Research Article

Implementation Model of Dryland Rice Business Supporting Food Security Buton Utara, Indonesia

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Abstract | Buton Utara Regency is known as the centre of dryland rice production in Southeast Sulawesi Province, playing an essential role in meeting the community's food needs with agricultural potential that continues to grow. This drives the government's commitment to making Buton Utara Regency an organic district. Dryland rice is one of the local products of Buton Utara Regency and is famous nationally and internationally. However, various phenomena cause the underdevelopment of dryland rice farming in Buton Utara Regency, including the dynamics and multiple problems surrounding the dryland rice agribusiness system in this region. Based on these phenomena, this study aims to build an implementable dryland rice agribusiness model through a systems approach based on strategic variables in each subsystem. Data collection procedures through observation, interviews, FGD (Focus Group Discussion) and documentation to collect data related to problems and actors involved in each agribusiness subsystem and to design an agribusiness model for dryland rice farming, Interpretive Structural Modeling (ISM) analysis is used. The findings of the development of dryland rice agribusiness through the approach of four agribusiness subsystems show the importance of paying attention to the problems of limited government commitment, human resources, facilities and infrastructure, and capital. The main obstacles faced include the lack of development policies, low awareness of healthy food, and minimal support for infrastructure and capital. This study can conclude that there are various problems in each agribusiness subsystem, so the model built for the development of dryland rice agribusiness does not run optimally.

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Introduction

Food security in Indonesia, especially in areas with dryland characteristics such as Buton Utara, is one of the main challenges that need to be overcome to realize sustainable agriculture and the welfare of local communities. Previous studies on the impact of climate change on the agricultural sector have shown that extreme weather conditions, changes in rainfall patterns, and increasing global temperatures hurt crop productivity, including dryland rice, which is one of the primary commodities of rural communities (Suranny *et al*., 2022; Rejekiningrum *et al*., 2022). Facing the challenges, adaptation strategies that focus on water management and selecting rice varieties resistant to dryland conditions are crucial (Rejekiningrum *et al*., 2022)). Interpretive Structural Modeling (ISM) in this study aims to build an implementation model for dryland rice farming that can increase food security in Buton Utara.

Along with the impact of climate change, optimizing water management in drylands is a strategic step. Research on water management in drylands in Indonesia shows that the availability of limited water resources can be anticipated through deep well irrigation and soil amelioration techniques (Ayu *et al*., 2022). This is in line with the conditions in Buton Utara, which has limited rainfall, so innovation in irrigation and land management is necessary to increase the productivity of dryland rice. Related studies in the Nusa Tenggara region and Lombok Island also emphasize optimizing dryland to support sustainable food security (Mulyani *et al*., 2014; Wuryantoro *et al*., 2021).

Previous research has shown that dryland farming contributes significantly to the socio-economic level of farmers, especially in areas vulnerable to climate change. West Lombok Regency, the carrying capacity of dryland farming significantly increases farmers' income (Wuryantoro *et al*., 2021; Ayu *et al*., 2022). Analysis of the supply chain and added value of rice commodities emphasizes the importance of sustainable rice production systems to strengthen food security (Taridala *et al*., 2021; Sjah *et al*., 2021). Buton Utara, developing dryland rice that considers local socio-economic aspects can help improve farmer welfare while minimizing the risk of crop failure due to fluctuating climate change.

Cultivation of dryland rice in dryland supported by agricultural technology and adaptive management systems is a strategic solution to facing food security challenges. The development of this implementation model ensures that rice varieties are adapted to local conditions, as has been studied in Southeast Sulawesi. Efforts to develop rice as a raw material for rice are essential to note. However, this rice-based food security improvement program should still consider ecological sustainability. Efforts to create food security conditions and ensure environmental (ecological) sustainability are two things that must be united (Rukka *et al*., 2020; Sasmita and Kodir, 2020). Currently, the challenges are increasingly tricky in presenting both simultaneously (Antriyandarti *et al*., 2018; Priyadi *et al*., 2020), so it requires commitment from all parties to continue to strive to achieve food security without damaging the ecological environment.

Dryland rice can be an alternative food developed in line with environmentally friendly sustainable farming. In addition to dryland rice farming with its bero system, including farming that pays attention to ecological sustainability, the food products produced are organic products that are safe for health (Rosmalah *et al*., 2019). Dryland farming can also be a solution to meet the need for rice food, which has so far been prioritized in rice fields because this farming is carried out on dryland, which has much greater potential than rice fields. In 2023, the national rice harvest area will decrease by 2.45% compared to the previous year, to 10.20 million hectares, with production decreasing by 2.05% to 53.63 million tons of dry milled grain (DMG). This is influenced by weather anomalies such as increasingly intense prolonged droughts due to climate change. Climate change, including shifts in the rainy season, causes a delay in the planting season of up to 2-3 months. The direct impact is a decrease in productivity of up to 6.5% during a specific period, as happened during El-Niño 1997/98. Long-term projections estimate a reduction in productivity of 15-25% by 2080 if mitigation measures are not taken (BPS, 2023).

Buton Utara Regency has an extensive dryland agricultural ecosystem, making it a strategic area for research on the impact of climate change on dryland rice production. This area is vulnerable to the effects of climate change, such as shifts in rainfall patterns and the threat of drought. The Buton

Utara Regency Government actively encourages research and development of agricultural systems to improve food security. Buton Utara Regency, dryland rice is one of the local products that is an icon of Buton Utara Regency, and it is famous not only at the national level but also globally (Figure 1). The Buton Utara government has widely adopted various policies to make this area an organic food barn that can contribute to national food security. Various phenomena cause the underdevelopment of dryland rice farming, including the dynamics and multiple problems surrounding this dryland rice agribusiness system. Therefore, it is necessary to build a dryland rice agribusiness model through a systems approach based on strategic variables in each subsystem, including input subsystems, farming subsystems, processing and marketing subsystems, and supporting subsystems so that the objectives of developing dryland rice farming can be achieved more effectively and sustainably. The existence and sustainability of this dryland farming are essential to note, considering that dryland farming is still the choice of some people and is a form of local wisdom that is still maintained to this day (Rosmalah, 2022).

