Path Analysis of Exogenous Variables against Technology Adoption Levels of Dairy Cattle in West Sumatera

Herawati T, Priyanto D

Indonesian Research Institute of Animal Production
E-mail: herawati_tati@yahoo.com

(received 15-02-2017; revised 22-03-2017; accepted 29-03-2017)

ABSTRACT

Herawati T, Priyanto D. 2017. Path analysis of exogenous variables against technology adoption levels of dairy cattle in West Sumatera. JITV 22(1): 9-15. DOI: http://dx.doi.org/10.14334/jitv.v22i1.1603

Path analysis of the regression equation can be used to see the direct and also indirect influence of some exogenous variables against endogenous variables. The rate of feed technology adoption as an endogenous variable can be directly or indirectly influenced by some exogenous variables. The purpose of this research was to test multiple exogenous characteristics variables of dairy cows farms against the feed technology adoption rate as endogenous variables, through path analysis. Research conducted in the city of Padang Panjang, West Sumatra in particular farmer group of dairy cattle in 2016. Endogenous variable is the level of adoption of feed technology (Z). Whereas the exogenous variables are the level of education (X1), the age of farmer (X3), the amount of cow’s lactation (X2), farm scale (Y1) and milk production (Y2). The last two variables are exogenous which are bridging the influence indirectly. Obtained results showed that only X3 which directly influenced Z, with a value of ρZX3 = 0.834 and P = 0.018. Other variables X1 and X2 partly significantly influenced Y1 and X3 significantly influenced Y2 with value of path coefficient in successively ρY1X1 = 0.133 and P = 0.040; ρY1X2 = 0.982 and P = 0.000; ρZX3 = 0.841 and P = 0.008. Therefore, there was no special model of causal relationships between the empirical variables X and Y against Z, except the X3 which had structure model Z = ρZX3 X3 + ρZX2 X2 + ρZX1 X1. It was concluded that the age strongly influenced the feeding technology adoption. The older the age of farmers, the more difficult for adopting recommended technology.

Key Words: Path Analysis, Dairy Cattle, Feed Technology Adoption

INTRODUCTION

Dairy cattle farming, currently still concentrated in the Java Island, even though the dairy consumers spread evenly around Indonesia. Fresh milk production in Indonesia is concentrated in Java Island (95%) with negative total net export-import trading (Hasan 2016; Farid & Sukesi 2017). The efficiency is an obstacle of Indonesian fresh milk production in the outside of Java Island. This as shown by milk production data in 2000, which showed 6,420 dairy cows in North Sumatera producing 4,615 ton fresh milk, meanwhile in West Java with 84,788 dairy cows were able to produce 184,515 ton fresh milk (Yusdjia et al. 2016). In 2016 the population of dairy cows in Indonesia, increased up to 533,860 (BPS 2016). Therefore, the improvement
efficiency of rearing dairy cow, in Java Island is crucial in order to fulfill National fresh milk demand. The government, through policies package and programs of provincial services, has attempted to improve productivity and income of dairy cattle farmers. The policy of Milk Processing Industry, which obliges to buy domestic milk, is one example policy to protect dairy cattle farmers (Budiyono 2012). Indonesian Agency for Agricultural Research and Development (IAARD), through the technical implementation units has developed feed technology to support the increase of national dairy cattle productivity (Mathius 2014; Ginting & Elisabeth 2014; Adnyana & Mardianto 2016). However, the productivity of dairy cattle in the outside Java Island reminds low (Yusdja 2017; Diwyanto et al. 2017). From the point of view of technology introduction, it is allegedly that technology of dairy cattle production introduced, cannot be adopted well in a location. Not optimal adoption of the technology may be induced by ineffective adoption method (Nugroho et al. 2014; Nuryanti & Swastika 2016).

Factors affecting adoption of dairy cattle technology consist of exogenous and endogenous factors of user. The exogenous factors are farm scale; the amount of cow's lactation and milk production, meanwhile the endogenous factors are level of education and age of the farmers which help determine attitude and level of understanding of the technologies introduced. Study of correlation factors should be conducted to optimize the adoption, since the interaction between factors may be specific both for the commodity or the location (Sudaryanto & Agustian 2017). That is underlying this study conducted.

This study was aimed to test multiple exogenous characteristics variables of dairy cows farms against the feed technology adoption rate as endogenous variables, through path analysis. Research conducted in the city of Padang Panjang, West Sumatra in particular farmer groups of dairy cattle. This location has good potential in dairy cattle development supported by suitable agro-climate, feed source availability and independence level of farmers. The city of Padang Panjang is well known as the biggest agribusiness region of dairy cattle in the West Sumatera (Sartika & Rahmi 2012). Meanwhile, quantification of technology adoption correlation factors was conducted by assessing that correlation factors through path analysis. This model may be used to find out the direct and also indirect effects on several factors reflected on path coefficient value following structural model mathematically (Trinayani et al. 2013; Azis & Kamal 2017). The understanding of this correlation factors will optimize introduction and adoption process of feed technology of dairy cattle.

