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options that is mostly practiced by rice farmers is to manage and operate the farm machinery on a custom hiring basis. The option can be a good choice when the farm area is too small to justify the costs of owning the farm machinery (Paman *et al.*, 2014). Custom hiring services have been essential for the widespread use and ownership of agricultural machines in many countries where small farms are dominant. More importantly, by developing custom hiring, small farmers will be easy to access farm machines without keeping them and bearing depreciation and maintenance costs.

The effective management of farm machinery is one of the most critical factors in reducing operational costs. The custom hiring service can be an effective way for machine-owning farmers to spread fixed costs over more land, reduce per unit costs, and increase cash flow (Houssou *et al.*, 2015). Custom hiring is regarded as a set of machine management packages that are capable of generating profits (Koike, 2009; Kinga & Chetem, 2019). Through custom hiring services, small farmers can use costly machinery and increase their profits (Anil, 2019). For instance, the farm income of farmers who apply for mechanization under machinery hire services is significantly higher than that of farmers who do not (Oktovianto *et al.*, 2018). Moreover, in the case of a power tiller hired farm, the received net income was higher than that of a tractor ownership farm (Barman & Deka, 2019). Tractors that offer custom hire services are profitable with an average of 23.13 ha per annum only (Paman *et al.*, 2010).

Currently, custom machinery hire services have been widely adopted by most small farmers in many countries (Sims *et al.*, 2011). Studies conducted by Chancellor (1971) in Malaysia and Thailand, Singh *et al.* (2013) in India, Onomu *et al.* (2020) and Alabadian & Yusuf (2013) in Nigeria, Milufarzana (2015) and Mottaleb *et al.* (2017) in Bangladesh, Shin *et al.* (2014) in Korea, Takele & Selassie (2018) in Ethiopia, Takeshima (2017) in Nepal, Kadhim (2018) in Iraq, Kinga & Chetem (2019) in Bhutan, and other countries have shown the widespread adoption of custom machinery hire services. According to Tesema *et al.* (2023), some factors significantly and positively affecting farmers' decisions on hiring tractor services are off-farm income, farm size, the oxen number owned, the extension personnel's influence, and the farming goal.

In Indonesia, farm machinery hire services have also been practiced by small farmers, primarily in rice production center areas across the country (Hamidah & Soedarto, 2006; Sugiarto, 2010; Mayrowani & Pranadji, 2012; Paman *et al.*, 2010; Paman *et al.*, 2014; Paman *et al.*, 2016; Sukmana *et al.*, 2017; Tarigan, 2018; Arizka *et al.*, 2022). Results of the above studies indicate the importance of custom hiring services for spreading the use of farm machines among small farmers and for deriving an economic benefit from hiring businesses. However, the performance of farm machinery hire services can vary widely between geographic regions, countries, farm areas, and even across individual hire business providers due to different agroecosystem and management practices.

The rice farming in Riau Province is also dominated by smallholder farmers who cannot economically afford to purchase farm machines for the cultivation of their fields. Such conditions have led small farmers to practice custom hiring services for acquiring farm machines. The farm machinery hire services popularly called UPJA (Unit Pengelola Jasa Alsintan) are established to manage farm machinery that is directly aided by the government for small rice farmers. The objective of this research is to evaluate the performance of the farm machinery hire services practiced by small rice farmers. There is not much evidence of machinery hire service businesses in Indragiri Hulu Regency. The research is expected to inform the machinery hire service managers and the government to improve their business performance in the future.

