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# Factors Influencing Rice Seed Production and Distribution: A Case Study of Ogan Komering Ilir Regency, South Sumatra

**Winnie Andhini[1], Muhammad Yazid*[2], Riswani[2]**
[1]Master of Agribusiness Study Program, Faculty of Agriculture, Sriwijaya University, Palembang City, Indonesia
[2]Agribusiness Study Program, Department of Agriculture Socioeconomics, Faculty of Agriculture, Sriwijaya University, Palembang City, Indonesia
*Correspondence Email: yazid_ppmal@yahoo.com

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## ABSTRACT

Superior seed breeding is one of the food products that has the opportunity and importance to be developed in an agribusiness system because its needs among farmers are increasing. The agribusiness system concerns all activities in the agricultural sector ranging from the upstream industry, farming, downstream industry to its distribution to consumers. This study aims to analyze factors related to seed production and distribution problems (government, breeders, markets, and users) in OKI Regency as one of the largest rice producing region in South Sumatera . The selection of the research location used the purposive sampling method, while the sample withdrawal used non-probability sampling by taking samples of seed breeder farmers in Bumi Agung Village, Lempuing District, OKI Regency. There are 60 rice seed breeders in this village who were purposively selected as a sample of this study. Primary data in this study was collected by means of a survey using a questionnaire and analyzed using SEM and CLD. The results indicate that the input and post-harvest subsystems have a significant effect on seed production and distribution, with the highest determination value on the distribution variable, so these two aspects need to be strengthened. The user subsystem (farmer) has the least influence, signaling the need for a specific strategy so that farmer preferences and participation can further contribute to the success of the seed system. The Causal Loop Diagram (CLD) analysis found two main dynamics, namely (1) reinforcing loops between government–production–market–distribution that can strengthen growth; and (2) balancing the input-production loop that requires management so that there is no excessive dependence on external inputs.
***Keywords***: *CLD, distribution, production, Seed, SEM,*

## BACKGROUND

Seeds are one of the main elements in agricultural cultivation. The selection of seeds will determine the production and quality of agricultural commodities. With such a strategic role of seeds, the government includes seeds as one of the main elements in realizing food sovereignty. There are three main components needed in efforts to build seed independence in Indonesia, namely the development of new superior varieties, the development of seed quality, and aspects of their use, both in terms of dissemination and supervision and control (Waluyo et al., 2022). One of the increases in rice production is influenced by the use of seeds. The biggest contribution in rice production is the use of superior seeds compared to the application of other technologies. This is because the marketing cost of certified seeds is relatively cheaper compared to the cost of producing fertilizers and others.

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Seed-related constraints especially at the farmers level, particularly limited access to certified superior seeds, can be addressed through on-farm seed breeding using quality source seeds.

The situation in the field shows that the use of superior seeds is still relatively limited. More than 60 percent of the use of rice seeds among the community comes from the informal sector, namely in the form of grain set aside from part of the previous season's harvest which is carried out repeatedly (Afrizon et al., 2022). Rice is a staple food commodity that plays a central role in addressing food security challenges in Indonesia. The number of people in Indonesia tends to increase from year to year. Therefore, the demand for rice is getting bigger along with the increase in the population in Indonesia. For this reason, serious efforts are needed to maintain national and household food security. Efforts to increase rice production to maintain rice self-sufficiency face various problems. These problems are in the form of physical, biological and socioeconomic obstacles. To overcome these problems, the government needs to take policies in rice development in order to achieve better results (Nafi'ah, 2021).

South Sumatra has initiated seed breeding development in districts with the potential to produce certified seed breeders, involving farmers, private seed producers, and government agencies. To ensure seed quality and genetic purity, a certification system is implemented. Seed certification is a regulated process that guarantees the physiological, physical, and genetic quality of seeds, from application to labeling, and ensures the continuous supply of certified seeds under the supervision of the Seed Supervision and Certification Center for Food Crops and Horticulture.

Ogan Komering Ilir Regency is one of the rice seed producers in South Sumatra after Ogan Komering Ulu Timur. The role of rice seed producers is important in the provision of certified seeds in the Ogan Komering Ilir Regency area. The certification process in maintaining seed quality is not easy, so production is still constrained in meeting seed production targets in Ogan Komering Ilir Regency (OKI). The use of superior seeds at the farmer level is still low, this is due to several factors, including the limited availability of source seeds, limited source seeds, limited number of seed producers or breeders, farmers' access to superior seeds is very limited, and lack of application of superior seeds (Putra et al., 2023). Research by Waluyo et al., (2022) identified various problems in the production and distribution of rice seeds in South Sumatra, including OKI Regency. The study noted that the main obstacles include limited access to superior seeds, lack of coordination between government agencies and breeders, and challenges in timely distribution. In addition, erratic weather factors also affect seed production. In addition, there is a lack of proper coordination between the government, producers, markets, and consumers that make it difficult to obtain seeds of superior varieties.

