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SURAT KETERANGAN

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Yang bertanda tangan di bawah ini, Ketua LPPM Universitas Wiralodra, menerangkan dengan sebenarya bahwa karya ilmiah yang diajukan sebagai bahan pertimbangan kelayakan kenaikan jabatan akademik dosen, atas nama:

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Dengan data Karya Ilmiah, seperti di bawah ini:

No	Karya Ilmiah	Judul	Identitas
1	2	3	4
1	Buku Referensi	Wirausaha Budidaya Sayuran Organik Berbasis Eco Enzyme	Diterbitkan di: Penerbit K-Media, Yogyakarta. (i) ISBN: 978-623-174-905-5, (ii) Edisi: I, Oktober, (iii) Tahun terbit: 2025.
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Indramayu, 29 Juni 2026
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Tembusan:

1. Arsip

DIVERSIFICATION OF RICE SYSTEM: A SUSTAINABLE LIVELIHOOD FOR RICE FARMING HOUSEHOLDS IN INDRAMAYU DISTRICT, WEST JAVA, INDONESIA

by Wiwik Ambarsari

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ORIGINAL ARTICLE

DIVERSIFICATION OF RICE SYSTEM: A SUSTAINABLE LIVELIHOOD FOR RICE FARMING HOUSEHOLDS IN INDRAMAYU DISTRICT, WEST JAVA, INDONESIA

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Abstract: Agricultural development is a challenge and a way for sustainable livelihoods considering that increasingly narrow agricultural land causes agricultural productivity to decline. The rice diversification system is a solution to the potential by-products of rice and cattle. The purpose of this research is to explain rice system diversification in increasing farming productivity as an alternative solution. There were two secondary dataused. Rice production and beef cattle production were from the Central Statistics Agency in West Java Province and Indramayu district (2013-2017). The development of beef cattle was supported by the Organic Fertilizer Processing Unit program (2013-2017). The secondary data were analyzed descriptively. The results of this study were positive beef cattle population growth of 18.43 percent during the period 2013-2017, the average number of beef cattle per year as much as 11,012 tails, the average amount of beef cattle manure per year in solid form as much as 116,943,192 tons and liquid as much as 55,894,882 liters and the population of beef cattle still needs to be increased because the amount of solid manure of freshly available beef cattle could be absorbed as much as 3.35 percent for increased productivity of rice fields. Indonesian government assistance was very much needed by rice farmers groups in carrying out a rice diversification system through the Organic Fertilizer Processing Unit program. Furthermore, the potential for rice straw and cattle livestock to become additional income and new sustainable livelihoods for rural farming households.

Key words: Diversification, Farming productivity, Rice system, Livelihood sustainability, Farmer household.

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1. Introduction

Livelihood sustainability is a challenge and a solution to sustainable agricultural development.Livelihood diversification is one of the livelihood sustainability strategies for farmer households in fulfilling their lives in rural areas [Conway and Chambers (1992), Ellis (2000)]. Livelihood sustainability strategies include agricultural intensification and extensification, livelihood diversification, and migration [Scoones (1998)]. Remittances from migrants are an alternative strategy to continue the livelihoods of poor and vulnerable farmer households and encourage the sustainability of agricultural development [Budi Kusumo *et al*. (2023)]. The government has carried out efforts to increase rice production through integrated crop management programs, such as Integrated Disease and Pest Field Schools (IDPFS) and the rice system [Ministry of Agriculture Republic of Indonesia (2017)]. Diversification of the rice system is an integration of rice farming and livestock with both poultry (duck or fish) and ruminants (cattle, goats, buffalo, sheep). Examples are the integrated rice–duck farming [Suh (2014), Teng *et al*. (2016), Xu *et al*. (2017)]; fish-paddy [Islam *et al*. (2015), Prajanti and Susilowati (2016)];

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rice-fish-duck [Nayak *et al*. (2018)], rice-cattle or buffalo [Lindawati *et al*. (2018), Nainggolan *et al*. (2019)]. Agricultural integration interacts eco-biologically interdependence from the output of one product with the production of another product as an input of the other in space and time, it supports each other [Soni *et al*. (2014)].

Diversification of rice systems provides increased productivity as a source of income for small family farmers [Rapsomanikis (2015)]. Sustainable food systems from diversification of rice systems through integrated farming with the technological transfer so that more holistic objectives can be considered [Shilomboleni *et al*. (2019)]. Besides, innovations provided by human resources are the main drivers of sustainable rice farming [Roy *et al*. (2014)]. Rice farmers have the opportunity to participate in various programs to increase rice production. The development of rice production by province in Indonesia from 2013 to 2017 shows that rice production experienced positive growth in Indonesia by 14.17 percent [Ministry of Agriculture (2017, 2018)]. The average rice production has reached 75.65 million tons over the past five years in Indonesia. West Java is one of the centres of rice, which experienced a positive production growth of 3.60 percent [Ministry of Agriculture (2017, 2018)] can be seen in Table 1.

