The decision in adopting the legowo super planting system on maize in Tonasa Village, South Sulawesi, Indonesia

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Abstract. Demand for maize is increasing as the population and food industry increase in Indonesia. The Agency for Agricultural Research and Development of Indonesia has recommended legowo super planting system on maize to improve productivity. This research aims to identify factors that affect farmers' decision to adopt legowo super planting system and to know the relationship between the factors affecting decision making with the decision to adopt the legowo super planting system. Multiple linear regression analysis is used to determine factors that affect adoption. Rank Spearman Correlation test (rs) is used to examine the relationship between the factors that influence decisions with farmers' decisions in adopting the legowo super technology. The sample in this study were 40 maize farmers in Tonasa Village, Takalar Regency, South Sulawesi, Indonesia. The results found that factors influencing the farmers' decision to adopt legowo super planting system on maize in Tonasa Village are the farm size and the relative advantage of the innovation, while the relative advantages, compatibility, trialability, observability, and communication networks have a relationship with farmers' decisions in the adoption of legowo super planting system on maize in Tonasa Village.

1. Introduction
Agriculture still offers a prominent source of livelihood and contributes greatly to the national income for most developing countries. One of the main objectives of the Indonesian government is to ensure the provision of adequate food for all its citizens with a diverse and healthy diets rich in carbohydrates, proteins, vitamins, and minerals. This goal can be achieved by increasing food crop production. The population growth has caused an increasing demand for maize products in Indonesia. South Sulawesi, especially Takalar Regency is one of the maize granaries in Indonesia. Ministry of Agriculture of the Republic of Indonesia through the Agency for Agricultural Research and Development has made several efforts to improve the productivity of maize with some technological innovations and then recommend it to the farmers. One such example of innovation is the legowo super planting system on maize. This planting system was recommended by the Agricultural Research Agency of Indonesia in 2016.

Legowo planting system is a planting method designed to boost crop productivity by increasing plant populations and the effects of peripheral plants; where planting is done by tightening the distance of the plant in a row and stretching the distance between the plants. This system has been conducted in several provinces in Indonesia. The purpose of this planting system is aimed at increasing the intensity of sunlight to optimize photosynthesis and assimilation and facilitate the maintenance of plants,
especially weeding manually and with herbicide, fertilization, and water supply. This planting system is also associated with efforts to increase production through an increase in the Cropping Index (IP) of maize. With increasing IPs then yields can be improved and land management becomes more effective [1]. Based on the explanation, this research aims to: 1) identify what factors are affecting the decision of farmers in adopting legowo super planting system in Tonasa Village; 2) find out the relationship between internal and external factors with the decision to adopt legowo super planting system in Tonasa Village.

Legowo planting system is an intermittent cultivation pattern between two or more rows of plants and separated by one empty row. Usually, this planting system is often applied to rice plants, which is commonly known as jajar legowo 2:1 and 4:1. But currently legowo planting system can also be applied to maize crops [2]. In contrast to rice, maize does not form saplings so that the application of legowo planting system in maize crops is more objected to:

- Increase the sunlight intensity on the leaves and it is expected that the results of assimilation increase so that the filling of grain can be fully loaded.
- Ease the nursing activity of plants, especially weeding both manually and using herbicides, fertilization, and watering.

According to [1], one of the things that make some farmers reluctant to adopt this planting system is because it requires more labor and time in terms of land cultivation and planting. Research done by [3] measures the level of adoption with three benchmarks, namely: the speed or time interval between receiving information and the application carried out, the proportion of land area that has been "applied" the new innovation, and the quality of intensification by comparing the application with the recommendations that have been delivered by the extension agent.

Based on such understanding, it can be concluded that some of the main ideas about the adoption of innovation in relation to agricultural development are as follows:

1. The adoption of innovation requires a continuous communication process to introduce, explain, educate, and help the community to know, want, and be able to apply the new technology.
2. The adoption of innovation is an ongoing and continuous decision-making process, to: pay attention to, accept, understand, appreciate, and apply the new technology.
3. The adoption of innovation requires readiness to make changes in the practice of farming.

