Determinants of the mixed crop and livestock farming practice among smallholder farmers in Magelang Regency, Central Java Province

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Abstract. The mixed crop and livestock (MCL) farming could enhance farmers to improve their farming practice. This study aims to analyse factors that influence the adoption of MCL farming in Magelang Regency. A multistage random sampling method was used to select the locations and the respondents. Data were collected through personal interview based on structured questionnaire from 161 smallholder farmers. Logit models was applied to analyse the binary choices of practising MCL farming. The result indicated that age, consulting toward extension agent, and number of livestock kept by farmer were significant at the level 10%, experience on raising livestock was significant at the level 5% and type of ruminants was significant at the level 1%. It may conclude that the younger farmers and farmers who raised large ruminants were have more possibility to adopt the MCL farming practice.

1. Introduction

Indonesia is known as an agrarian country, which makes agriculture as one of the main sector contributing national and regional economy, e.g. Magelang Regency. In this regency, agriculture dominates the Gross Regional Domestic Product (GRDP) in 2017 up to 21.78%. Agriculture absorbed 34.52% of the labour force, becomes the primary occupation in rural area [1], [2]. The largest agricultural subsector is food crops that ranked based on harvested area are rice, corn, cassava, sweet potato and peanuts, while rice commodity controls 33.78% of the total area [2]. Many farmers in rural area are defined as smallholder farmer who have own less than 2 ha of land, and mostly keep ruminants livestock between 2-4 head for large ruminants and 2-6 for small ruminants, as an assets and savings [1], [3]–[5]. Ruminant livestock populations in Magelang Regency for goats, sheep, beef cattle and buffalos are 87.750, 92.100, 78.286 and 5.978, which buffalo population ranks 3rd within 35 regencies/cities in Central Java [6].

To develop agriculture sector in rural areas, the government of Magelang Regency introduced mixed crop and livestock (MCL) farming to farmers through various programs such as, Field School of Integrated Crop Management (SLPTT) in 2007, Farmer Empowerment through Agricultural Technology and Information (P3TIP) in 2008-2010, Gelar Teknologi in 2011, and The Organic Fertilizer Processing Unit (UPPO) in 2017. All programs was made to enlighten farmers about MCL farming as a synergistic farming approach between crops and livestock that manage the waste of one
component as resources for another to decrease the used of farming inputs such as chemical fertilizer, pesticide, and purchased feed [7]–[9]. The use of agricultural and livestock waste as an input make farming more efficient, thus increasing farmers’ income [10]. In addition, MCL farming is an eco-friendly farming system for sustaining agriculture [11], [12]. Many technologies, informations and knowledge about MCL farming were delivered in the programs, such as technology for making organic fertilizers, natural pesticides, processing of agricultural waste like dry straw and fermentation. Those technologies were disseminated to farmers, perhaps they could change their conventional farming methods, then farming becomes more efficient and profitable.

Although MCL farming is more efficient and profitable than the conventional farming, smallholder farmers still did not adopt it altogether [7]. Many studies showed that adoption of MCL farming was affected by farmers characteristics and farm characteristics [7], [13]–[19]. Farmer’s age, family size, farmer experience both on agricultural sector and raising livestock could affect the adoption [15], [16]. Furthermore, the access in information and knowledge like formal education, frequently contacting extension agents, membership of farming group, and number of training that had participated could determine the adoption [13], [14], [18], [19]. The characteristics of farm such as land size, family labour, number and type of animals that kept, type of plants grewed could also affect the adoption [16], [17]. Therefore, this study’s goal is to analyse whether those factors influence the adoption of MCL integration.