Superior seed breeding is one of the food products that has the opportunity to be developed in an agribusiness system. The agribusiness system concerns all activities in the agricultural sector from procurement to marketing of products produced by farming businesses that are interrelated with each other, in other words starting from the upstream industry, farming, downstream industry to distribution to consumers. In other words, an agribusiness system is a complex network that involves various interrelated subsystems to produce, process, and distribute agricultural products. Thus, from the production subsystem to the consumer subsystem, each part has an important role in ensuring the smooth and efficient of the entire agribusiness process (Krisdiana et al., 2024). Referring to the above explanation, the problem that can be seen is that the scarcity of superior seed products that trigger superior seed breeding must be developed, the correct implementation of an agribusiness system is a stimulus to develop this seed breeding agribusiness system. How to implement the agribusiness system of rice plant breeders in Ogan Komering Ilir Regency, so that this rice seed breeder can continue to run and can even develop and make Ogan Komering Ilir Regency a superior seed provider

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that is able to provide superior seeds for the Ogan Komering Ilir Regency area and even supply other districts.

The novelty of this study lies in its integrated analysis of rice seed production and distribution within a single agribusiness system framework, combining PLS-SEM and Causal Loop Diagram (CLD) approaches. Unlike previous studies that examine production or distribution separately, this research captures both statistical causal relationships and dynamic feedback mechanisms, including reinforcing and balancing loops that shape system performance.

This study contributes to the field by providing empirical evidence from Ogan Komering Ilir Regency, a key rice-producing area that has received limited attention in prior research. The findings enhance agribusiness system theory by demonstrating the interdependence between input availability, user demand, cost structures, and distribution efficiency, while also offering practical insights for policy formulation, particularly in cost control, pricing strategies, and distribution system improvement to support sustainable rice seed breeding.

## RESEARCH METHODS

This study was conducted in Bumi Agung Village, Lempuing District, Ogan Komering Ilir Regency, South Sumatra Province, from December 2024 to February 2025. The research location was purposively selected because the village has rice seed breeders who collaborate with CV UPB Berkah Tani, the largest certified rice seed producer in Ogan Komering Ilir Regency, one of the main rice-producing regions in South Sumatra. To capture the seed marketing process, observations were also conducted at locations where the seeds are traded and used.

The study employed a survey method using structured questionnaires and direct field observations. A non-probability sampling technique was applied by selecting 60 rice seed breeder farmers in Bumi Agung Village as respondents.

Data were analyzed using Structural Equation Modeling with a Partial Least Squares approach (PLS-SEM) to model and examine the relationships among variables within the agribusiness subsystems. PLS-SEM is a variance-based SEM technique suitable for predictive analysis and theory development, allowing simultaneous assessment of the measurement model (validity and reliability) and the structural model (relationship estimation).

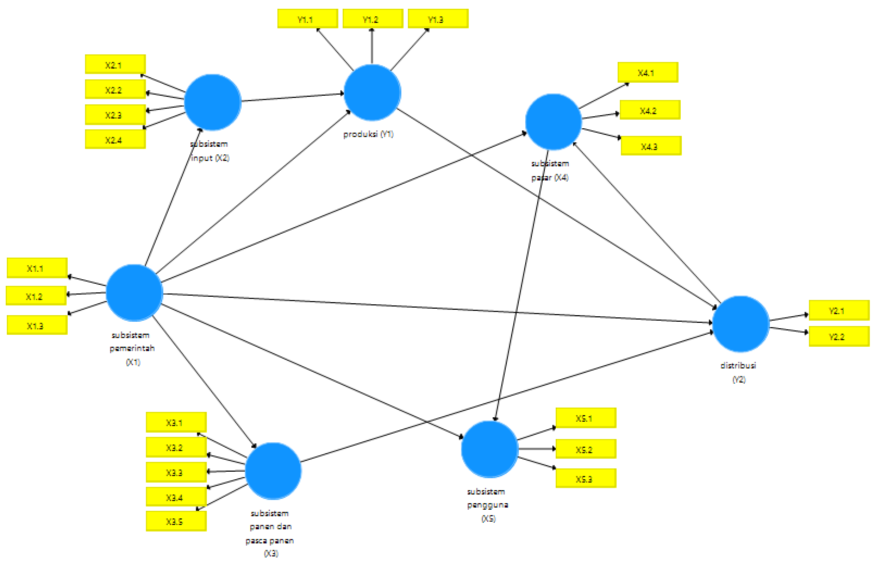


**Figure 2.** Structural Equation Model

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**Outer Model Analysis Stage**

External model analysis is often also known as a measurement model to ensure that the *measurement* used is suitable for measurement (valid and reliable). In addition, the outer model defines how each indicator relates to its latent variable. The outer *model* equation in this study can be written as follows:

