Stepping up from subsistence to commercial intensive farming to enhance welfare of farmer households in Indonesia

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Abstract
This article assesses the welfare impact of intensive chilli farming and determines the factors motivating farmers to engage in commercial farming. This study uses a structural equation model that measures the direct and indirect effects of explanatory variables on intensive chilli production and welfare. This study uses data of field surveys of randomly selected 220 farmers in three regions of Java. The results show that stepping up to intensive and profit-oriented farming improved farmers’ welfare. Internal and external factors, directly and indirectly, affected farmers’ decision to devote more resources to commercial chilli farming. Farmers’ knowledge, as well as access to credit, technology adoption, marketplace, and traders, played significant roles in improving rural welfare. The government needs to reform marketing system of horticultural products and establish market infrastructures to accommodate oversupply during peak season. Easy and flexible credit should be available and accessible to farmers, with technology applicable to such agriculture.

KEYWORDS
chilli farming, external and internal factors, farming society, structural equation modelling (SEM), welfare impact
The agricultural sector still plays essential roles in the emerging economies, where poor people dominate the population. The majority of the people in developing regions are engaged in the agricultural industry, and especially subsistence farming (International Labour Organization, 2011), and they are smallholder farmers (Cervantes-Godoy, 2015). At global level, 72% of farms are less than 1 ha, and 12% are between 1 and 2 ha. However, concerning the farmland, farms over 100 ha in size occupy more than half of the world farmland, whereas the share of farms up to 2 ha is only about 12% (Food and Agriculture Organization, 2014). Exiting from the subsistence and participating in commercial intensive farming will have a significant impact on welfare throughout much of the world, including Indonesia. Integrating vegetables into farming systems has attracted attention to address rural poor across the globe. Commercial vegetable production can lead to increased farm productivity and higher farm gate values compared than can cereal and other staple crops (Weinberger & Lumpkin, 2007).

This article assesses the impact of moving from subsistence to intensive chilli farming on farmers' welfare and analyses socio-economic, technical, and institutional factors that affect a typical farmers' decision to engage in intensive chilli farming in Java, Indonesia.

Agriculture as a resilient sector for Indonesian economy motivates this study. Rural employment in the sector still dominated with 58% of the nonpoor and 75% of the poor (McCulloch, 2008). The sector in 1981 constituted 24.5% of gross domestic product (GDP) and employed 54.8% of the total workers. As well, the sector in the 1990s endowed approximately 50% of employment and around 20% of GDP (Hill, 2000).

There was a substantial transformation in the contribution of the agricultural sector to the national economy. In terms of percentage, the contribution of agricultural sector gradually decreases from about 16% in 2000 to 12% in 2014. However, in terms of magnitude, the amount of GDP from agricultural sector increases significantly from about IDR 220 trillion to IDR 350 trillion for the same periods. The transformation implies that other sectors grow at a higher rate than the agricultural sector. Concerning the employment rate in the agricultural sector, the role of agricultural sectors in providing jobs for Indonesian people drops significantly from about 44% in 2004 to about 30% in 2014. However, in terms of magnitude, the number of people working in the agricultural sectors is still high, despite a gradual decrease during the last 10 years (Badan Pusat Statistik, 2016a).

Smallholding farmers characterize the majority of farm in Java. Even though Java is one of the regions that produce chilli, only a few farmers engaged with intensive chilli farming. Many farmers are still in subsistence and semisubsistence farming. Those farmers are expected to step up from subsistence to intensive and commercial agriculture. Chilli was selected because it is one of the high-valued crops. It is projected that smallholding farmers allocate a piece of land and other resources for cultivation of chilli to increase income and improve their wellbeing.

The next part of this section explains and justifies the importance of chilli farming as the motivation of this study. The next sections briefly review recent literature on vegetable production in developing countries and explain research methods and analytical procedures including the description of models and measurement of variables used in the analysis. Results and discussions are provided in the following section, and summary of findings and policy implications are formulated in the last part.

Chilli is one of the essential vegetable commodities in Indonesia. Because of the profitability of intensive chilli production, the potential exists for higher household income if more vegetable crops can be cultivated in intensive production. Crop intensification has been conducted since...
the Green Revolution (Mariyono, Kompas, & Grafton, 2010), which means that agrochemicals are used to reach the potential production (Mariyono, Kuntariningsih, & Kompas, 2018). Operating intensive chilli farming provides income, employment, and nutritional benefits to millions of smallholder farmers, rural labourers, and consumers. Along with rice as staple food (Timmer, 2014), a large part of the national production of chilli is consumed in a fresh form, as a majority of Indonesian people consume chilli in the daily meals.

Chilli production uses about 20% of the vegetable land and produces 12% of the total vegetable output, with a low average yield than other vegetables in general (White, Morey, Natawidjaja, & Morgan, 2007). Chilli crop acreage very sharply fluctuates year to year, depending on market price, the level of pest and disease attack, weather conditions, and several other factors. In 2015, it was cultivated on about 255,000 ha, with annual production of close to 1.9 million tonnes. Among the top five vegetables grown in Indonesia, chilli was the highest regarding cultivated area and production. Chilli also provided the highest share regarding vegetable sector values in Indonesia (Badan Pusat Statistik, 2016b). The productivity of chilli was about 7.5 tonnes/ha. By regional and international standards, the average productivity of chilli was low in Indonesia (Ali, 2006). It suggests that a considerable scope for technology including high-yielding cultivars and better management practices to increase production at a national level through enhancing productivity, and without encroaching on grain production areas.