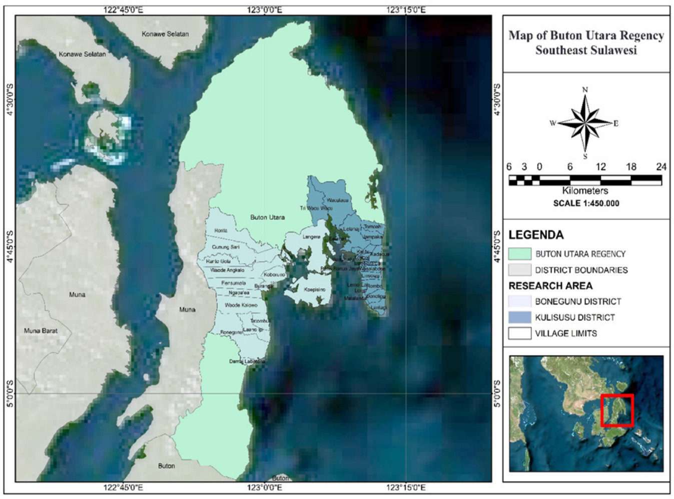

Figure 1: *Map of Buton Utara Regency, Southeast Sulawesi.*

The development of dryland rice agribusiness requires harmony of support between subsystems, which, of course, will involve stakeholders who play a role in each subsystem of dryland rice agribusiness. The role of stakeholders is not only to define the problems/ constraints faced but also to find solutions and build a shared vision about the attributes of organic farming systems and organic products, which are agricultural products (Lastariningsih *et al*., 2021; Nasikh *et al*., 2021). Organic rice farming is the development of a farming subsystem. The relationship between subsystems is very close, so if one subsystem fails, it will affect the failure of other subsystems and, overall, will affect the failure of the agribusiness system.

The development of dryland rice farming needs to be a concern in order to realize an organic, sustainable, and environmentally friendly farming system. The farming system is the community's best and most rational adaptation to its natural and social environment (Warman, 2015). Dryland rice farming can be an alternative future agricultural system, considering that this farming is cultivated on dryland, which still has great potential in Indonesia. In addition, the food products produced are organic products, which are currently very popular with the community. Research on dryland rice agribusiness has been conducted before but is only partially discussed. For example, research conducted by Kusnandar *et al*. (2013); Riry *et al*. (2021) and Sadimantara *et al*. (2021) only discusses the institutional aspect, while research related to dryland rice as a whole in the four agribusiness subsystems never been studied, even the commodities that are often studied tend more towards organic rice and do not specifically lead to dryland rice. Therefore, studies related to dryland rice agribusiness need to be examined to find a suitable model for developing agricultural agribusiness to support national food security based on local food (*Locality wisdom*).

The use of Interpretive Structural Modeling in research, such as the dynamics of causality driving the circular economy in SMEs (Oliveira *et al*., 2024), the relationship between ecosystem services and agricultural management (Villa-Cox *et al*., 2023), sustainable livelihood capital and climate change adaptation (Mobeen *et al*., 2023), structural social capital in encouraging agricultural entrepreneurship (Lang *et al*., 2023), green supply chain management (Chakraborty *et al*.,2023), emerging market perspective (Alawamleh *et al*., 2023), barriers to commercializing crops for small farmers (Tuni *et al*., 2022), sustainable waste management system in Ethiopia (Mekonnen *et al*., 2022), interpretive structural modelling of supply chains during covid-19 (Tamtam and Tourabi, 2021), supply chain collaboration on green innovation performance (Yang and Lin, 2020), and barriers to implementing green supply chain management practices (GSCM) (Jayant and Azhar, 2014).

The novelty of this study lies in the substance of the study, namely the implementation model of dryland rice agribusiness in Buton Utara Regency based on a four-subsystem approach that has never been done. In this study, the dryland rice agribusiness to be studied includes all agribusiness subsectors from upstream to downstream agribusiness. Based on the above, efforts to develop dryland rice farming in Buton Utara Regency, Indonesia, require a design of an agribusiness model that can be implemented through a structural system approach based on strategic variables in each subsystem.

Materials and Methods

This research is a descriptive study that combines qualitative and quantitative approaches (mixed methods research). This study uses an embedded concurrent method by simultaneously collecting qualitative and quantitative data. This research will be conducted in Kulisusu District and Bonegunu District, Buton Utara Regency (Figure 2), which are determined as research locations intentionally (Purposive) considering that the area is the centre of dryland rice production in Buton Utara Regency, the selection of sample villages will be carried out through the Data collection procedure method through observation, interviews, FGD (Focus Group Discussion) and documentation. The initial exploration and observation phase stage focuses on building contact meetings with local dryland farmers, community leaders (village leaders/customary leaders), dryland rice farmer groups and community members related to all dryland rice agribusiness subsystems in Buton Utara Regency. Exploration, observation and interviews are designed to collect data related to the problems and actors involved in each agribusiness subsystem, then reduce data by classifying, directing, removing unnecessary data and organizing data so that conclusions can be drawn and verified. The Interpretive Structural Modeling (ISM) method designs an agribusiness model for dryland rice farming.

