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Article

Initiation and Dissemination of Organic Rice Cultivation in Bali, Indonesia

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Abstract: Organic farming has attracted attention in Indonesia because consumers increasingly prefer the putative safety and health benefits of organic farm products. Although national standards for organic farm products were established in 2002, some products sold as organic products in supermarkets do not carry the certification mark. This study investigated organic rice farming on the island of Bali in Indonesia using fieldwork to ascertain the actual increase in organic farming. Results revealed that government certified organic farming used originally produced cattle manure to grow organic rice. At the market, however, some "quasi-organic farming" products, which had not been given the organic farming certification, were sold as organic rice. This eventuality suggests that although organic farming has been increasing steadily in Bali, development of sustainable recycling agriculture demands technical guidance and increased publicity for organic farming, based on national certification, to address misunderstandings and confusion about the definitions of organic farming and national standards that are transparent to producers and consumers.

Keywords: Bali; cattle manure; certification; conventional rice; Indonesia; national standard; organic farming; organic rice; sustainability

1. Introduction

Indonesians' staple food is rice: the most important cereal for the country. Rice production in Asian, and other countries, and regions has increased considerably by virtue of the Green Revolution, providing solutions to food shortages and reducing poverty [1]. In Indonesia, the rice yield per unit area increased approximately three-fold from 1760 kg ha^{-1} in 1961 to 5150 kg ha^{-1} in 2013. Rice harvested areas increased approximately two-fold from 6,860,000 ha in 1961 to 13,840,000 ha in 2013. Annual rice production increased nearly six-fold from 12,080,000 tons in 1961 to 71,280,000 tons in 2013 [2]. The country is currently the third greatest producer of rice in the world. Concurrently, domestic rice consumption has been increasing each year as a result of dietary changes associated with population growth and economic development, making Indonesia a leading global rice consumer [3]. Stabilization and further growth of rice production have been increasingly required in recent years, as evidenced by the occasional emergency import of rice from neighbors, such as Thailand and Myanmar.

Cultivation of productive crops through the Green Revolution has necessitated the use of large amounts of fossil energy resources for the use of agricultural machinery, chemical fertilizers, synthetic agricultural chemicals, and other inputs. It also led to various environmental problems, such as reduced biodiversity, from the use of chemicals, soil and water pollution, and eutrophication [4].

Organic farming has been attracting greater attention in recent years in Indonesia as a result of the growing preference of farmers and consumers for safety and health benefits of organic products and governmental promotion of organic products [5]. This was triggered when the Asian financial crisis struck the country in 1998, leading to measures supporting a return to a sustainable agricultural production system in balance with the environment (*i.e.*, organic farming) from a production system that was becoming increasingly dependent on chemical fertilizers at the time [6]. Farmers are deeply interested in organic farming to obtain product unit prices that are higher than those of products grown using chemical fertilizers, but with the attendant lower yields of organic farming [7]. Some supermarkets in Indonesia have set up organic rice sections, stimulating and encouraging consumer demand for organic rice. Domestically, however, the certification system has yet to be fully enforced. In Bali, in this study, for instance, "organic rice" grown in Jatiluwih, a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage site, is sold without the certification mark attached.

Indonesia's national standard agency, Badan Standardisasi Nasional (BSN), established the National Standard of Indonesia on Organic Food Systems (SNI 6729-2010) in 2002 [8]. This national standard system conforms to the Guidelines for the Production, Processing, Labelling and Marketing of Organically Produced Foods (CAC/GL 32-1999) issued by the Codex Alimentarius Commission, the international food standard commission established by Food and Agriculture Organization (FAO) and World Health Organization (WHO) in 1962 [8,9]. The certification mark was set up based on this standard system by the Komite Akreditasi Nasional [10], the national accreditation committee of

Indonesia, and Lembaga Sertifikasi Pangan Organik (LSPO), or the Institute of Organic Food Certification, certifies organic farm products. Currently, the LSPO has seven branches: LSPO Sucofindo (Jakarta), LSPO Mutu Agung Lestari (Jakarta), LSPO INOFICE (Bogor), LSPO BIOCert Indonesia (Bogor), LSPO Sumatera Barat, LSPO LeSOS (Mojokerto), and LSPO Persada (Yogyakarta). LSPO certification is required for the attachment of the certification label "Organik Indonesia" (Figure 1) to organic farm products.

Figure 1. Certification mark of organic products in Indonesia.

This study was undertaken to investigate the recent conditions of organic rice farming in Bali, Indonesia, and to identify the status of diffusion of organic agriculture.