$X1.1 = A_{X1.1}\eta_{X1} + \varepsilon_{X1.1}$ (1)
$X1.2 = A_{X1.2}\eta_{X1} + \varepsilon_{X1.2}$ (2)
$X1.3 = A_{X1.3}\eta_{X1} + \varepsilon_{X1.3}$ (3)
$X2.1 = A_{X2.1}\eta_{X2} + \varepsilon_{X2.1}$ (4)
$X2.2 = A_{X2.2}\eta_{X2} + \varepsilon_{X2.2}$ (5)
$X2.3 = A_{X2.3}\eta_{X2} + \varepsilon_{X2.3}$ (6)
$X2.4 = A_{X2.4}\eta_{X2} + \varepsilon_{X2.4}$ (7)
$X3.1 = A_{X3.1}\eta_{X3} + \varepsilon_{X3.1}$ (8)
$X3.2 = A_{X3.2}\eta_{X3} + \varepsilon_{X3.2}$ (9)
$X3.3 = A_{X3.3}\eta_{X3} + \varepsilon_{X3.3}$ (10)
$X3.4 = A_{X3.4}\eta_{X3} + \varepsilon_{X3.4}$ (11)
$X3.5 = A_{X3.5}\eta_{X3} + \varepsilon_{X3.5}$ (12)
$X4.1 = A_{X4.1}\eta_{X3} + \varepsilon_{X4.1}$ (13)
$X4.2 = A_{X4.2}\eta_{X3} + \varepsilon_{X4.2}$ (14)
$X4.3 = A_{X4.3}\eta_{X3} + \varepsilon_{X4.3}$ (15)
$X5.1 = A_{X5.1}\eta_{X3} + \varepsilon_{X5.1}$ (16)
$X5.2 = A_{X5.2}\eta_{X3} + \varepsilon_{X5.2}$ (17)
$X5.2 = A_{X5.2}\eta_{X3} + \varepsilon_{X5.3}$ (18)
$Y1.1 = A_{Y1.1}\eta_{XY} + \varepsilon_{Y.1}$ (19)
$Y1.2 = A_{Y1.2}\eta_{XY} + \varepsilon_{Y.2}$ (20)
$Y1.3 = A_{Y1.3}\eta_{XY} + \varepsilon_{Y.3}$ (21)
$Y2.1 = A_{Y2.1}\eta_{XY} + \varepsilon_{Y.1}$ (22)
$Y2.2 = A_{Y2.2}\eta_{XY} + \varepsilon_{Y.2}$ (23)

Where:
A = *Loading matrix*
X1.j = Indicators or *observed variable* or manifest variable of exogenous variables
X1,2,3.j and Y1.j = Indicators or *observed variable* or manifest variable of endogenous variables
ε = Variable exogenous
η = Allow variable to be deposed
$\varepsilon_{x1.j}$ = *Measurement error* from the exogenous variable indicator
$\varepsilon_{x,2,3.j}$ dan $\varepsilon_{Y1.j}$ = *Measurement error* from endogenous variable indicators
j = 1,2,3.. n

The outer model is evaluated by looking at validity and reliability. Validity in the outer model was measured through loading factor, average variance extracted (AVE), and cross loading.

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### Inner Model Stage

*An inner model* is a model that shows the relationship and strength of estimation between latent variables or constructs. SEM-PLS is built for a model that has one direction of causality so that the relationship between exogenous variables and endogenous variables is often known as a *causal chain system* which can be written as follows:

$X1=\beta x4+\zeta$ (18)
$X2=\beta x1+\beta x4+\zeta$ (19)
$X3=\beta x1+\beta x2+\beta x4+\zeta$ (20)
$Y=\beta x1+\beta x2+\beta x3+\zeta$ (21)

Where:
X4 = Variable Exogens
X2,X3 and Y = Endogenous variable
$\beta$ = *Path coefficient*
$\zeta$ = *Unexplained variance* or residual variables

*The inner model* or structural model is reviewed through several assessments, including *R-square*, hypothesis and significance tests.

### Research Indicators

Based on the research approach made, the research uses the following research indicators:

**Table 1.** Research Indicators

| Variabel Latent | Construct | Indicator | Notation |
|---|---|---|---|
| Government (X1) Rahman & Sari. (2021) | 1. Seed | The seeds I use are of excellent quality | X1.1 |
| | 2. Fertilizer Usage | The fertilizer I use is effective in increasing crop production | X1.2 |
| | 3. Pesticide Use | The pesticides I use are effective in controlling plant pests and diseases | X1.3 |
| | 4. Agricultural Tools and Machinery | The farm tools and machinery I use help improve work efficiency. | X1.4 |
| Input Subsystem (X2) Pannell et al., (2014). | 1. Harvest Procedure | I feel that the harvesting procedures used today are already very effective. | X2.1 |
| | 2. Drying | The process of drying the harvested seeds went well and according to standards. | X2.2 |
| | 3. Pembersihan | The cleaning of the crop is well done and can remove all the dirt present. | X2.3 |
| | 4. Sorting | The sorting of crops is carried out very carefully and in accordance with quality standards | X2.4 |
| | 5. Storage | The storage facilities used meet standards and are able to maintain the quality of crops | X2.5 |
| Harvest and Post-Harvest | 1. Training Coaching | The training provided improved my ability in rice cultivation techniques. | X3.1 |

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| Variabel Latent | Construct | Indicator | Notation |
|---|---|---|---|
| Subsystems (X3) Purwanto & Suryani. (2020) | 2. Seed Provider Policy | The government's policy on the provision of seeds makes it easier for me as a farmer | X3.2 |
| | 3. Certification and Labeling | Clear certification and labeling provide certainty regarding the quality of the seeds I use | X3.3 |
| Markets Subsystems (X4) Prasetyo & Wibowo. (2019) | 1. Seed Prices | The price of rice seeds in the market is affordable for farmers | X4.1 |
| | 2. Seed Availability | The availability of rice seeds in my area meets the needs of farmers | X4.2 |
| | 3. Market Demand | The high market demand affects me in choosing seed varieties | X4.3 |
| Consumer (X5) Siddiqui et al., (2022) | 1. Seed Needs | The seeds I need are always available when needed | X5.1 |
| | 2. Timeliness of getting seeds | I always receive seeds on time according to a predetermined schedule | X5.2 |
| | 3. Consumer-level pricing | The price of the seeds I received was proportional to the benefits provided | X5.3 |
| Production (Y1) | 1. Production Volume | I feel that the volume of rice seed production in our place has reached the expected target | Y1.1 |
| | 2. Seed Quality | The quality of the rice seeds we produce is always in accordance with national standards | Y1.2 |
| | 3. Productivity | The tools and technologies used in production support our increased productivity | Y1.3 |
| Distribution (Y2) | 1. Distribution Channels | The distribution channels used can reach the entire target market | Y2.1 |
| | 2. Relationship with Buyers | Communication between the company and the buyer runs smoothly and openly | Y2.2 |