**MATERIALS AND METHODS**

Research conducted in the city of Padang Panjang, West Sumatra in particular farmer group of dairy cattle in 2016. This study used quantitative and qualitative approaching through structured survey. The respondents were four dairy cattle farmer groups and one individual farmer (Table 1).

Data analyzed were the age of farmer (year), the level of education of farmer (year), the amount of cow's lactation (head), farm scale (head), milk production (litter/day) and adoption rate (score: 1-4).

The narrative descriptive analysis was used as qualitative analysis model. Quantitative analysis model was performed in the main basis of path analysis model consisting of exogenous (level of education, the age of farmer, the amount of cow's lactation, farm scale and milk production) and endogenous (level of adoption of feed technology) variables with two hypotheses tested:

1. First hypothesis and structural formulation model

\[ H_0 : \rho_{x1} = \rho_{x2} = \rho_{y2} = 0 \quad \text{vs} \quad H_1 : \rho_{x1} \neq \rho_{x2} \neq \rho_{y2} \neq 0 \]

Hypothesis: Level of education (X1), Amount of lactating cows (X2) and farm scale (Y2) contributed simultaneously to adoption rate of feed technology (Z).

First structure model and path coefficient shape

2. Second hypothesis and structural formulation model

\[ H_0 : \rho_{x1} = \rho_{x2} = \rho_{y2} = 0 \quad \text{vs} \quad H_1 : \rho_{x1} \neq \rho_{x2} \neq \rho_{y2} \neq 0 \]

Hypothesis: Age of farmers (X1), Amount of lactating cows (X2) and Milk production (Y2) contributed simultaneously to adoption rate of feed technology (Z).

Second structure model and path coefficient shape

---

**Table 1. Respondents of the survey in the city of Padang Panjang.**

<table>
<thead>
<tr>
<th>Name</th>
<th>District</th>
<th>Sub-District</th>
<th>The Number of Member (persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serambi Karya Mandiri</td>
<td>Koto Katiak</td>
<td>East Padang Panjang</td>
<td>9</td>
</tr>
<tr>
<td>Harapan Baru</td>
<td>Ganting</td>
<td>East Padang Panjang</td>
<td>12</td>
</tr>
<tr>
<td>Parmato Mudo Nagari</td>
<td>Silang Bawah</td>
<td>West Padang Panjang</td>
<td>7</td>
</tr>
<tr>
<td>Makmur Batu Batire</td>
<td>Kampung Manggis</td>
<td>West Padang Panjang</td>
<td>10</td>
</tr>
<tr>
<td>Rafles (individual farmer)</td>
<td>Kampung Manggis</td>
<td>West Padang Panjang</td>
<td>1</td>
</tr>
</tbody>
</table>
Herawati T, Priyanto D. Path analysis of exogenous variables against technology adoption levels of dairy cattle in West Sumatera

\[ Y_1 = \rho_{y1x1} X_1 + \rho_{y1x2} X_2 + \varepsilon_1 \quad \text{(1)} \]

\[ Z = \rho_{y1y1} Y_1 + \varepsilon_2 \quad \text{and} \quad \rho_{y2x3} X_3 + \rho_{y2x2} X_2 + \varepsilon_3 \quad \text{(3)} \]

\[ \text{dan} \quad Z = \rho_{y2y2} Y_2 + \varepsilon_4 \quad \text{(4)} \]

(1) Direct effect of exogenous variables (X_1 and X_2) to endogenous variable (Y_1) and indirectly to Z variable with \( \varepsilon_1 \) error.

Direct effect of Y_1 variable to Z variable with \( \varepsilon_2 \) error.

\[ Y_2 = \rho_{y2x3} X_3 + \rho_{y2x2} X_2 + \varepsilon_3 \quad \text{dan} \quad Z = \rho_{y2y2} Y_2 + \varepsilon_4 \]

(1) Direct effect of exogenous variables (X_3 and X_2) to endogenous variable (Y_2) and indirectly to Z variable with \( \varepsilon_3 \) error.

Direct effect of Y_2 variable to Z variable with \( \varepsilon_4 \) error.

**RESULTS AND DISCUSSION**

**Testing result of the first model**

Simultaneous effect of education level, amount of cows lactation and farm scale to the adoption rate of feed technology, which was notified as \( Z = f(X_1, X_2, Y_1) \).