Moreover, [4] suggests that the speed of adoption is influenced by many factors, namely:

a. The nature of innovation, both intrinsic in nature including scientific information, values, level of complexity, trialability and observability, as well as extrinsic characteristics which include compatibility and relative advantage of the innovation.
   1. Relative advantage is the level at which a new idea is considered better than the ideas that existed before. The level of advantage is often expressed in the form of economic benefits.
   2. Compatibility is the extent to which the innovation is considered consistent with existing values, prior experience, and recipient needs. Compatibility provides greater assurance and less risk to the recipient and makes the new idea more meaningful to the recipient.
   3. Complexity is the level at which an innovation is considered difficult to understand and to use. The complexity of an innovation is reversibly related to the adoption speed. The more complicated an innovation is for a person, the slower the adoption will be.
   4. Trialability is a level where innovation can be tried on a small scale. New ideas that can be tried on a small scale are usually adopted faster than innovations that can not be tried on a small scale.
   5. Observability is the level at which the results of innovation can be seen by others. The observability of innovation is linearly correlated with the adoption speed.

b. The characteristics or characteristics of prospective users.

c. Decision-making innovation.
d. Communication channel used.
e. The condition of the extension agent.
f. Variety of information sources. Whether the information of the innovation directly comes from extension agents, or from fellow members of farmer groups, or even from other sources.

2. Methodology
The research was conducted in Tonasa Village, Takalar Regency, South Sulawesi, Indonesia. The sample in this research is 40 maize farmers. To determine the factors that affect adoption, multiple linear regression analysis is used. To examine the relationship between the factors that affect decisions of adopting with farmers’ decisions in adopting the legowo super planting system, Spearman Rank Correlation test (rs) is used.

The formula of Rank Spearman correlation coefficient (rs) is as follows [5]:

$$r_s = 1 - \frac{6 \sum_{i=1}^{n} d_i^2}{N^3 - N}$$

Where:
- $r_s$: Spearman rank correlation coefficient
- $N$: Number of samples
- $d_i$: Difference in ranking between variables

To see how strong the relationship between the factors affecting decision making with the decision to adopt the legowo super planting system will follow the following table below [6]:

| Interval Coefficient | Correlation Coefficient | Relationships Interpretation |
|----------------------|-------------------------|------------------------------|
| 0.00 - 0.199         | + and -                 | Very low                    |
| 0.20 - 0.399         | + and -                 | Low                         |
| 0.40 - 0.599         | + and -                 | Strong enough               |
| 0.60 - 0.799         | + and -                 | Strong                      |
| 0.80 - 1.000         | + and -                 | Very strong                 |

From the analysis, it will be obtained whether $r$ is positive or negative. If the correlation coefficient $(r)$ is positive $(r > 0)$ then there is a positive or direct relationship. This means that if there is an increase in X variable, it will be followed by an increase in Y variable. Conversely, if there is a decrease in X variable, it will be followed by a decrease in Y variable. The correlation coefficient $(r)$ is negative $(r < 0)$ means if there is an increase in X variable then will be followed by a decrease in Y variable.

3. Results and Discussion

3.1 Adoption based on Characteristics of Innovation
Characteristics of innovation are traits possessed by an innovation that is perceived or observed as something new for someone or society that is used to achieve the goal in solving problems [7]. The characteristics of innovation described below illustrate relative advantages, complexity, compatibility, trialability, and observability.

| Farmers’ Perception | Indicator | Relative Advantage | Complexity | Compatibility | Trialability | Observability |
|---------------------|-----------|--------------------|------------|---------------|--------------|---------------|
|                     | Adopter   | Non-adopter        | Adopter    | Non-adopter   | Adopter      | Non-adopter   | Adopter      | Non-adopter   |
| Very high           | 12        | 0                  | 5          | 0             | 14           | 5             | 10           | 0             | 13           | 0             |
| High                | 8         | 2                  | 5          | 7             | 6            | 11            | 3            | 6             | 7            | 14            |
| Moderate            | 0         | 11                 | 3          | 8             | 0            | 4             | 5            | 5             | 0            | 6             |
| Low                 | 0         | 5                  | 7          | 3             | 0            | 0             | 2            | 7             | 0            | 0             |
| Very low            | 0         | 2                  | 0          | 2             | 0            | 0             | 2            | 0             | 0            | 0             |
| Total               | 20        | 20                 | 20         | 20            | 20           | 20            | 20           | 20            | 20           | 20            |
Source: Author Elaboration, 2017.