2. MATERIALS AND METHODS

2.1. Method and Survey Location

This research was conducted using a survey method located in Indragiri Hulu Regency, Riau Province (see Figure 1). Indragiri Hulu is one of the 11 regencies of Riau Province and is situated in the southern part of the province with a total land area of 7,723.80 km². This regency has 14 districts, and 7 of them were selected as survey locations, namely Kuala Cenaku, Kelayang, Rengat Barat, Peranap, Batang Peranap, Rakit Kulim, and Pasir Penyau. There are eleven groups of farm machinery hire services (UPJA) spread across the 7 districts, with the highest number in Kuala Cenaku (5 groups) and one group in each of the other districts, totaling 11 groups. The UPJA various types of machines, such as tractors, transplanters, combine harvesters, power threshers, and rice milling units for servicing jobs for group members.

Farm machines managed by UPJA providers offer mechanization services for rice farming. Rice is commonly grown in rain-fed paddy field areas that require sufficient rainfall to support cultivation. Such conditions make rice cropping highly dependent on the rainy season. The total harvested area in Indragiri Hulu is 4,643 hectares, with rice production of about 17.225 ton and a productivity of 3.71 ton per hectare in 2020 (BPS, 2021). This figure is lower than the average productivity at the provincial and national levels, which are 3.76 tonnes and 5.47 tonnes per hectare, respectively.

2.2. Data and Analysis

Field surveys were carried out from September to October 2022 in the 7 selected districts to collect primary data. A total of 11 managers and 22 operators were purposively selected as samples and were interviewed personally by visiting the hire service centers or their houses. The collected data consisted of the type and number of farm machines managed, seasonal working areas, service charges/rates, and operational costs (including labor, fuel, lubricant, and repair and maintenance). The collected data were tabulated and then analyzed as follows:

1. Field performance analysis

Most field machine performance is reported as land area (hectare) per hour or tons per hour for stationary machines (Finner & Straub, 1985). Field machine performance in this research was measured in terms of the rate at which farming operations are performed within a certain time limit and expressed in field working capacity. The field working capacity (FWC) was calculated under actual working conditions by using Equation (1):

$$FWC = \frac{\text{Total working area}}{\text{Total operating time}} \quad (1)$$

The coverage area (CA) was a number of area owned by farm machinery hire service groups. The percentage coverage area was calculated through Equation (2).

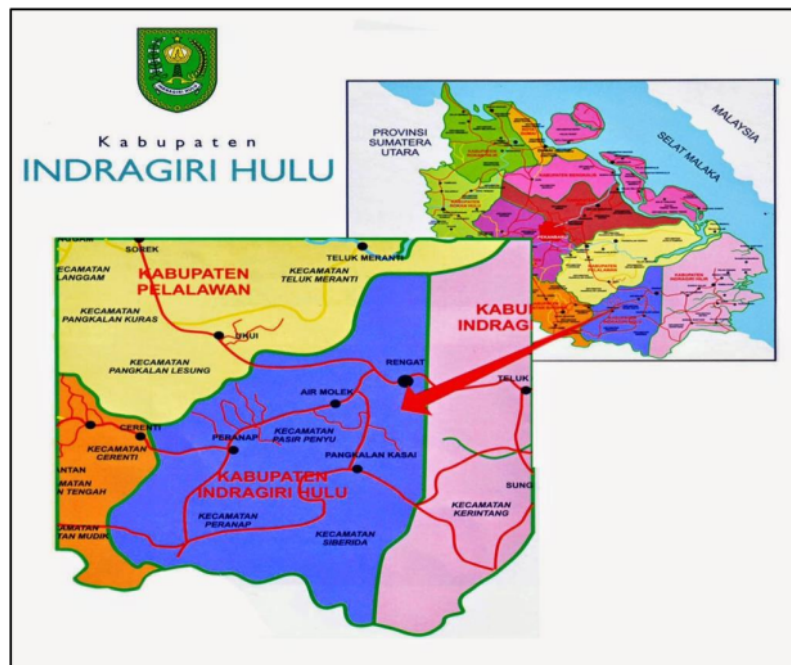


Figure 1. Map of Indragiri Hulu Regency showing survey location.

$$CA (\%) = \frac{\text{Area worked by machine (ha)}}{\text{Total working area owned by group (ha)}} \times 100 \quad (2)$$

