DEVELOPMENT OF ORGANIC-BASED RICE FARMING ON THE ECOSYSTEM AND CULTURE OF SUBAK IN BALI

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Abstract

Green Revolution technology changed the behavior of farmers from low-input traditional rice farming to high-input modern rice farming, which had implications on the use of excessively synthetic fertilizers and pesticides, degradation of rice fields, and the extinction of some local paddy varieties which had high-quality rice. This is contrary to the global issue of food security, which requires high-quality rice products with safety assurance of the absence of pesticide residues and other synthetic chemicals, before entering the international market. The solution on the fourth is back to nature by cultivating environmentally friendly technology through organic-based Cicih Gondrong rice farming. This study aims to facilitate and educate rice farming using the local resource (compost from cattle manure, grass, and rest crop and Cicih Gondrong rice), and reduction of external input. Further rice intensification technology through an approach of eco-farming and subak culture wisdom to improve the efficiency of input allocation toward more profitable and sustainable rice farming. The methods of survey and demonstration plots are used to arrange production functions and efficiency tests on Cicih Gondrong rice *farming. The demonstration plot of organic-based rice farming using specific techniques of cultivation. This blended method is expected can produce a model development of organic-based* Cicih Gondrong *rice farming on the ecosystem and culture of subak. The significance: (1) to enrich the Agribusiness Management with ecocultural based rice farming (2) the improvement and conservation of local rice farming to increase productivity and profitability and sustainability of rice farming in subak and strengthen Bali's local secure food*.

Keywords: *Cicih Gondrong; Culture; Efficiency; Organic-based; Subak*.

INTRODUCTION

Since 1972, rice cultivation in Subak, Bali, has undergone major changes with the introduction of the early rice varieties IR5 and IR8, which are one of the Green Revolution programs (driven by petrochemical fertilizers and pesticides and made affordable by farmers through subsidies. Pesticides, easy credits financed by the development of national oil revenues. The start of the Green Revolution led to many positive impacts, namely rice self-sufficiency in 1984 (Firdaus et al., 2020). But since 1990, the Green Revolution has caused many negative impacts, such as B. increasing economic inequality between poor and rich farmers, the extinction of a large number of

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local rice varieties, soil pollution with pesticides and physical damage, biological fertility and soil chemistry (Nugraheni, 2014). This phenomenon causes farmers in subak to suffer more and be marginalized because the productivity and income of their rice farming business decreases (Sendra, 2017). This phenomenon is further exacerbated by the rapid growth of tourism in the capital city of Bali, resulting in changes in the level of land, water, earthworks, and very high cash capital activities from the agricultural sector to the tourism sector (Chou & Universtiy, 2017).

Although the introduction of superior rice varieties has been carried out intensively, there are still several farmers in Bali who survive in local rice cultivation, namely in Jatiluwih Village, Belulang Subcommittee and Wangaya Beta in Tabanan and Suday, Suwug, Sinabuni, Sawan and Busungbiu Regencies. Buleleng has a cultivation area of more than 250 ha per year. Cultivated rice is a variety that has been cultivated for decades and is now selected by nature in Buleleng Regency which is known by the local community as Cicih Gondrong rice (Astarini et al., 2020). Cicih Gondrong local rice cultivation is favored by farmers because it has good adaptability to optimal and suboptimal land, good rice taste, fragrant aroma, rotting quickly, good rice quality and average productivity compared to the productivity of newer rice varieties bcompetition. The planting period of Cicih Gondrong rice is relatively short among all types of local rice in Bali, about 115 days.

Changes in subtask preferences for planting new rice varieties are now starting to occur (He et al., 2021). Some advanced and subaltern farmers dislike new rice varieties because they require intensive cultivation, high input costs (chemical-synthetic fertilizers and pesticides) and more labor, the taste of rice is not good, and the price is cheap. Corresponding to Subak's ecosystem and culture to implement sustainable agriculture and subak. Although local cultivars respond very well to organic and synthetic fertilizers and are certainly tested for their resistance to pests and diseases, they are an invaluable collection of genetic resources (Wang et al., 2018).

According to research Kardi (2015) Althoughlocal cultivars respond very well to organic and synthetic fertilizers and have certainly been tested for their resistance to pests and diseases, they are very valuable genetic material. Appropriate technology for organic rice cultivation using selected rice varieties Cicih-Gondrong should be applied intensively and comprehensively in Subak to expand and implement good agricultural practices for the rich biodiversity in rice fields and increase the productivity and income of rice cultivation. This research was conducted to reduce the volatility of production and income of rice farming businesses and integrate organic rice farming using local varieties of Cicih Mumps into the subak ecosystem and culture.