Relative advantage is the degree to which an innovation is considered better than what existed before. Relative advantage shows the extent to which the adoption of legowo super planting system in maize is considered beneficial for farmers. The relative advantage perceived by the dominant of adopters is in the very high category (12 people), while the most of the non-adopters (11 people) assume that the relative advantages of the super legowo super planting system in maize are in the moderate category. The advantages felt by adopters such as increasing production and more efficient compared to the previous planting system because it suppresses production costs. [8] argues that the most important and very influential factors for recipients of innovation in relative advantages are economic, social and difficulty level. Innovation is adopted faster if users consider it better than what they currently have.

The majority of the adopters (7 people) consider complexity of legowo super planting system in maize to be in the low category, while most of the non-adopters (8 people) consider it has moderate complexity. Thus it can be concluded that the respondents consider the legowo super planting system in maize not difficult to understand and practice. The difficulty of understanding and using innovation influences someone to adopt an innovation. This is in line with [9] opinion that innovations that are more complicated and difficult to learn will be adopted more slowly than less complicated innovations. The easier an innovation understood by the adopter, the faster the innovation could be adopted.

Farmers consider that the legowo super planting system in maize is compatible with the norms in the community and in accordance with current needs. They said that this technology does not violate the rules in their community, even creating mutual cooperation between them. This is in accordance with the opinion of [10] that innovation that is consistent with the values and norms of the social system will be adopted at a faster rate than an innovation that is not in accordance with existing values and norms.

The trialability indicator for the adopting farmers was dominated (10 people) by the very high category, while the majority of the non-adopters (7 people) consider it to be low. Farmers feel that by trying to implement legowo super planting system on maize on a small scale will provide more tangible evidence of increasing their farming production. In line with this, [11] suggests that innovations that can be tried before full adoption can be adopted at a faster rate than innovation that requires a commitment to full adoption from the start.

All respondents who adopted and did not adopt assumed that the level of observability of the rowing system of super legowo planting on corn was high. One reason is that they consider the corn plant can provide a beautiful aesthetic view because it is very neat and regular in distance. In addition, the increase in production yields that increase the income of the respondent farmers after using the legowo super planting system is something that can be seen and shown to the community. As [8] revealed that people will be more inclined to adopt when they can easily and quickly see positive results.

### 3.2 Factors Affecting the Adoption of Legowo Super Planting System on Maize

The farmers can consider many reasons before deciding to adopt the legowo super planting system because the decision to be taken requires prior planning to predict the outcome or output of the decision. There are 3 factors that affect the respondents in the adoption of legowo super planting system on maize. First is the characteristic of the farmers which includes age, level of education, the number of family members, farming experience, and farm size. Second is the characteristics of innovation that include relative advantage, complexity, compatibility, trialability and observability. The third factor is the communication network. The results of linear regression analysis are presented below.
Table 3. Factors affecting farmers in adopting legowo super planting system on maize in Tonasa Village, South Sulawesi, Indonesia.

| Model                        | Standardized Coefficients | T      | Sig.   |
|------------------------------|---------------------------|--------|--------|
| (Constant)                   |                           |        |        |
| Age                          | -0.005                    | -0.042 | 0.967  |
| Education                    | 0.024                     | 0.172  | 0.865  |
| Number of family members     | -0.042                    | -0.444 | 0.661  |
| Farming experience           | 0.046                     | 0.431  | 0.670  |
| Farm size                    | 0.876                     | 2.207  | 0.036  |
| Relative advantages          | 0.478                     | 3.131  | 0.004  |
| Complexity                   | 0.076                     | 0.786  | 0.439  |
| Compatibility                | 0.013                     | 0.121  | 0.904  |
| Trialability                 | 0.022                     | 0.180  | 0.859  |
| Observability                | 0.187                     | 1.507  | 0.144  |
| Communication network        | 0.010                     | 0.098  | 0.923  |

N                      : 40
R square           : 0.833

Source: Primary Data, 2017.