The total working area was obtained from adding working area per group for each machine by using Equation (3). The average working area (AWA) was calculated according to Equation (4) and (5).

$$\text{Total working area} = \sum_{i=1}^n WAG_i \quad (3)$$

where $i = 1, 2, 3 \dots n$, and WAG_i is the working area per group (ha or ton)

$$\text{AWA per group} = \frac{\text{Total working area}}{\text{Number of group}} \quad (4)$$

$$\text{AWA per unit machine} = \frac{\text{Total working area}}{\text{Number of machine}} \quad (5)$$

2. Economic performance analysis

Model mathematic used to calculate machinery cost, revenue, and profit per growing season involved some variables need to be shortly explained. Total costs (TC) are divided into two categories: fixed costs (FC) and variable costs (VC) and were calculated by the following equation (Paman *et al.*, 2015):

$$TC = FC + VC \quad (6)$$

Fixed costs (also called ownership costs) calculated in this research were depreciation cost by using *Straight-Line method* (Hunt, 2016; Paman *et al.*, 2015). The depreciation cost was calculated using equation:

$$D = \frac{P-S}{T} \quad (7)$$

where D = depreciation (IDR/year), P = purchase price (IDR/unit), S = salvage or selling price (IDR/unit), and T = time between buying and selling (year).

The variable costs (also called operating costs) included repairs and maintenance, fuel, lubrication, and operator wage. The variable costs (ha/growing season) were then calculated as follows:

$$VC = R\&M + F + L + O \quad (8)$$

where VC = Variable costs (IDR), $R\&M$ = repairs and maintenance (IDR), F = fuel (IDR), L = lubricant (IDR), and O = operator charge (IDR).

The total revenue was obtained from the total working area during one growing session and then multiplied by rental charge per hectare. The revenue was calculated using equation:

$$TR = WA \times RC \quad (9)$$

where TR = total revenue (IDR), WA = working area (ha), RC = rental charge (IDR/ha).

According to Owombo *et al.* (2012), the profit (π) obtained by UPJA was computed by the following equation:

$$\pi = TR - TC \quad (10)$$

3. RESULTS AND DISCUSSION

3.1. Machinery Hire Services and Type of Machine

Farm machinery hiring services are business enterprises organized by farmers into groups. These groups have been formed by farmers in each village with rice fields. The members of the groups are farmers who own paddy fields and they are given priority for the services. Table 1 shows the total coverage areas for each group, which are obtained by adding the paddy field areas owned by individual farmer members. The coverage area ranges from 12 to 427 hectares for Batu Gajah Jaya and Tani Rejo, respectively.

Table 1. The number of coverage areas and farm machines managed by machinery hire service groups.

Name of MHS	Coverage area (ha)	Type of Machines					
		HT	MT	WP	Transplanter	CH	PT
Bina Tani	408	6	-	3	1	1	3
Mekar Serumpun	129	5	-	3	1	1	3
Tani Rejo	427	6	-	3	1	1	3
Bina Sejahtera	124	6	-	3	1	1	3
Harapan Baru	85	4	-	3	1	1	3
Agri Mulia	150	5	3	3	1	1	3
Harapan Jaya	110	5	1	3	-	-	3
Berkah Bersama	22	4	1	3	-	-	3
Mandiri	23	4	-	3	-	-	3
Ingin Maju	250	4	1	3	-	-	3
Batu Gajah Jaya	12	4	1	3	-	-	3
Total	1,740	53	7	33	6	6	33

Note: MHS = Machinery Hire Services; HT = hand tractor; MT = mini tractor; WP = water pump; CH = combine harvester; PT = power thresher

There are 6 types of popular farm machines managed by machinery hire service groups, namely hand tractors, mini tractors, water pumps, transplanters, combine harvesters, and power threshers (see Figure 2). The number of farm machines varied among groups, with hand tractors being the most dominant at 53 units. The other machine types are water pumps and power threshers, accounting for 33 units each. Both machines were provided by the government, with 3 units allocated to each group. They have become more familiar among farmers for rice farming operations because they have been used for a long time in the survey areas. Especially for hand tractors, there are 2 popular types: moldboard plows and rotary tillers. Both hand tractors match the scale of farms owned, which are generally small.