Therefore, the study was conducted with the aim of: (1) Analyze the technical efficiency of Cicih Gondrong organic rice farmers and their economic efficiency. (2) Analyze the cost and return (R/C) of organic cultivation of Cicih Mumps rice. (3) Describe the subak ecosystem and culture that supports the development of organic-based Cicih Gondrong rice farming; and (4) Designing a model for the development of Cicih Gondrong rice cultivation based on organic subaqueous ecosystems and cultures.

RESEARCH METHODS

Data and analytical methods

This research utilized data from the intensive study conducted in Sawan district, Buleleng regency, and in Penebel district, Tabanan regency, Bali. The main data collection was conducted with a survey of some farmers who used organic-based rice farming (Fertilizers were: Organic, Urea, and NPK, and also without pesticides). The survey also collects data for the description of the ecosystem and culture of the subak. Demonstration plots of organic-based rice farming were conducted to complete data for estimation of the production function of Cicih Gondrong organic-based rice farming. The demonstration plots were tested on 4 rice field plots, each with an area of 30 acres, and used the moving rice seeds technique with the planting model of Legowo 2:1 which was 40 cm and 20 cm row spacing and the distance between rows of plants in the lane was 10 cm (see Figure 1). The interrupted water supply (intermittent irrigation) through the making of a trench around each of a maximum of 250 m2. Fertilizers were: Organic, Urea, and NPK. Subak community involvement through participatory rural appraisal (PRA).

The population is all farmers participating in the Subak culture in Bali, who grow rice conventionally or organically (Lorenzen, 2015). Meanwhile, the sample is a group of farmers who were randomly selected from the population to become respondents in the study (Odoh & Nwibo, 2017). The selection of the sample must be done in a representative manner to ensure that the results of the study can be generalized to the larger population (Etikan et al., 2016).

Figure 1
Cicih Gondrong rice with the planting model of Legowo 2:1

Cobb-Douglas production function was chosen as a functional relationship between *Cicih Gondrong* rice production and its variable inputs of land and fertilizers. The Log form of its production function was as one of the data compression techniques used to reduce the size of the data by utilizing the presence of repeated patterns in the data. This technique works by representing these repeating patterns in a shorter format, so that the size of the data can be significantly reduced without losing important information.

In general, RLB divides data into a series of runs (paths) each run consisting of the same data value repeated n times, where n is the consequential sum of those same data values (Kiang et al., 2021). Each run is then represented by two values, namely the same data value and the length of the run.

Some of the assumptions made in the application of RLB are that the data to be compressed contains considerable repeating patterns, so this technique is used effectively. In addition, RLB can significantly reduce the size of the data only if the data to be compressed has sufficiently repeatable characteristics.

$\text{Log } Y = \alpha + \beta_1 \text{Log}X_1 + \beta_2 \text{Log}X_2 + \beta_3 \text{Log}X_3 + \beta_4 \text{Log}X_4$

Estimation of this production function used *Maximum Likelihood Estimation* (MLE). MLE is more suitable for use in data that has a complex distribution, while OLS and GMM are usually suitable for use in data that has a normal distribution. Since this study involves the subak ecosystem and culture in Bali, the data used may have a complex distribution, so MLE is more suitable for use method in *Software Frontier 4.1*.

Table 1
Definition of operational variables for the rice production function

Variable	Code	Definition	Measurement scale
Production	LogY	The logarithm of rice production	kg
Land area	Log X_1	The logarithm of planted area	are
Organic	Log X_2	The logarithm of Organic fertilizer	kg
Urea	Log X_3	Logarithm of Urea fertilizer	kg
NPK	Log X_4	The logarithm of NPK fertilizer	kg

RESULTS AND DISCUSSION

Research on the development of organic agriculture in the subak ecosystem and culture in Bali can provide benefits for the development of sustainable and environmentally friendly agriculture, as well as maintaining the local wisdom of Balinese subak culture.

Production functions and efficiency on organic-based Cicih Gondrong rice farming

The demonstration plots of organic-based Cicih Gondrong rice farming produced 1.298 tons of rice per 30 acres or gave productivity of 4.324 tons of rice/ha with a profit of Rp 7,260,300.00 per 30 acres or gave income productivity Rp 24,201,000.00/ha. The excess of organic-based rice cultivation was an increase in organic matter and biodiversity that were the potential to increase the productivity and income of rice farming in the next planting season. Through the participatory rural appraisal of these demonstration plots afterward, the farmers could plan, implement, utilize, and assess organic-based rice farming methods.

