Aceh farmer’s acceptance of agricultural technology

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Abstract. The use of technology in rice farming is urgently needed by farmers to increase productivity and increase business efficiency. The characteristics of technological innovation consisting of relative advantages, compatibility, trialability, and adoption can influence farmers’ attitudes to adopt technology. Some technological innovations used by farmers using a machine combining harvesters, tractors, Ciherang-type superior seeds, and planting. The purpose of this research is to conduct a consistent constitutional trial of various technological innovation variables and public acceptance of the technology being introduced. This research was conducted in Aceh Besar and Pidie Jaya districts using the Confirmatory Factor Analysis (CFA) analysis model and descriptive analysis. The final results of this study are expected so that the government can adopt policies that are appropriate to the needs of technology in agriculture that can be accepted by the community.

1. Introduction

Food plants are strategic and important commodities because food is a primary human need and access to food is a basic human right for each Indonesian citizen. One of the top commodities in Indonesia is rice [1]. Farmers are very important in agricultural development and are the primary actors in agriculture production [2]. One of the absolute prerequisites for agricultural development is innovative technological development amidst the ever-changing farming industry [3]. Therefore, farmers require innovative new technology in lowland rice farming to potentially increase productivity, increase business efficiency, and increase farmers’ income.

There have already been several technological innovations in rice farming including combine harvesters, tractors, improved irrigation strategies, and use of superior seeds. According to Rogers [4], new technology usage typically occurs through a five-stage process, namely: awareness, interest, evaluation, trial, and adoption. One of the most important stages in the process of adopting an innovative technology is the stage of persuasion or attitude formation. The speed of innovative technology adoption is very dependent on farmers' perceptions of the technology. Farmers have different perceptions of each existing technology and innovation, as the characteristics of the technology and innovation can influence farmers' attitudes around the technology.

In the book Diffusion of Innovations [4], Rogers distinguishes between and tries to study the characteristics of adopters, as well as the innovation properties that affect the rate of adoption. He developed a classification scheme that describes the perceived attributes of innovation. Five different attributes were proposed; 1) relative advantage, the degree to which innovation is perceived as better than an idea (or practice); 2) compatibility, the degree to which an innovation is deemed consistent with
existing values, past experiences, and potential adoption needs; 3) complexity, the extent to which an innovation can be understood, 4) the ability to experiment, namely the extent to which an innovation can be tested by observing it; 5) observation, that is, innovation can be observed and understood.

Not all farmers as agricultural business actors immediately accept a new technology. This could be due to the absence of introduction to the use of this technology from related parties such as agricultural extension agents or the agricultural office. Additionally, the lack of knowledge possessed by farmers due to low education rates also hampers technology adoption. This is problematic because innovations in farming can lead to significant benefits — particularly in rice farming — such as faster land processing time through tractors, expedited harvest time through combine harvester machines compared to human labor, and improved farmer’s welfare. Therefore, this study aims to measure the constructs and characteristics of technological innovation variables and to study public acceptance of the introduced technology.

2. Materials and methods

2.1. Research sites and sample

This research was conducted in the Aceh Besar District, Aceh Tengah District, and Pidie Jaya Regency. The location selection for this study was based on regional data based on superior commodities in Aceh Province which was calculated using the Location Quotient (LQ) method. The population in this study were rice farmers in Aceh Besar District, Central Aceh Regency, and Pidie Jaya Regency. Sampling was conducted using the Quota Sampling technique, which determines the number of samples based on certain characteristics [5].

Data analysis in this study used Confirmatory Factor Analysis (CFA) to see consistent results of construct testing against various characteristics of technological innovation variables. Meanwhile, descriptive analysis is used to see how farmers accept technological characteristics which can be divided into 5 categories; application of equipment (tractor and combine harvester), application of environment (irrigation), application of production and processing systems (superior seeds of the Ciherang brand), application of buildings, and security of the production products.

3. Results and discussion

Indonesian people are still largely dependent on rice for daily food intake, and the higher the population growth will increase the national demand for rice in coming years. Based on the results of Ilham’s study [6] various efforts have been made to meet the national demand for rice. Government helps with several efforts including programs for farmers related to agricultural diversification, preventing the rate of conversion, discovering new technologies, printing new rice fields, and optimizing the adoption and diffusion of technologies that have been developed. The last two efforts are related to increasing rice productivity. This is also corroborated by Fagi et al. [7] regarding the increase in rice productivity which is closely related to the use of seeds from superior varieties. The successful use of superior varieties must also be supported by adequate water irrigation and fertilizers. The three interactions contributed up to 75 percent to the rate of increase in rice production.
Table 1. The use of pre-harvest-post-harvest technology for rice farming.