Furthermore, mini tractors have 7 units, while rice transplanters and combined each have 6 units in their respective groups. The rice transplanters and combine harvesters have only been used in the survey areas for the last 5 years. The group members who use the machines are still limited due to the smaller number of machines managed by machinery hire service groups. Interviews with group managers revealed that they require more farm machines to cover the entire area. Most farmers recognized that both transplanters and combine harvesters have become increasingly important in reducing yield loss from harvesting and threshing operations. Farmer awareness is expected to help increase the application of farm machines in various rice farming operations.

The farm machinery hire service groups offer services to farmers, primarily group members, every growing season for performing various rice farming operations. The kind of services depends on the type of farm machines managed. In these cases, the services consist of land preparation with hand tractors or mini tractors, transplanting with transplanters, harvesting, and threshing with combine harvesters, and threshing with power threshers. Water pumps are offered together with hand tractors/mini tractors and used when the water supply into the paddy field is not sufficient to perform tillage operations. Based on the number of farm machines available in groups, it is impossible to work the whole coverage area owned by groups. Moreover, some machines sometimes cannot be used due to experiencing permanent breakdowns. Table 1 presents the number of coverage areas and types of machines managed by machinery hire service groups.

The limited number of hand tractors owned by farm machinery hire service groups resulted in a large number of areas per hand tractor. The coverage area per unit varied greatly, ranging from less than 10 (Berkah Bersama, Mandiri, Batu Gajah Jaya) to more than 60 (Ingin Maju, Bina Tani, Tani Rejo) (Fig. 2). The area per hand tractor was 31 hectares, with at a range from 3 to 71 hectares per hand tractor. This average was higher than the number for full mechanization, which is about 10 hectares per hand tractor (Herdt, 1983). Actually, there are a few individual rental services in the survey areas that could be accessed to fulfil the lack of farm machines in the areas. Because of the inadequate number of individual rental services, the work done by them remains insignificant. Although most farmers prefer to own farm machine individually, they have low financial power to purchase the machine due to low income and limited access to financial resources like banks. In addition, rice farmers commonly rely heavily on government



Figure 2. Types of farm machines operated by machinery hire service groups.

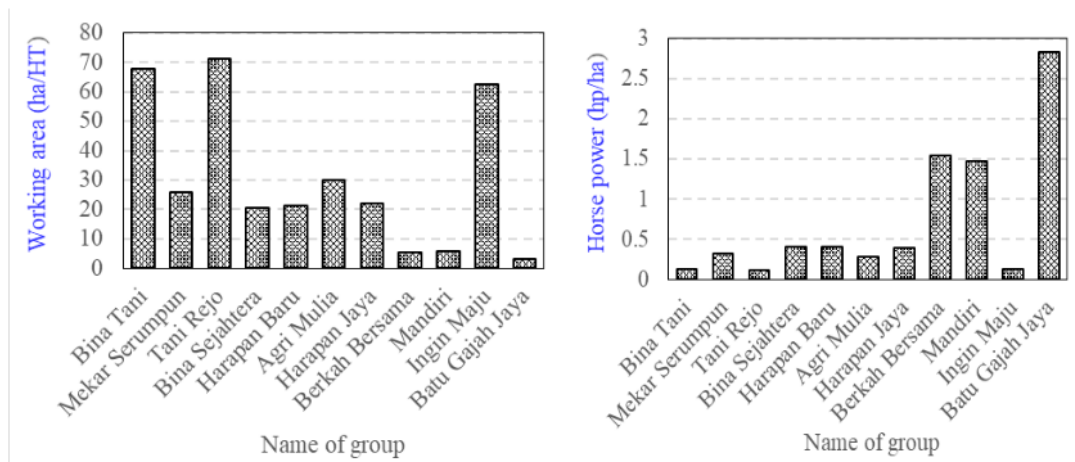


Figure 3. Working areas per unit of hand tractor (HT) and horsepower (hp) per hectare for each farm machinery hire service group.