2. Basic Information Related to Rice Cultivation in Bali

Interview survey to Agricultural Agency of Bali Province was conducted in December 2013, to assess the organic farming conditions. Basic information related to rice farming in Bali (paddy field area, yield per unit area, yield amount, rice varieties, and cropping system) was obtained from the officers' knowledge, experiences and their statistical data of Bali agriculture.

The paddy field area in Bali has been declining: from 98,000 ha in 1983 to 83,000 ha in 2003 and 82,000 ha in 2012. The primary contribution to this decline is the conversion of paddy fields into residential land, suggesting the pressure of tourism on agricultural land. An increase in young people leaving agriculture to work in tourism-related employment caused a sharp decline in the farmer population from 460,000 in 2003 to 400,000 in 2013. Approximately 60% of the 400,000 farmers were small farmers having agricultural land area of 0.5 ha or less. Approximately 80% of them had started working as a farmer after completing elementary education. The household income of full-time farmers is 1,000,000–1,500,000 Indonesian rupiahs per month (approximately 80–120 US dollars). Many of them earn additional income from selling paintings or other merchandise.

The rice planting area (double cropping) in Bali was approximately 154,000 ha in 2012, the harvested area was approximately 149,000 ha, the yield per unit area was 5.84 ton ha^{-1}, and yield amount was approximately 866,000 tons (Table 1). The difference between the planted area and harvested area was attributable to production relinquished by the farmers attributable to blast and damage from birds and rats. Adequately developed irrigation facilities contribute to the high level of yield in comparison to other regions in Indonesia [11].

Table 1. Planted area, harvested area, yield and yield amount for rice by Bali province in 2012.

No.	Regency	Planted area (ha)	Harvested area (ha)	Yield (ton ha^{-1})	Yield amount (ton)
1	Buleleng	22,852	22,359	5.75	128,616
2	Jembrana	9250	9298	6.38	59,297
3	Tabanan	40,983	39,437	5.65	222,706
4	Badung	20,754	19,708	6.13	120,754
5	Denpasar	4514	4684	6.33	29,650
6	Gianyar	31,690	30,111	5.78	174,007
7	Bangli	6180	5986	4.71	28,165
8	Klungkung	5802	5560	6.07	33,740
9	Karangasem	11,913	11,857	5.79	68,618
	Bali	153,938	149,000	5.84	865,553

Data from Bali province agricultural agency.

The variety planted the most in 2012 was Ciherang, an Indica variety rice (Table 2). Production of this variety, however, has been decreasing in recent years because of its vulnerability to blast. Instead, the proportion of the Inpari lines (high-yield and pest-resistant) developed since 2008 has been increasing. Local varieties are also grown, albeit in small areas. These local varieties include aromatic rice and red rice, such as Ijo Gading and Beras Merah, for which the yield per unit area is smaller than that of high-yielding varieties, which is highly palatable and used in Hindu ceremonies (e.g., weddings, funerals, and prayers to deities; see Figure 2a) and is, therefore, produced in all regions.

Table 2. Rice varieties and their percentage of planted area in Bali province.

No	Variety name	Type	Group	Percentage of planted area in Bali province (%)				
				2008	2009	2010	2011	2012
1	Ciherang	Indica	HYV	75.1	76.3	76.2	57.5	49.6
2	Cigeulis	Indica	HYV	8.5	9.8	10.5	-	31.7
3	IR 64	Indica	HYV	8.3	5.3	2.1	21.8	2.1
4	Tukad Balian	Indica	HYV	3.2	2.0	-	-	-
5	Local varieties	-	Local	2.1	1.8	-	-	1.7
6	Pepe	Indica	HYV	-	-	4.3	-	-
7	Intani-2	Indica	HYV	-	-	1.4	-	-
8	Inpari-6	Indica	HYV	-	-	-	5.4	-
9	Inpari-13	Indica	HYV	-	-	-	2.4	10.4
10	Inpari-7	Indica	HYV	-	-	-	2.2	-
11	Others	unclear	unclear	2.9	4.8	5.5	10.8	4.6

Data from Bali province agricultural agency. HYV: High-yielding variety; Local: Local variety.

Bali Agricultural Agency fundamentally recommends one of two production methods throughout each year: one is exclusive cultivation of rice; the other is double-cropping of rice and single-cropping of a secondary crop (*Palawija*). *Palawija* are crops secondary to rice, which include corn, peanuts, and soy beans. Conventionally, local varieties with a long growing period are cultivated during the rainy season. High-yielding varieties, such as Ciherang, are grown during the dry season.