| Type of Technology       | Aceh Besar | Pidie Jaya | Aceh Tengah |
|-------------------------|------------|------------|-------------|
| Tractor                 | 21         | 29         | 17          |
| Combine Harvester       | 10         | 33         | 0           |
| Irrigation              | 14         | 25         | 0           |
| Ciherang superior seeds | 16         | 13         | 3           |

Based on the research results, the use of technology such as tractors, combine harvesters, irrigation systems, and Ciherang high-yielding seeds have been implemented by rice farmers in Aceh. However, there are several reasons why some rice farmers in Aceh Tengah District do not use combine harvesters, for instance if the farmers’ rice fields are not large enough to use a combine harvester during harvest time. The irrigation system in Aceh Tengah District is also different from the other two districts, farmers do not use irrigation because the sloping rice fields and lack of water sources force farmers to plant rain-fed rice. This results in a longer rice harvest time compared to other regions.

According to Adriani et al., [8] there are two main drivers of successful agricultural technology in developing countries. The first is the availability and affordability of technology and second is the farmers’ expectations that adoption will continue to reap benefits which determines the extent to which farmers are risk averse. There are a number of factors that drive the above expectations, ranging from the availability and size of land, family labor, prices, and profitability of agricultural enterprises.

The spread of modern agricultural equipment as a means of technological integration has been accompanied by intensification of agriculture and other rural economic practices but has also been accompanied, in many cases, by some workers, especially agricultural workers, leaving rural areas and looking for work in urban areas [9]. So, one of the main drawbacks of switching to mechanical agriculture is the loss of local jobs.

3.1. Characteristics of technological innovation

According to Rogers [10], there are five characteristics of innovation which will be discussed below. Relative advantage. The degree to which an innovation is considered better than the innovation it replaces. If the new technology provides some kind of increase in effectiveness or efficiency, it tends to be adopted faster. The relative advantages of adopting an innovation can be expressed in terms of economic benefits, social prestige, reduced inconvenience, lower investment costs, savings in time and power, and other rewards or benefits.

Compatibility. An innovation is considered consistent with existing values, past experiences, and technology has to match where the technology is being used. It is hoped that the technological innovation that appears is a continuation of old technological values. Technology must be in accordance with its users’ values and ideologies, as technology has a socio-cultural linkage. Complexity. This is the degree to which an innovation is deemed difficult to understand and use. The more complex an innovation is, the more difficult it will be to adopt. Trialability is the degree to which an innovation can be tested prior to adoption. New ideas that can be tested can be adopted more quickly. Observability. This is the degree to which the results of an innovation can be observed by others. If the innovation has a high level of observability, it will be relatively easy to learn about the innovation and assess the potential benefits.
Based on table 2, the characteristics of technological innovation are; relative advantage, complexity, and divisibility are of significant value. The use of tractors has an effect on rice farming activities such as increasing farmer income, increasing production, and shorter time to cultivate the land. Characteristics of the complexity of the innovation of tractor use also show that with tractors, farming activities are made easier, as well as the role of agricultural extension workers to make rice farmers more familiar with tractors and understand how to use tractors so that with assistance and socialization from extension workers, farmers can benefit from using them tractors both in terms of time and finances.

Table 3. Characteristics of combine harvester technology innovation.

| Estimate  | S.E.  | C.R.  | P     | Label |
|-----------|------|-------|-------|-------|
| Rel4 ← Relative Advantage | 1.071 | .258  | 4.148 | *** Significant |
| Rel3 ← Relative Advantage | 1.338 | .316  | 4.230 | *** Significant |
| Rel1 ← Relative Advantage | 1.000 |       |       |       |
| Complex4 ← Complexity | 1.033 | .298  | 3.471 | *** Significant |
| Complex3 ← Complexity | .743  | .271  | 2.747 | .006  |
| Complex2 ← Complexity | .495  | .237  | 2.085 | .037  |
| Complex1 ← Complexity | 1.000 |       |       |       |

The combine harvester technology is a modern harvester that is used to harvest cereal crops, because it is capable of cutting, threshing, drying grain, and breaking straw in one operation. The machine is equipped with cutting tools, a threshers, and rice milling [11].

Based on table 3, the significant characteristics of technological innovation regarding harvesters are relative advantage and complexity. The use of a combine harvester has a direct positive relationship rice to farmer’s production capabilities which affects farmers’ income, and makes harvesting faster and easier. In addition, the use of this combine harvester is not difficult for farmers because it is operated by skilled workers. Typically, a combine harvester is owned by a third party who rents out the machine along with labor to help with the harvesting process.
Another consequence of this modern harvester is that it that many communities around agricultural areas have lost their jobs as harvesters. During the farmer interview portion of this study, it was discovered that most of the workers who had previously worked as day laborers for farmers had switched their livelihoods or gone to other areas to look for jobs. This resulted in a loss of livelihood for some who were accustomed to working within the traditional harvest system.

