer as 0.7546, 0.7421, and 0.7212, respectively.

Table 18. Relationship between machine age and repair cost rate

Machin	Function	Correlation coefficient (r)
Power tiller	$Y = 0.2974\ X^{1.215}$	0.7546
Farm tractor	$Y = 0.7869\ X^{1.0327}$	0.9773
Rice transplanter	$Y = 0.7708\ X^{1.1346}$	0.9638
Combine	$Y = 1.6687\ X^{0.7705}$	0.9232
Cultivator	$Y = 0.5926\ X^{0.671}$	0.7421
Grain dryer	$Y = 0.3080\ X^{1.1754}$	0.7212

7. Parts exposed to failure break down

The parts exposed to frequent break down by the machinery as shown in Table 19, were the radiator in power tiller, axle retain in tractor, planting finger in rice transplanter, chain in combine, carburator in cultivator, and bearing in grain dryer.

Table 19. Order of parts exposed to failure break down

Order	Power tiller	Farm tractor	Rice transplanter	Combine	Cultivator	Grain dryer
1	radiator	axle retainer	planting finger	chains	carburetor	Bearings
2	clutch wire	universal joint	planting arm	lugs	spark plug	Electric circuit
3	starting device	hydraulic pump	clutch wire	knife	clutch wire	Electric motor
4	clutch disk	clutch disk	fuel tank	track roller	starting lope	Burner
5	battery	battery	starting lope	threshing tooth	axle retainer	Screw conveyer

※ V-belt is not included in the order.

8. The status for delayed repairing

Because agricultural machinery are subject to wear and tear while in operation they have to be repaired on time otherwise the utilization rate will be reduced and also great loss will be incurred.

About 27% of farmers didn't get repair service on time, while 85% of these farmers used the same machines after repairing and 15% used another machines by borrowing from neighbors, and purchasing new machines(Fig.2),

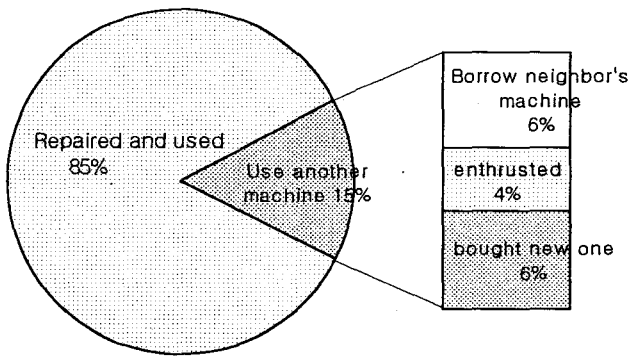

Fig 2. Operation means after machine's failure

The main reasons for delayed repair were: unavailability of mechanic(25%) and unavailability of parts (75%). And, the reasons for no parts were no parts available in local service shop of imported model, and out moded model, etc (Fig.3).

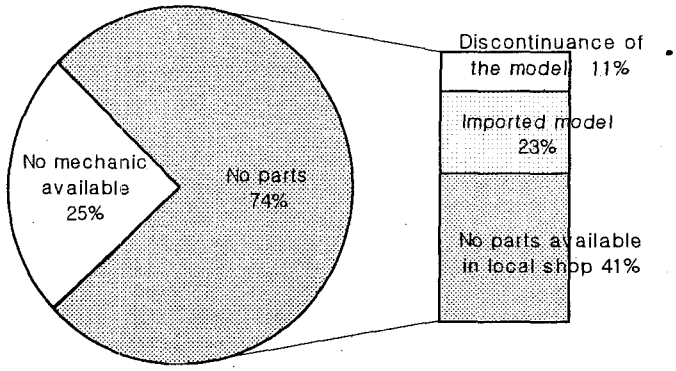

Fig 3. Reasons of the delayed repairing

CONCLUSION

This study was conducted to find out an effective machinery utilization strategy by surveying and analyzing the utilization and repair status for major farm machinery such as power tiller, tractor, rice transplanter, combine, cultivator, and grain dryer etc. the 24 cities and counties of 8 provinces.

The results of this study are summarized as follows;

(1) The age distribution for the surveyed farmers showed the highest on the age range 40 to 50years old (68%). The average farming area was 3.79ha per household, which was relatively larger than the national average of 1.35ha.

(2) The average working period was 8.7years for power tiller, 5.3years for tractor, 5.1years for rice transplanter, 4.6years for combine, 5.1years for cultivator, and 4.3years for grain dryer.

(3) The annual working performance were 0.67ha/yr, 190.2hr/yr, 54.2days/yr for power tiller, 27.49ha/yr, 208.6hr/yr, 36.4days/yr for tractor, and 2.56ha/yr, 44.6hr/yr, 5.7days/yr for cultivator.

(4) The annual working performance were 6.55ha/yr, 59.1hr/yr, 7.3days/yr for rice transplanter, 14.47ha/yr, 74.0hr/yr, 9.3days/yr for combine, and 9.35ha/yr, 254.4hr/yr, 16/4 days/yr for grain dryer. But, for rice transplanter, personal labor and hired labor showed almost same coverage area.

(5) The average serviceable period from purchasing to deterioration was 10.0years for power tiller, 7.5years for tractor, 7.4years for rice transplanter, and 5.4years for combine.

(6) Most farmers want to purchase heavy duty or large scale and convenient models for tractor, rice transplanter, and combine, but similar models with the current type for grain dryer.

(7) The annual repair cost and frequency number of repair showed highest in combine at 1,079thousands won and a frequency of 6.2times per year. For tractor, 779 thousands won and 2.0times per year. But for power tiller, rice transplanter, cultivator, and grain dryer, the frequencies of break down were relatively low at less than 2.0times per year. The repair cost was also low with disposable parts.

(8) The annual repair cost rates were 4.8% for combine, 3.9% for tractor, 3.5% for rice transplanter, 2.0% for power tiller, and 1.6% for grain dryer and cultivator in order.

(9) Most frequently deteriorated parts were radiator for power tiller, axle retainer for tractor, planting finger for rice transplanter, chain for combine, carburetor for cultivator, bearing for grain dryer.

(10) The main reasons for delayed repair service were: unavailability of mechanics (25%) and unavailability of parts (75%). The reasons for the latter were unavailability in local shops (55%), imported model (23%), and out moded model (15%), etc.

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