Data in Table 1 shows that rice production experienced positive growth in Indonesia by 14.17 percent from 2013 to 2017. The average rice production has reached 75.652.246.60 tons over the past five years in Indonesia. West Java is one of the centres of rice, which experienced a positive production growth of 3.60 percent. Rice production by the district in West Java can be seen in Table 2.

Agricultural integration has an impact on increasing income. Indramayu produced the highest rice production with an average value of 1.59 million tons over the past five years. However, the growth of rice production decreased by 17.21 percent in Indramayu from 2013

Table 1: The Rice Production (tons) by The Province in Indonesia (2013-2017).

Province	**Production (tons)**					**Average**	**Growth 2017 over 2013 (%)**
	2013	**2014**	**2015**	**2016**	**2017**		
East Java	12,049,342	12,397,049	13,154,967	13,633,701	13,185,414	12,88,094.60	9.43
West Java	12,083,162	11,644,899	11,373,144	12,540,550	12,517,736	12,031,898.20	3.60
Central Java	10,344,816	9,648,104	11,301.422	11,473,161	11,420,881	10,837,676.80	10.40
South Sulawesi	5,035,830	5,426,097	5,471,806	5,272,081	6,016,016	5,444,366.00	19.46
North Sumatera	3,727,249	3,631,039	4,044,829	4,609,791	5,145,204	4,231,622.40	38.04
Others	28,039,310	28,099,277	30,051,673	31,825,483	33,097,200	3,222,588.60	18.04
Indonesia	71,279,709	70,846,465	75,397,841	79,354,767	81,382,451	75,652,246.60	14.17

Source: Ministry of Agriculture (2017 and 2018).

Table 2 : The Rice Production (tons) by The District in West Java (2013-2017).

District	**Production (tons)**					**Average production (tons)**	**Growth 2017 over 2013 (%)**
	2013	**2014**	**2015**	**2016**	**2017**		
Indramayu	**1,684,753**	**1,625,179**	**1,465,741**	**1,800,444**	**1,394,772**	**1,594,177.60**	**-17.21**
Karawang	1,147,212	1,122,582	1,188,633	1,260,290	1,679,300	1,279,603.26	46.38
Subang	1,022,571	964,845	1,028,009	1,273,133	1,323,110	1,122,333.59	29.39
Sukabumi	767,668	897,485	842,654	963,925	920,895	878,525.40	19.96
Majalengka	707,038	675,713	654,045	767,434	872,294	735,304.80	23.37
Others	6,753,920	6,359,095	6,194,062	6,475,325	6,327,365	6,421,953.55	-6.32
West Java	12,083,162	11,644,899	11,373,144	12,540,550	12,517,736	12,031,898.20	3.60

Source: Ministry of Agriculture, 2017 and 2018; The Central Bureau of Statistics (CBS) West Java Province, 2015, 2016, and 2017; The Central Bureau of Statistics (CBS) Indramayu District, 2014, 2015, 2016, 2017, and 2018; The Central Bureau of Statistics (CBS) Majalengka District, 2014, 2015, 2016, 2017 and 2018; The Central Bureau of Statistics (CBS) Subang District. 2014, 2015, 2016, 2017, and 2018; The Central Bureau of Statistics (BPS) Sukabumi District, 2014, 2015, 2016, 2017 and 2018.

to 2017 (Table 2). The decline in rice production will have an impact on the income of rice farmers. The most of rice production is declining due to the effects of global climate change [Nuraisah and Kusumo (2019)]. Global climate change has an impact on the risk of crop failure occurring, pest attacks increase, rice yields decrease, and farmers' incomes decrease [Nuraisah and Kusumo (2019)]. Besides, improper handling of harvest and post-harvest can increase the shrinkage of rice production so that rice production will decrease [Soemantri *et al*. (2016)]. An integrated farming system of fish-crop-farms is influential in securing their home economy. Farmers do the separation of their generated based on market demand to ensure that their income is quite a month in Magelang [Prajanti and Susilowati (2016)]. Likewise, integrated farming systems on coconut and beef cattle systems involving food crops produce higher revenues, 117.22 percent to 129.17 percent than coconut-beef cattle systems, or 215.05 percent to 236.97 percent uninterested coconut and beef cattle systems in Minahasa [Rundengan *et al*. (2014)].