Interpretative Structural Modeling (ISM) analysis identifies and maps the relationships between elements in a complex system. The initial stage involves collecting data from various sources, such as literature, expert interviews, or focus group discussions (FGDs), to identify relevant elements, such as factors, challenges, or system components. Next, these elements are compared in pairs to determine the direct relationships between elements, represented in the Structural Self-Interaction Matrix (SSIM). SSIM is converted into a binary adjacency matrix (valued at 0 or 1) to describe the direct relationships between elements. With the ISM algorithm, the analysis is carried out to construct a hierarchy or level of elements, where elements with the most significant influence are placed at the bottom level as driving factors, while elements that are more influenced are at the top level. Finally, a structural diagram is created to visualize the relationships between elements and their levels of influence in the analyzed system.

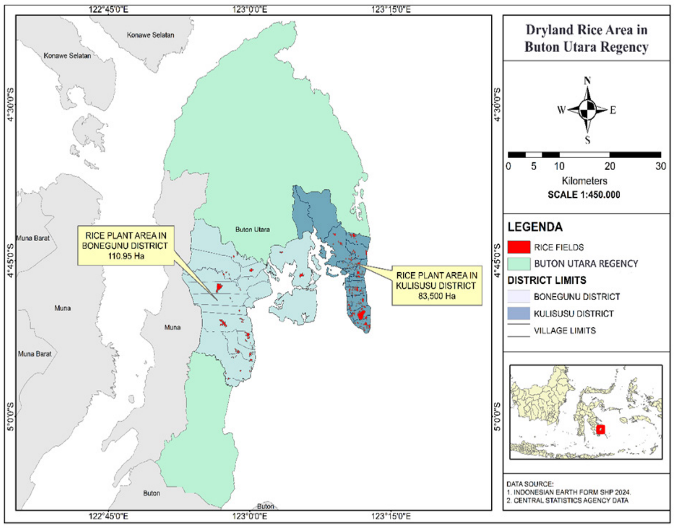

Figure 2: *Dryland rice area in Buton Utara regency.*

The Interpretative Structural Modeling (ISM) method is very effective for analyzing complex systems with many interrelated elements, making it relevant to studying climate change issues involving various biophysical, social, and economic factors, especially in a local context such as Buton Utara Regency. ISM allows the preparation of a hierarchical relationship map between elements, making it easier to prioritize the main factors that must be addressed in climate change mitigation efforts. This method integrates qualitative data, such as expert opinion, with quantitative analysis using a relationship matrix, resulting in a comprehensive and structured analysis to support evidence-based decision-making.

Results and Discussion

Problems in each subsystem of dryland rice agribusiness that cause the dryland rice agribusiness to not develop in Buton Utara Regency

Input provision subsystem: The results of the literature study and brainstorming conducted by

several experts showed that the problems that occurred in the input subsystem include:
A1: availability of seed production facilities, organic fertilizers, organic pesticides; A2: capital limitations; A3: availability of labour; A4: price of dryland rice production facilities; A5: limited human resources for farmers; A6: new technology/innovation.

Based on these results, fundamental problems and the priority order of issues in the input subsystem were identified based on ISM (Interpretive Structural Modeling) analysis (Figures 3, 4), resulting in the following results:

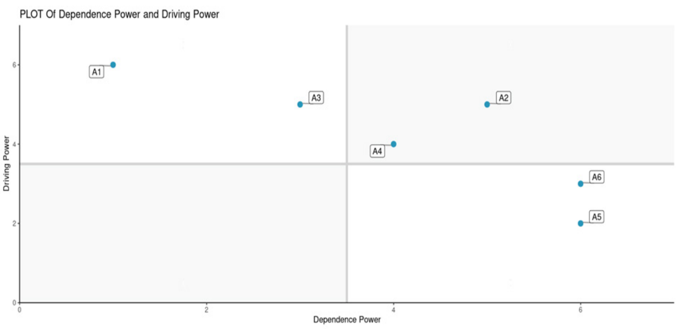

Figure 3: *ISM graph.*

Figure 4: *Graph level for constraints or problems in the input subsystem.*

Based on the analysis using interpretive structural modelling (ISM), the critical problems in the input subsystem that can affect the sustainability and development of dryland rice agribusiness (dryland rice) are the availability of seed production facilities, organic fertilizers, and organic pesticides. Farmers still find it difficult to obtain superior seeds due to the lack of access to information related to certified superior seeds. The seeds obtained by farmers are from setting aside some of the remaining harvests in each harvest season, so the quality of the seeds used has not been scientifically tested; they are only tested based on the farmers' experience. This is experienced by almost all dryland farmers who cultivate dryland rice. Generally, the seeds grown by farmers come from the informal sector, namely in the form of grain set aside from part of the previous season's harvest, which is done repeatedly. In addition, dryland farmers also need organic fertilizers and organic pesticides to maintain the brand of dryland rice products as organic products. This isn't easy and limits the production cycle carried out by farmers because the nutrients they utilize are still obtained from natural processes, namely through the bero method, which takes a long time.

The ideal fallow or land rest period is between 3 and 4 years to restore land fertility, so this causes farmers to have to stop the cultivation process on the same land and wait for the land to be processed for replanting. Currently, land used for dryland rice farming is limited and is widely converted to corn fields, plantations and even mining. This condition requires farmers to apply organic fertilizers and use organic pesticides to restore soil fertility more quickly. Another obstacle in the input subsystem is limited capital and labour. Generally, the capital farmers own comes from the accumulation of income from savings from farming and other income outside of agriculture. This is what is used as business capital. Income from this sector is insufficient because farmers in cultivation are still subsistence-oriented. The labour used still relies on family labour and existing social capital, namely the tradition of exchanging help between farmers in the planting and harvesting.