Chilli provides a significant contribution to the local and national economy, and it has the potential to trigger inflation. With an increase in the rapidity of modern technology and innovations, adoption of intensive chilli farming is expected to give a substantial contribution to Indonesian rural economic development. However, the introduction of new technology is not always successfully adopted by farmers. It also reflects the low level of national productivity of chilli in Indonesia. Some of the constraints on enhancing adoption of chilli by ordinary farmers are like lack of credit, limited access to technological and market information, a small holding of farm size, lack of human capital, a chaotic supply of complementary inputs, and inappropriate transportation infrastructure.

2 | LITERATURE REVIEW

In the agribusiness sector, stepping up from subsistence to advanced farming is considered a way to reach prosperity. With the availability of technology and innovation in the industry, farmers can improve their welfare by adopting such technology and innovation. The adoption and widespread diffusion of agricultural technology and innovations are essential components for the progress of farming and rural development (Huang, Hu, van Meijl, & van Tongeren, 2004). Successful adoption of technology can be a dominant force in reducing poverty with more favourable outcomes on reducing poverty and rural development process (de Janvry & Sadoulet, 2002). Since the initiation of the Green Revolution in late 1960, intensive farming has been driven by adoption of new technology and innovation (Mariyono et al., 2010). It is considered as developmental impacts of agriculture. One of the most crucial factors of the effectiveness of such influence is the level of adoption of technology and innovation and on their profitability (Griliches, 1957).

Despite general acknowledgement of the central role of technical change and technology adoption in influencing economic growth, productivity, and competitiveness, there is a lack of understanding on actual path how socio-economic forces affect technical change in agriculture
A variety of factors can influence technical change, but its determinants and the actual process taking in a place are still a less understood topic in the literature of development economics. There are also some of the very widely discussed and debated public policy issues in the rural development sector.

Levels and types of agricultural supports given by government play an essential role in the development and adoption of new technology, which eventually impact on technological change, poverty alleviation, and rural development process. In fact, technological change in agriculture, or implementation of knowledge and adoption of technology and innovations, tends to be location specific, primarily affected by variation in local agroecological setting, economic forces, social and institutional settings, and public policies (Langyintuo & Mekuria, 2005).

With the absence of successful adoption and diffusion process, innovation or generation of new technologies become useless, and the agricultural sector virtually becomes stagnant. Therefore, adoption and diffusion of innovation of modern agricultural technology have attracted considerable attention among development economists for a long time. Majority population livelihoods in developing countries depend upon agriculture and because new and improved technologies would provide more opportunity to increase productivity and farm income substantially than the cases earlier. The literature on adoption and diffusion of agricultural technologies is very vast, especially for cereals and food crops, and related crop management practices in the tropics; this article does not attempt to provide a review with all of the literature here but only select studies closely related to the issues discussed in this study.

Since Griliches’s (1957) pioneering work on adoption of hybrid corn in the United States, the majority of the adoption studies have been conducted to answer one of the questions: What determines whether a particular producer adopts or rejects an innovation, or a new technology package (Ghadim & Pannell, 1999). In those studies, factors affecting the adoption of agricultural innovation group into socio-economic elements, farm characteristics, and policy factors. The factors affecting technology adoption in agriculture can be sorted into four major categories; They are technology-specific factors, farmers’ specific socio-economic factors, agroecology specific factors, and broader institutional and public policy factors.

Past studies have illustrated that farmers’ status related to wealth, formal education, farming size, and frequency of contacts with extension staff members are significant factors affecting the farmers’ decision to adopt or not adopt an agricultural technology and innovations in the context of development (see Doss, 2006; Feder et al., 1985). Some studies have also clearly demonstrated that the factors affecting adoption improved agricultural technology and management recommendations by poor farmers are not the same as for richer farmers to adopt; thus, farmers’ wealth level is a vital aspect of the technology adoption process in the developing countries. Capital in the form of either accumulated savings or access to capital markets is necessary to finance many new agricultural technologies (Sunding & Zilberman, 2001). Access to credit and decision to adopt the new agricultural innovation are positively associated (Ferdousi, 2015). Farmers are unable to revitalize the farm when they failed to access credit (Asmit & Koesrindartoto, 2015).

A complex set of factors affects the adoption and diffusion of agricultural technology, mainly social and cultural factors and communication methods involved in the technology adoption process. Rogers (1995) suggested that adoption of technology was dependent on some social and economic characteristics, for example, compatibility with the existing values and norms, complexity, observability, trial-ability, and relative advantages. These findings are relevant to technologies not only in the agricultural sector but also in a variety of disciplines. El-Osta and
Morehart (1999) identified adulthood of farm operator, farm size, and specialization as essential factors in the increased likelihood of technology adoption. Caswell, Lichtenberg, and Zilberman (1990) and Caswell, Fuglie, Ingram, Jans, and Kascak (2001) reported that high levels of farm operator education are likely to persuade the adoption of advanced technology management. Others say that lack of adequate inputs and up-to-date information may be complications to adoption (Feder & Slade, 1984). Doss (2006) and Sunding and Zilberman (2001) summarized sound syntheses of such literature on adoption of technology in agriculture.