The results of the SEM analysis will be used as a basic foundation for creating a causal loop diagram. The Causal Loop Diagram (CLD) in an agribusiness system is a visual tool used to describe the dynamic interactions between various components in an agribusiness system. CLD is used to map the cause-and-effect relationship between factors that affect each other, both positively and negatively, and to show the existence of feedback loops or feedback loops in the system. In the context of agribusiness, CLD helps to understand how factors such as production, distribution, markets, and users (e.g. farmers) interact with each other (Dhirasasna & Sahin, 2019).

Components in a Causal Loop Diagram:

1. Cause-Effect Relationship: Indicated by an arrow connecting two variables, and marked with (+) for positive relationships (when one variable increases, other variables also increase) or (-) for negative relationships (when one variable increases, another variable decreases).

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2. Positive Feedback Loop: Indicates a cause-and-effect loop that reinforces a process, such as improving seed quality that increases market demand, which ultimately increases production.
3. Negative Feedback Loop: Indicates a stabilization or balancing in the system, such as when an increase in production costs suppresses demand because prices become too high.

Assumption Causal Loop Diagram (CLD)

1. Seed Production and Quality (Reinforcing Loop - R1): Assumption: Increased training (by the government) improves farmers' skills → results in better seed quality → increases market confidence in seeds → increases demand → encourages more training and certification.
2. Production and Yield Inputs (Reinforcing Loop - R2): Assumption: The availability of inputs (seeds, fertilizers, pesticides, tools) increases yields → higher yields increase farmers' incomes → increase investment in quality inputs.
3. Marketing and Market Availability (Balancing Loop - B1): Assumption: Improved seed quality increases the availability of seeds in the market → increased market demand increases prices → higher prices encourage further production → however if the price is too high, it can reduce the purchasing power of users.
4. User and Market Satisfaction (Reinforcing Loop - R3): Assumption: The timeliness of seed distribution meets the needs of farmers during the growing season → increases farmer satisfaction → farmers tend to buy more seeds from trusted sources → drive future distribution efficiency.
5. Role of Government and Support Systems (Reinforcing Loop - R4): Assumptions: Supportive government regulations (e.g. subsidies or input incentives) increase farmers' input access → encourage higher yields → increase confidence in government policies → encourage more policy support.
6. Distribution Problem (Balancing Loop - B2): Assumption: Distribution delays decrease the availability of seeds → reduce user satisfaction levels → lower market confidence → reduce demand → worsen distribution efficiency.

Based on the agribusiness system framework, this study hypothesizes that the input subsystem significantly influences rice seed production. Furthermore, the harvest and post-harvest subsystem is expected to have a significant effect on rice seed distribution, while rice seed production is hypothesized to influence seed distribution performance. In addition, government support is assumed to affect the input subsystem, as well as the harvest and post-harvest and market subsystems, through policies, subsidies, and institutional support mechanisms.

## RESULT AND DISCUSSION

### Evaluation *Measurement Model (Outer Loading)*

Measurement model evaluation aims to find out the relationship between latent variables and their indicators or outer models are also defined to find out how each indicator relates to its latent variables. The results of the calculation of outer loading using the PLS (*Partial Least Square*) program will produce the validity of the indicator which can be said to be valid if the value of outer loading is >0.60 (Amanda *et al.*, 2020). The calculation using the PLS program in this study produced the full model as follows:

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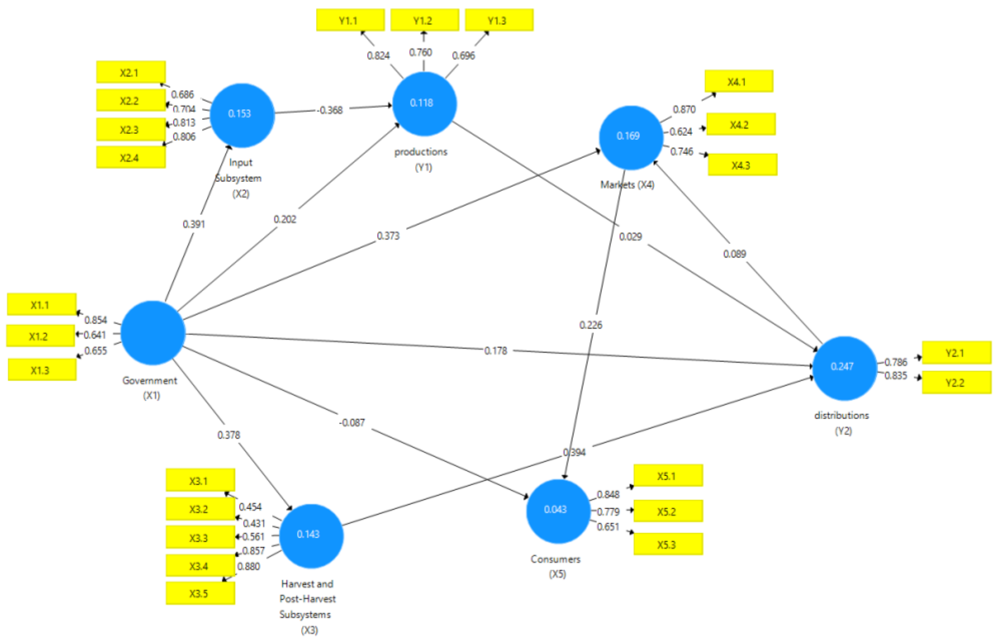