Farming/ cultivation subsystem
The problems faced in the cultivation subsystem are identified as follows:
A1: field layout; A2: limited quality of human resources; A3: land limitations; A4: land status; A5: lack of workforce; A6: capital constraints; A7: OPT control; A8: limited government assistance; A9: lack of government commitment; A10: lack of supporting staff; A11: issue of production decline; A12: land conversion.

The key constraints or problems in the cultivation subsystem are limited human resources, limited land and limited capital (Figures 5, 6). Limited human resources are caused by the lack of assistants (extension workers) because extension workers are given areas of guidance, generally more than 1 area of guidance, so the quality of communication, visits, and assistance are less than optimal. The number of villages in the research area, namely Bonegunu District, is 13. In contrast, the number of extension workers is five people, and the number of villages in Kulisusu District is 16 villages with seven agricultural extension workers. The government's commitment and assistance to develop dryland rice by providing supporting facilities in farming has also not been maximized.

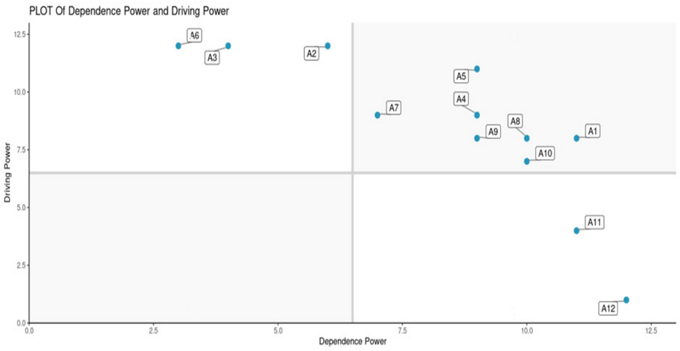

Figure 5: *ISM graph of main constraints or problems in the cultivation subsystem.*

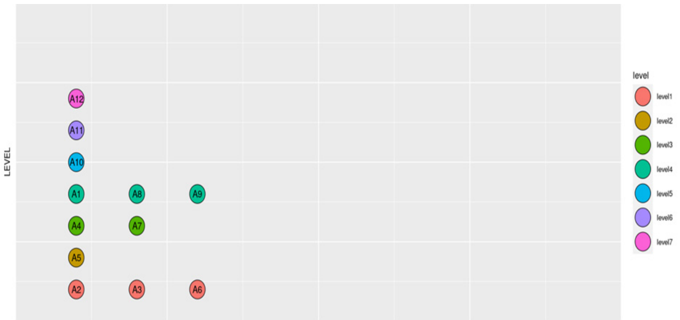

Figure 6: *Graph level for problems in the cultivation subsystem.*

The policies issued by the government tend to change and do not focus on solving problems surrounding dryland rice agribusiness (dryland rice). The policy of switching commodities to yellow corn, which was encouraged in 2022, threatens the sustainability and development of this dryland rice agribusiness. Organic red rice products from Buton Utara Regency have been known domestically and abroad. The limited land owned by farmers is also a key constraint in the cultivation system because farmers generally only have 1 or 2 locations of field land (Rosmalah, 2022; Rosmalah *et al.*, 2022) so that it affects the cultivation cycle because the dependence on nutrients still relies on the fallow process (fallow farming system).

Processing and marketing subsystem

The constraints faced by farmers in the marketing subsystem include:

A1: the low purchasing power of the community; A2: lack of public awareness of healthy food; A3: lack of consumer confidence; A4: lack of farmers' marketing skills; A5: limited equipment and infrastructure; A6: capital constraints; A7: no certification yet; A8: lack of market and price guarantees; A9: lack of support from the government.

The analysis results using the interpretive structural modelling (ISM) method are explained in the following ISM graph (Figures 7, 8).

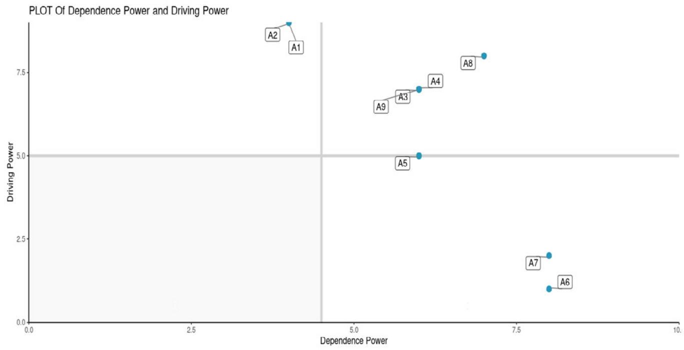

Figure 7: *ISM graph of constraints on the processing and marketing subsystems.*

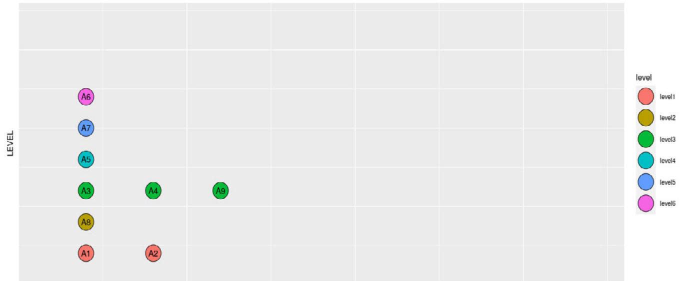

Figure 8: *Graph of key constraint levels in the processing and marketing subsystems.*

The main problems faced in the marketing subsystem are low purchasing power and lack of awareness of healthy food. Maintaining the existing consumption culture is one of the inhibiting factors in people's motivation to switch to organic food. In addition, age characteristics and education levels affect people's awareness of switching to and buying organic food (Wang *et al.*, 2023) and the culture of following other people's consumption patterns (Liang *et al.*, 2024; Cummins *et al.*, 2014). These two problems are the main problems faced in the agribusiness subsystem of dryland rice marketing, which is organic rice. Cummins *et al.* (2014) stated that public awareness of organic food will affect purchasing power for organic products. This is in line with research (Wang *et al.*, 2023), which states that different individual characteristics, family characteristics, health status, quality of will, social trust, and market education are essential factors in consumer health awareness.