This model was motivated by field condition that generally, the large-scale business willing to adopt the technologies introduced. The increase of the number of lactation cow lead to the desire to expand the business scale and to increase milk production. It surely would increase farmer’s income. Education level had positive correlation to the adoption rate of technology (Shiferaw et al. 2015; Saridewi & Siregar 2016).

The result of path tracking analysis to test variable: education (X_1), amount of lactating cows (X_2) and farm scale (Y_1) simultaneously, contributed to the adoption rate of feed technology (Z), showed that \( R^2 \) and probability value by 0.086 and 0.921>5%, respectively (Table 2). Therefore, the \( H_0 : \rho_{zx1}=\rho_{zx2}=\rho_{zy1}=0 \) was accepted. This meant that there was no direct effect from the X_1 and X_2 variables against the Z and indirect effect that was through the Y_1. In consequence, the test was continued for partial test of the X_1 and X_2 variables against Y_1. The partial test resulted \( R^2 \) and F value by

<table>
<thead>
<tr>
<th>Model</th>
<th>R Square</th>
<th>Std. Error of the Estimate</th>
<th>F Change</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.086</td>
<td>0.907</td>
<td>0.156</td>
<td>0.921</td>
</tr>
</tbody>
</table>

\[ a \) Predictors: (Constant), Education (X_1), Lactation Cow (X_2), Farm Scale (Y_1)

\[ b \) Dependent Variable: Adoption of Technology (Z)
ended technology (Z) (Table 4). The correlation framework between the X and Y might have been a result of the same time, the acceptance of information technology improvement and adoption of technology. It seemed there was no direct correlation between the farm variables: age (X1), amount of lactation cow (X2) and milk production (Y2), showed a weak contribution (P=8%) to the adoption rate of feed technology (Z) (Table 4). The path coefficient tracking result showed that the age (X1) affected directly to the adoption rate of feed technology with the path coefficient and significance level value by -0.843 and 18%, respectively. Whereas, the other factors were not significantly affected the Z (Table 5). The negative value of the coefficient p2x3 showed an inverse correlation of the age to the technology adoption rate. This indicated that the older farmer the less the interest in adopting the recommended technologies. Young stakeholders were more interested in the new technologies which meant that age was a significant effect (Gyau et al. 2014).

The simultaneous effect of age, amount of lactation cow and milk production against the adaptation of feed technology, was noted as Z = f(X2, X1, Y2).

Table 3. Coefficients of the first partial path model (1)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-1.857</td>
<td>1.705</td>
<td>-1.089</td>
<td>0.318</td>
</tr>
<tr>
<td>X1.Education</td>
<td>1.698</td>
<td>0.651</td>
<td>0.133</td>
<td>2.607</td>
</tr>
<tr>
<td>X2.Lactating Cow</td>
<td>1.891</td>
<td>0.995</td>
<td>1.016</td>
<td>19.902</td>
</tr>
</tbody>
</table>

a Dependent Variable: Farm Scale (Y1)

0.985 and 200.399, respectively with probability value by 0.00 5% showed that the X1 and X2 simultaneously contributed against the Y1. That meant the H0: \( \rho_{y1x1}=\rho_{y1x2}=0 \) was rejected and the alternative hypothesis, H1: \( \rho_{y1x1} \neq \rho_{y1x2} \) was accepted with the value presented in Table 3.

Path coefficient value of the partial test was \( \rho_{y1x1} = 0.133 \) with lower significance value by 0.040 than the probability value by 0.05. That meant that the H0: \( \rho_{y1x1}=0 \) was rejected or the H1: \( \rho_{y1x1} \neq 0 \) was accepted. It also meant that the education contributed to the farm scale level. Then the value of \( \rho_{y1x2} = 1.016 \) with significance level by 0.00 showed that the number of lactation cow was significantly affected by the farm scale. The higher education and number of lactation cow increased the willingness to increase the farm scale. Education level might have changed the mindset, even better reasoning, so it might have been concluded that higher education level leading someone to be more rational (Narti 2016), for a better mindset resulting in a better management for their agribusinesses (Ruggiero et al. 2017; Kumaran et al. 2017). Even the value showed the contribution of education level to the farm scale, as a result of the willingness to expand their business, in this study, showed there was no direct correlation between the farm scales with the adoption rate of technology. It seemed that the correlation test of the adoption rate of technology to the farm scale needed to be carried out as stated by the Rosandy et al. (2012) that one attempt to expand the business scale was improvement and adoption of the technologies. At the same time, the acceptance of information technology (IT) required special efforts. The low rate of IT adoption was influenced by many factors that the most were from the internal. Those factors were social, institutional and financial (Fauzi et al. 2017; Suhaeti & Suhami 2017; Yuwono 2017).