The production function was analyzed from 22 samples of Cicih Gondrong organic-based rice farming (18 samples from farmers and 4 samples from the demonstration plots). The average production of 22 samples was 1.688 tons. To produce this amount, the average inputs allocated were: Planted area of 43.2 acres, Organic fertilizer of 2.8 tons, Urea fertilizer of 52 kg, and NPK fertilizer of 54 kg therefore the average productivity was 3.906 tons of rice/ha. The average dose of inputs was: Organic fertilizer 6.5 tons/ha, Urea fertilizer 120 kg/ha, and NPK fertilizer 125 kg/ha.

The result of frontier production function analysis on the Cicih Gondrong rice production (Table 2) indicated that factors Planted area (X1), Organic fertilizer (X2), and NPK fertilizer (X4) were significant. The regression coefficients of these factors are positive indicating that utilization of these factors could be increased to make rice production more efficient. The factor Urea fertilizer (X3) was not significant. The technical efficiency of 22 samples of Cicih Gondrong organic-based rice farming had an average of 0,963 with a standard deviation of 0.0301 or a variant coefficient of 3.13%. The average technical efficiency of 0,963 was lower than 1 (one), indicating that the technical efficiency among the rice farming was not efficient yet, so it was possible to add the quantity of some inputs Planted area, Organic, and NPK fertilizer which allocated to increase Cicih Gondrong rice production. The average technical inefficiency (1-TE) = 0,037 indicated some failures to use organic-based technique and to allocate some variable inputs in achieving maximum rice production

Table 2
The result of estimating frontier production function on the Cicih Gondrong organic based rice farming

Variable	Coefficient	t-ratio	Significance
Constant	1.895	5.13	0.000
LogX_1 (Planted area)	0.642	2.06	0.053
LogX_2 (Organic fertilizer)	0.166	2.05	0.055
LogX_3 (Urea fertilizer)	-0.535	-0.85	0.403
LogX_4 (NPK fertilizer)	0.673	2.19	0.041
Log-likelihood	50.287		
Average technical efficiency (TE)	0.963		
Average technical inefficiency (1-TE)	0.037		
Return to scale (RTS)	0.946		

Variant coefficient 3.13% indicated that the technical efficiency among organic-based rice farming was rather same level (producing techniques were rather stable). The average technical efficiency (TE) of these 22 samples of Cicih Gondrong organic-based rice farming was 0.963, with average actual production (QY) of 1.688 tons in an average area of 43.2 acres or productivity of 3.906 tons rice/ha, but its average potential production (QQ) was 1.841 tons or productivity 4.260 tons rice/ha. This case indicated that the actual rice production was lower than the potential rice production, so it was very required some effort to increase rice production.

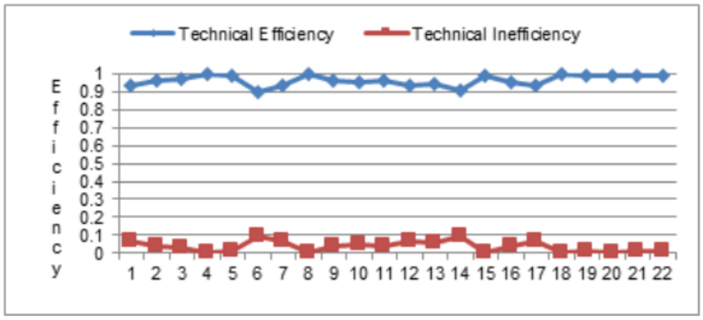

Figure 2
The technical efficiency and technical inefficiency of 22 samples organic-based Cicih Gondrong rice farming

The result of the allocative efficiency analysis for the Cicih Gondrong rice farming production (Table 3) indicated that the ratio marginal value productivity per input price for several inputs: Planted area, Organic fertilizer, and NPK fertilizer lacked efficiency (> 1), but input Urea fertilizer was not efficient (< 1). The average allocative efficiency of these 4 inputs (PE) was 1.532, and so the economic efficiency (EE = TE.PE) was 1.475 (not yet efficient). Therefore, to improve the total efficiency or to achieve economically efficient for the organic-based Cicih Gondrong rice farming (production and profit close to maximum level), the allocation of the inputs should be increased from the doses: Planted area 43 acres, Organic fertilizer 6.5 ton/ha and NPK fertilizer 125 kg/ha. Input Urea fertilizer should be decreased from 120 kg/ha.