Supporting subsystems

Activities that play a role in developing another dryland rice agribusiness:

A1: lack of government commitment; A2: inadequate infrastructure; A3: high cost of certification; A4: lack of market information; A5: financial institutions do not yet support; A6: limited number and quality of PPL; A7: weak farmer groups; A8: lack of the role of community leaders; A9: lack of the role of universities; A10: organic technology has not spread to PPL and farmers.

The main problem faced in the supporting subsystem of dryland rice agribusiness is the lack of government commitment and adequate facilities and infrastructure (Figures 9, 10). Dryland farmers in Indonesia have almost the same characteristics throughout the region. Farming culture, limited capital, knowledge derived from local wisdom and straightforward farming methods are the main characteristics and obstacles if left as they are without support and commitment from the government in the form of policies that favour the quality of human resources, technological innovation and facilities and infrastructure that support its sustainability. Until now, dryland farmers can still exist with minimal conditions (Rosmalah *et al.*, 2019, 2022), so dryland rice agribusiness has not experienced significant development and tends to stagnate.

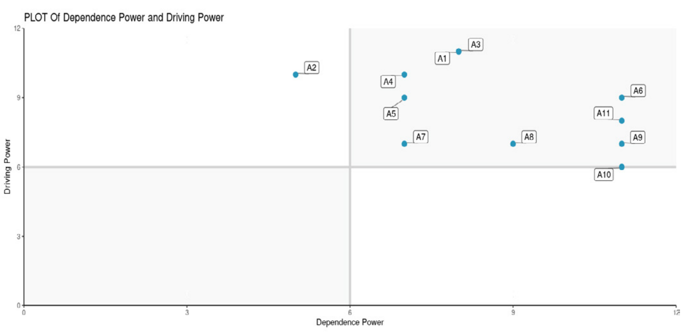

Figure 9: *ISM graph of constraints on supporting subsystems.*

Figure 10: *Graph of key constraint levels on supporting subsystems.*

The development of dryland rice farming needs to be a concern in order to realize an organic, sustainable, and environmentally friendly farming system. The dryland system is the community's best and most rational adaptation result to its natural and social environment (Warman, 2015). Although dryland farming is a traditional farming system that is considered primitive, in reality, this farming system is still practised in various regions of Indonesia and even the world (Devendra and Thomas, 2002; van Vliet *et al.*, 2012; Mukul and Herbohn, 2016); so that it is proven that this dryland farming system still survives in all conditions.

Agribusiness model of dryland rice

The implementation model in dryland rice agribusiness in this study will answer the problems that are the main obstacles by providing an activity model needed for each dryland rice agribusiness subsystem related to dryland rice agribusiness in each agribusiness subsystem, namely the structure or activity model required and the institutions that play a role in each subsystem.

Input subsystem

The activities required include:

A1: provision of organic production facilities; A2: provision of agricultural tools and machinery; A3: provision of capital; A4: provision of workforce; A5: counselling; A6: training; A7: mentoring; A8: field monitoring; A9: empowerment of farmer groups; A10: increasing the number and quality of PPL.

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

Driver Power Rank Dependence Hierarchy

A1 1 1 1 1 1 1 1 1 1 1 10 1 3 6

A2 1 1 1 1 1 1 1 1 1 1 10 1 3 6

A3 1 1 1 1 1 1 1 1 1 1 10 1 4 5

A4 0 0 0 1 1 1 1 1 1 1 7 2 10 1

A5 0 0 0 1 1 1 1 1 1 1 7 2 8 3

A6 0 0 0 1 1 1 1 1 1 1 7 2 6 4

Figure 11: *Canonical matrix of activities required in the input subsystem.*

Based on the analysis (Figures 11, 12), it was found that the critical activities needed by farmers in the input subsystem are the provision of production facilities or inputs, agricultural tools and machines, and capital.

Activities related to the input subsystem are related to the production facilities used to carry out cultivation activities. The development model (Figure 13) related to the activities required in the input subsystem based on the canonical matrix is described as follows:

