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***Research paper***

# Social Factors Affecting Productivity of Integrated Farming: An Experience from Ngantang District, Indonesia

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**Abstract**

Integrated farming system (IFS) is one of important ways to support sustainable agriculture. There are some important social factors needed to support the success of IFS, beside technical and economical factors. This study aimed to analyze factors of knowledge, attitude, management, and production behavior in affecting productivity of integrated farming. The study was done in Ngantang District, Malang Regency, East Java, Indonesia. Respondents are farmers who applied integrated farming, namely rearing dairy cow, processing biogas and planting crop in one farming system. Data was analyzed by using Structural Equation Modeling (SEM). The result indicates that the strongest influences are obtained between attitude to the production behavior and between management to the productivity of integrated farming, with the influence strength almost double to the others. Next, is the strength of the influence of knowledge to attitude; production behavior to the productivity; management to production behavior. All of them have positive relation. Lastly, the weakness and negative relation is the influence of knowledge on management. It can be inferred from the result that developing positive farmers' attitudes to the environment and food safety is important to do. Moreover improving management of integrated farming is also important to increase its productivity.

***Keywords***: *Social factors, integrated farming, SEM, dairy cow, biogas slurry.*

## 1. Introduction

In recent years, there is a growing concern regarding sustainable agriculture. One of the implementation is integrated farming system (IFS). Integrated farming is the integration of all components of agriculture in one system or management. It can be a combination of crop and livestock. The main benefit of integrated farming is to optimize usage of agricultural resources, costs efficiency and minimizing waste (zero waste).

Integrated farming system emphasizes on the economic based on environmental friendly technology and optimizing of all sources of energy produced. It involves more than one sub-sector in an integrated system. Integrated farming can be a combination of crop-livestock; crop-fish; livestock-fish, or integration of the three sub-sector (crop-livestock-fish).

Integrated farming is an ideal concept of agriculture, however, the implementation in Indonesia is still a discourse. It is because the community's knowledge and awareness is still low. Therefore, social factors is also an important factors affecting performance of integrated farming system. Therefore, farmers' knowledge and attitude concerning with environment is important to study. Madamba (1980) stated that the application of integrated farming should be tailored to the capabilities, resources, and needs of farmers who work as well as in tune with the different economic and social environmental factors around farmer (Madamba, 1980). Moreover, Behera & Sharma (2007) also mentioned that the components of farming system interact with the physical, biological and socio-economic factors, which is not under the control of household.

Integrated farming needs a relative high capital. Although integrated farming is very suitable to apply in Indonesia which has a tropical climate, sunshine is available along the year and high rainfall is available almost half of the year.

Some implementation of integrated farming showed a better performance of yield and profit. Channabasavanna et al. (2009) found that the implementation of integrated farming system on small farm in India take productivity of 26,3% up to 32,3%, these is higher than the conventional farming, rice-rice (Channabasavanna, et al, 2009). Moreover, Relawati et al (2012) also found that the implementation of integrated farming increase productivity of vegetables and rice crops, at least 20% higher than the conventional system (Relawati et al, 2012). The integration of crop and livestock farming could increase production, besides improve quality of soil and foods diversity (Hilimire, 2011).

This study aimed to analyze the social factor affecting productivity of integrated farming implemented at dairy cow and some crops (mostly vegetable).

## 2. Literature Review

Many research found that the success of sustainable agriculture is related with social factors. For example, an animal production has contribution to the global sustainability and it is a combination of eco-agro-social perspective (Hellstrand, 2013). Hellstrand also mentions that there is no difference between organic and conventional dairy cow, in term of milk production (measured with energy correction milk = ECM). However, the economic result of milk production is quite different.

Some researches show that multidiscipline approach is needed to solve the sustainable environment. Kalaugher et al (2013) studied an integrated biophysical and socio-economic framework for analysis of climate change adaptation strategies, they involve socio-economic background and integrate management strategies and economic factors in the whole farm model. Moreover Wu & Mweemba (2010) examined Zambian farmers' awareness and attitude toward the degradation of the environment and their relationships with a trust to evaluate their perceived capacity to take actions to improve the environment; the result showed that greater environmental awareness leads to greater involvement in land management programs (Wu & Mweemba, 2010). Meanwhile, Nan et al (2011) found that the primary cause of the bad environment of rural area is low environment awareness of farmers (Nan, Banghong, & Haifen, 2011). Moreover, according to Mzoughi (2011) social concerns i.e. environmental commitment leads to farmers' adoption in integrated crop protection and organic farming.