Table 4. Characteristics of superior seed technology innovation of Ciherang brand.

|                      | Estimate | S.E.  | C.R.  | P       | Label    |
|----------------------|----------|-------|-------|---------|----------|
| Rel4 ← Relative Advantage | 1.159    | .265  | 4.373 | ***     | Significant |
| Rel3 ← Relative Advantage | -1.395   | .366  | -3.813| ***     | Significant |
| Rel2 ← Relative Advantage | 1.299    | .326  | 3.985 | ***     | Significant |
| Rel1 ← Relative Advantage | 1.000    |       |       |         |           |
| Comp3 ← Compatibility | 2.183    | 1.206 | 1.811 | .070    |           |
| Comp2 ← Compatibility | 1.893    | 1.085 | 1.746 | .081    |           |
| Comp1 ← Compatibility | 1.000    |       |       |         |           |
| Complex4 ← Complexity | 1.617    | .426  | 3.799 | ***     | Significant |
| Complex3 ← Complexity | 1.996    | .502  | 3.977 | ***     | Significant |
| Complex2 ← Complexity | 2.096    | .474  | 4.425 | ***     | Significant |
| Complex1 ← Complexity | 1.000    |       |       |         |           |
| Trial3 ← Trialability | 7.979    | 13.268| .601  | .548    |           |
| Trial2 ← Trialability | 7.549    | 12.562| .601  | .548    |           |
| Trial1 ← Trialability | 1.000    |       |       |         |           |
| Div4 ← Divisibility  | -1.243   | .413  | -3.007| .003    | Significant |
| Div3 ← Divisibility  | -1.529   | .437  | -3.500| ***     | Significant |
| Div2 ← Divisibility  | .903     | .356  | 2.533 | .011    |           |
| Div1 ← Divisibility  | 1.000    |       |       |         |           |

Based on Table 4, the significant characteristics of technological innovation are relative advantage, complexity, and divisibility for superior seeds from the Ciherang brand. This is also supported by research conducted by Siata [12] related to the use of superior seeds which can increase yield by 15% compared to the use of uncertified seeds. One of the most widely used rice seeds is from the Ciherang brand. The popularity of Ciherang rice seeds is influenced by the farmers' seeds and rice taste preferences. The taste of rice produced by Ciherang seeds is favored by farmers. Ciherang variety of rice seeds produce fluffier, cleaner, and odorless rice.

Another factor that affects farmers in the utilization of Ciherang rice seeds is the production factor. The higher the production value produced by farmers when using Ciherang superior varieties of rice seeds, the more willing the farmers are to using it. In the application of Ciherang variety rice seeds, the factor of land area owned by farmers also affects farmers in using versus not using Ciherang variety rice seeds, because the more land the farmers have, the more willing the farmers are to adopt technology such as superior Ciherang seeds to increase their farming capabilities.
Table 5. Characteristics of irrigation technology innovation.

| Label               | Estimate | S.E.  | C.R.  | P    | Label       |
|---------------------|----------|-------|-------|------|-------------|
| Comp2 ← Compatibility | 1.196    | .449  | 2.665 | .008 |             |
| Comp1 ← Compatibility | 1.000    |       |       |      |             |
| Complex3 ← Complexity | 1.134    | .312  | 3.630 | ***  | Significant |
| Complex2 ← Complexity | 1.278    | .361  | 3.538 | ***  | Significant |
| Complex1 ← Complexity | 1.000    |       |       |      |             |
| Div3 ← Divisibility   | -.704    | .317  | -2.222| .026 |             |
| Div2 ← Divisibility   | 1.216    | .514  | 2.367 | .018 |             |
| Div1 ← Divisibility   | 1.000    |       |       |      |             |

Based on Table 5, the characteristics of technological innovation for irrigation are only significant regarding complexity. This means that according to farmers, current irrigation systems are considered sufficient to provide economic benefits. Additionally, farmers do not need a long time to understand the function and implementation of current irrigation channels. This irrigation can only be found in Aceh Besar and Pidie Jaya districts, rice farmers in Central Aceh district use a rainfed system for their rice farming. Research in Ethiopia comparing the technical efficiency of farmers relying on irrigation systems versus rain-fed agricultural production found that there is a positive effect of irrigation on the technical efficiency of agriculture, and households participating in irrigation practices, which have increased technical efficiency of 8.92%, compared to households do not participate in irrigation practices [13, 14].