From the test results above, causal-empiric correlation framework between the X1 and X2 to Y1 might have been formed as the following formulas:

\[
Y_1 = \rho_{y1x1} X_1 + \rho_{y1x2} X_2 + \varepsilon_1.
\]

\[
Y_1 = 0.133 X_1 + 1.016 X_2 + \rho_{y1} \varepsilon_1.
\]

\[
\rho_{y1} (\text{remind variable}) = 1 - R^2 = 1 - 0.985 = 0.015
\]

\[
Y_1 = 0.133 X_1 + 1.016 X_2 + 0.015 \varepsilon_1.
\]

Testing result of the second model

The result of path tracking analysis to test variables: age (X1), amount of lactation cow (X2) and milk production (Y2), showed a weak contribution (P=8%) to the adoption rate of feed technology (Z) (Table 4). The path coefficient tracking result showed that the age (X1) affected directly to the adoption rate of feed technology with the path coefficient and significance level value by -0.843 and 18%, respectively. Whereas, the other factors were not significantly affected the Z (Table 5).

From this study result, it was expected to be a basis of selection of the target characteristics to improve the adoption rate of technology. Considering that technology adoption was expected to provide significant correlation to improve the productivity and increase the population of livestock. Besides, effective socialization was required to deliver better understanding and build the willingness to adopt the technologies.
Herawati T, Priyanto D. Path analysis of exogenous variables against technology adoption levels of dairy cattle in West Sumatera

Table 4. Testing result of direct effect model

<table>
<thead>
<tr>
<th>Model</th>
<th>R Square</th>
<th>Std. Error of the Estimate</th>
<th>F Change</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.713</td>
<td>0.508</td>
<td>4.149</td>
<td>0.080</td>
</tr>
</tbody>
</table>

a Predictors: (Constant), Age of farmers (X3), Lactating Cow (X2), Milk Production (Y2)
b Dependent Variable: Adoption of Technology (Z)

Table 5. Coefficient value of direct path toward Z (2)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td>B</td>
</tr>
<tr>
<td>(Constant)</td>
<td>6.395</td>
<td>0.967</td>
<td></td>
<td>6.610</td>
</tr>
<tr>
<td>X2. Lactating Cow</td>
<td>0.027</td>
<td>0.049</td>
<td>0.244</td>
<td>0.542</td>
</tr>
<tr>
<td>Y2. Milk Production</td>
<td>-0.001</td>
<td>0.005</td>
<td>-0.142</td>
<td>-0.312</td>
</tr>
<tr>
<td>X3. Age</td>
<td>-0.077</td>
<td>0.022</td>
<td>-0.834</td>
<td>-3.439</td>
</tr>
</tbody>
</table>

Dependent Variable: Adoption of Technology (Z)

Table 6. Coefficient value of partial path toward Y2 (2)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td>B</td>
</tr>
<tr>
<td>(Constant)</td>
<td>39.794</td>
<td>83.201</td>
<td></td>
<td>0.478</td>
</tr>
<tr>
<td>X3. Age of farmers</td>
<td>-0.705</td>
<td>1.936</td>
<td>-0.078</td>
<td>-0.364</td>
</tr>
<tr>
<td>X2. Lactating cow</td>
<td>8.971</td>
<td>2.300</td>
<td>0.841</td>
<td>3.900</td>
</tr>
</tbody>
</table>

Dependent Variable: Milk Production (Y2)

Table 7. The Value of path coefficient

<table>
<thead>
<tr>
<th>Variable</th>
<th>Testing Result</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endogenous</td>
<td>Exogenous</td>
<td>R²</td>
</tr>
<tr>
<td>Z</td>
<td>X1</td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y1</td>
<td></td>
</tr>
<tr>
<td>Y1</td>
<td>X1</td>
<td>0.985</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>X3</td>
<td>0.713</td>
</tr>
<tr>
<td></td>
<td>Y2</td>
<td></td>
</tr>
<tr>
<td>Y2</td>
<td>X2</td>
<td>0.722</td>
</tr>
<tr>
<td></td>
<td>X3</td>
<td></td>
</tr>
</tbody>
</table>
CONCLUSION

The study concluded that only age of farmers that had direct effect to the adoption rate of feed technology. The older the age of farmers the more difficult for adopting recommended technology. Education and the amount of lactation cow significantly affected the farm scale. The higher education and the greater number of lactating cows the higher willingness of farmer.

REFERENCES