The government assists the increasing production of farmers through the Program of Organic Fertilizer Processing Units (OFPU). It becomes an additional source of income for rice farmers [Martmono *et al*. (2013)]. Ministry of Agriculture provides instruction on technical implementation as a reference in implementing the activities of the development of the Organic Fertilizer Processing Unit (OFPU) for farmers. It is expected to produce organic fertilizer and cattle farms sustainability [Ministry of Agriculture (2018)]. The sustainable Integrated Bio-cycle Farming System (IBFS) is a good approach for integrating multi-sectors for multiple multi sectors (agricultural, horticultural, plantation, forestry, livestock, fisheries, and others) can be integrated through a sustainable integrated Bio-cycle agricultural system approach to producing food, feed, fuel, fertilizer, pharmacy, education, eco-Tourism and others [Agus *et al*. (2011)].

Agricultural diversification provides a role in increasing farmers' production and income and maintaining a sustainable environment. Diversification of agricultural systems is defined as a deliberate agricultural practice, the absence of biodiversity. The goal is to maintain existing ecosystems as important agricultural inputs, namely soil fertility, pest and disease control, efficient water use and pollination. Various existing Diversification Farming System (DFS) concepts are concerned about overlapping, namely sustainability, multifunctional, organic, or eco-farming [Kremen *et al*. (2012)]. The results of research in Amerika continent show that the diversification of the agricultural system provides a better environment and does not harm the community than the conventional Peruvian system [Kremen and Miles (2012)]. Good environment from diversification of the agricultural system, such as biodiversity, soil quality, carbon absorption, soil water resistance capacity, energy used by efficiency and resilience to climate change. Also, various agricultural systems can improve the control of the weed, disease, and arthropod pests, improving the service of pollination [Kremen and Miles (2012)]. Integration of several crops and livestock in agricultural production systems for food production and high agricultural profitability, is a form of diversified farming done in India [Meena *et al*. (2018)]. The combination of business in the system of diversification of agriculture is a plantation of paddy + irrigation + betel vines than more profitable and feasible others [Gasson (1988)]. The others such as paddy + pulse + dairying + poultry, paddy + vegetables + dairying, paddy + irrigation plantation + rain plantation + dairying, irrigation plantation + dairying and padi + irrigation + flowers [Gasson (1988)]. The study in Amerika states that the family experience of ranchers affects the survival of family partners working off-farm [Mishra and Goodwin (1997)]. A government capital subsidies program is beneficial to small families in Kansas to survive as the profession of farmers gain income from off-farm as a diversified form of agricultural business [Mishra and Goodwin (1997)].

Agricultural productivity has an impact on income. Productivity is the ratio of output volume to input usage volume [OECD (2001a)]. Productivity measurement aims to see technical changes, perform efficiencies to maximize company profits, and cost savings in production [OECD (2001b)]. The productivity of the agricultural sector at the commodity level can be measured through intermediate inputs (seeds, fertilizers and pesticides), key inputs (factors of production, such as labor, soil and capital) and certain outputs. Farmer-level productivity is measured from agricultural production on main crops (holding), land area and by-products. By-products are agricultural waste that can be utilized after going through certain technical processes, such as hay used for animal feed and livestock manure into manure for fertilization [FAO (2017)]. Agricultural productivity on land can be improved through nutrition management [Rehman *et al*. (2019), Yuniarti *et al*. (2019)], diversification of crops [Burchfield and Poterie de la (2018), Makate *et al*. (2016)] and livestock [Karunarathna and Wilson (2017)], intercropping and groundwater management [Kamdi *et al*. (2020)]. Fertilizer provision, improved seed distribution and credit distribution greatly affect agricultural gross domestic product [Rehman *et al*. (2019)].

Capital assistance from government programs to small family breeders has been done in previous research. This research used the data of government assistance programs, namely the Program of Organic Fertilizer Processing Units (OFPU), aimed at rice farmers in the rice group. This study describes the potential area of by-products of rice straw waste and cattle populations in a quantitative descriptive manner that is still rarely found in previous studies. This study aimed to investigate agricultural productivity through a rice diversification system from government assistance to rice-livestock farming households. Agricultural productivity in the diversification system can see result of quantitative descriptive analysis of potential by products of rice straw and cattle populations in Indramayu District, West Jawa.

2. Methods

The research method used was the descriptive approach. The Organic Fertilizer Processing Unit (OFPU) program according to the Department of Agriculture and Horticulture of Indramayu District has been received by 62 groups of rice farmers from 31 sub-districts in Indramayu District in the form of 620 beef cattle and organic fertilizer making machines [Agriculture and Horticulture Office in Indramayu District (2017)]. This program was implemented gradually during the period 2013-2017. Research data was sourced from the Central Statistics Agency, namely rice production and beef cattle population. The secondary data were analyzed descriptively. Research results were then discussed using appropriate literature.