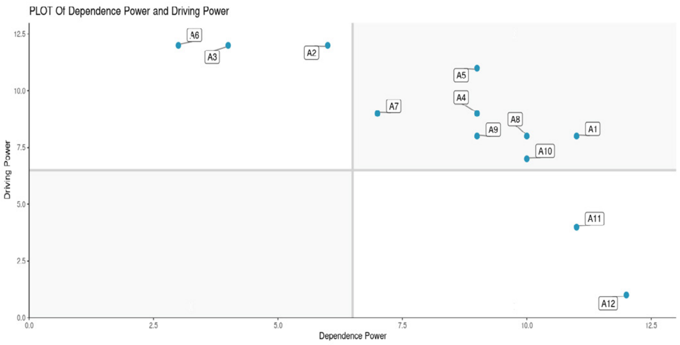

Figure 12: *ISM graph of activities required in the input subsystem.*

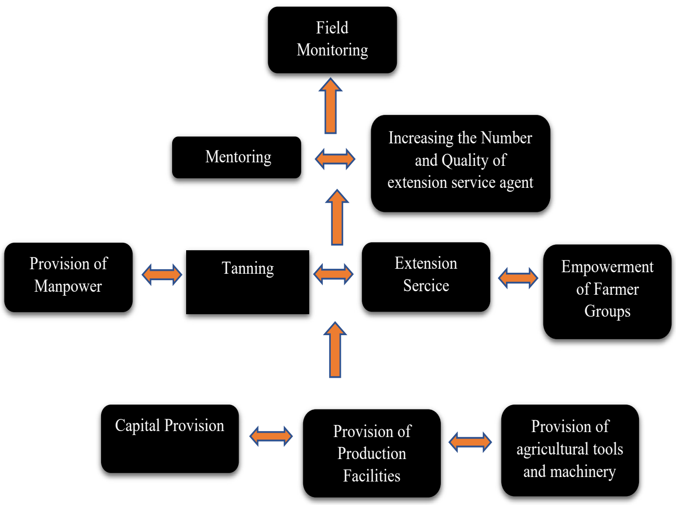

Figure 13: *Implementation model of dryland rice agribusiness in the input subsystem.*

Cultivation subsystem

Activities required in the cultivation subsystem include:

A1: counselling; A2: training; A3: mentoring; A4: provision of production facilities; A5: provision of agricultural tools and machinery; A6: provision of capital assistance; A7: land boundary settings; A8: OPT control; A9: empowerment of farmer groups; A10: formation of cooperatives.

The analysis results based on the ISM graph (Figure 14) are described as follows. Hierarchically, the development model (Figure 15) based on these critical activities is described in the canonical matrix. The implementation model (Figure 16) is based on the required activities.

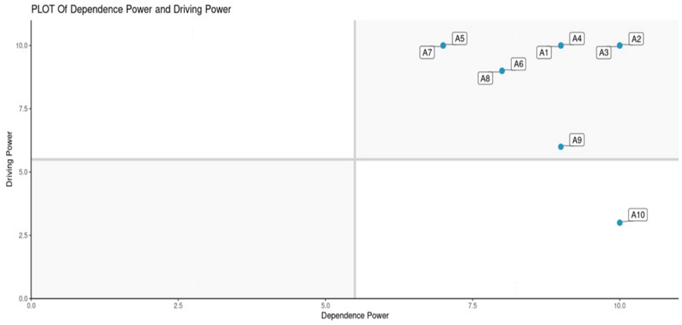

Figure 14: *ISM graph of activities required in the cultivation subsystem.*

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12

Driver Power Rank Dependence Hierarchy

A1 1 1 1 1 1 1 1 1 1 1 1 1 12 1 5 6

A2 0 1 1 1 1 1 1 1 1 1 1 1 11 2 5 6

A3 0 0 1 1 1 1 1 1 1 1 1 1 10 3 5 6

A4 0 1 0 1 1 1 1 1 1 1 1 1 10 3 9 3

A5 1 1 1 1 1 1 1 1 1 1 1 1 12 1 6 5

A6 1 0 0 1 0 1 1 1 1 1 1 1 9 4 8 4

A7 1 1 1 1 1 1 1 1 1 1 1 1 12 1 11 2

A8 1 0 0 1 0 1 0 1 1 1 1 1 8 5 8 4

A9 0 0 0 1 0 0 1 0 1 1 1 1 6 6 9 3

A10 0 0 0 0 0 0 1 0 0 1 1 1 4 7 12 1

A11 0 0 0 0 0 0 1 0 0 1 1 1 4 7 12 1

A12 0 0 0 0 0 0 1 0 0 1 1 1 4 7 12 1

Figure 15: *Canonical matrix of activities required in the cultivation subsystem.*

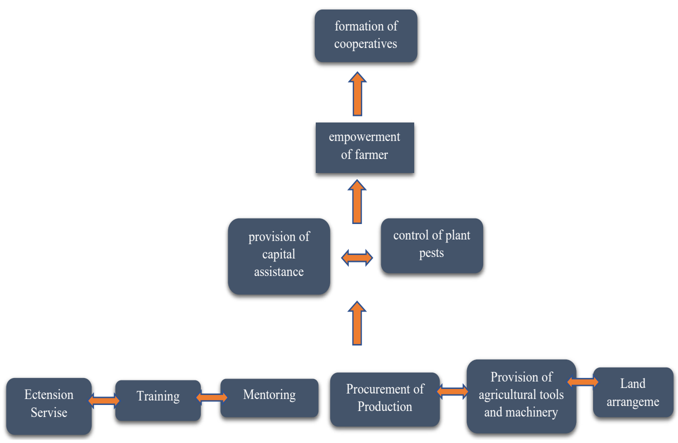

Figure 16: *Implementation model in cultivation system.*

The development of dryland rice agribusiness begins with improving key activities, namely extension, training, mentoring, provision of production facilities, agricultural tools and machinery and land management. These activities have a significant driving force that affects the implementation of other activities. Controlling plant pests, empowering farmer groups and establishing cooperatives require serious and intensive assistance for farmers, considering the limited knowledge based on experience gained from generation to generation. Access to capital sources and other supporting sources will also be provided through extension, training and mentoring, as well as the provision of agricultural inputs, agricultural machinery and land management, which can be obtained through facilitation by extension workers to related institutions and helping to build partnership networks between farmers and other competent parties such as capital institutions or cooperatives and Bumdes.

Marketing and processing ssubsystem

Based on the constraints or problems faced in the marketing and processing subsystems, the agribusiness development model in this subsystem refers to the following activities.

A1: certification; A2: provision of market information; A3: price guarantee; A4: promotion; A5: partnership; A6: supervision; A7: provision of capital assistance; A8: empowerment of farmer groups; A9: establishment of red rice outlets; A10: improve transportation facilities; A11: formation of cooperatives.