This research focuses on three social dimensions, i.e. knowledge, attitude and behavior as social factors influencing productivity of IFS. It is not easy to relate social factors and farm productivity, since social factors are imprecise. Therefore we put management among social factors and productivity of IFS. Management is an important factor in developing integrated farming. Brodt et al (2006) have related social values at different management style with farm production on biologically integrated farming system (Brodt, Klonsky, & Tourte, 2006). We hypothesize that knowledge influences attitude and management, next attitude and management influence production behavior, and lastly, management and production behavior influence productivity of IFS.

Using structural equation modeling (SEM) is relevant in the analysis using theory of plan behavior. SEM is used in the analysis that relate farmer's attitude and behavior (Kauppinen et al., 2010). SEM is also used to relate attitudes of confidence, perceptions of net benefit, perceived usefulness, education level and farm size to the precision agriculture technologies (Mims, Norwood, & Mask, 2005). This paper also uses SEM analysis to analyze social factors of knowledge, attitude, management, and production behavior in affecting productivity of integrated farming system.

## 3. Methods

The study was done in Ngantang District, Malang Regency, East Java, Indonesia. Respondents are farmers who applied integrated farming, namely rearing dairy cow, processing biogas and planting crops (mostly vegetables) in one farming system. Most vegetables planted with integrated farming are potato (50%), mustard greens (25%), and the rest are eggplant, tomato, red onions, and cabbage. Interview with farmers and field observation was done during May to August 2016.

Primary data was analyzed by using Structural Equation Modeling. The social factors analyzed in the SEM model are: knowledge, attitude, management, and production behavior. These factors are expected to affect the productivity of dairy cow and vegetables crops. Table 1 shows the latent variable and indicator included in the structural equation modeling (SEM).

The main objective of this work is to analyze the influence of knowledge, attitude, management, and production behavior toward productivity of integrated farming. Since all exogenous variables are latent variables, that could not be directly measured, so they are reflected from the indicators as mentioned in Table 1. Meanwhile the endogenous variable (productivity) are formatted from the indicators. All indicators were measured with Likert scale with range from 1 to 5. Operation of the SEM analysis used the software of WarpPLS.

**Table 1:** Latent Variable and Indicator of the SEM Model

| Latent Variable | Indicator | Indicator type |
|---|---|---|
| X1 = Knowledge | X1.1 = knowledge about integrated farming<br>X1.2 = knowledge about dairy cow farming<br>X1.3 = knowledge about vegetable farming<br>X1.4 = knowledge about benefit of biogas slurry<br>X1.5 = knowledge about environmental sustainability | Reflective |
| X2 = Attitude | X2.1 = attitude on dairy cow farming<br>X2.2 = attitude on vegetable farming<br>X2.3 = attitude on food safety<br>X2.4 = attitude on environmental sustainability | Reflective |
| X3 = Management | X3.1 = Planning farm activities<br>X3.2 = Controlling farm activities | Reflective |
| X4 = Production behavior | X4.1 = Use dairy waste for crops<br>X4.2 = Using organic manure for crops (or semi organic)<br>X4.3 = Use plant waste for dairy cow<br>X4.4 = Giving feed additive for dairy cow | Reflective |
| Y1 = Productivities | Y1.1 = Productivity of dairy cow<br>Y1.2 = Productivity of vegetable crops | Formative |

## 4. Result and Discussion

Since the data are measured with Likert scale, they are firstly analyzed to check their validity and reliability. Table 2 shows the convergent and discriminant validity of the research instrument. If a loading is higher than 0.3, the indicator fulfills the convergent validity. Meanwhile, if the loading is higher than the cross-loading, the indicator fulfils discriminant validity.

Table 2 shows that all loading of indicators fulfill convergent validity and almost all of them fulfill discriminant validity. All indicator of X3 and Y1 fulfill the discriminant validity. Moreover, almost all indicator of X1, X2 and X4 fulfill the descriminant validity, except: X1.2 = knowledge about dairy cow farming; X2.2 = attitude on vegetable farming and X4.3 = Use plant waste for dairy cow. Therefore, it can be justified that the test result performs that almost all data are valid. Therefore, it can be used to the next analysis.

Table 3 shows the result of all criteria to test the goodness of fit of the SEM model. All criteria recommend that the model is fit and feasible to analyze the model. By prioritizing the three first criteria to be explained, two of them are significant at 1% significant level. Meanwhile, the AARS is significant on the alpha of 7%. The APC=0.344 means that the average of all path coefficient is 34.4%. This model is also free of the disturbance of multi-collinearity. Table 2 show detail of all criteria, includes the explanation and it is clear enough.