3. Results and Discussion

Indramayu District produces the most massive rice production in West Java, so it is dubbed rice barns. The average production in Indramayu reached 1,59 million tons from 2013 to 2017. Gantar became the district that gave the highest contribution to rice production compared to other communities in Indramayu District over the past five years. Gantar's contribution to rice production is 7.30 percent of all rice production in the Indramayu District. The second and third highest rice contributors after Gantar Sub-District were Kroya and Cikedung in Indramayu District from 2013-2017. Kroya contributed was to rice production by 6.09 percent. Cikedung contributed was to rice production by 5.7 percent. The growth of rice production in the Indramayu District decreased by 17.21 percent from 2013 to 2017, and only a small number of districts did not experience a decline in production. Sub-districts that have not experienced a decline in productivity growth during the last five years, namely Sindang (8 percent), Cantigi (15.12 percent), Pasekan (10.54 percent), Arahan (16.37 percent) and Sukra (1.21 percent). Rice Production in Indramayu District from 2013 to 2017 can see in Table 3.

3.1 Potential of Rice Straw and Beef Cattle Population

The average straw rice was produced by 1 to 1.2 times (22.0±5.1 tons per ha per year) of rice production (18.8±2.9 tons per ha per year) [Van *et al*. (2014)]. Data in Table 3 shows that the highest average rice production per year is in Gantar, as much as 116,408.17 tons, so the average amount of rice straw in Gantar reaches 116,408.17 tons per year to 139,689.80 tons per year. The potential for rice straw is sufficient as a source of fibre for beef cattle feed during the dry season in the Gantar. Rice straw as a dry material consumption as much as 3.51 kg per tail per day or equivalent to 1.27percent of body weight can increase the body weight to 0.25 kg per day [Wiyatna *et al*. (2012)]. Data Table 4 shows that Gantar has an average number of beef cattle of 3,249.80 heads, so the need for dry feed for rice straw is 11,406.80 kg per day 4,163,481.27 kg per year. If the average amount of rice straw is taken from the lowest 116,408.17 tons, the remaining rice straw feed needs are 116,396,763.20 kg per day or 112,244,688.73 per year. The potential for rice straw is an opportunity to increase the number of beef cattle in Gantar, reaching 27.95 times from the initial amount to 90,862.25 heads (Table 4). Thus, the potential for rice straw in Indramayu District is 1,594,177.60 tons (Table 3), an opportunity for the number of beef cattle to reach 1,244,995.27 heads from the average number of initial beef cattle of 11,011 tails for the last five years (2013-

Table 3: The Rice Production (Tons) by Sub-District in Indramayu District (2013-2017).

Sub-District/ District	Production (tons)					Average production (tons)	Growth 2017 over 2013 (%)
	2013	2014	2015	2016	2017		
Haurgeulis	67,898.56	66,693.67	47,290.36	68,448.32	40,460.92	58,158.37	-40.41
Gantar	118,680.95	118,275.13	102,507.34	134,248.79	108,328.65	116,408.17	-8.72
Kroya	91,790.14	98,796.93	93,244.99	119,525.56	82,386.92	97,148.91	-10.24
Gabuswetan	86,084.59	85,334.90	69,539.35	90,809.27	69,758.01	80,305.22	-18.97
Cikedung	93,187.43	92,725.05	92,355.14	90,109.27	86,778.85	91,031.15	-6.88
Terisi	85,583.69	72,779.21	74,328.17	91,017.58	69,679.11	78,677.55	-18.58
Lelea	79,057.62	74,740.87	74,722.01	75,214.70	70,977.10	74,942.46	-10.22
Bangodua	50,345.30	41,421.56	48,062.36	56,190.99	34,511.26	46,106.29	-31.45
Tukdana	67,234.13	54,815.28	63,334.69	71,381.67	39,000.97	59,153.35	-41.99
Widasari	36,864.71	46,133.50	44,925.68	40,835.28	28,363.36	39,424.51	-23.06
Kertasmaya	41,947.69	42,306.19	43,435.83	47,061.76	33,758.69	41,702.03	-19.52
Sukagumiwang	42,374.57	38,749.46	39,127.86	45,627.24	28,798.21	38,935.47	-32.04
Krangkeng	60,152.38	55,783.40	33,455.52	66,062.50	43,547.28	51,800.22	-27.61
Karangampel	29,341.51	29,623.66	22,192.91	32,709.84	20,781.20	26,929.82	-29.17
Kedokanbunder	32,171.91	29,902.66	25,487.98	31,377.74	24,717.86	28,731.63	-23.17
Juntinyuat	58,112.43	58,439.00	46,652.38	62,400.34	47,123.41	54,545.51	-18.91
Sliyeg	54,103.70	57,899.01	48,617.45	64,533.97	53,500.05	55,730.84	-1.12
Jatibarang	45,778.12	43,861.29	41,327.08	44,008.16	38,600.54	42,715.04	-15.68
Balongan	25,619.90	30,861.29	17,474.03	28,095.49	15,224.38	23,455.02	-40.58
Indramayu	19,877.80	18,169.53	17,983.11	22,890.06	18,959.67	19,576.03	-4.62
Sindang	23,535.07	15,872.63	16,587.68	30,215.25	25,417.41	22,325.61	8.00
Cantigi	17,738.22	17,992.70	10,382.84	21,108.54	20,419.62	17,528.38	15.12
Pasekan	11,558.33	7,048.92	7,569.30	12,314.38	12,776.70	10,253.53	10.54
Lohbener	35,462.60	34,190.21	24,699.18	36,207.73	32,078.62	32,527.67	-9.54
Arahan	26,716.80	29,027.16	23,860.35	36,504.09	31,089.14	29,439.51	16.37
Losarang	73,558.91	69,288.27	55,605.35	75,029.60	69,081.15	68,512.66	-6.09
Kandanghaur	78,322.80	55,879.69	50,136.77	74,466.51	54,035.99	62,568.35	-31.01
Bongas	60,877.57	55,105.53	56,310.10	62,713.60	38,095.60	54,620.48	-37.42
Anjatan	89,187.62	90,266.72	101,828.05	96,623.83	64,970.31	88,575.31	-27.15
Sukra	51,735.20	48,831.50	35,509.30	40,666.54	52,359.50	45,820.41	1.21
Patrol	32,852.58	45,641.90	37,186.81	32,008.63	39,191.10	37,376.20	19.29
Indramayu	**1,684,753.00**	**1,625,179.00**	**1,465,741.00**	**1,800,444.00**	**1,394,772.00**	**1,594,177.60**	**-17.22**

