Determinant factors of applying mixed crops and livestock farming in Indonesia

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Abstract. Smallholder farmers have been integrating their limited resources as a strategy of sustainable farming system. Mixed Crops and Livestock (MCL) Farming becomes the most popular approach in developing countries. However, it remains a question in MCL farming system, whether farmers apply this farming practice as an income generating activity or a survival strategy. This paper aims to explore the determinant factors of MCL practice among farmers in Indonesia. A cross-sectional data of the Indonesia Family Life Survey (IFLS) in 2014 was used by involving 3,702 farm household (2,957 of non-MCL farmers and 745 of MCL farmers). A binary choice model was employed to estimate the probability of practicing MCL farming in Indonesia. The results showed that the cultivated land size and age of farmers negatively explained the choice of practicing MCL among farmers in Indonesia. This indicated that MCL farming tends to be practiced by younger farmers with smaller land size. The livestock asset is insignificant within the MCL farming. It indicates that crop farming is the primary farming while keeping livestock is more complementary activity among MCL farmers.

1. Introduction
The experience of Mixed Crop and Livestock (MCL) farming in the world have indicated that this practice produce about half of the world’s food [1]. MCL farming is believed as the best practice of integrated farming system that provides both advantages and disadvantages. Farmers in mixed systems share the attention and resources over several farming activities which may lead to disadvantages with the reduction of the economics scale. Meanwhile, farmers will gain the possibility of reducing risk on farming, spreading labor and re-utilizing their limited resources as their benefit [2]. However, implementation of MCL farming initiates the farm productivity and environmental-friendly trade-off [3]. Since the MCL farm production efficiency determine the wealth of the farm household, farm size and improved technology adoption are essential to balance the productivity and environmental concerns [4].

In Asian agriculture, MCL farming is practiced as a survival strategy of small farm livelihood [5]. Apart of the cultural system, the technical aspect of mixed crop and livestock lies in the extent and nature of nutrient transfers between the different factors of the farming system [6]. The practice in Indonesia show that the nutrient transfer enables the biomass life cycle at farm level which is shown as a daily farming life such as: use of manure in rice/maize/grain legume systems in upland Java, introduction of forages in crops for use by cattle on Bali and use of cattle for draught power in rice in southern Sumatera [7].
As an experience in Indonesia, the possibility of farming risk reduction by practicing MCL farming can be business risk mitigation. For instance, practicing MCL may mitigate the effect of the price fluctuation and climate change on household income based on the commodities [8]. However, the MCL farming practice require the technology adoption in order to ensure the biomass life cycle [9]. The technology adoption indicate the need of investment to sustain food production at farm level farm [1]. As an intensification farming system, MCL farmers should also manage the farm investment to earn the reasonable income for their household. Nonetheless, among MCL farmers in Indonesia, some questions would be raised are: what are the characteristics of MCL farmer? And why do they practice MCL farming? This study aims to investigate social economic factors determining MCL practice among farmers in Indonesia. The results will illustrate the characteristics of MCL farmers in Indonesia.

2. Material and methods
This study was conducted in a cross-sectional using secondary data source from the 5th wave of Indonesian Family Life Survey (IFLS) which was collected at 2014. A total of 3,702 farms household (2,957 of non-MCL farmers and 745 of MCL farmers) were selected purposively as respondents by considering several criteria, including (1) managing land, (2) receiving assistance related to agriculture / livestock, (3) owning assets in agriculture and/or livestock, and (4) having a minimum age of 15 years. This age determination was based on the provisions of IFLS 5 where the age of above 15 years old was considered to know information about the household. Table 1 shows the list of variables that were used as into the model of determinant factors of MCL practice among farmers.

| Table 1. List of the variables |
|-----------------------------|
| Acronym | Variable description | Type of measurement |
| **Dependent variable** | | |
| MCL practice | Practice of the mixed crop-livestock farming system | Dummy (0=No, 1=Yes) |
| **Independent variable** | | |
| Age | Age of respondent | Years |
| Family | Farmer’s family member | Person |
| Education | Formal education level | Years |
| Land | Cultivated land size by farmer for crop farming | m² |
| Livestock asset | Livestock assets based on raised animal by farmers | IDR |