Figure 2. Specific pictures on rice consumption and rice cultivation in Bali, Indonesia. (**a**) The rice was used in Hindu ceremonies as *canang*; (**b**) The ears were sown in nursery beds at 10 cm intervals; (**c**) Hand rotary tractors were used for paddy field plowing; (**d**) Petro Organic; (**e**) Cattle sheds; (**f**) Certified organic rice; (**g**) Fermenting the manure**;** (**h**) Manure and packaged manure products.

Table 3 presents the fertilization structure of the conventional cultivation using chemical fertilizers promoted by Bali Agricultural Agency of Bali Province and organic cultivation. Chemical fertilizer cultivation includes two types, both of which use urea or compound fertilizers and whose total nitrogen input is approximately 120 kg ha^{-1}. The current nitrogen input in Bali is approximately 1.7 times that of Japan (70 N kg ha^{-1}) in 2006 [12] and was equivalent to that of Japan (109 N kg ha^{-1}) in 1985 [13]. For organic farming, however, the government recommends using only of 500 kg ha^{-1} (4.0 N kg ha^{-1}) of the organic soil conditioner "Petro Organic" (C = 12.3%, C/N ratio = 15.2, water content = 8.2%, and pH = 8.0) supplied by the government. This organic soil conditioner is produced on the island of Java. The Bali Agricultural Agency lacked knowledge of the ingredients and components of the product.

Table 3. Fertilization system in the Bali Agricultural Agency for farmers.

Cultivation	Urea (N: 46%) (kg ha^{-1})	Phonska (N:P_2O_5:K_2O:S = 15:15:15:10) (kg ha^{-1})	TSP (P_2O_5: 48%) (kg ha^{-1})	KCl (kg ha^{-1})	Petro Organic (kg ha^{-1})
Conventional No. 1	200	200	-	-	-
Conventional No. 2	250	-	100	50–70	-
Organic	-	-	-	-	500
Price (rupiah kg^{-1})	1800	2300	2000	6000	500

Data from Bali province agricultural agency.

3. Organic Farming in Jatiluwih Village

Fieldwork was conducted in the village of Jatiluwih in the regency of Tabanan, the production center of rice, claimed as organic, that is sold widely in the Bali market. The survey took place in December 2013, when multiple farmers were interviewed about the rice varieties they grew, their cultivation methods, cropping systems, and whether they practiced organic farming. The terraced paddy fields in Jatiluwih are listed as a World Cultural Heritage Site. It is both a major rice-farming region in Bali and a popular tourist site [14]. The total area of Jatiluwih terraced paddy fields is approximately 300 ha, consisting of seven *subak*. *Subak* are Bali's traditional irrigation institutions comprising paddy field owners and cultivators [15].

Table 4 presents the cultivation methods and cropping systems reportedly used by the farmers who were interviewed for the study. The varieties grown include non-waxy and waxy local varieties in the rainy season and high-yielding varieties in the dry season. The red rice of Jatiluwih's local variety is particularly well-known. It is sold at high prices for religious services and private consumption. The cropping system is commonly double cropping. As for seed preparation, all seeds of local varieties were raised at home whereas high-yielding varieties included some purchased from seed producing farmers and some provided by the government free of charge (for low-income farm households). The methods of raising seedlings differ considerably between the local varieties and high-yielding varieties. Local varieties are planted by sowing the ears in nursery beds at 10 cm intervals (Figure 2b), whereas seed broadcasting is used for high-yielding varieties. The growing period was approximately two weeks for both types. Although water buffaloes were used for paddy field plowing in the past, hand rotary tractors are now commonly used (Figure 2c). Petro Organic (Figure 2d) and cattle manure are used for fertilization, meaning that organic farming is practiced. For the amount of Petro Organic used, many of the farmers answered "the more the better". Specific amounts of the fertilizer used could, therefore, not be confirmed. Cattle manure is produced from dung of one or two cows, which are kept and fed the weeds growing near the paddy fields of each farm household (Figure 2e). Many farmers answered that they used urea and Petro Organic for the cultivation of high-yielding varieties. Weed control for local varieties is carried out by hand-pulling the weeds to remove them. For high-yielding varieties, herbicides are used in addition to manual removal. Harvesting methods differ between those used for local varieties and those used for high-yielding varieties. For local varieties, *ani-ani*, or a small rice-harvesting hand-knife for cutting each stalk of rice separately, is used first to cut ears of rice, which are kept in a raised-floor storehouse. This method of harvesting local varieties is based on traditional beliefs [16]. High-yielding varieties are harvested through high-level cutting using a sickle

followed by threshing-by-beating (partly machine threshing) [17]. All high-yielding varieties are produced for distribution. They are sold by area to companies (rice distributors and retailers) before harvesting and are reaped by seasonal workers hired by such companies.