Most of the past studies on the adoption of technology are relevant to cereal or food crop production in the case of developing countries, or technologies in the case of high-value crops in the context of developed nations. However, technology adoption in the vegetable sector in general and factors leading to the adoption of a particularly high-value vegetable versus alternative cereal crops have not been assessed rigorously in details. This study focuses on one of the strategic high-value vegetable commodities and factors affecting its engagement by agribusiness players.

3 | METHODOLOGY

3.1 | Theoretical framework

Based on a theory of production economics (see Pindyck & Rubinfeld, 2017), this study uses the concept of production transformation curve (PTC) as underlying analysis. The PTC is a curve depicting all maximum output possibilities for two goods, given a set of resources and other factors. The PTC assumes that all resources are used efficiently. Factors such as labour, capital, and technology will affect the resources available, which will dictate where the PTC lies. The shape of a PTC is commonly drawn as concave to the origin (at point O) to indicate increasing opportunity cost with increased output of a good. The concavity of the PTC to the origin is because the resources are not perfectly adaptable in the production of products; that is, the resources cannot be perfectly transferred between product one to others (Salvatore, 1996).

The slope of PTC at any point is called the marginal rate of transformation (MRT). It defines the rate at which production of one product can be redirected (by reallocating productive resources) into the production of the others. Thus, MRT increases in absolute value as one moves from the top left of the PTC to the bottom right of the PTC. A producer maximizes revenue by putting a position at any point of PTC when MRT equals the relative price of products.

Figure 1 shows a graphical representation of PTC, which describes the production of chilli on the horizontal axis and other crops on the vertical axis given a fixed set of resources and the state of the art in technology. A curve close to origin denotes an initial condition. At point A, all resources are not allocated to produce chilli, or the level of chilli production is zero. This point represents a corner solution, where the relative price of chilli over the price of other products is very low. In this case, the MRT is higher than the relative price at this point. Suppose the price of chilli increases such that the relative price of products increases and MRT moves to point B. The producer responds to the change in the price ratio by reallocating resources to produce more chilli until the MRT equals the new relative price. The mechanism for movement from point B to point C is the same as that for the movement from point A to point B. As the relative price is too high, the producer will only produce chilli at point D, where all resources are devoted to producing it. This point is another corner solution, where the relative price of the products is higher than MRT. This condition occurs when the price of chilli is high. In the form of proportion, chilli production at points A and D is 0% and 100%, respectively.
available resources, the decision of producer to produce chilli at any point between A and D follows the change in the relative price. Thus, the proportion is dependent on the relative price. The change in relative price is because price of other product changes while the price of chilli is constant; while the price of other products is constant, the price of chilli changes; or both prices change at a different rate.

Only points on or within a PTC are actually possible for the producer to achieve in the short run. In the long run, if the technology improves, the economy’s capacity to produce both products increases. Economic growth occurs if this potential is realized. The increase in the economy’s capacity is shown by a shift of the PTC to the right.

Now suppose an outward shift of the PTC from the initial position to a new curve further away from the origin. The new PTC results from technological progress due to enhanced knowledge and technology innovation of how to transform inputs into outputs. Suppose that the price ratio is kept unchanged at point C. The producer will respond the change by utilizing the correct proportion of available resources to produce chilli and other crops at point E. Because the new knowledge and technology innovation are purposively targeted for chilli farming, the percentage of chilli at point E is higher than that at point C. Thus, another factor affecting the percentage of chilli is an improvement in technology applicable to chilli farming.

Such a shift manifests an improvement in welfare, where the economy of the communities is already operating at its full productivity, which means that more of all outputs can now be produced during the specified period without forgoing the output of either product. The two main factors of the position of the PTC at any given time are the state of the art in technology and management expertise, which are reflected in the available production functions, and the available quantities of factors of production.

3.2 | Empirical model

This study focused on chilli farming in Java, because farming in Java is smallholding and still subsistence and semisubsistence. Primary data were collected at a farm level. Household
level information was collected via a survey using structured questionnaires, and group level qualitative data were collected from group discussion among farmers. The number of samples purposively selected using stratified random sampling was 220 farmer households conducted in 2013–2014.

A fundamental concept adopted in the study is the theory of cumulative causation proposed by Myrdal (1957). It is a multicausal approach where the core variables and their linkages are explained. The idea behind the theory is that a change in one form of a foundation will lead to consecutive changes in other establishments. The theory has been studied by Fujita (2007) and verified by Bartoletti, Cimoli, Pinna, and Zunino (2015) to show that the process of development in many countries followed an interrelationship. In Indonesia, the model has been used by Mariyanti and Mahfudz (2016) to explain a proper solution to the Indonesian style of poverty that previously remains unresolved. The model has been successful to show that many significant variables have impacted on poverty reduction.

