Adoption of the mixed crop and livestock farming’s technology in Magelang Regency, Central Java

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Abstract. Mixed Crop and Livestock (MCL) farming provides opportunities for smallholder farmers to increase farm efficiency by using crop and livestock waste as the farming input resources. This study examined the correlation between farmer’s adoption level of MCL and their characteristics. Data were collected by multistage random sampling method through questionnaire for 132 smallholder farmers in five districts (Bandongan, Candimulyo, Kaliangkrik, Ngluwar and Salam). The processing of feed from crop waste and fertilizer from livestock waste technologies was the determinant of adoption level. It was divided into 3 categories, i.e. low, medium and high level. Results showed that 68.94% of respondents were in the low level, 21.97% was in the medium level and 9.09% was in the high level. There was a significant relationship between consulting to extension agents, number of training, farmers’ length of group membership, experience on raising livestock, and ruminants’ type raised by farmers toward adoption level on the technology of MCL farming.

1. Introduction
The technologies of mixed crop and livestock (MCL) farming is mainly disseminated to smallholder farmers for improving their farming way, from conventional farming to conservation farming [1] [3]. Researches have showed that conventional farming decreased soil fertility due to the using of intensive tillage, also extremely depend on chemical fertilizers and pests [1] [4]. Therefore, MCL farming was introduced to prevent those effects, with using crop and livestock waste as a natural resource for each enterprise.

Mixed crop and livestock (MCL) farming system is known as an eco-friendly farming system that combines crop and livestock sector, crop waste become a prominent source of feed and livestock waste become a source to fertilize the farmlands within the farm itself [4] [6]. The synergy among those enterprises plays a key solution for improving soil fertility, and also make farming become more efficient and profitable [4] [5].

MCL farming had attested in many countries and regions in tackling those problems, either in enhancing soil fertility or making efficient farming, albeit rather slowly in adoption, especially in developing countries or regions, including Magelang Regency in Indonesia [6] [8] [10]. Many factors relate and affect the decision to adopt a technology, such as farm characteristics and farmer
characteristics [11]. Labor resources, land size and number of livestock was included as farm characteristics [11] [12], meanwhile age, education, cooperation, information access both from training and extension agent, experience was included as farmer characteristics [13] [17]. Therefore, this study’s aim was to convey the relation between those factors and adoption level of MCL farming’s technology.

2. Materials and Methods
This study was conducted in 5 districts in Magelang regency (Bandongan, Candimulyo, Kaliangkrik, Ngulwar and Salam) that was selected randomly through multistage random sampling. We used a structured questionnaire to collect the data, since February – July 2019 with a total 132 respondents of smallholder farmers. The questionnaire was used to collect the information about farmer characteristics, farm characteristics and the technologies that was used by farmers for processing crop residue into feed and livestock waste into fertilizer. All the variables are defined in Table 1.

| Table 1. Variables’ definitions and their measurement |
|-----------------|-----------------|-----------------|
| Variables       | Definition                                           | Type of Measurement |
| **Dependent Variable** |          |                  |
| MCL category    | The level of technology adoption of the mixed crop and livestock system used by farmers dividing into 3 categories | Categorical (1=Low, 2=Medium, 3=High) |
| **Independent Variables** |          |                  |
| Age             | Age of the main farmers in the household in years  | Continous          |
| Education       | Formal education in years                           | Continous          |
| Size household  | Total number of people in the household             | Continous          |
| Family labor    | Farmers rely on family members as a labor           | Dummy (1=Yes, 0=No) |
| Crop experience | Experience on crop sector in years                  | Continous          |
| Livestock experience | Experience on raising livestock in years   | Continous          |
| Length of membership | Length of membership of farmers’ group in years | Continous          |
| Consultation    | Farmers had contacted extension agents for a private consultation | Dummy (1=Yes, 0=No) |
| Number of training | Total number of training participated by farmers | Continous          |
| Landszie       | Large land tenure                                   | Continous          |
| Land ownership  | Farmers own the land                                | Dummy (1=Yes, 0=No) |
| Ruminants type  | Type of ruminant                                    | Dummy (1=Large ruminants, cow and buffalo; 0=Small ruminants, goat and sheep) |
| Number of livestock | Total number of livestock kept by farmers in Tropical Livestock Unit (TLU) | Continous          |
| Livestock ownership | Farmers own the livestock                            | Dummy (1=Yes, 0=No) |

*TLU is a Tropical Livestock Unit which a mature cow and buffalo equal 0.5 TLU and a mature goats and sheep equal 0.1 TLU.
The technologies of MCL farming that were delivered to farmers in those districts are processing of crop and livestock waste, such as drying and fermenting crop residues, and also adding dolomite lime to livestock residues and fermenting livestock waste. Those technologies were listed in consultation between the extension agent and it have been delivered in all districts in Magelang Regency through a numerous program, such as Field School of Integrated Crop Management (SLPTT), Farmer Empowerment through Agricultural Technology and Information (P3TIP), Gelar Teknologi, and many training or practices that obtain MCL farming.