**Table 2:** Combined loadings and cross-loadings

| | X1 | X2 | X3 | X4 | Y1 | Type (a | SE | P value |
|---|---|---|---|---|---|---|---|---|
| X1.1 | 0.744 | -0.303 | -0.291 | 0.267 | 0.240 | Reflective | 0.115 | <0.001 |
| X1.2 | **0.301** | 0.115 | -0.215 | -0.535 | 0.552 | Reflective | 0.139 | 0.018 |
| X1.3 | 0.761 | -0.412 | -0.028 | -0.194 | -0.202 | Reflective | 0.114 | <0.001 |
| X1.4 | 0.748 | 0.555 | 0.131 | 0.108 | -0.204 | Reflective | 0.115 | <0.001 |
| X1.5 | 0.785 | 0.114 | 0.260 | 0.038 | -0.049 | Reflective | 0.113 | <0.001 |
| X2.1 | 0.009 | 0.878 | -0.249 | -0.191 | 0.118 | Reflective | 0.108 | <0.001 |
| X2.2 | 0.643 | **0.432** | -0.359 | 0.316 | 0.125 | Reflective | 0.131 | 0.001 |
| X2.3 | -0.275 | 0.900 | 0.096 | -0.048 | 0.124 | Reflective | 0.107 | <0.001 |
| X2.4 | -0.069 | 0.550 | 0.522 | 0.137 | -0.488 | Reflective | 0.125 | <0.001 |
| X3.1 | 0.159 | -0.177 | 0.968 | -0.064 | 0.090 | Reflective | 0.104 | <0.001 |
| X3.2 | -0.159 | 0.177 | 0.968 | 0.064 | -0.090 | Reflective | 0.104 | <0.001 |
| X4.1 | 0.283 | -0.158 | -0.162 | 0.890 | 0.028 | Reflective | 0.108 | <0.001 |
| X4.2 | 0.119 | 0.189 | -0.062 | 0.822 | 0.011 | Reflective | 0.111 | <0.001 |
| X4.3 | -0.993 | 0.496 | -0.024 | **0.309** | 0.558 | Reflective | 0.138 | 0.016 |
| X4.4 | 0.075 | 0.297 | -0.358 | -0.567 | 0.364 | Reflective | 0.124 | <0.001 |
| Y1.1 | -0.074 | 0.383 | -0.029 | -0.416 | 0.732 | Formative | 0.115 | <0.001 |
| Y1.2 | 0.074 | -0.383 | 0.029 | 0.416 | 0.732 | Formative | 0.115 | <0.001 |

**Table 3:** Goodness of fit of the inner model

| Description | Criteria | Explanation |
|---|---|---|
| Average path coefficient (APC) =0.344 | P=0.004 | Significant |
| Average R-squared (ARS)=0.201 | P=0.044 | Significant |
| Average adjusted R-squared (AARS)=0.168 | P=0.065 | Sign. at α = 7% |
| Average block VIF (AVIF)=1.049 | acceptable if <= 5, ideally <= 3.3 | Acceptable, ideal |
| Average full collinearity VIF (AFVIF)=1.603 | acceptable if <= 5, ideally <= 3.3 | Acceptable, ideal |
| Tenenhaus GoF (GoF)=0.344 | small >= 0.1 medium >= 0.25 large >= 0.36 | Medium |
| Sympson's paradox ratio (SPR)=0.833 | acceptable if >= 0.7, ideally = 1 | Acceptable |
| R-squared contribution ratio (RSCR)=0.948 | acceptable if >= 0.9, ideally = 1 | Acceptable |
| Statistical suppression ratio (SSR)=1.000 | acceptable if >= 0.7 | Acceptable |
| Nonlinear bivariate causality direction ratio (NLBCDR)=0.917 | acceptable if >= 0.7 | Acceptable |

### 4.1. Description of Integrated Farming

Integrated farming implemented at the research location is described below. Dairy cow farmers who processed cow feces to become biogas and used its slurry as manure for their vegetable crop were interviewed to obtain data about their knowledge, attitude, management and production behavior, as well as their productivities of milk and vegetable. We hypothesize that environmental awareness that is reflected on knowledge, attitude, management and environmental friendly production behavior influence productivity of the integrated farming. Greater environmental awareness leads to bigger productivity of IFS, vice versa.

Respondents are 40 farmers who applied integrated farming, namely rearing dairy cow, processing biogas and planting vegetables in one farming system. The most vegetables planted with IF are potato (50%), mustard greens (25%), and the rest 25% are eggplant, tomato, red onions, and cabbage. Farmers use biogas slurry as manure of their vegetable crops.

Benefits of slurry application on the IFS are: reduce cost of chemical fertilizer, increase crops productivity, and produce healthier products. This application reduces cost of chemical fertilizer 30% up to 50%. At some crops, productivity also increases with application of slurry. The other benefit is their products gradually become more organic.