The results of the ISM analysis (Figures 17, 18) are explained in the ISM chart.

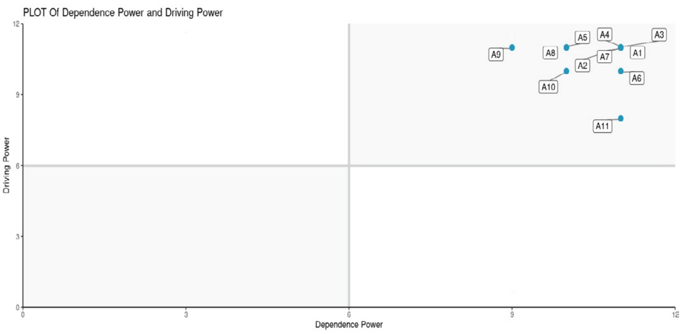

Figure 17: *ISM graph of activities required in the processing and marketing subsystem.*

The implementation model (Figure 19) that can be built in the dryland rice agribusiness marketing and product processing subsystem based on the canonical matrix is as follows.

The main activities critical to developing organic rice agribusiness are product certification guarantees, access to market information, price guarantees by policymakers, building partnership networks, product promotion, capital assistance, and establishing organic brown rice outlets. Product certification guarantees are necessary because brown rice products produced from dryland farming are not all certified with an organic label. This is very important for product brands that can be sold in local or national markets and internationally. Certification will also increase the status of brown rice to be more guaranteed in quality, thus encouraging consumers to buy without hesitation. Market information is essential for identifying consumer preferences towards products. Price guarantees must also be standardized to maintain market price stability for organic brown rice products. Partnerships need to be expanded, and promotions need to be increased after a quality guarantee in the form of product certification. In addition, adequate capital assistance and the establishment of brown rice outlets will play a vital role in developing dryland rice agribusiness.

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13

Driver Power Rank Dependence

A1 1 0 0 0 1 0 1 1 1 1 1 1 1 9 4 12

A2 1 1 1 1 1 1 1 1 1 1 1 1 1 13 1 6

A3 1 1 1 1 1 1 1 1 1 1 1 1 1 13 1 4

A4 1 0 0 1 1 0 1 1 1 1 1 1 1 10 3 10

A5 1 1 1 1 1 0 1 1 1 1 1 1 1 12 2 9

A6 1 1 1 1 1 1 1 1 1 1 1 1 1 13 1 3

A7 1 1 0 1 0 0 1 1 1 1 1 1 1 10 3 7

A8 1 0 0 1 0 0 0 1 1 1 1 1 1 8 5 8

A9 1 0 0 1 1 0 0 0 1 1 1 1 1 8 5 11

A10 1 1 0 0 1 0 0 0 1 1 1 1 1 8 5 10

A11 1 0 0 1 1 0 0 0 1 0 1 1 1 7 6 11

A12 1 0 0 1 0 0 0 0 0 0 0 1 1 4 7 12

A13 0 0 0 0 0 0 0 0 0 0 0 0 1 1 8 13

Figure 18: *Canonical matrix of activities required in the processing and marketing subsystems.*

Supporting subsystems

The activities required in the supporting subsystem to develop an implementation model for dryland rice agribusiness include:

A1: preparation of dryland rice development program; A2: coordination between agencies and farmer institutions; A3: research; A4: counselling; A5: training; A6: mentoring; A7: provision of facilities and infrastructure; A8: provision of capital assistance; A9: partnership; A10: promotion; A11: empowerment of farmer groups; A12: formation of cooperatives.

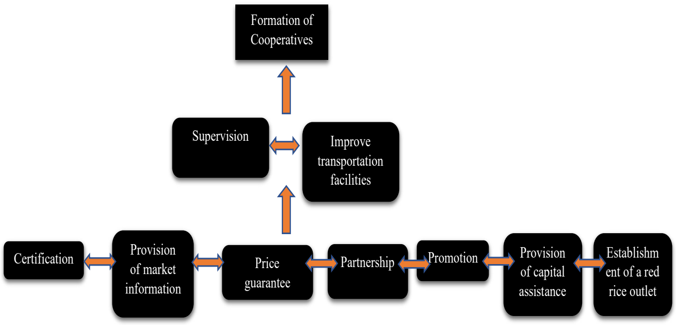

Figure 19: *Implementation model of dryland rice in the processing and marketing subsystem.*

The results of the ISM analysis (Figure 20) related to the dryland rice agribusiness development model based on supporting subsystems are explained in the ISM graph.

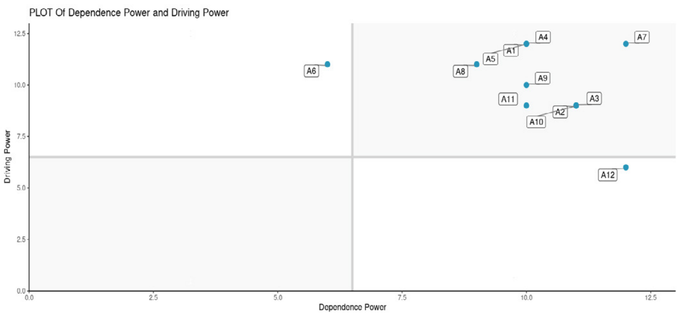

Figure 20: *ISM graph of activities required in the supporting subsystem.*

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	Driver Power	Rank	Dependence	Hierarchy
A1	1	1	1	1	1	1	1	1	1	1	1	1	12	1	10	3
A2	1	1	0	0	0	1	1	1	1	1	1	1	9	4	11	2
A3	1	1	1	0	0	0	1	1	1	1	1	1	9	4	11	2
A4	1	1	1	1	1	1	1	1	1	1	1	1	12	1	10	3
A5	1	1	1	1	1	1	1	1	1	1	1	1	12	1	10	3
A6	1	0	1	1	1	1	1	1	1	1	1	1	11	2	6	5
A7	1	1	1	1	1	1	1	1	1	1	1	1	12	1	12	1
A8	1	1	1	1	1	0	1	1	1	1	1	1	11	2	9	4
A9	1	1	1	1	1	0	1	0	1	1	1	1	10	3	10	3
A10	1	1	1	1	1	0	1	1	0	1	0	1	9	4	11	2
A11	0	1	1	1	1	0	1	0	1	1	1	1	9	4	10	3
A12	0	1	1	1	1	0	1	0	0	0	0	1	6	5	12	1