**Figure 3.** Results of PLS Analysis Model

Based on Figure 4, it can be observed that several sub-variables (indicators) still have loading factor values below 0.60. This indicates that these indicators do not meet the validity standard or are not strongly associated with the latent variables they are intended to measure; therefore, they must be eliminated. The purpose of this elimination is to improve the model fit to the data and to enhance the validity and reliability of the model (Yarsasi et al., 2025). The indicators eliminated from the model are the price indicators within the harvest and post-harvest subsystem, namely X3.1 with a loading factor of 0.454, X3.2 with a loading factor of 0.430, and X3.3 with a loading factor of 0.561, in order to obtain a revised model that meets the validity threshold of >0.60.

***Revised Model***

The model revision was conducted by eliminating invalid indicators, resulting in the following revised model:

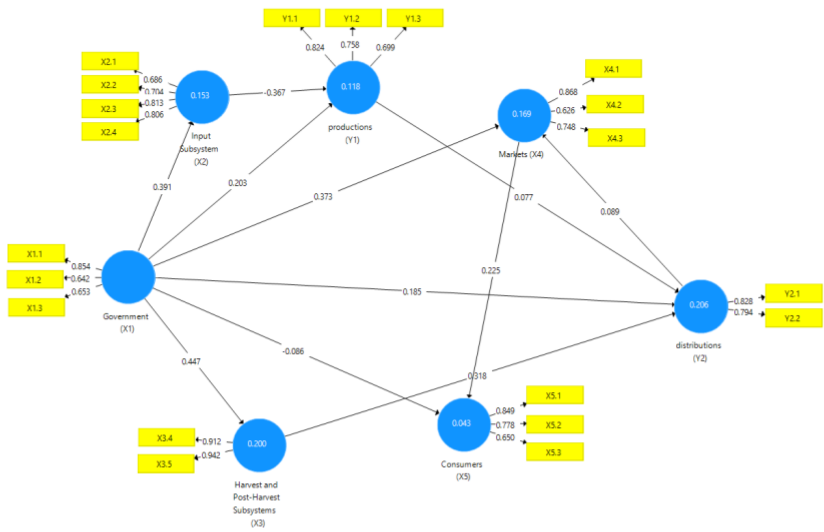


**Figure 4.** Results of PLS Analysis Model Revision

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Based on Figure 5, it can be observed that all indicators of the variables analyzed in the revised model have loading factor values greater than 0.60, indicating that they are valid and suitable for use. Accordingly, the model can be further tested to examine the relationships between latent variables and their indicators. The evaluation is conducted through validity testing, which includes convergent validity, Average Variance Extracted (AVE), composite reliability testing, and the coefficient of determination.

***Convergent Validity***

The convergent validity test is used to assess the validity of each relationship between an indicator and its corresponding latent construct. Convergent validity is evaluated based on the loading factor values, where indicators with loading factors greater than 0.60 are considered valid (Samsudin et al., 2025).

**Table 2.** Results of *Outer Loading* Test of Seed Breeding Model

| Variable | Distribution (Y2)__ | Production (Y1)__ | Government Subsystem (X1) | Input Subsystem (X2)__ | Harvest And Post-Harvest Subsystems (X3)_ | Market Subsystem (X4)_ | Consumers Subsystem (X5)__ |
|---|---|---|---|---|---|---|---|
| X1.1 | | | 0,686 | | | | |
| X1.2 | | | 0,704 | | | | |
| X1.3 | | | 0,813 | | | | |
| X1.4 | | | 0,806 | | | | |
| X2.4 | | | | 0,912 | | | |
| X2.5 | | | | 0,942 | | | |
| X3.1 | | | | | | 0,854 | |
| X3.2 | | | | | | 0,642 | |
| X3.3 | | | | | | 0,653 | |
| X4.1 | | | | | 0,868 | | |
| X4.2 | | | | | 0,626 | | |
| X4.3 | | | | | 0,748 | | |
| X5.1 | | | | | | | 0,849 |
| X5.2 | | | | | | | 0,778 |
| X5.3 | | | | | | | 0,650 |
| Y1.1 | | 0,824 | | | | | |
| Y1.2 | | 0,758 | | | | | |
| Y1.3 | | 0,699 | | | | | |
| Y2.1 | 0,828 | | | | | | |
| Y2.2 | 0,794 | | | | | | |

Source : Data Processed, 2025

Based on the data presented in Table 2, it can be concluded that all indicators used in this study are valid, indicating that each indicator demonstrates a high level of reliability in measuring its respective latent variable. According to Hajjar (2018), good indicator validity reflects that the measurement instrument is capable of explaining each latent variable accurately and consistently, thereby allowing the analysis results to be interpreted with greater confidence.