Based on the theoretical framework, this study proposes that the proportion of resources allocated to intensive chilli farming by producers is an outcome of various responses from the market environment, resource endowment, and acquired knowledge and technology innovation. Thus, the proportion of land and other resources allocated to intensive chilli farming is the central variable. Farmers, directly and indirectly, respond to many factors through a process of cumulative causation. The stepping up to intensive farming leads to an increase in welfare. In this case, intensive farming and farmers’ welfare are considered endogenous variables. In economic theory, endogenous variables arise from interactions within the market exchange process. Intensive farming and welfare are stimulated by exogenous variables directly and indirectly through mediating variables, which include credit and technology. The mediating

![Proposed analytical model](https://ssrn.com/abstract=3402786)
TABLE 1 Description and measurement of selected variables of the sampled survey

| Variables                  | Definition                                                                 | Measurement unit | $M$ value | $SD$ value |
|----------------------------|---------------------------------------------------------------------------|------------------|-----------|------------|
| **Endogenous variables**   |                                                                           |                  |           |            |
| Farmers’ welfare$^a$       | Level of prosperity perceived by local societies, 1 = poor, 2 = fairly poor, 3 = medium, 4 = rich, 5 = very rich | Score            | 2.19      | 1.14       |
| Intensive farming         | Fraction of total land devoted to intensive chilli farming                | Percentage       | 23.83     | 24.17      |
| Technology                | Number of advanced farming technologies adopted by farmers                | Unit             | 0.89      | 1.08       |
| Credit access             | Whether farmers accessing credit for farming                               |                  | 0.21      | 0.41       |
| **Latent variables**       |                                                                           |                  |           |            |
| Household endowment       | Richness of farmers, constructed by family size, land size, land tenancy, and land fragmentation |                  |           |            |
| Farmers’ knowledge        | Competence of farmers’, constructed by age, education, experiences in general and specific farming, and training |                  |           |            |
| Age                       | Age of household head                                                     | Year             | 44.46     | 10.57      |
| Education                 | Time dedicated to acquire formal education                                | Year             | 7.63      | 2.81       |
| Farm experience           | Time devoted to undergo general farming                                   | Year             | 20.47     | 11.71      |
| Vegetable experience      | Time devoted to undertake vegetable farming                               | Year             | 10.71     | 9.85       |
| Chilli experience         | Time allocated to operate chilli farming                                   | Year             | 11.08     | 10.98      |
| Training                  | Number of training programmes attended by farmer                          | Times            | 2.18      | 1.38       |
| Family size               | Number of family members in a household                                   | Individual       | 4.11      | 1.26       |
| Land size                 | Area of cultivated lands                                                  | Hectare          | 0.55      | 0.41       |
| Tenancy                   | Fraction of land rented in by the farmer                                  | Percentage       | 31.81     | 41.32      |
| Parcels                   | Number of plots of land (fragmented land)                                 | Unit             | 2.75      | 1.80       |
| **Exogenous variables**   |                                                                           |                  |           |            |
| Telephone                 | Use of mobile phone in the agribusiness activities                        |                  | 0.30      | 0.46       |
| Marketplace               | The distance of market (or agribusiness station) to farm location          | km               | 4.89      | 3.73       |
| Traders                   | Number of traders contacted by farmers before harvesting                   | Individual       | 1.07      | 0.73       |
| Sources                   | Number of credit sources available to farmers                             | Unit             | 2.52      | 0.88       |

(Continues)
variables are also considered endogenous. The exogenous variables are independent of the market process. In this case, the exogenous variables are external factors, which consist of market information, marketplace, and supporting institutions given by the third party. Through a cumulative causation process, all variables interact directly and indirectly.

Based on the theoretical framework and the concept of cumulative causation, this study adopted and adjusted the concept of farmers’ decision to devote land and other resources to intensive chilli production. The endogenous interrelationship between the statistical variables to establish circular causation in the intensive chilli production can be expressed in Figure 2.

For that purpose, this study employed structural equation modelling (SEM) as an analytical tool. This tool is a compelling multivariate technique that measures direct and indirect effects and performs test models with multiple endogenous and latent variables and several regression equations simultaneously (Alavifar, Karimimalayer, & Anuar, 2012). SEM is preferable to usual methods because it reduces multicollinearity and attenuation bias (Tang & Folmer, 2016).

There were two latent variables called “farmers’ knowledge” and “households’ endowment.” Farmers’ knowledge was constructed by age, education, experiences, and training. Households’ endowment was constructed by family size, farming size, land tenancy, and land fragmentation. Endogenous variables in this study were credit access, technology adoption, intensive farming, and farmers’ welfare. Exogenous variables consisted of telephone, market information, marketplace, credit accessibility, number of credit sources and traders, farmers’ knowledge, and households’ endowment. There were direct and indirect influences from one variable to other variables. For example, households’ endowment affected farmers’ welfare directly and indirectly through the mediation of intensive farming.

A series of hypotheses were tested at least at a 90% confidence interval. The null hypothesis was that there is no effect of every path (represented by an arrow) on the corresponding variable. The alternative hypothesis was that the null hypothesis was false. The study employed STATA Ver. 13 to estimate the model (see StataCorp, 2013). The expected effect of each variable was presented in standardized value, to be a comparable one with another (Freedman, 2009).