Figure 21: *Canonical matrix of key activities in the supporting subsystem.*

Hierarchically, the critical activities required for dryland rice agribusiness development (Figure 21) are described in the canonical matrix.

The development model (Figure 22) based on supporting subsystems is compiled using the ISM graph and the following canonical matrix.

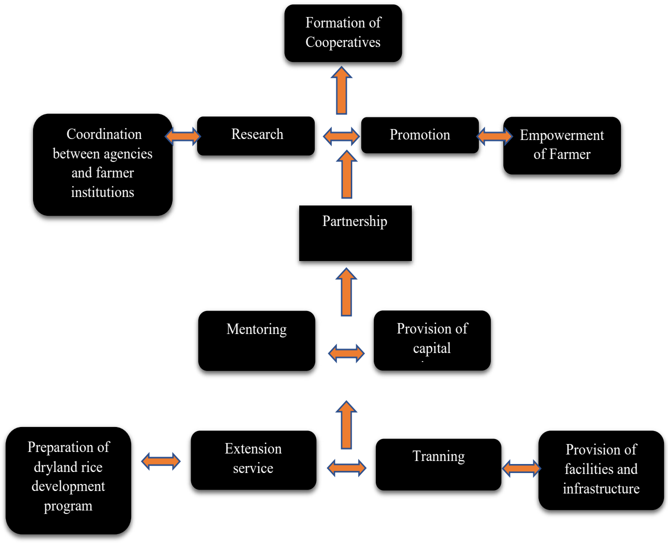

Figure 22: *Implementation model of dryland rice agribusiness in supporting subsystem.*

Key activities that influence the development of dryland rice agribusiness in the supporting subsystem are preparing dryland rice development programs, extension, training and provision of facilities and infrastructure. The preparation of dryland rice programs is closely related to extension and training activities. This is an inseparable part because the programs issued by the government in the form of agricultural sector development policies include farmer empowerment in the form of extension and training.

This was also stated by Nuraini *et al.* (2016) in their research related to organic rice agribusiness institutions in the supporting subsystem that the most critical supporting institutions are financial institutions, water user farmer associations, or agricultural extension institutions, certification institutions, both international and national and government support through its policies to provide facilities and facilities and infrastructure to support the development of organic rice farming. Therefore, in the dryland rice development model, these three activities are a unity that always goes hand in hand. Provision of facilities and infrastructure, as well as providing capital assistance, can also be part of the dryland rice development program, which is essential to prioritize in the form of policies to facilitate farmers access to capital and the use of agricultural tools and other infrastructure to help smooth the running of farming businesses.

Conclusions and Recommendations

The development of dryland rice agribusiness through the approach of four agribusiness subsystems is essential to see the problems and opportunities that can be the basis for improvement and growth. Each subsystem has different issues. The main obstacles that cause organic rice farming to be less developed are the lack of government commitment, farmers limited human resources, facilities and infrastructure, and limited capital. The government's ongoing concerns about a decline in dryland rice production have resulted in the absence of a specific policy for developing dryland rice farming and a lack of infrastructure support. The lack of quality human resources of farmers causes a lack of knowledge and awareness of environmental sustainability, and low awareness of healthy food causes people's purchasing power for organic products such as dryland rice to be still low. The limited human resources of farmers and limited capital cause a low bargaining position in marketing, so the market and price of organic rice are not yet guaranteed. Farmers also need capital to procure inputs and cover the costs of more intensive rice cultivation. To improve the quality of farmers' human resources, increasing the number and quality of PPL is vital in determining the development of organic rice farming. Capital support from banks is essential and can be done by forming cooperatives that aim to carry out joint marketing to improve bargaining positions and expand marketing. Specific and practical recommendations for improving the implementation of dryland rice farming in North Buton Regency are as follows: (1) increasing the availability of superior seeds, (2) optimizing the use of agricultural technology, (3) strengthening farmer institutions, (4) diversifying agricultural systems, (5) improving agricultural infrastructure, and (6) incentive policies.

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Novelty Statement

The uniqueness of this research is rooted in its focus on developing an implementation model for dryland rice agribusiness in Buton Utara Regency, utilizing a four-subsystem approach that has not been explored before. This study comprehensively examines the agribusiness chain, covering all subsectors from upstream to downstream activities.

Author's Contribution

Sitti Rosmalah: Research planning, field data collection, drafting research concepts and methodology.
Hartati, Harianti: Data collection coordinator.
HR: Data analysis and statistics.
Selvi Diliyanti Rizki: Model development.
Rustam: Economist.
La Ode Muh. Munadi: Socio-economic data collection.
Rina Astarika: Environmental and ecological approach.
La Ode Jabuddin: Policy evaluation.
Abdul Rizal: Data processing and writing assistance.
Muh. Obi Kasmin: Field assistance.
Muhtar Amin: Editor and reviewer.

Conflict of interest
This research has no conflict of interest regarding funds, organizations, government, or other higher education institutions.

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