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***Average Variance Extracted (AVE)***

Validity testing aims to determine whether a research instrument truly measures what it is intended to measure. In this study, validity is assessed using the Average Variance Extracted (AVE) value. An AVE value of ≥ 0.50 indicates good validity, whereas an AVE value ≤ 0.50 suggests low validity (Cheung et al., 2024).

Table 3. Average *Variance Extracted (AVE) Test Results*

| Variable | Average Variance Extracted (AVE) | Conclusion |
|---|---|---|
| Distribution (Y2) | 0,658 | Valid |
| Production (Y1) | 0,581 | Valid |
| Input Subsystem (X2) | 0,569 | Valid |
| Harvest And Post-Harvest Subsystems (X3) | 0,860 | Valid |
| Market Subsystem (X4) | 0,568 | Valid |
| Government Subsystem (X1) | 0,523 | Valid |
| Consumers Subsystem (X5) | 0,582 | Valid |

Source : Data Processed, 2025

Based on Table 3, all latent variables exhibit AVE values greater than or equal to 0.50. This finding indicates that each latent variable demonstrates good convergent validity. Therefore, it can be concluded that the measurement instruments used in this study meet adequate validity criteria. According to Mohd Dzin and Lay (2021), data with sufficient validity can be considered reliable and suitable for supporting hypothesis testing and more accurate interpretation of research findings.

***Coefficient of Determination (R-Square)***

The determination coefficient can be used to test the structural model by looking at the value *R-Square* which indicates how much the independent variable is able to explain the dependent variable (Nasution et al., 2020). The value of the determination coefficient can be seen in the following table:

Table 4. Value of Determination Coefficient

| Research Variables | R Square |
|---|---|
| Distribution (Y2)__ | 0,206 |
| Production (Y1)__ | 0,118 |
| Input Subsystem (X2)__ | 0,153 |
| Harvest And Post-Harvest Subsystems (X3)_ | 0,200 |
| Subsystem (X4)_ | 0,169 |
| Consumers Subsystem (X5)__ | 0,043 |

Source : Data Processed, 2025

Based on Table 4. it can be seen that the value of the determination coefficient (R Square) in the distribution variable (Y2) is 0.206. This shows that 20.6% of the variation in distribution can be explained by independent variables that influence it, while the remaining 79.4% is explained by factors outside the model. This value indicates that distribution has a relatively strong influence compared to other variables, considering that in social and agribusiness research the $R^2$ value above 0.20 is considered significant enough to explain a complex phenomenon.

In the production variable (Y1), the R Square value is 0.118 or 11.8%. This means that the model is only able to explain a small part of the variation in rice seed production, while the remaining

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88.2% is influenced by other factors such as climatic conditions, cultivation technology, and farm management. The low value of the R Square often occurs due to many external factors that are difficult to control.

In this study, other variables that may have the potential to influence but are not included in the model are government policies regarding regulations, seed subsidy programs, agricultural machinery assistance, and basic grain price policies have a great influence on the sustainability of seed production and distribution. According to Feni et al., (2024) The role of the government is one of the main pillars of agribusiness in Indonesia.

Then the adoption of technology, whether in the form of new superior varieties, mechanization, or digitalization of agriculture, can accelerate production, reduce yield loss, and facilitate distribution. According to Erwin *et al*., (2024) The level of technology adoption determines the speed of modernization of the agricultural system. There are also social and institutional factors of farmers. Farmer groups, cooperatives, and partnership networks have an important role in distribution efficiency, market access, and increasing farmers' bargaining power. São Paulo *et al.,* (2024) emphasizing that institutions are the key to strengthening the agribusiness chain.

Climate and environmental conditions on climate change, rainfall, water availability, and soil fertility have a significant effect on the success of rice seed production. According to Sihombing et al., (2023) mentioned that climate is one of the biggest external factors that determine global agricultural productivity.

Limited capital and access to financing are often obstacles in the procurement of inputs, technology, and post-harvest. The support of financial institutions or banks can be an important variable that drives agribusiness sustainability (Masturi et al., 2021).

As well as access to infrastructure and logistics such as roads, transportation, storage warehouses, and distribution facilities are important variables that determine market and distribution efficiency. According to Fauzi, (2025) Logistics infrastructure is part of the value chain that determines the competitiveness of products.

#### 4.5.1.1. Hypothesis Testing

On hypothesis testing is used *Bootstrapping* to determine the influence between variables through the significance value between variables shown by the value *P-Value.* When the value *P-Value* < 0.05, it can be interpreted that endogenous variables have a significant effect on exogenous variables. Meanwhile, if the P-Value > 0.05, the endogenous variable does not have a significant effect on the exogenous variable (Berba & Olivia, 2022).