3.2. Farmers acceptance assessment of technology characteristics
The following graph illustrates the farmers' assessment of the characteristics of the technology they have used, either through government assistance or from farmer initiatives.

![Figure 1. Assessment of farmer acceptance of technology characteristics.](image)

Figure 1 shows that the technology related to the application of product security and building applications has not been used by the respondent rice farmers. The technology that has been most widely used by Acehnese farmers is technology related to the application of production and processing systems, environmental applications, and equipment applications. Farmers' assessment of this technology is very positive. In general, farmers feel the characteristics of technological innovation which consist of relative advantage, suitability, testability, and observability, and complexity.

In every technology adoption process, colleagues exert considerable influence. For example individuals benefit from acting like friends and neighbors and often acquire technological knowledge of
from colleagues about the drawbacks and benefits. Additionally, individuals learn how to use new approaches from their peers. This is consistent with the results of interviews with farmers who stated that they were first introduced to new technology from fellow farmers or from agricultural extension workers.

Research from Adriani et al., [8] also shows the positive impact of agricultural technological innovation to decrease the allocation of working time, to reduce unemployment, and increase the income and welfare of farm households.

4. Conclusions
From the research results it can be concluded that:

1. The significant characteristics of technological innovation for tractors and superior seeds of the Ciherang brand are relative advantage, complexity, and divisibility. Meanwhile, the characteristics of the Combine Harvester technology innovation that have significant value are relative advantage and complexity, while the characteristics of irrigation technology innovation only have significant value on the complexity factor.

2. The assessment of farmers' acceptance of the characteristics of technology related to the application of product security and the application of buildings has not been used by the respondent rice farmers. The technology that has been widely used by Acehnese farmers is technology related to the application of production and processing systems, environmental applications, and equipment applications.

References
[1] Swastika D K, Wargiono J, Soejitno and Hasanuddin A 2007 Analisis Kebijakan Peningkatan Produksi Padi Melalui Efisiensi Pemanfaatan Lahan Sawah di Indonesia J Anal Kebijak Pertan. 5 36–52
[2] Fatchiya A, Amanah S, and Kusumastuti Y I 2016 Penerapan Inovasi Teknologi Pertanian dan Hubungannya dengan Ketahanan Pangan Rumah Tangga Petani. J Penyul. 12 190-197
[3] Mosher A T 1983 Menggerakkan dan Membangun Petani (Jakarta: Yayasan Guna)
[4] Rogers E M 2003 Diffusion of Innovations Fourth Edition (New York: The Free Press)
[5] Sugiyono 2012 Metode Penelitian Kuantitatif dan R&D (Bandung: Alfabet)
[6] Ilham N 2008 Profil Teknologi Pada Usahatani Padi dan Implikasinya Terhadap Peran Peran Pemerintah. Anal Kebijak Pertan. 6 335–351
[7] Fagi A, Abdullah B and Kartaatmajja S 2001 Peranan Padi Indonesia dalam Pengembangan Padi Unggul Prosiding Budaya Padi (Bogor: Pusat Penelitian dan Pengembangan Tanaman Pangan)
[8] Adriani D, Zahri I, Wildayana E, Maryadi, Hamzah M and Yulius 2018 Farmer’s welfare in Telang’s integrated independent city: Lesson learned from migrant and local farmers in tidal land, South Sumatera. IOP Conf Ser Earth Environ Sci. 122 1-6
[9] Biggs S, Justice S 2015 Rural and Agricultural Mechanization: A History of the Spread of Small Engines in Selected Asian Countries. IFPRI Discuss Pap. 01443 1-44
[10] Rogers E M 2003 Diffusion of Innovations. Fifth Edit (New York: Free Press)
[11] Malayu H 1999 Organisasi & Motivasi. Dasar Peningkatan Produktivitas (Jakarta: BumiAksara)
[12] Siatia R 2016 Faktor-Faktor Yang Mempengaruhi Petani Dalam Penerapan Benih Padi Varietas Ciherang Di Desa Pudak Kecamatan Kumpah Ulu. Sosiohumaniora. 18 240–247
[13] Yuya B A 2014 Comparative analysis of technical efficiency of smallholder irrigated and rain-fed farm production: The case of Girawa District, Oromia, Ethiopia. J Agric Econ. 2 54–62
[14] Agussabti, Rahmadiansyah, Satriyo P, Munawar AA 2020 Data analysis on near infrared spectroscopy as a part of technology adoption for cocoa farmer in Aceh Province, Indonesia. Data Br. Apr 1;29