Source: The Cental Bureau of Statistics (CBS) Indramayu District, 2014, 2015, 2016, 2017, and 2018.

2017).

3.2 Bran, Groats and Rice Husks of the Rice Mill

Rice milling processing milled dry grain (MDG) produces rice and waste (by products). Rice husk (15-20percent), Rice Bran (8-12 percent) and Rice Brewer (± 5 percent) are the side products made from rice milling [Widowati (2000)]. The average amount of each MDG waste per year (2013-2017) in the three highest rice-producing districts and Indramayu District is presented in Table 5.

The data in Table 5 shows that rice waste in the form of milled dried grain (MDG) is abundant in Indramayu District. Average MDG waste production over the last five years (2013-2017) amounted to 239,126.64 tons of husks, 127,534.21 tons of bran 79,708.88 tons of groats in Indramayu District. MDG waste is potential as a source of raw materials of the animal feed industry or advanced food.

The groats, bran/bran, and rice husks can be further processed into food, feed ingredients and organic

Table 4: The Average amount of Rice Straw and Potential of the Beef Cattle Population in Gantar, Cikedung, Terisi Sub-District and Indramayu District.

No	Sub-District/ District	Average rice production, 2013-2017	The average amount of rice straw (ton)	The average number of beef cattles	Use of rice straws		Remaining rice straws		Potential of the beef cattle population
		(ton of MDG per year)	One time of rice production *	(tails)	3.51 kg/ head/day	(365 days) kg /total/ year	Ton/total/day	Kg/total/year	(tails)
1	Gantar	116,408.170	116,408.170	3,249.80	11,406.80	4,163,481.27	116,396.763	112,244.689	90,862.25
2	Cikedung	91,031.150	91,031.150	1,432.60	5,028.43	1,835,375.49	91,026.122	89,195.775	71,054.25
3	Terisi	78,677.550	78,677.550	2,132.20	7,484.02	2,731,668.03	78,670.066	75,945.882	61,411.66
4	Indramayu	1,594,177.600	1,594,177.600	11,011.60	38,650.72	14,107,511.34	1,594,138.949	1,580,070.089	1,244,333.29

Source: *Mishra and Goodwin (1997), taken the lowest figure and processed it by authors.

fertilizers. Rice groats can be used as a mixture to make the ultrarice containing high calcium, hard-made texture, and the rice was soft to fulfil the spasm iciness of calcium nutrient intake for Indonesian people [Wariyah (2010)]. Rice bran becomes a mixture to make the analogue rice rich in protein and has a high fibre content [Kurniawati (2013)]. Also, rice bran can be processed as a mixed ingredient to make functional food, which is analogue rice that has low glycemic content [Noviasari *et al*. (2015)]. Rice bran as a source of protein for beef feed as much as 2 kg plus 1 kg *Indigofera zollingeriana* produces the best performance. Waste rice husk can be utilized as husk charcoal, biobriket, and bokashi to make dependence on chemical fertilizers, and wood fuels decreased [Sari *et al*. (2017)]. Thus, rice waste, both rice straw, and paddy rice, is not wasted and becomes a useful by product for rice farmers in increasing agricultural productivity.