Table 4. Cultivation methods in Jatiluwih and Buangga.

Location	**Jatiluwih (Organic cultivation and conventional cultivation = quasi-organic farming)**	**Buangga (Organic cultivation)**
Cropping Pattern and variety	RS: Local variety (waxy and nonwaxy) DS: High-yielding variety (Ciherang, IR64, *etc.*)	RS and DS: Ciherang During RS and DS: *Palawija* (Peanuts)
Seed preparation	Local variety: Home seed-raising High-yielding variety: Purchase from nursery company or seed handouts from local government (low-income farmer)	Home seed-raising
Method of raising seedling	Local variety: Row seeding on panicle at *ca.* 10 cm intervals High-yielding variety: Broadcast seeding	Broadcast seeding Cattle manure: 2–3 kg m^{-2} Duration: 12–15 days
Paddy field preparation	Hand tractor or buffalo (mostly tractor)	Hand tractor
Fertilizer	Local variety: Petro Organic and Cattle manure (farmer's discretion) High-yielding variety: Urea 100 kg ha^{-1} and Petro Organic (farmer's discretion)	Cattle manure: 2000 kg ha^{-1}
Transplanting	Handplanting	Handplanting
Planting density	Local variety and High-yielding variety: 20–25 cm × 20–25 cm, 3 seedlings per hill	25 cm × 25 cm, 3 seedlings per hill
Weed management	Local variety: Manually High-yielding variety: Manually and herbicide	Manually (7–10 days and 1 month after transplanting)
Harvest	Local variety: ani-ani (personal consumption and selling) High-yielding variety: High-level cutting (selling, labor from Java island)	A harvest group of local people High level cutting using sickle (Personal consumption and sales)

RS, Rainy season (October–March); DS, Dry season (April–September).

4. Organic Farming in Getasani Village

Subsequently, field research was conducted in the village of Getasani in the regency of Badung, where organic farming is practiced, based on the information provided by the Bali Agricultural Agency. The survey was administered in March 2014: farmers in *Subak* Buangga ("Buangga") were interviewed about the rice varieties they grew, their cultivation methods, cropping systems, and whether they practiced organic farming. Buangga comprises approximately 200 farmers, managing a total paddy field area of 140 ha. Organic cultivation began in 2007 with an area of 10 ha. At the time

of the survey (2014), an area of 40 ha was certified as an organic farm based on the national standards (Figure 2f).

The cultivation methods and cropping systems in Buangga were investigated to ascertain the conditions of organic cultivation that had received the national certification (Table 4). Ciherang rice was grown in both the rainy and dry seasons; peanuts were grown as *Palawija* (secondary crop). A compost material called Zeorganic had been used in the past, but it lacked growth effects. Now they use only the cattle manure produced independently. This cattle manure is produced by a manure production group in Buangga consisting of 25 farmers supplying two cows each, totaling 50 cows. The cattle manure production process of is the following: (1) feed the weeds that have been pulled from around cattle sheds; (2) collect dung at the central square; (3) mix the dung, lime, and ash (residues from burning grass, *etc.*) and ferment the mixture (Figure 2g); and (4) distribute the manure mixture (one week during the dry season and one month during the rainy season) (Figure 2h). The annual compost production volume is 100–120 tons. The distribution system is such that the compost produced by the farmers is purchased by the local government for 600 rupiahs per kilogram. The product is purchased by farmers for 100 rupiahs per kilogram. In other words, the farmers reportedly receive a government subsidy of 500 rupiahs per kilogram of cattle manure allocated to the system.

Seedlings are raised by placing 2–3 kg m^{-2} of cattle manure on a nursery bed and sowing and growing seeds for 12–15 days until they are young rice-seedlings. The paddy fields use 2000 kg ha^{-1} of cattle manure. The amount of cattle manure used for paddy fields in Japan is 10,000 to 20,000 kg ha^{-1} [18]. Although varying compost quality, environment, soil, and other factors do not allow a simple comparison, the amount used in Buangga is less than that used in Japan. Weeds are controlled by manually pulling them at 7–10 days from the transplantation of young seedlings. Based on our interview to 10 farmers in Buangga, the annual yield of organic rice is approximately 5.6 ton ha^{-1}, which is nearly equivalent to the mean yield in whole Bali. The rice is harvested by a local harvesting group. Part of the harvested rice is used for private consumption.