Table 5. P-Value Results

| | P Values | Conclusion |
|---|---|---|
| Distribution (Y2) -> Market Subsystem (X4) | 0,517 | Insignificant |
| Input Subsystem (X2) -> Production (Y1) | 0,039 | Significant |
| Harvest and post-harvest subsystems (X3) -> distribution (Y2) | 0,007 | Significant |
| Market Subsystem (X4) -> Consumers Subsystem (X5) | 0,346 | Insignificant |
| Government Subsystem (X1) -> Distribution (Y2) | 0,216 | Insignificant |
| Government Subsystem (X1) -> Production (Y1) | 0,276 | Insignificant |
| Government Subsystem (X1) -> Input Subsystem (X2) | 0,007 | Significant |
| Government Subsystem (X1) -> Harvest and Post-Harvest Subsystem (X3) | 0,000 | Significant |
| Government Subsystem (X1) -> Market Subsystem (X4) | 0,003 | Significant |

Source : Data Processed, 2025

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Based on the results of *the Path coefficient*, it can be seen that the independent variable that has a significant effect on the production dependent variable (Y1) is the input subsystem because these endogenous variables have a *P-Value* of > 0.05. Meanwhile, the independent variables that have a significant effect on the distribution dependent variable (Y2) are the harvest and post-harvest subsystems (X3) because these independent variables have a *P-Value* value of > 0.05.

Input subsystem variable (X2) has a significant effect on production (Y1). This finding is in line with conditions in the field, seed breeders use basic seeds as the basic material (breeder) for their cultivation. The availability of inputs such as high-quality rice seeds, fertilizers and pesticides in the input subsystem supports the output of seeds produced by seed breeders. The higher the quality of rice seeds used by seed breeders, the higher the quality of rice seeds produced by paying attention to the balanced use of fertilizers and pesticides. This is in line with research conducted by (Thapa & Dhakal, 2024) It shows that increasing agricultural inputs including seeds, fertilizers, pesticides, and labor can significantly increase the output of quality rice seeds.

The results of this study show that the harvest and post-harvest subsystems (X3) has a significant effect on the Distribution (Y2). Conditions in the field show that modern harvest handling is able to accelerate the process of harvesting and distributing grain to middlemen and rice millers so that the quality of grain is maintained until the processing process into rice. The faster the harvesting process, the faster farmers will prepare capital for the next planting season. Effective distribution of rice seeds will support the availability of rice seeds at agricultural input retailers located in each village to support the next planting season. This is in line with research Arends-Kuenning *et al.,* (2022). They found that efficiency and quality at the harvest and post-harvest stages greatly determine the distribution of seeds to support the next growing season.

The market subsystem (X4) showed no significant influence on distribution (Y2). This can happen because dynamic market conditions do not always directly affect distribution decisions, especially if the company's internal factors are more dominant in distribution decision-making. The market subsystem (X4) also showed no significant influence on the user subsystem (X5). This finding can occur because of the user's subsystem against other factors such as purchasing power, preferences, market competition and regulation of the market itself. This influenced them to use the rice seeds available on the market subsystem (Harli et al., 2018).

Government (X3) shows a non-significant influence on Distribution (Y2). This is in accordance with the findings of Rahman and Sari, (2021) who stated that government intervention sometimes does not have a direct impact on companies' distribution processes, especially in the private sector which has high autonomy in managing their distribution. In addition, the Government variable (X3) also has no significant effect on Production (Y1). indicates that the role of the government in regulating production is often regulatory and long-term policy, so the impact is not directly visible on daily or quarterly production.

The influence of the government on distribution, production and user subsystems in this study states that the government subsystem includes coaching, government policies in the provision and certification of seeds have a significant effect on distribution and production in seed breeding is rejected. This is because in the implementation of production and distribution in seed captivity, there is still very little guidance provided by the government. In addition, the government's policy in making it easier for seed breeders to market seeds has not been fully realized in the form of *a seed e-catalog* that can be accessed by all farmers in South Sumatra, especially in OKI Regency. Meanwhile, the policy of certifying seeds derived from seed breeding has been carried out in various seed breeders assisted by the OKI Regency Agriculture Office, but it is still limited or not optimal. Perhaps government policies or interventions are not strong enough to affect the distribution and

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production process directly in OKI Regency. This shows the need for increased policy interventions and more effective coaching programs to support the rice seed agribusiness system.

In contrast to distribution and production in rice seed breeding. The government subsystem has a significant influence on the input subsystem, harvest and post-harvest subsystem and market subsystem. This influence occurs because the policies implemented by the government are able to have a direct impact on the three subsystems. The policy of procuring subsidized fertilizer assistance and providing certified rice seeds is able to increase the availability of saprodi in the agricultural input subsystem (Nguyen et al., 2023). In addition, policies on harvest and post-harvest handling issued by the government, such as the lowest grain price policy, alsintan assistance and grain storage warehouse assistance, can have a direct impact on increasing farmers' income and maintaining the quality of grain stored to be distributed to *Offtaker* (Bisheko & G, 2024). In line with the market subsystem which is influenced by government policies related to the quality of packaged rice marketed and cheap rice assistance held by the government through Perum Bulog (Ruspayandi et al., 2022).

***Structural Equation Model***

The structural equations in the model are arranged by paying attention to the values *Path Coefficient* of each independent variable to the dependent variable. On *Path Coefficient* Every 10% increase in the independent variable leads to a variable percentage increase in the dependent variable (Li et al., 2022).