2. Materials and methods

| Variable name            | Description                                      | Unit   | Mean   | St. Dev. | Min  | Max  |
|--------------------------|--------------------------------------------------|--------|--------|----------|------|------|
| Age                      | Main farmers’ age                                | Year   | 55.832 | 10.390   | 32   | 80   |
| Educ                     | Main farmers’ formal education                   | Year   | 7.031  | 3.675    | 0    | 15   |
| Agriculture              | Main farmers’ experience on agricultural sector  | Year   | 32.708 | 15.709   | 1    | 70   |
| Livestock                | Main farmers’ experience on keeping livestock     | Year   | 22.505 | 17.224   | 0.25 | 70   |
| Family labour            | Family as a resource for farming labour          | Dummy  | .391   | .490     | 0    | 1    |
| Family size              | Number of people in the smallholder farmers      | Number | 4.354  | 1.567    | 1    | 10   |
| Group’s length           | Membership’s length of farmers group in          | Year   | 7.826  | 7.949    | 0    | 29   |
| Consultation             | Farmers had consulted with extension agents      | Dummy  | .180   | .386     | 0    | 1    |
| Training                 | The amount of training participated by farmers    | Number | 1.255  | 1.947    | 0    | 13   |
| Livestock-own            | Livestock owned by farmer                        | Dummy  | .646   | .479     | 0    | 1    |
| Ruminants                | The ruminants’ type (1 = cow and buffalo are     | Dummy  | .559   | .498     | 0    | 1    |
|                          | large ruminants), (2 = goat and sheep are small  |        |        |          |      |      |
|                          | ruminants)                                       |        |        |          |      |      |
| TLU                      | Number of livestock that kept by farmers in      | TLU    | .829   | .810     | 0.1  | 8    |
|                          | Tropical Livestock Unit (TLU)                    |        |        |          |      |      |
| Land-own                 | Land owned by farmers                            | Dummy  | .627   | .485     | 0    | 1    |
| Land size                | The area of land owned by farmers in hectares    | Hectares| .134  | .202     | 0    | 1.3  |
| Rice                     | Farmers grow rice                                | Dummy  | .950   | .218     | 0    | 1    |
| Secondary crop           | Farmers grow crops that planted as second crop   | Dummy  | .416   | .495     | 0    | 1    |
|                          | in dry season, i.e. maize, ground nut, cassava   |        |        |          |      |      |
|                          | and sweet potato                                 |        |        |          |      |      |

Primary data was used to analyse the determinants of MCL farming’s integration adoption on smallholder farmers in Magelang Regency through multistage random sampling methods. The data were collected through personal interview based on structured questionnaire in February – July 2019, from 5 districts that were chosen randomly i.e. Bandongan, Candimulyo, Kaliangkrik, Ngluwar and Salam. The study was included 161 respondents of which 60 respondents were categorized as adopters of MCL farming while the others were non-adopters. Adopters were identified when farmers use crops waste as feed and livestock waste as fertilizer into their land’s crop for 3 growing season constantly.
Non-adopters were identified when farmers infrequently use either crops waste as feed or crops livestock waste as fertilizer, and also when farmers use neither crops waste feed nor livestock waste fertilizer. Many researchers have measured the factors that influenced the adoption of MCL farming, including studies about farmers characteristics and farms characteristics determine the adoption innovation [7], [13]–[18]. The variables were categorized into two groups consisted the dependent variable and the independent variable. The dependent variable is the adoption of MCL farming, meanwhile the independent variables showed in Table 1.

Logistic Regression Analysis was applied to analyse the determinants of the MCL farming adoption since it is more simpler to use [15], [16]. The adoption determinants can be analysed used the logit models as follows:

\[ Y_i = \alpha + \beta X_i + u_i \]

Where \( Y_i \) represent MCL farming adoption which is a dependent variable. \( Y_i \) possess the value of 1 if farmers belong to adopter group and 0 if the opposite occurrence. The independent variables was represented by \( X \), which is expected to influence the adoption of MCL integration, \( \alpha \) represents the intercept, \( \beta \) represents the regressions coefficients of the independent variables, \( u \) is the residual and \( i \) represents smallholder farmer individually [13], [15].