assistance to provide farm machinery for them. The big opportunity to provide machinery rental services to fulfill the demand of farming operations may not be fulfilled.

The number of areas per hand tractor ranged from 3 ha to 71 ha per hand tractor for the Batu Gajah Jaya group and Tani Rejo Group, respectively (Fig. 2). Consequently, the hand tractors were used more intensively to achieve the maximum number of areas that can be done for a growing season. This intensive use frequently led to hand tractors breaking down. Interviews with operators revealed that most hand tractors permanently broke down (were damaged) before the economic life had ended. Moreover, the average number of horsepower per hectare was found to be about

0.7 hp, ranging from 0.12 hp for the Tani Rejo group to 2.83 hp for the Batu Gajah Jaya group. While at least 0.8 hp per hectare is required to make optimum rice yield (Jain, 1979). Based on such horsepower requirements, only 3 (27%) groups of machinery hire services had more than the required horsepower level, while 73% of groups remained lacking in horsepower.

3.2. Technical Performance

The farm machines managed by machinery hire service groups are used according to the type and kind of operations. Each machine is operated by two operators: a main operator and an assistant operator. Some operators can operate more than one type of farm machine, depending on their experience and skill level. These operators have more than 5 years of experience and higher skills from vocational-technical school. Interviews with operators revealed that the number of operators is limited, primarily for rice transplanters and combine harvesters. There is no special training program for operators of rice transplanters and combine harvesters in the regency as well as within the province.

The working capacity of the machine depends greatly on the operator's skill, land conditions, and the type (make) of the machine. The bigger farm machine has a higher field capacity and, in turn, significantly reduces time and cost. The working capacity of farm machines managed by farm machinery hire service groups is presented in Table 2. According to Table 2, the field working capacity of the hand tractor is about 0.13 ha/h or 7.69 h/ha. This field working capacity is larger compared to the 0.025 ha/h found by Sulnawati *et al.* (2016). The field working capacity of mini tractors was found to be 0.26 ha/h or 3.85 h/ha. This finding is larger than the research conducted by Leni *et al.* (2022) which reported 0.133 ha/h. Furthermore, the field capacity of the transplanter was 0.16 ha/h or 6.25 h/ha, which is more than the 0.12 ha/h reported by Iqbal *et al.* (2021). The field working capacity of combine harvesters was 0.20 ha/h or 5 h/ha. Comparing this to the research conducted by Zakky *et al.* (2021) which reported 0.125 ha/h, the finding is bigger. The next working capacity was 0.66 ton/h for the power thresher, which is higher than the 0.569 ton/h found by Suhendra *et al.* (2019). Based on the findings, it indicates that farm machines in the survey area are more intensively used. This was conducted to achieve the target area that must be accomplished during the season.

Table 2. Field working capacity of various types of farm machines.

Type of Machines	Number of Machines (unit)	Field working performance (capacity)	
		(ha/h)	(h/ha)
Hand tractor	26	0.13	7.69
Mini tractor	7	0.26	3.85
Transplanter	6	0.16	6.25
Combine harvester	6	0.20	5.00
Power thresher	33	0.66*	1.52**

Note: capacity for power thresher is expressed in: * ton/h; and ** h/ton

Due to the limited number of farm machines available, it is difficult to completely cover the entire area of the group. As a result, most group coverage areas were serviced by individual rental machines or manual tools like hoes for tilling and sickles for harvesting (Figure 4). Manual tools are more commonly used compared to individual rental machines, as the latter are still limited in availability in the survey areas and are primarily used for specific operations such as threshing and harvesting.