Cross-sectional data were collected from three regions in Java in Indonesia, called west region consisting of West and Central Java, central areas comprising Central Java and Yogyakarta, and east region containing Central and East Java. Each surveyed region was a chilli production area and has a distinct variation of production characteristic of chilli farming in Java. This survey collected both secondary and primary data. Primary data were collected at the farm household level and the village level. Household level information was obtained using one-to-

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### TABLE 1 (Continued)

| Variables  | Definition                                                                 | Measurement unit | M value | SD  |
|-----------|---------------------------------------------------------------------------|------------------|---------|-----|
| Simplicity| Ease of accessing credit by farmers (1 = difficult, 5 = easy)              | Score            | 2.88    | 1.31|
| Market info| Access to market knowledge closely available to farmers                   | 1 = yes; 0 = no  | 0.50    | 0.50|

*Note. Total sample of household survey = 220. The standard deviation of the percentage of chilli acreage of the total sample is high because of high variation across sites. Because of this difficulty in getting the total wealth of households, this study took into account landholding, housing, and vehicles as a proxy of variable for the wealth status of a household. The wealth ranking used in this study can better capture the relative wealth status of all farmers in the farm communities.*
### TABLE 2  Validity test for measurement of latent variables

| Variables                          | Effect     | Robust SE | z value    |
|------------------------------------|------------|-----------|------------|
| Age < Rural farmers' knowledge     | 0.7453     | 0.0406    | 18.36***   |
| Constant                           | 4.2140     | 0.2073    | 20.33***   |
| Education < Rural farmers' knowledge | -0.3425   | 0.0580    | -5.91***   |
| Constant                           | 2.7270     | 0.1303    | 20.92***   |
| Farm experience < Rural farmers' knowledge | 0.9547   | 0.0354    | 26.98***   |
| Constant                           | 1.7514     | 0.0919    | 19.06***   |
| Vegetable experience < Rural farmers' knowledge | 0.4495   | 0.1007    | 4.47***    |
| Constant                           | 1.0893     | 0.0666    | 16.36***   |
| Chilli experience < Rural farmers' knowledge | 0.5926   | 0.0761    | 7.79***    |
| Constant                           | 1.0109     | 0.0525    | 19.24***   |
| Training < Households' endowment   | 0.0440     | 0.0705    | 0.62n      |
| Constant                           | 0.4642     | 0.0411    | 11.3***    |
| Family size < Households' endowment | 0.2636   | 0.0651    | 4.05***    |
| Constant                           | 3.2700     | 0.1756    | 18.62***   |
| Land size < Households' endowment  | 0.8661     | 0.0364    | 23.77***   |
| Constant                           | 1.3356     | 0.1379    | 9.68***    |
| Parcels < Households' endowment    | 0.7298     | 0.0447    | 16.32***   |
| Constant                           | 1.5329     | 0.0982    | 15.61***   |
| Tenancy < Households' endowment    | -0.1837    | 0.0742    | -2.47**    |
| Constant                           | 0.7718     | 0.0499    | 15.46***   |
| Number of observations             |            |           |            |
|                                    | 220        |           |            |
| $R^2$                              | 0.99       |           |            |
| Likelihood ratio test overall      | 1,443.53***|           |            |
| Log pseudo-likelihood              | -11,096.93 |           |            |

**Note.** < denotes “depends on.” n denotes insignificance.

Source: Author’s analysis.

***Significance level at 1%.

**Significance level at 5%.
one interviews with structured questionnaires. Group level qualitative data were collected from group discussion among farmers. Definition, measurement, and summary statistics of selected variables are shown in Table 1.

4 | RESULTS AND DISCUSSION

4.1 | Descriptive presentation of farmers characteristics

The description of farmers' characteristics in the study areas, on average, is presented in Table 1. In general, the relative wealth status of the farmers is classified as medium. Farmers were about 45 years old. Their education was low, as they underwent formal education up to junior high school only. They had been a farmer for about 20 years, of which about 10 years was spent cultivating vegetables, chilli in particular. They have participated in agricultural training about twice. Their household size was relatively small, which account for four family members. They were categorized as smallholder farmers because their farm size was less than 1 ha and about 32% of the land was rented. The land was fragmented in about three separated plots.

Of the total landholding, farmers devoted about 25% for intensive chilli farming. They adopted only one type of agronomic technology in chilli farming. About 21% of the total sample accessed credit from two to three credit providers. They perceived that access to credit available in the location was not too difficult. About 30% of farmers had utilized mobile phone regarding intensive chilli farming activities. They contacted at least one buyer/trader before harvesting chilli. Half of the total sample farmers accessed market information. The market for vegetables or agribusiness station was about 5 km away from the farm location. Each characteristic of household, farming, agribusiness activities, and wealth status could have an interrelation with others. The interlink is presented in the following SEM.

4.2 | Estimated structural equation modelling

Before discussing the primary results, it would be practical to see the measurement validity of latent variables, and fitting indicators, which are presented in Table 2.

The model provides significant results, which are indicated by high $R^2$ and likelihood ratio test for overall variables. The $R^2$ suggests that all paths of variables explained almost 100% of the model. All variables significantly constructed latent variables, except training that assembled farmers' knowledge. The insignificance of training could be the case because it was irrelevant to the chilli farming aspect. Mostly, farmers got training on general topics. A package of training special on vegetables has impacted vegetable productivity including chilli (Luther, Mariyono, Purnagunawan, Satriatna, & Siyaranamual, 2018). Education showed a significant negative sign, meaning that formally educated farmers led to lower knowledge of chilli farming. The negative impact of education is conceivable because of the higher risk aversion among more educated farmers. The phenomenon is similar to that of more experienced farmers in some cases (Feder & Savastano, 2017). Despite the importance of training and formal education in the real world, these factors were irrelevant to intensive chilli farming practices.