3. Results and discussion
The outcome of logistic regression showed that age, consulting toward extension agent, and number of livestock that kept by farmer were significant at the level 10%, experience on raising livestock was significant at the level 5% and type of ruminants was significant at the level 1%. The determinants that affect the adoption of MCL farming represent in Table 2.

| MCL          | Odds Ratio | Std. Err | z     | P     |
|--------------|------------|----------|-------|-------|
| Age          | .937       | .035     | -1.72 | 0.086*|
| Educ         | .888       | .071     | -1.48 | 0.139 |
| Agriculture  | .981       | .029     | -0.64 | 0.524 |
| Livestock    | 1.063      | .027     | 2.43  | 0.015*|
| Family labour| 1.423      | .758     | 0.66  | 0.508 |
| Family size  | .970       | .163     | -0.18 | 0.855 |
| Group’s length| .961       | .036     | -1.08 | 0.280 |
| Consult      | 4.381      | 3.881    | 1.67  | 0.095*|
| Training     | 1.013      | .156     | 0.08  | 0.932 |
| Livestock-own| 1.433      | .772     | 0.67  | 0.505 |
| Ruminants    | 40.496     | 28.322   | 5.29  | 0.000*|
| TLU          | 2.147      | .920     | 1.78  | 0.074*|
| Land-own     | .905       | .504     | -0.18 | 0.857 |
| Land size    | .482       | .703     | -0.50 | 0.617 |
| Rice         | .498       | .591     | -0.59 | 0.557 |
| Secondary crop| 2.196     | 1.220    | 1.42  | 0.157 |

Observation 161
LR chi2 93.57
Pseudo R2 0.44

*Significance at level 0.1; **Significance at level 0.05; ***Significance at level 0.01
The outcome showed that farmer’s age have a negative effect toward the adoption, which indicates that the younger farmers have a higher probability to adopt MCL farming than the older farmers [16], [20]. Consulting to extension agent have a positive influence to adopt innovation. Extension agent was the right hand of the government in carrying out the agricultural programs in order to disseminate an innovation technology to farmers [20]. Therefore, MCL farming will be more adopted if farmers can reach out extension agents easily. The number of livestock that kept by farmers increase the adoption of MCL farming. It relates due to the manure produced by livestock, the more livestock kept by farmers, the possibility to adopt MCL farming is increasingly high [14]. Farmers who owned large number of livestock are indicated more well-off than farmers who only have small numbers of livestock, so they could access more knowledge, information and others inputs, so that way the adoption rate is highly than the less one [21]. Experience on raising livestock was found significant, our finding found that the length of experience on raising livestock enlighten farmers for utilizing crops waste as feed for livestock. This occurrence due to the limited of land and feed resources, and also these experience increase farmers’ awareness about profitable farming by adopting crops residue as feed [21].

Most of smallholder farmers in rural areas kept ruminants as a saving and insurance [5], [22]. The type of ruminant that kept by farmers was affected due to the maintenance costs of the ruminants. In most situations that occurred in rural areas, the indigent poor farmers will keep mainly poultry, the less poor will keep small ruminants, then large ruminants (cattle and buffaloes) would be kept by the prosperous farmers [23]. Our research found that farmers who keep small ruminants owned smaller land than farmers who keep cattle and buffaloes. Farmers who owned large farm size have a higher perchance to adopt new innovations or technologies, because of some innovations or technologies were likely more costs [18], [24]. Meanwhile the rate of adoption was lower by the poor farmers, whose lacked in many ways, such as information about new technologies, funding, and others resources [21], [24], [25]. This is why the extension agents have a key role in disseminating new innovations and technologies to rural farmers, helping them to solve their problems and enhance their quality of life.

4. Conclusions
Factors influenced the adoption of MCL farming are estimated by using primary data from smallholder farmers in Magelang Regency. This study showed that the adoption of MCL farming was affected by farmers and farm characteristics. MCL farming practice will be more adopted by younger farmers. Farmers who can reach out extension agents easily have a higher probability to adopt MCL farming. Experience on raising livestock have an impact on MCL farming’s adoption. The possibility to adopt MCL farming practice was also influenced by the number and type of livestock kept by farmers.

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