Table 3
The price/allocative efficiency and economic efficiency of the organic based Cicih Gondrong rice farming

Variable	Regression Coeficient	Ratio NPM_x /P_x	Efficiency
Constant	1.778		
$LogX_1$ (Planted	0.680	2.656	EH = 1.532
area)	0.239	1.724	ET = 0.946
$LogX_2$ (Organic	-0.155	-21.592	EE = 1.475
fertilizer)	0,683	23.340	
$LogX_3$ (Urea			
fertilizer)			
$LogX_4$ (NPK			
fertilizer)			

The cost and return of the organic-based Cicih Gondrong rice farming were as follows. The price of Cicih Gondrong rice in normal market order was Rp 12000,-/kg. The average return (revenue) of 22 samples of organic-based Cicih Gondrong rice farming was Rp 20,264,000.00. Its average cost was Rp 10,262,000.00, so the average profit was Rp 10,002,000.00 per 43.2 acres or gave income productivity of Rp 23,152,000.00/ha per season and the R/C ratio was 1.97. The standard deviation of the profit 22 samples organic based Cicih Gondrong rice farming was Rp 6,961,400.00 or the coefficient of variance was 30.07% (not so much variously). The whole process of organic-based Cicih Gondrong rice farming for one cycle production (from preparation to crop and milling) needed time 5 (five) months, so the average farmer's income per month was Rp 2,000,400.00 if the planted area was 43.2 acres or Rp 4,630,000.00 if the planted area one hectare.

Ecosystem and culture of subtasks in support the development of organic-based Cicih Gondrong rice farming

The vision and mission of the agricultural development in Bali are to realize a sustainable agriculture system that is capable of ensuring a dynamic food security system and advanced agribusiness system, with a low level of social costs, to satisfy all of its stakeholders (Mariyono et al., 2021). This concept of agricultural development should be continued to internalize local wisdom and local genius (tradition, belief/religion, aspiration, and culture) to agricultural exercise and practices. One of the local wisdom is the Tri Hita Karana philosophy, which is the three harmonious relations of a cause of happiness. They are: (1) Parhyangan is the harmonious relations of farmers with Paramatma/God (the source of Atma), which is largely expressed through the agricultural rituals of Subak, and agricultural practices based on the balance of ecosystems (Rwa Bhineda); (2) Pawongan is the alignment of relations among farmers through adherence to conformities and regulations (awig-awig); and (3) Palemahan is the alignment of the relationship of farmers to the environment and surrounding ecosystems. Human resources become the central determinant of the success of Tri Hita Karana appliance in agricultural development. If all these harmonious relationships are achieved, it will provide a balance in the development of rice farming in one subak entity. Therefore the implementation of agricultural technology that is truly friendly to the environment (organic-based farming) in the subak ecosystem as a pearl of local wisdom is very essential. This is a good agricultural practice.

Agricultural practice based on Atma's (highest) awareness to maintain the balance of the universe embodied in tradition, religion, aspiration, and culture of farmers in subak to achieve a true-virtuous-gorgeous (*sathyam-civam-sundharam*) life is what constitutes good agricultural practice. Points out, the organic farming system was based on the rationality that the law of natural equilibrium was the most perfect creation of God (Salikin, 2003). Humans being part of the system of the universe were not destined to be the ruler of the universe, but were responsible for preserving it (Jokilehto, 2017).

Rationality in utilizing science and technology of agriculture must be harmonious with the system of values in tradition, religion, aspiration, and culture that put humans as the most righteous creature (Ouyang et al., 2017). The problem now is that many farmers in subak ignore these worthy messages. Therefore reinforcement program for internalizing the wisdom in tradition, religion, aspiration, and culture of subak needs to be embedded in the program of increasing organic-based rice production.

Every subak has Awig-Awig. Awig-Awig is a legal product of a traditional organization (customary law) in Bali, which is generally made by consensus and serves as a guideline to behave for members of the organization. Awig-Awig is made based on fairness and propriety so that all members avoid deviations in carrying out their duties and responsibilities as well as in the use of their rights. Awig-Awig has advantages given as the product of customary law in Bali, Awig-Awig has domain knowledge, namely: ethics, physical and metaphysical of life (magic qualities), so it is more powerful to bind and believed and obeyed (Sukarma, 2016). Subak as one of the traditional organizations has Awig-Awig subak. Any irregularities or violations of agreements or decisions which have been set in Awig-Awig Subak can be subjected to harsh sanctions. With the Awig-Awig subak, it is expected to create peace and order around the subak (Sutawan, 2008).