The estimated SEM is presented in Figure 3, showing that farmers’ welfare increased when they engaged with intensive farming by devoting more resources to intensive chilli farming. In this case, the resources could include land and other agricultural inputs to operate intensive chilli farming. The welfare was also substantially influenced by households’ endowment and
slightly affected farmers’ knowledge. In the rural and suburban areas of Java, landholding and education level contributed social status to farmers. The wealthy farmers in such areas usually hold large land and high education level.

Further, farmers engaged in intensive commercial farming because of many factors. Factor endowment discouraged farmers from doing so. It was a logical phenomenon because farmers with high endowment were already prosperous in relation to the amount of land and parcels. It indicates that farmers with a few land would devote more resources to improve their welfare. Significant negative signs of households’ endowment to tenancy and intensive farming suggest that farmers operated intensive agriculture on a high proportion of leased land. Landless farmers rented the lands for chilli farming to improve their prosperity. In high-value crops, farmers rented in fertile lands. However, this is not the case for rice farming, in which farmers leased parcels of land that were usually less fertile. This type of land tenancy leads to inefficient agriculture. Jamal and Dewi (2009) showed that share tenancy, which was common in Java, caused less efficient farming. There is a positive association between land ownership and productivity (Deb, Pramanik, Khan, & Bantilan, 2015). The productivity of farming on different status of land matters (Iheke & Chikezie, 2016).

Farmers’ knowledge, represented by adulthood and experiences in any farming, stimulated them to engage in intensive farming. Credit access and technology adoption played a substantial role in encouraging farmers to engage in agribusiness of chilli. Credit and technology should be available at the same time. Credit was used as operating capital in intensive farming, which was commonly higher than the conventional one. Adoption of improved technology led to high production and eventually increased welfare. The distance of marketplace, or agribusiness station, to farm location also contributed an important role. The closer the marketplace is to farming, the more likely are farmers going to engage in the chilli-based agribusiness. It is very sensible
because farmers should sell the product in a fresh form. Chilli is perishable, and thus long delay
in the transportation will reduce the quality of chilli. Traders or customers determined farmers’
tention to engage in intensive farming. The timely availability of traders ensured that the
product is marketable. Engagement in agribusiness of chilli was indirectly influenced by market
information and the use of the telephone through the mediation of technology and credit. The
role of the telephone was indirectly significant via the mediation of farmers’ access to credit and
technology adoption, which was also dependent on other exogenous factors. Sources of credit
and simplicity of accessing credit gave a vital function. Farmers would be encouraged to utilize

TABLE 3  Estimated structural equation modelling

| Variables          | Effect | Robust SE | z value |
|--------------------|--------|-----------|---------|
| Farmers’ welfare <-|        |           |         |
| Constant           | 1.4012 | 0.1007    | 13.91***|
| Intensive farming  | 0.5226 | 0.0598    | 8.73*** |
| Farmers’ knowledge | 0.0899 | 0.0536    | 1.68*   |
| Households’ endowment | 0.6693 | 0.0811    | 8.25*** |
| Intensive farming <-|       |           |         |
| Constant           | 0.4225 | 0.1358    | 3.11*** |
| Technology         | 0.1569 | 0.0560    | 2.80*** |
| Credit             | 0.2411 | 0.0630    | 3.83*** |
| Marketplace        | −0.1267| 0.0514    | −2.47** |
| Traders            | 0.3321 | 0.0544    | 6.10*** |
| Farmers’ knowledge | 0.0001 | 0.0000    | 14.37***|
| Households’ endowment | −0.3579| 0.0537    | −6.67***|
| Credit <-          |        |           |         |
| Constant           | −2.0142| 0.0715    | −28.15***|
| Mobile phone       | 0.1130 | 0.0265    | 4.27*** |
| Simplicity         | 0.4744 | 0.0764    | 6.21*** |
| Sources            | 0.4938 | 0.0794    | 6.22*** |
| Technology <-      |        |           |         |
| Constant           | 0.5946 | 0.0833    | 7.14*** |
| Market info        | 0.0799 | 0.0679    | 1.18n   |
| Mobile phone       | 0.2343 | 0.0702    | 3.34*** |

Number of observations 220

$R^2$ 0.99

Likelihood ratio test 1,443.53***

Log pseudo-likelihood $−11,096.93$

Note. <- denotes “depends on.” n denotes insignificance.

Source: Author’s analysis.