The data in Table 3 shows a decline in rice production in Indramayu District, from 2013 to 2017 of 17.21 percent. This decline in rice production has resulted in a decrease in rice farmer yields. The rice diversification system is one way to increase agricultural productivity. This rice diversification system supports OFPU activities for rice farmers, namely beef cattle and organic fertilizer processing equipment. Beef cattle that have been given to farmer groups through support from OFPU activities is presented in Table 6.

3.3 OFPU Program from Government to Farmer Groups

The data in Table 6 shows that the Indramayu District Government has implemented the OFPU Program from 2013 to 2017, given to farmer groups. The number of cattle originating from OFPU activities amounted to 620 tails was given to 62 farmer groups in Indramayu District from 2013 to 2017. The addition of livestock with this signifies an increase in livestock annually. The Program to increase cattle production through OFPU is given to the farmer group in the form of cash and goods gradually. The importance of farmers entered into membership in the farmer group to have accesses to obtain assistance in the form of financing from the government [Wulandari *et al*. (2018)]. Farmers in the membership of farmer groups supported by the government to increase the knowledge using fertilizer and fertilizer processing to achieve priority increase in farmers income in the development of the OFPU program. An integrated farming system is an alternative

Table 5: Types of MDG Waste from Rice Milling per year in Gantar, Cikedung, Terisi Sub-District and Indramayu District.

No	Sub-district/ District	Average rice production (tonnes of MDG per year)	Average production of husks (tons) (15-20%) *	Average production of bran (tons) (8-12%) *	Average production of groats (tons) (5%) *
1	Gantar	116,408.17	17,461.23	9,312.65	5,820.41
2	Cikedung	91,031.15	13,654.67	7,282.49	4,551.56
3	Terisi	78,677.55	11,801.63	6,294.20	3,933.88
4	Indramayu	1,594,177.69	239,126.64	127,534.21	79,708.88

Source: *Wiyatna *et al*. (2012), taken the lowest figure and processed it by authors.

Table 6: Number of Farmers Groups that received OFPU activities in Indramayu district.

Year	Number of Farmers Groups	OFPU assistance in the form of Beef Cattle (tails) activities
2013	3	30
2014	9	90
2015	9	90
2016	12	120
2017	29	290
Amount	62	620

Source: Agriculture and Horticulture Office in Indramayu District (2017)

to rural community development conducted by the Group of livestock and rice farming development. It takes a participatory approach to rural communities to play an active role in running the business [Prasetyo and Mauludin (2016)]. The growth of the beef cattle population in the Indramayu District was positive at 18.34percent, and the average beef cattle population of 11,011.60 tails from 2013 to 2017. The beef cattle population in Indramayu District is presented in Table 7.

3.4 The Average Value of the Beef Cattle Population

The data in Table 7 shows that the average value of the beef cattle population in the Indramayu District was 11,011.60 heads in the last five years (2013-2017). Patrol sub-district ranked first in the growth of beef cattle population in the previous five years (2013-2017) of 462.11 percent, followed by Karangampel (380 percent), Sukagumiwang (282.45 percent), Lelea (151.17 percent) and others. However, the average number of beef cattle in the three highest sub-districts in the last five years (2013-2017) was in Gantar Sub-district (3,249.80 tails), Filled (2,132.20 tails) and Cikedung (1,432.60 tails) decreased. The decrease in beef cattle production is due to factors of small business scale, poor concentrate feeding, unskilled labour, forage of unavailable feed and un awake animal health [Ekowati *et al*. (2018)]. The decline in beef cattle production can be overcome through innovations in the development of beef cattle intertwined between farmers and the government in the provision of feed, strengthening human resources capabilities, connecting local farmers and traders to the market so that the sustainability of beef cattle production continues [Stür *et al*. (2013)].

The production system of cattle breeding provides beef cattle manure production as a waste that has added value for farmers, so beef cattle manure processing technology becomes an indispensable fertilizer [Widiati and Widi (2016)]. There is a positive and real impact relationship between total income and socio-economic factors such as landholding, permanent asset creation, food security, nutritional safety, labour generation, marketing behaviour, education and livestock. The integrated farming system between plants and livestock provides double income and the economy, namely social and ecological benefits. Production of beef cattle waste in the form of solid dirt as much as 29.5 kg per tail per day and 14.1 litres of liquid impurities (urine) per tail per day provide added value in the form of manure that can improve soil fertility [Ponnusamy and Devi (2017)]. The highest amount of beef cattle manure based on the highest number of beef cattles in the three sub-districts in Indramayu were Gantar, Cikedung and Terisi Sub-Districts is presented in Table 8.