The MCL farming practice can be seen as a binary decision making by farmers. In this model, there were two opposite outcomes than are estimated as non-MCL farmer or MCL farmer. The variables of MCL practice among farmers can be estimated based on socio-economic characteristics, such as age, farmer’s family member, level of education, livestock asset, and land that cultivated by farmer. A binary choice model by using Logit was selected in this study to determine the factors that influence MCL practice due to computational convenience reasons[10,11]. A linear relationship of the MCL farming practice among farmer can be assumed and expressed as a variable \(y_i\), a function of observed explanatory variables \(x_i\) and an error \(\varepsilon_i\):

\[
y_i = x_i \beta + \varepsilon_i
\]  

(1)

The MCL farming practice among farmer was a binary model of two outcomes: if no, \(y=0\) and yes, \(y=1\). Therefore, the probability of \(y=1\) is modeled by an equation as followed:

\[
Pr(Y_i=1|x_i) = G(x_i \beta)
\]

(2)
where $G$ is a function with the only values zero and one and particularly mentioned as:

$$\Pr (MCL=1) = G (\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k + e) \quad (3)$$

$\Pr (MCL=1)$ is the probability of MCL farming practiced by the individual farmer given the explanatory variables $x_1, \ldots, x_k$. The $\beta_0$ is the intercept and $\beta_1, \ldots, \beta_k$ are the estimated parameters for the explanatory variables while $e$ is an error. Meanwhile, the binary model based on the logistic distribution is:

$$G (z) = \frac{exp (z)}{1+exp (z)} \quad (4)$$

3. Result and discussion

3.1. Farmer characteristics

Farmer characteristics in this study can be described by several variables (age, number of family member, formal education, and livestock assets) in the Table 2. The results show that there were two characteristics different among MCL and non-MCL farmers in this study. First, MCL farmer’s age was significantly older than non-MCL farmers. Second, the land managed by MCL farmers was significantly narrower than non-MCL farmers. Other characteristics of respondents were not considerably different since the t-test didn’t show any significance. Therefore, we may assume that MCL farmers in Indonesia were characterized by younger farmer with smaller land size. However, there should be continued by Logit test to show whether those characteristics consistently affect to decide the MCL farming practice.

**Table 2. Descriptive statistics of respondent’s characteristics**

| Variables     | Unit     | Total mean | Min | Max   |
|---------------|----------|------------|-----|-------|
| Age           | Year     | 34.85±12.75 | 15  | 64    |
| Family        | Person   | 4.76±1.95  | 1   | 16    |
| Education     | Year     | 9.88±3.78  | 1   | 18    |
| Land          | m²       | 8,758.39±20,390.55 | 100 | 600,000 |
| Livestock     | IDR      | 488,587.3±3,387,019 | 0   | 50,000,000 |
|               | asset    | 488,587.3±3,387,019 | 0   | 50,000,000 |

** P<0.05

A Non-MCL Farmer is a farmer who practices a single farming either cropping or livestock raising. We didn’t separate as cropping and livestock farming because in this paper we focus on how farmer integrate their commodities in to a mixed farming practice.

3.2. Factors determining of crop-livestock system

The results of Logit estimation in Table 3 show that age and the cultivated land size of farmers significantly determined the decision on practicing MCL among farmers in Indonesia. The negative sign indicated that MCL farming tends to be practiced by the younger farmers with smaller land size. This finding confirmed that younger farmers with smaller land size are more likely to diversify their farming activities such MCL farming [12]. In addition, the problem on farmer’s regeneration occurred in Indonesia is also confirmed. There were only limited land and resource left in farm households to be inherited to their young children. Since the land was essential in food production, younger generation selected another profession that gives more benefit to them. Therefore, the alternative farming strategy by younger farmers to practice MCL farming should be studied further whether it gives a positive impact to the farm household.
### Table 3. Binary choice model results of factors determining crop livestock farming system

| Variables       | Coefficient | Standard Errors | z-value |
|-----------------|-------------|-----------------|---------|
| Constant        | -1.080      | 0.196           | -5.52   |
| Age             | -0.006      | 0.003           | -1.78*  |
| Family          | -0.001      | 0.021           | 0.04    |
| Education       | -0.004      | 0.010           | -0.41   |
| Land            | -7.866      | 3.500           | -2.25** |
| Livestock asset | 8.640       | 1.090           | 0.79    |

Likelihood Ratio = 10.81**  
* P<0.1 ** P<0.05 ***P<0.01

### 4. Conclusion

The study on determinant factors of applying MCL farming showed that MCL farming tends to be practiced by the younger farmers with smaller land size. The insignificance of livestock asset indicated that livestock is more complementary activity among MCL farmers. However, further study is needed to discover whether the MCL farming give a benefit impact to the farm households.

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