***Significance level at 1%.
**Significance level at 5%.
*Significance level at 10%.
| Variables                  | Effect  | Robust SE | z value | Standardized |
|---------------------------|---------|-----------|---------|--------------|
| **Indirect effects**      |         |           |         |              |
| Farmers’ welfare ←       |         |           |         |              |
| Technology                | 0.0863  | 0.0320    | 2.70*** | 0.0820       |
| Credit                    | 0.3514  | 0.0875    | 4.02*** | 0.1260       |
| Marketplace               | −0.0202 | 0.0082    | −2.45** | −0.0662      |
| Market info               | 0.0149  | 0.0134    | 1.10n   | 0.0065       |
| Telephone                 | 0.0831  | 0.0261    | 3.19*** | 0.0334       |
| Simplicity                | 0.0518  | 0.0161    | 3.23*** | 0.0598       |
| Sources                   | 0.0801  | 0.0241    | 3.32*** | 0.0622       |
| Traders                   | 0.2728  | 0.0619    | 4.41*** | 0.1736       |
| Farmers’ knowledge        | 0.0251  | 0.0028    | 8.84*** | 0.0000       |
| Households’ endowment     | −0.2795 | 0.0612    | −4.57***| −0.1871      |
| **Intensive farming ←**   |         |           |         |              |
| Market info               | 0.5926  | 0.5354    | 1.11n   | 0.0125       |
| Telephone                 | 3.3173  | 1.0041    | 3.30*** | 0.0640       |
| Simplicity                | 2.0671  | 0.6326    | 3.27*** | 0.1144       |
| Sources                   | 3.1948  | 0.9175    | 3.48*** | 0.1191       |
| **Total effects**         |         |           |         |              |
| Farmers’ welfare ←       |         |           |         |              |
| Intensive farming         | 0.0251  | 0.0028    | 8.84*** | 0.5226       |
| Technology                | 0.0863  | 0.0320    | 2.70*** | 0.0820       |
| Credit                    | 0.3514  | 0.0875    | 4.02*** | 0.1260       |
| Marketplace               | −0.0202 | 0.0082    | −2.45** | −0.0662      |
| Market info               | 0.0149  | 0.0134    | 1.10n   | 0.0065       |
| Telephone                 | 0.0831  | 0.0261    | 3.19*** | 0.0334       |
| Simplicity                | 0.0518  | 0.0161    | 3.23*** | 0.0598       |
| Sources                   | 0.0801  | 0.0241    | 3.32*** | 0.0622       |
| Traders                   | 0.2728  | 0.0619    | 4.41*** | 0.1736       |
| Farmers’ knowledge        | 55.8437 | 33.6539   | 1.66*   | 0.0900       |
| Households’ endowment     | 0.7205  | 0.0612    | 11.78***| 0.4822       |
| Intensive farming ←       |         |           |         |              |
| Technology                | 3.4438  | 1.2756    | 2.70*** | 0.1569       |
| Marketplace               | −0.8051 | 0.3214    | −2.51** | −0.1267      |
| Market info               | 0.5926  | 0.5354    | 1.11n   | 0.0125       |
| Telephone                 | 3.3173  | 1.0041    | 3.30*** | 0.0640       |
| Simplicity                | 2.0671  | 0.6326    | 3.27*** | 0.1144       |
| Sources                   | 3.1948  | 0.9175    | 3.48*** | 0.1191       |

(Continues)
credit when many credit providers were locally available, and the bureaucracy of obtaining credit was straightforward. The magnitudes and significances of estimated variables are presented in Table 3.

Engagement in chilli-based agribusiness significantly improved farmers' welfare. The agribusiness provided higher income than did other cereal crops (Weinberger & Lumpkin, 2007). Farmers perceived that profit generated by intensive chilli farming was about four times higher than that by rice farming. The highest positive effects on chilli-based agribusiness came from farmers' access to credit, technology adoption, and availability of customers.

Conversely, the highest negative influences came from farmers' endowment and marketplace. Credit access was hugely affected by the number of credit sources and bureaucratic process of credit. When the credit indirectly improves farmers' welfare through mediations of other variables, it plays a role as a catalytic agent. The use of the telephone influenced technology adoption.

Each variable could have direct and indirect effects resulting in a total impact on other variables. The immediate effects were the same as those reported earlier in Table 3. The estimated indirect and total effects of each variable are presented in Table 4.

Indirectly, welfare was highly triggered by credit access and traders; and at the same time, it was highly obstructed by the endowment. This particular finding showed that farmers who were already wealthy tended to allocate fewer resources to agribusiness than did those who were relatively poor.

Conversely, the poor farmers allocated more resources to agribusiness via technology adoption and accessing credit to improve their welfare. The availability of customers in the market encouraged farmers to intensify their farming. Poor farmers also leased lands to operate intensive agriculture. Allocation of resources for the intensive crop cultivation was greatly stimulated by the straightforward procedure of credit access and number credit sources. These indirect

### Table 4 (Continued)

| Variables         | Effect  | Robust SE | z value | Standardized |
|-------------------|---------|-----------|---------|--------------|
| Traders           | 10.8870 | 1.9765    | 5.51*** | 0.3321       |
| Farmers' knowledge| 1.0000  | (Constrained) |  | 0.0001       |
| Households' endowment | −11.1542 | 2.2371    | −4.99*** | −0.3579      |
| Credit <-         |         |           |         |              |
| Telephone         | 0.1007  | 0.0229    | 4.39*** | 0.1130       |
| Simplicity        | 0.1474  | 0.0234    | 6.29*** | 0.4744       |
| Sources           | 0.2278  | 0.0385    | 5.92*** | 0.4938       |
| Technology <-     |         |           |         |              |
| Market info       | 0.1721  | 0.1463    | 1.18n   | 0.0799       |
| Telephone         | 0.5532  | 0.1672    | 3.31*** | 0.2343       |

Note. <- denotes “depends on.” n denotes insignificance.

Source: Author's analysis.

***Significance level at 1% .

**Significance level at 5%.

*Significance level at 10%.
effects on chilli-based agribusiness were through the mediation of access to credit, as well as through technology adoption.