5. Discussion

Earlier studies of organic rice farming in Indonesia have been conducted in areas such as Yogyakarta and East Java [7,19,20]. For Bali, however, few investigations have observed the entire rice cultivation on the island and research organic farming based on the national standards like in this study, except the report of MacRae (2011) [21] on organic farming from the perspective of farm management. Nagano (2010) [22] reported that, similar to the results of the present study, red rice produced in Jatiluwih was cultivated using the ancestral method that did not use agrochemicals or chemical fertilizers, which was known as the brand name Jatiluwih Rice. The fieldwork in this study, however, caused the finding that cultivation of high-yielding varieties used urea in some cases in addition to Petro Organic. The National Standard of Indonesia on Organic Food Systems (SNI 6729-2010), issued in 2002, states that "use of chemical fertilizer and pesticides must be avoided", which disqualifies paddy fields practicing organic farming in the rainy season but conventional cultivation using chemical fertilizers in the dry season for the organic farming certification. Such "quasi-organic farming" is widely practiced in Jatiluwih. The presumed reason is that, as reported by Farmia (2008) [20],

the farmers consider their agricultural products organic even when a small amount of chemical fertilizers is used in combination with organic fertilizers.

The Bali Agricultural Agency began the management of certification for organic agricultural products in 2009. Official data from interviews indicate that 25 groups were certified for organic farming during the four years between 2009 and 2013. The crops certified as organic products included rice, onion, mangosteen, bananas, dragon fruit, oranges, *etc.* Five groups were certified for organic rice farming; the total cultivation area was 191 ha. One of these five groups surveyed in this study was Buangga.

Market research at two supermarkets in Bali revealed only a single type of product carrying the certification mark out of a number of products labeled as "organic." This finding suggests a lack of recognition of the certification system despite the growing interest of producers and consumers in organic rice. The prices of these rice products labeled as "organic" in the study were 17,000–19,000 (or higher) rupiahs per kilogram irrespective of whether the certification mark was attached to them, which were higher than average prices of conventionally grown rice priced around 8500–9000 rupiahs per kilogram.

Organic agriculture has begun to increase steadily in Bali, Indonesia. Therefore, misunderstanding and confusion related to the definition and national standards were evident both among the producers and consumers. One cause is presumably the current lack of agricultural extension centers and promoters that provide guidance for the basic idea and technical aspect of organic farming in Bali. Because producers are increasingly interested in reducing the environmental burden and maintaining food safety, development of human resources and agricultural extension centers is also required to protect sincere producers. Simultaneously, publicity activities are necessary to facilitate consumers' appropriate understanding of organic products. Additionally, the quasi-organic farming practiced in Jatiluwih and other regions might be managed and promoted as "low-external input sustainable agriculture" (LEISA) [23]. Approximately 800 tons of waste materials per day are discharged in Sarbagita (the area encompassing the city of Denpasar and regencies of Badung, Gianyar, and Tabanan) in Bali, 70% of which are purportedly organic [24]. Such organic wastes include food residues from households and hotels, dead leaves from roadside trees, and other biomass. Composting such waste materials and using them for organic farming is likely to contribute to measures against environmentally conscious farming practices and development of sustainable recycling agriculture in Bali.

6. Conclusions

This study investigated the prevailing conditions of organic farming in Bali, Indonesia. The results show a steady increase in organic farming and also confusion related to organic products in the market. Agricultural human resources and extension centers must be developed. Consumers must be educated to promote and protect sustainable agriculture in Bali. An increase in low-environmental load agriculture is likely to contribute considerably to the management of environmental and waste issues of Bali.

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Author Contributions

Fumitaka Shiotsu, Nobuo Sakagami, Naomi Asagi, and Masakazu Komatsuzaki conceived the study. Fumitaka Shiotsu, Nobuo Sakagami, and Naomi Asagi designed the study. Fumitaka Shiotsu and Nobuo Sakagami conducted the research and analyzed the data under the supervision of Dewa Ngurah Suprapta, Nurwulan Agustiani, Youji Nitta and Masakazu Komatsuzaki. Fumitaka Shiotsu and Nobuo Sakagami wrote the manuscript. All authors checked and approved the final draft.

Conflicts of Interest

The authors declare no conflict of interest.

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