3.5 The Average Amount of Solid (faces) and Liquid Beef Cattle (urine)

The data in Table 8 shows the average amount of solid (faces) and liquid beef cattle (urine) in Gantar, Cikedunag, Terisi, and Indramayu Districts, for five years (2013-2017). The benefits of beef cattle manure

Table 7: The Beef Cattle of Population (tails) in Indramayu district (2013-2017).

Sub-District/ District	Population (tails)					Average	Growth 2017 over 2013 (%)
	2013	2014	2015	2016	2017		
Haurgeulis	362	382	55	55	128	196.40	-64.64
Gantar	3,218	3,273	3,355	3,555	2,848	3,249.80	-11.50
Kroya	170	197	228	228	313	227.20	84.12
Gabuswetan	143	183	212	212	321	214.20	124.48
Cikedung	1,207	1,204	1,629	1,629	1,494	1,432.60	23.78
Terisi	1,797	2,022	2,497	2,497	1,848	2,132.20	2.84
Lelea	213	245	281	281	535	311.00	151.17
Bangodua	65	68	78	78	169	91.60	160.00
Tukdana	298	350	412	412	457	385.80	53.36
Widasari	32	21	33	33	56	35.00	75.00
Kertasmaya	146	41	53	53	233	105.20	59.59
Sukagumiwang	151	168	191	191	502	240.60	232.45
Krangkeng	30	23	10	10	41	22.80	36.67
Karangampel	15	30	7	7	72	26.20	380.00
Kedokanbunder	171	217	259	259	194	220.00	13.45
Juntinyuat	135	149	177	177	337	195.00	149.63
Sliyeg	789	835	1,005	1,005	924	911.60	17.11
Jatibarang	197	192	94	94	192	153.80	-2.54
Balongan	15	19	7	7	24	14.40	60.00
Indramayu	74	110	28	28	24	52.80	-67.57
Sindang	211	163	21	21	158	114.80	-25.12
Cantigi	53	60	58	58	76	61.00	43.40
Pasekan	37	22	9	9	3	16.00	-91.89
Lohbener	46	22	20	20	18	25.20	-60.87
Arahan	82	95	3	3	34	43.40	-58.54
Losarang	92	83	70	70	41	71.20	-55.43
Kandanghaur	35	20	8	8	24	19.00	-31.43
Bongas	96	103	108	108	91	101.20	-5.21
Anjatan	88	83	101	101	201	114.80	128.41
Sukra	24	29	30	30	55	33.60	129.17
Patrol	95	105	30	30	534	158.80	462.11
Indramayu	**10,44**	**10,489**	**11,092**	**11,538**	**11,895**	**11,011.60**	**18.43**

Source: The Central Bureau of Statistics (CBS) Indramayu District, 2014, 2015, 2016, 2017 and 2018.

can be made into organic fertilizer, which functions to fertilize the soil and increase yield. The application of manure and vermicompost can increase leaf chlorophyll and grain yield components such as the number of fertile tillers and grains, but the weight is decreased by 1000 grains. The highest rice production is obtained from a combination of beef cattle manure (30 tons per ha) and vermicompost (10 tons per ha). The first-year show gained 3537 kg per ha, 3958 kg per ha the second year, increased content N (8-20 percent), P (22-23 percent), and K (20-33 percent), but reduced starch levels by 3-7 percent [Rahimabadi *et al*. (2018)].

Gantar Sub-District is an area that has the highest average population of beef cattle (3,249.80 heads) (Table 7), so the production of beef cattle manure is also the highest compared to other areas in Indramayu District. If 29.5 kg of stable beef cattle manure is produced, then beef cattles can produce 95,869.10 kg of stable beef cattle manure in Gantar per day. If as much as 30 t ha^{-1} beef cattle manure [Rahimabadi *et al*. (2018)] is given to the rice fields, then the new rice field area can be given 3.2 ha day^{-1}, 95.87 ha month^{-1},

Table 8: Number of Beef Cattle Manure in Gantar, Cikedung, Terisi Sub-Districts and Indramayu District.