There are still many Awig-Awig Subaks that are not written and well documented, so there is a tendency for farmers to disregard Awig-Awig, especially disregarding in the context of conservation of land and water resources to support organic-based rice farming, when they are faced with the swift currents of modern technology development and commercialization of lands and water due to the side effects of globalization. In order the ecosystem and culture of subak can well support the organic based rice farming: (1) Awig-Awig should list the rules and sanctions against pollution of pesticides and poison trash to irrigation canals and rice fields (including the imposition of strict sanctions to against Awig-Awig); (2) Awig-Awig subak should include rules to accommodate efforts to prevent changes in the function of agricultural land to non-agricultural as well as to to prevent spread of pests and diseases of plants and animals; (3) participatory all parties appraisal should be continued to make people aware of the importance of Bali local agriculture and food security by improving elements of cognitive, psychomotoric and affective of the farmers that be expanded in the forum of subak with much presenting counseling and demonstrating plots of organic-based rice farming, so that the farmers can have agribusiness behavior with high industrial culture to increase good and healthy rice and to raise the return of agricultural lands.

Model for the development of organic-based Cicih Gondrong rice farming on the ecosystem and culture of Subak

The appropriate technology package for organic-based Cicih Gondrong rice cultivation that incorporates technical and economic efficiency assessment becomes the main component for the development of organic-based rice farming in Subaks. This main component cannot run on its own and must be supported by: (1) exploration of soil biophysical characteristics and land ecosystem following Cicih Gondrong rice cultivation; (2) Cicih Gondrong seed breeding and organic fertilizer provided independently by Subak; (3) revitalization of Awig-Awig (customary rules) of Subak; and (4) adherence to Tri Hita Karana philosophy as illustrated in The Model of Figure 3. Whenever all of these components run well it is expected to produce outcomes: (1) science of Environmentally Friendly Agriculture and Management of Agribusiness through an approach of Subak cases; and (2) increasing of productivity and profit of rice farming and Bali Local Secure Food fortifying.

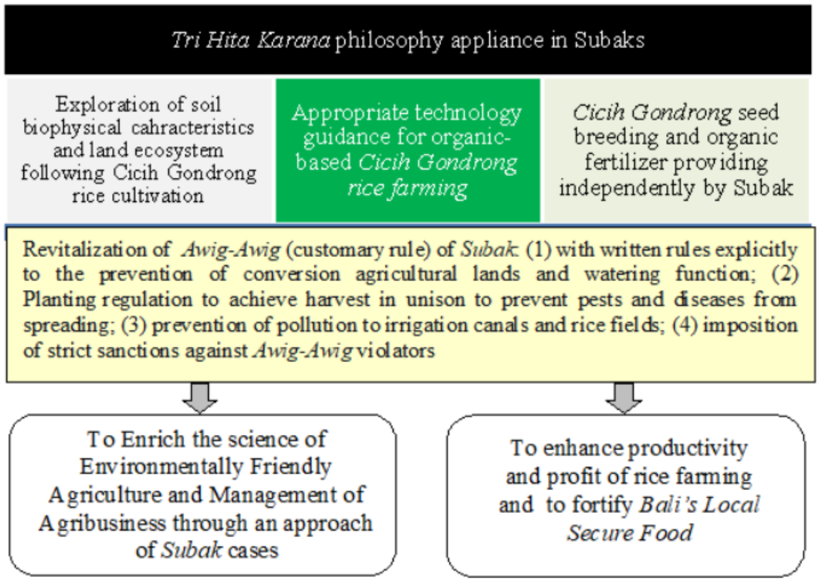

Figure 3
Model for the development of organic-based Cicih Gondrong rice farming

CONCLUSION

The ecosystem and culture of subak can well support organic-based rice farming: (1) Awig-Awig should list the rules and sanctions against pollution of pesticides and poisoned trash in irrigation canals and rice fields (including the imposition of strict sanctions against Awig-Awig); (2) Awig-Awig subak should include rules to accommodate efforts to prevent changes in the function of agricultural land to non-agricultural as well as to prevent the spread of pests and diseases of plants and animals; (3) participatory all parties appraisal should be continued to make people aware of the importance of Bali's local agriculture and food security

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