The outcomes of direct and indirect forces were total effects. In total, the essential factors determining farmers’ welfare were agribusiness activities, in which farmers operated intensive chilli farming. Agribusiness itself was simultaneously stimulated by credit access and technology adoption. Thus, the important factors determining credit access and technology adoption became essential in improving farmers’ welfare. In this study, such factors included the simplicity of credit access, the number of credit sources, marketplace close to agribusiness locations, and use of the telephone.

4.3 | Motives of farmers to grow chilli

The results of estimated SEM fitted farmers’ motivations to engage in chilli agribusiness, as presented in Figure 4.

Farmers reported that economic motive was the main driver affecting the farmers’ decision to engage in chilli agribusiness. Other reasons were agro-climatic conditions, possession of suitable land, and suitable microclimate and soil fertility. Noorhadi and Sudadi (2003) reported similar factors in vegetable farming in Indonesia. Other reasons, such as good fit with the local cropping patterns, were less critical than others. Regarding the technology introduced to farmers, a wise decision needs to be considered in selecting environmentally friendly farming. A recent study by Mariyono, Kuntariningsih, Suswati, and Kompas (2018) shows that chilli farming has excessively applied agrochemicals and led to environmental problems.

5 | CONCLUSIONS AND POLICY IMPLICATIONS

Agribusiness of chilli could provide more income and employment than could other crops when it was operated intensively. However, intensive chilli agribusiness has primarily been done by only a small fraction of farmers. Many smallholding farmers are still poor and subsistence or

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1The weighted average rank is formulated as $R = \frac{1}{N} \sum (n^2 S)$, where $n$ is the number of farmers responding to each category, $N$ is the total sample, and $S$ is a score, in which the higher score, the more important it is.
semisubsistence. There were some significant socio-economic as well as other higher order factors affecting the extents of land and other resources allocated to chilli farming. Stepping up from subsistence or semisubsistence to intensive agriculture with high-valued crops provides hope for welfare improvement. With the use of a SEM approach, the direct impact of engagement in agribusiness of chilli on farmers’ welfare and the impacts of some of these factors on farmers’ decision to engage in agribusiness were determined. These factors could provide direct and indirect impacts through the mediation of other factors.

The results show that devoting more resources to operating intensive chilli farming has enhanced farmers' welfare. Internal and external factors affected farmers' decision to devote more resource for chilli agribusiness both directly and indirectly. Internal factors consisted of household endowment and knowledge. Households' endowment, which represented the current position of richness, lowered the decision; however, households' knowledge, which represented human capital, raised the decision. Farmers with low endowment were possible to engage in intensive farming by leasing land from others. The farmers could select fertile land for operating agribusiness in chilli. External factors such as traders, credit, technology, and market information also played significant roles in boosting farmers to engage in chilli agribusiness. Credit functioned to finance operating capital of the farming, and the technology improved the efficiency of chilli production. Credit access provided the highest positive impact; in contrast, households' endowment gave the highest negative impact. Encouraging farmers to engage in profitable chilli agribusiness, credit access, and technology should be readily available and accessible to ordinary farmers.

Policy implications concerning this finding need adequate formulations such that farmers’ welfare will increase. In this case, worse-off farmers should be the primary target because they would respond much to allocate more resources for intensive chilli agribusiness. A strong recommendation to the policy-makers (government) is to reform marketing system and price regulation related to chilli and other horticultural products. So far, the price of chilli is very volatile, and it provides adverse impacts on both consumers and chilli farmers. One of the potential sources of price volatility is the absence of government regulation applied to horticultural products including chilli. Horticultural price is floating and dependent on the market supply and demand. As chilli is a strategic commodity that contributes to economic inflation in the country, the price regulation will guarantee farmers’ expectation on chilli price both during peak season and off-season. The government should also establish agribusiness terminals and marketing infrastructure in many potential chilli-producing regions to increase market efficiency, which means that the harvest during peak season can be absorbed and distributed evenly to other marketing regions. In the long run, the existence of agribusiness stations near production centres enables farmers to sell their produce promptly. Market failure, or inability of the existing market in clearing the seasonal production of chilli, is the major cause of the very low price of chilli. As chilli is perishable, if the current agribusiness stations fail in clearing the product, the unsold chilli will perish in the market. Thus, postharvest handling facilities should also be provided.

Soft loan or microcredit should be accessible and locally available. The bureaucratic process in accessing credit also should be straightforward. One of the factors that discourage farmers from accessing soft load is the collateral required by credit providers. Local governments need to provide a guarantee to convince the credit providers that farmers will make timely repayment of their credit. In case farming fails, there is a flexibility of repayment in the coming growing season; even when there is a disaster, the government repays the credit for farmers. The comfortable, flexible access to microcredit enables farmers to adopt a technology, and the
technology is expected to reduce the seasonality of chilli production. Currently, off-season agro-
nomic technology applicable to chilli has been available. Reduction in seasonality of chilli pro-
duction leads to less volatile prices. The ultimate impact of such policies will ensure that
farmers grow chilli and increase farmers’ welfare.

Better targeting of agricultural research on resource-poor producers might be the primary
vehicle for maximizing direct poverty-alleviating effects. In the context of the limited literature
that explains farmers’ behaviour in the engagement of intensive vegetable farming for agribusi-
ness sector, the finding from this study would likely to contribute to better planning and
targeting vegetable sector research and development activities in Indonesia, and tropical Asia
in general.

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