| Practices                       | Given Score |
|--------------------------------|-------------|
| Processing crop waste          |             |
| Fresh crop waste               | 1           |
| Dried crop waste               | 2           |
| Fermented crop waste           | 3           |
| Processing livestock waste     |             |
| Fresh livestock waste          | 1           |
| Added dolomite lime            | 2           |
| Fermented livestock waste      | 3           |

Based on the technologies of processing crop residues and livestock waste that adopted by farmers, they were given score differently, then divided into 3 categories, low, medium and high. Low level of MCL technology adoption was categorized if farmer had score 2 and below. It means that farmers did not process crop and livestock waste before using it. Farmers adopted neither the drying or fermenting process of feed nor adding dolomite lime or fermenting process of livestock waste. Medium level of adoption was categorized if farmer had score 3 to 4, and high level of adoption was defined if farmers had score 5 and above. The number of MCL technology adoption level of farmers was presented in Figure 2, while Table 3 presented the descriptive statistics of the variables. Those variables were selected based on previous research studies. Then, we examined the correlation between farmer’s adoption level of MCL farming and their characteristics.
Table 3. Descriptive statistics of the variables

| Variables          | Unit   | Mean  | St. Deviation | Min  | Max  |
|--------------------|--------|-------|---------------|------|------|
| Age                | Year   | 56.14 | 10.73         | 32   | 80   |
| Education          | Year   | 7.05  | 3.72          | 1    | 15   |
| Size household     | Number | 4.37  | 1.52          | 1    | 15   |
| Family labor       | Dummy  | 0.34  | 0.48          | 0    | 1    |
| Crop experience    | Year   | 33.08 | 15.91         | 2    | 70   |
| Livestock experience| Year   | 22.99 | 17.12         | 0.25 | 70   |
| Length of membership| Year  | 7.59  | 7.88          | 0    | 29   |
| Consultation       | Dummy  | 0.20  | 0.40          | 0    | 1    |
| Number of training | Number | 1.33  | 2.08          | 0    | 13   |
| Landsize           | Ha     | 0.14  | 0.22          | 0    | 1.3  |
| Land ownership     | Dummy  | 0.62  | 0.49          | 0    | 1    |
| Ruminants type     | Dummy  | 0.62  | 0.49          | 0    | 1    |
| Number of livestock| TLU    | 0.90  | 0.87          | 0.1  | 8    |
| Livestock ownership| Dummy  | 0.65  | 0.48          | 0    | 1    |

3. Results and Discussion

Figure 2 presented that the majority of the respondents (68.94%) were categorized in low level on MCL’s technology adoption, whereas the smallest was high level of adoption (9.09%). It showed that farmers still mostly use neither the technologies of processing crop residues into feed nor the processing of livestock into fertilizer. Farmers in Magelang Regency mainly used fresh crops residues as livestock feed, meanwhile livestock waste was directly used in their farmland.

The correlation analysis was used in this study to indicate the relationship between the independent variables (farm and farmer characteristics) and the dependent variable (MCL category). Table 4 revealed that farm and farmer characteristics i.e. livestock experience, length of group membership, types of ruminant, number of training and consultation have a significant relation toward adoption level of MCL farming’s technology. Consulting with extension agents, attending training, length of group membership and experience on raising livestock broadened farmers’ access to information. Those characteristics obviously assisted the farmers at gaining information and knowledge about the technology of MCL farming that have enhanced the adoption level [13] [17].
Table 4. Relationship between respondents’ characteristics toward adoption level

| Characteristics       | Correlation Coefficient (r) | p-value a |
|-----------------------|-----------------------------|-----------|
| Age                   | -0.0656                     | 0.4547    |
| Education             | 0.0976                      | 0.2655    |
| Size household        | 0.0076                      | 0.9306    |
| Family labor          | -0.0003                     | 0.9977    |
| Crop experience       | -0.0260                     | 0.7674    |
| Livestock experience  | 0.1954                      | 0.0247*   |
| Length of membership  | 0.2025                      | 0.0199*   |
| Consultation          | 0.3643                      | 0.0000*** |
| Number of training    | 0.2677                      | 0.0019**  |
| Landsize              | 0.1655                      | 0.0579    |
| Land ownership        | -0.0499                     | 0.5698    |
| Ruminants type        | 0.1936                      | 0.0262*   |
| Number of livestock   | 0.1073                      | 0.2207    |
| Livestock ownership   | 0.0115                      | 0.8955    |

aSignificance at level 0.05*; 0.01**; and 0.001***

4. Conclusion

From this study, we assumed that the low level of adoption was dominant in Magelang Regency. This fact was positively related to their characteristics i.e. experience on raising livestock, the length of membership, the number of training, the ruminants’ type that was kept by farmers and particularly the consultation with extension agents. It revealed that extension agents had an important role for encouraging farmers to adopt the higher level of technology adoption in MCL farming.

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