No	Sub-District/ District	Beef cattle population (tails)*	Beef cattle Manure	Beef cattle Urine	Beef cattle Manure	Beef cattle Urine	Beef cattle Manure	Beef cattle Urine
			(29.5 kg/day/ head)**	(14,1 liter/day)**	One month (ton)	One month (liter)	year (ton)	year (liter)
1	Gantar	3,249.80	95,869.10	45,822.18	2,876.073	1,374,665.40	34,512.876	16,495.985
2	Cikedung	1,432.60	42,261.70	20,199.66	1,267.851	605,989.80	15,214.212	7,271.878
3	Terisi	2,132.20	62,899.90	30,064.02	1,886.997	901,920.60	22,643.964	10,823.047
4	Indramayu	11,011.60	324,842.20	155,263.56	9,745.266	4,657,906.80	116,943.192	55,894.882

Source: * Table 7. ** Widiati and Widi (2016).

Table 9: Area of Rice fields and Beef Cattle manure absorbed in Gantar, Cikedung, Terisi Sub-District and Indramayu district.

No	Sub-District/ District	Beef cattle population (tails) *	Beef cattle manure/year (ton)	Rice field area that can absorb the availability of solid manure beef cattle (ha/year)	Rice field area (ha) ***	The land area that absorbs solid beef cattle manure (%)
1	Gantar	3,249.80	34,512.876	1,150.4292	6,096.00	18.87
2	Cikedung	1,432.60	15,214.212	507.1404	5,660.00	8.96
3	Terisi	2,132.20	22,643.964	754.7988	5,099.00	14.80
4	Indramayu	11,011.60	116,943.192	3,898.1064	116,245.00	3.35

Source: *Table 7. ** Widiati and Widi (2016). *** The Cental Bureau of Statistics (CBS) Indramayu District, 2018.

and 1,150.43 ha year^{-1}. According to Sari *et al*. (2017), Gantar's land is 6,096 ha, so Gantar is only able to provide beef cattle manure in a year for 18.87 per cent. Thus, Gantar still requires a beef cattle population of 48,411.2 heads to fulfil 4,945.57 ha of paddy fields that have not been applied beef cattle manure. The area of lowland rice land, which can absorb beef cattle manure in three sub-districts of Indramayu District, is presented in Table 9.

3.6 Area of Rice Fields and Beef Cattle Manure

The data in Table 9 also shows that the Cikedung sub-district, Terisi sub-district and Indramayu district, each of which is only able to provide beef cattle manure every year by 8.96percent, 14.80percent and 3.35percent of the total paddy fields in each region. Thus, Cikedung Sub-District, Terisi Sub-District and Indramayu District still need beef cattle to meet manure in paddy fields. The population of beef cattle still lacks in Cikedung Sub-district 47,966, Sub-district filled with 43,212 tails and Indramayu Regency 985.1272 tails. Therefore, rice farmers need to establish partnerships with the government and private sector to increase livestock populations, to improve technology and diversify rice production [Kusumastuti *et al*. (2015), Odoh *et al*. (2019)].

Thus, the rice diversification system through OFPU program activities from the government to farmers through farmer groups is an alternative solution in increasing agricultural productivity. In the form of beef cattle and beef cattle manure, the population of cattle increases, and beef cattle manure as organic fertilizer is available in the Indramayu district.

4. Conclusion and Recommendation

This study concludes that there is an increase in cattle and the availability of organic fertilizer in the Indramayu District. The Government's OFPU program in cattle assistance and organic fertilizer processing tools for farmers in rice farmer groups has increased agricultural productivity in Indramayu District. The results obtained by rice farmers through this OFPU activity are that cattle keep growing, and beef cattle manure is rising. Beef cattles are fed rice straw as a source of fibre and rice bran as a source of protein by rice farmers. Rice straw and bran are abundant in the harvest season. Rice straw can be cheap alternative forage for beef cattles in the dry season. Beef cattles are producing waste in the form of solid and liquid beef cattle manure. Beef cattle manure is processed into organic fertilizer, which is useful for soil fertility. The government hopes that this organic beef cattle fertilizer is given by rice farmers to the rice fields so that the productivity of the paddy fields increases. The process of utilizing waste between rice plants and cattle forms a cycle that is interconnected with one another in an integrated system. The impact of the use of all agricultural waste causes no waste left behind (zero west) and the environment becomes clean. Therefore, the diversification of the rice system has increased the population of cattle, and organic fertilizers are available in Indramayu District. The OFPU program is very appropriate to be continued so that rice farmers who have not received this Program can increase their agricultural productivity. Suggestions for rice farmers are that it is crucial to join a rice group because access to government assistance can only be obtained through rice groups. Other than that, the products of the rice diversification system can be a source of income and livelihood for farmer households. The request for further research is to look at how the development model for diversifying the livelihoods of rice farmer households in the Indramayu District, Indonesia.

Conflicts of interest

The authors have no conflict of interest to declare.

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