Table 6. Path *Coefficient Value*

| Item | Path Coefficient |
|---|---|
| Production (Y1)-Distribution (Y2) | 0,077 |
| Subsystem Input(X2)-Production(Y1) | -0,367 |
| Harvest and post-harvest subsystems (X3)-Distribution (Y2) | 0,318 |
| Government Subsystem (X1)-Distribution (Y2) | 0,185 |
| Government Subsystem (X1)-Production (Y1) | 0,203 |

Source : Data Processed, 2025

Based on the results of *the Path coefficient*, it can be seen that the input subsystem has a negative influence on seed production of -0.367. This shows that the availability of inputs is not directly proportional to the increase in production. This can happen because the inputs (seeds, fertilizers, pesticides) are not timely, not as needed, or low quality. This indicates the potential for misuse of input subsidies that make the impact counterproductive to production (Sopian et al., 2024).

In the subsystem, the government has a positive influence on seed production of 0.203. This positive coefficient shows that government policies play a fairly important role in increasing production. Interventions in the form of subsidies, extensions, technology support, and seed regulations provide a real boost to increase farmer productivity (Purnamasari et al., 2023).

The positive coefficient for production (0.077) indicates that the increase in rice seed production has an impact on distribution, although relatively weak. This means that increased production does increase the volume that must be distributed, but without the support of logistics infrastructure, the distribution system does not automatically improve (Qadir et al., 2024).

In the Harvest & Post-Harvest Subsystem (0.318) indicates that support in the harvest and post-harvest subsystems has a significant impact on distribution. Improved harvest efficiency, reduced yield loss, and good storage facilities ensure that production can be distributed smoothly.

In the Government subsystem (0.185), it shows that the role of the government contributes quite clearly in improving the rice seed distribution system. Policy support in the form of road infrastructure development, warehouses, and market regulations play a role in smooth distribution.

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**Agribusiness System Approach *Causal Loop Diagram* to Understand System Analysis of Interactions Between Sub-Systems**

In an effort to understand the complex dynamics that occur in rice seed breeding agribusiness systems, the *Causal Loop Diagram* (CLD) approach is used to map and analyze interactions between interrelated subsystems. This approach allows for the identification of cause-and-effect relationships as well as positive and negative feedback that affects the overall performance of the system. By visualizing the interconnectedness between subsystems such as sub-government, input sub-system, sub-production, sub-market, and sub-user, CLD provides a holistic view to see how changes in one component can impact others.

Loop dynamics in the rice seed agribusiness system is a pattern of cause-and-effect relationships that form a *feedback loop* between subsystems in the seed agribusiness chain. This loop describes how changes in one subsystem (government, input, production, market, distribution, or user) will affect other subsystems, and ultimately impact the initial subsystem. In other words, loop dynamics describe the repetitive interactions that govern the overall balance and growth of the system.

In the *System Dynamics* approach loops are divided into two main types, namely reinforcing Loop (R), which is a positive reinforcement loop that enlarges the direction of system change. In rice seed agribusiness, reinforcing loops drive sustainable growth cycles, such as the relationship between increased production and distribution and market demand.

The reinforcing loop (R1) is formed from the *flow of Government → Production → Market → Distribution → Users → Production*. This loop illustrates a positive reinforcement circle, where the stronger the government's role in regulating policies and providing support, the more rice seed production will increase. The increase in production then has an impact on availability in the market, which further smooths distribution. Effective distribution makes it easier for users (farmers) to obtain seeds, and in turn encourages increased production due to stable and recurring demand.

Thus, this reinforcing loop acts as a driver for the sustainability of the rice seed agribusiness system. reinforcing loops are positive feedback mechanisms that strengthen growth in a system. If managed properly, R1 can create a continuous growth cycle. However, without control, this cycle also has the potential to cause imbalances, such as overproduction that is not balanced with market absorption.The second is the Balancing Loop (B) which is a negative control loop that maintains the stability of the system. In rice seed agribusiness, the balancing loop functions to limit overdependence, for example, the negative relationship between input and production that reminds of the limit of efficiency.

The balancing loop (B1) occurs in the *Input → Production* relationship, which is characterized by a negative relationship. This suggests that the greater the dependence on external inputs (such as chemical fertilizers, non-local seeds, or pesticides), the lower the production efficiency. This loop functions as a controller in the system, so that there is no over-dependence on external factors that can limit production capacity. Balancing loop is a *self-regulating feedback* mechanism that keeps the system in a balanced state. In the context of rice seed agribusiness, B1 reminded that production does not only depend on the availability of inputs, but also on the efficiency of use, local technology, and the wisdom of farmers in managing resources. In other words, this loop serves to prevent over-dependence which can weaken the sustainability of production.

## CONCLUSION AND SUGGESTION

This study shows that the rice seed breeding agribusiness system in Ogan Komering Ilir Regency is mainly influenced by the input subsystem for seed production and the harvest and post-

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harvest subsystem for seed distribution. The SEM-PLS results confirm that these subsystems play a key role in determining system performance, while other subsystems exhibit weaker direct effects, so it's necessary to pay attention to the implementation mechanism to get the ideal perfomance of the agribusiness system. The CLD analysis highlights reinforcing and balancing feedback loops, indicating that production and distribution are interdependent and sensitive to input efficiency and post-harvest management. Overall, the integrated SEM-PLS and CLD approach provides a comprehensive understanding of the structural relationships and system dynamics of rice seed agribusiness.

This study recommended to strengthen harvest and post-harvest management, particularly in storage and handling facilities, to improve distribution efficiency. Government support should be more effective and targeted, focusing on training, certification, and timely input provision. Future studies should include additional factors such as climate, institutional arrangements, financing, and logistics infrastructure to enhance the sustainability of rice seed agribusiness systems.

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