Table 3 shows factors that affect the decision of maize farmers in adopting the legowo super planting system. R square value indicates that 83% of farmer's decision to adopt can be explained by explanatory variables. Furthermore, the results of the analysis prove that there are two variables that significantly affect the adoption decisions, i.e. farm size and the relative advantage of legowo super planting system (significant at 5%). If the farm size increased by 1%, then the farmers will 87% likely to adopt. Farmers with a narrow area of land are weak in capital, weak in knowledge and skills and often weak in their desire to move forward. In this case, farmers who have wider land will try to be more active in improving their farming activities [12].

In the case of relative advantage, if it is increases by 1%, then farmers will tend to adopt as much as 47%. Based on the interviews, almost all of the respondents said that they were willing to adopt because of the better productivity that they have got in implementing legowo super planting system. The findings of [13] stated that the indicator of the relative advantage that has the most influence on farmers’ decisions is the economic benefit of the innovation.

3.3 Relationships between Factors Influencing Decisions with Decisions to Adopt Legowo Super Planting System on Maize

To see how strong the two-way relationship between the factors that influence the decision of adoption with the decision to adopt, the spearman rank correlation analysis is used. The results of the analysis can be seen in Table 4 below.
Table 4. Relationship between factors affecting decisions and decisions to adopt legowo super planting system on maize in Tonasa Village, South Sulawesi, Indonesia.

| Factors Affecting Adoption | Adoption Decision | Correlation Coefficient | Sig. (2-tailed) |
|----------------------------|-------------------|--------------------------|-----------------|
| Age                        |                   | 0.035                    | 0.831           |
| Education                  |                   | -0.106                   | 0.516           |
| Number of family members   |                   | -0.56                    | 0.733           |
| Farming experience         |                   | -0.007                   | 0.967           |
| Farm size                  |                   | -0.145                   | 0.373           |
| Relative advantages        |                   | 0.860**                  | 0.000           |
| Complexity                 |                   | 0.152                    | 0.348           |
| Compatibility              |                   | 0.489**                  | 0.001           |
| Trialability               |                   | 0.532**                  | 0.000           |
| Observability              |                   | 0.723**                  | 0.000           |
| Communication network      |                   | 0.314*                   | 0.048           |

Source: Primary Data, 2017.

Note: ** Significant correlation at the 0.01 level (2 tailed)
      * Significant correlation at the 0.05 level (2 tailed)

Table 2 shows the characteristics of farmers, characteristics of innovation and communication networks that have proven to be significantly related to farmers’ decisions in adopting the legowo super planting system namely relative advantage, compatibility, trialability, observability and communication networks of the innovation. The results of rank spearman correlation tests found that the relative advantage has a very strong relationship with the decision of farmers to adopt. Compatibility, trialability, and observability have a strong enough relationship with the decision of farmers to adopt. The communication network with the decision of farmers to adopt has a low relationship. These types of relationships mean that the better the relative advantage, compatibility, trialability, observability, and the communication network of legowo super planting system, the more farmers tend to adopt.

Relative advantage, compatibility, trialability, and observability are definitely clear to be the characteristics of the innovation that must be considered by farmers before the decision making of whether to adopt or not to adopt, but the communication network is something different. The spread of communication networks in village is not as quick as in cities, whereas communication networks in villages is mostly spread from mouth to mouth. Relevant to this, [13] concludes that people who are more sociable and have many communication networks will be more open-minded to receive innovation.

4. Conclusion
Based on the results and discussion, the conclusions of this study are as follows:
1. Factors affecting farmers’ decisions in adopting legowo super planting system on maize in Tonasa Village is the farm size and the relative advantage of legowo super planting system. Identifying the most influential factors provides policy with opportunities to better support legowo super planting system.
2. Relative advantage, compatibility, trialability, observability, and communication network have relationship with farmer’s decision in adopting the legowo super planting system on maize in Tonasa Village.
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