The largest area that can be worked by available machines is the tillage operation because the number of tractors is more than other machine types. The total coverage area that can be tilled by available tractors (26 hand tractors and 7 mini tractors) was 54%, consisting of 42% and 12% by hand tractor and mini tractor, respectively. The smallest one is to irrigate the paddy field area, accounting for 0.2% of the total coverage area. According to interviews with operators, the machines are used to irrigate water into the paddy fields that have insufficient water supply to till the field. Meanwhile, the wide area that was planted and harvested by transplanters and combine harvesters was only 2% and 14%, respectively. The results encourage farm machinery hire service groups to add a sufficient number of farm machines. If the number of farm machines can work completely the whole coverage of groups, the application level of mechanization can become higher and also add income for the groups.

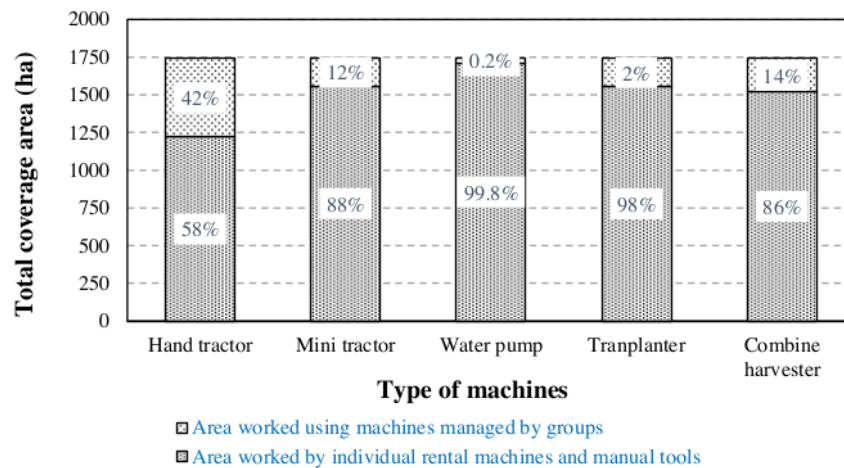


Figure 4. The number of coverage areas worked by farm machines.

Table 3. Seasonal working performance for various types of farm machines

Item	HT	MT	WP	RT	CH	PT
Total working area (ha/season)	520	182	27	185	220	88
Number of machines used (unit)	26	7	33	6	6	33
Average working area (ha/group)	47.3	16.5	2.5	16.8	20.0	8.0*
Average working area (ha/unit)	20	26	0.8	30.8	36.7	2.7**

Note: HT = hand tractor; MT = mini tractor; WP = water pump; RT = rice transplanter; CH = combine harvester; PT = power thresher

*) = ton/season; **) = ton/unit

Table 3 shows that only 26 units (49%) of the 53 hand tractors owned by 11 groups of hiring services could be operated to till the paddy field area, and the remaining 51% have been experiencing permanent breakdowns. The breakdowns were caused by aging, component failures, or waiting for a spare part order. Research conducted by Paman *et al.* (2022) found that approximately 13% of farm machines in Indragiri Hulu experienced permanent breakdowns. By using 26 hand tractors, the total working area reached 520 ha seasonally or 47.7 ha per group on average. It means that each hand tractor worked 20 ha per growing season. The use of hand tractors was planned by the manager group to reach a minimum target of seasonal work area of about 20 ha per machine. It intends to maximize the seasonal working area that can be accomplished by the available machine during one month of the growing season. The target area was not applied to mini tractors and other machines. Furthermore, seven mini tractors tilled the land area of 182 ha seasonally with 16.5 ha per group on average. There were 26 ha of land area that was worked by each mini tractor. The number of mini tractors that are managed by machinery hire service groups is still limited due to the limited government budget to purchase the tractors.