**Table 4**: Productivity of IFS in Comparison with the Average of Ngantang District

| IF Description | Crops (Tones/Ha) | | Milk (L/day/cow) | |
|---|---|---|---|---|
| | IFS Farmers | Average* in Ngantang | IFS Farmers | Average* in Ngantang |
| Dairy cow – biogas slurry – potato | 16.30 | 15 | 10.61 | 15.00 |
| Dairy cow – biogas slurry – mustard green | 26.74 | n.a. | 13.69 | |
| Dairy cow – biogas slurry – mayze | 9.04 | 5.5 | 11.33 | |
| Dairy cow – biogas slurry – rice | 6.50 | 6.7 | 12.50 | |
| Dairy cow – biogas slurry – cabbage | 22.31 | 33 | 15.00 | |
| Dairy cow – biogas slurry – eggplant | 5.00 | n.a. | 17.00 | |
| Dairy cow – biogas slurry – onion | 6.00 | 10 | 14.00 | |

*Taken from the Strategic Planning of Ngantang District

Fig 1 shows that all exogenous variables (X1, X2, X3 and X4) are significant in influencing the endogenous one (Y1= productivity of integrated farming). The arrows show the relational direction between one variable to the other. More detail of the SEM result is performed in Table 4.

The P values show the significance level of the influence one variable to another. The influence is showed by P value <0.01, it means that the significance level is 1%. This significant level happens on most of variables: knowledge to attitude, knowledge to management, management to production behavior, and management to productivity. Next, significant level of 5% happens on the influence of production behavior to productivity. There is only one non-significant influence, i.e. attitude to production behavior.

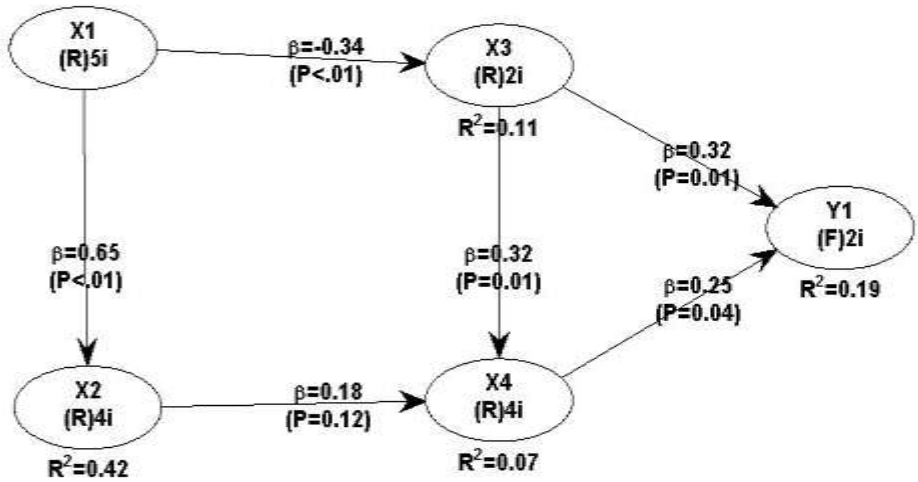


**Fig.1:** The SEM diagram of social factors affecting productivity of IFS

**Table 5:** Path coefficients and P values

| Latent variable | Path coefficient (P values) | | | |
|---|---|---|---|---|
| | X1 (knowledge) | X2 (attitude) | X3 (management) | X4 (prod.behavior) |
| X1 (knowledge) | | | | |
| X2 (attitude) | 0.652 (<0.001) | | | |
| X3 (management) | -0.336 (0.009) | | | |
| X4 (prod.behavior) | | 0.175 (0.120) | 0.325 (0.012) | |
| Y1 (productivities) | | | 0.324 (0.012) | 0.251 (0.043) |

The strength of the influence is reflected from the path coefficient. Knowledge affects attitude with positive relation (0.652) and stronger than its influence to the management (-0.336). Knowledge affect attitude with negative relation.

The strongest influence are obtained between knowledge to the attitude of integrated farming, with the influence strength almost double to the others. The next order is the strength of the influence of management to production behavior and management to productivity. All of them have positive relation and the same significant level (5%). The last order with the weakness relation is the influence of production behavior toward productivities, however, it still has 5% significant level.

## 5. Conclusion

Knowledge affects management, which further affects productivity of IFS. Management can influence productivity of IFS directly or indirectly through its production behavior, with the equal strength and level of significance. The result also shows that knowledge influences attitude, however attitude does not affect production behavior of IFS.

The order of effect’s strength of social factors to the productivity of integrated farming also implies to the effort priority to improve productivity of integrated farming. Developing positive knowledge to the environment and food safety is important, it needs farmers’ empowerment activities. Moreover, improving management of integrated farming is also important to increase its productivity. It could be done through the activities of farmers group.

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