Water pumps are used to irrigate land areas where the water supply is not sufficient to carry out tillage operations. Out of the 33 water pumps managed by 11 groups, only 27 hectares of land area used the machines, with an average of 2.5 hectares per group. The area per machine was relatively small, at only 0.8 hectares per growing season. This is because the survey was conducted during the dry season, and the machines are mostly used in the dry growing season when there is a lack of water supply. The number of paddy field areas planted by transplanters has reached 185 hectares using 6 machines, or about 16.8 hectares per group on average. The limited number of machines caused the total planted areas to be small. The transplanters were able to plant rice on about 30.8 hectares per growing season.

The combine harvester is an increasingly important type of machine used by farmers today. This is because the machines can perform two kinds of jobs together: harvesting and threshing. They can be more efficient in terms of

time, power, and costs compared to using reapers for harvesting and power threshers for threshing. Due to the limited number of combine harvesters available in groups, the total harvested area worked by the machines was relatively small, with a total of 220 ha for all groups during the season, averaging 20 ha per group. The machines harvested paddy fields, accounting for 36.7 ha each season.

The use of power threshers has been decreasing among farmers in the survey area today because the machine has been gradually replaced by combine harvesters. The use of the combine harvester has saved significant time and costs. The total rice produced from the coverage areas was 88 ton, with an average working area of 8 tons per group. The harvesting area of the combine harvester was 27.0 ton per machine.

Table 4. Economic performance of the machinery hire service groups.

Item	Range (IDR/Growing season)	Value (IDR/Growing season)	Range (%)	Percent (%)
Costs (variable + fixed costs)	20,656,600 – 75,036,000	37,773,564 (USD 2,518)	35.90-79.51	54.72
Revenue (output x price)	27,633,333 – 105,200,000	69,036,364 (USD 4,602)	-	100.00
Profit (revenue - costs)	6,976,733 – 58,333,500	31,262,800 (USD 2,084)	20.48-64.19	45.28
RCR (return cost ratio)	0.91 – 2.79	1.86		

Note: USD 1 = IDR 15,000.

3.3. Economic Performance

Economic performance is one of the measurements of success for the machinery hire services in managing the group business. The source of revenue for the business was from hiring various types of machines to farmers, especially for members of the groups. They used the hiring services to carry out their farming activities. Table 4 presents the economic performance of the machinery hire services per growing season.

According to Table 4, the machinery hire service businesses were profitable, accounting for IDR 31,262,800 (USD 2,084) per growing season on average. This profit was obtained from the average revenue of 69,036,364 (USD 4,602) per growing season minus the average costs of 37,773,564 (USD 2,518). Furthermore, the average value of the return cost ratio was derived as 1.86. This implies that for each one IDR (IDR1.00) invested in the machinery hire service business, you will receive a revenue of IDR 1.83 or a profit of IDR 0.83. This reveals that machinery hire services are a viable business and economically feasible in Indragiri Hulu State. Therefore, the machinery hire service businesses must be encouraged continuously, and the business scale must be enlarged by adding the number and types of machines to derive more income or profit.

4. CONCLUSIONS

The machinery hire services manage and operate 3–6 types of farm machines, like ha tractors, mini tractors, rice transplanters, combine harvesters, and power threshers. The number and type of farm machines managed by groups are not sufficient to cover the whole coverage area of each group, ranging from 0.2% for irrigating to 42% for tillage operations. Consequently, most of the farm machines worked at a high capacity due to reaching the seasonal target of working areas. The machinery hire services were profitable businesses on the farm level in the Indragiri Hulu Regency with profit of 31,262,800 (USD 2,084). The result suggests that the number and type of farm machines for hiring service groups must be increased to work entirely of the coverage areas owned by groups and to increase profit as well. The farmers can also use the individual rental services to complete their work during the hours available.

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