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Dear,

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 data used. 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 of 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.

Keywords: *diversification; farming productivity; rice system*

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 & 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 & Susilowati, 2016); 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 (BPS, 2013-2017). 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 (BPS, 2013-2017), can be seen in Table 01.

Table 01. 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

Province	Production (tons)					Average	Growth 2017 over 2013 (%)
	2013	2014	2015	2016	2017		
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.

Data in Table 01 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 02.

Table 02. 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.

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 to 2017 (Table 02). 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 & 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 & 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 & 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 & 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 & 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 & 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 & 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 & Poterie, 2018; Makate et al., 2016) and livestock (Karunarathna & 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 foiund 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.

METHOD

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.

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 milion 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 7.30percent 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 (8percent), 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 03.

Table 03. 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.

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 03 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 1.27 percent of body weight can increase the body weight to 0.25 kg per day (Wiyatna et al., 2012). Data Table 04 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 04). Thus, the potential for rice straw in Indramayu District is 1,594,177.60 tons (Table 03), 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 (2013-2017).

Table 04. 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 (ton of MDG per year)	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
			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.

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 (8-12percent), and Rice Brewer (± 5percent) 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 05.

Table 05. 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.

The data in Table 05 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 groatsin 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 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 03 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 06.

Table 06. 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)

OFPU Program from Government to Farmer Groups

The data in Table 06 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 (Sardjono et al., 2012). An integrated farming system is an alternative 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 & 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 07.

Table 07. The Beef Cattle of Population (Tails) in Indramayu District (2013-2017)

Sub-District/ District	Population (tails)					Average	Growth 2017over 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.

The Average Value of The Beef Cattle Population

The data in Table 07 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 462.11percent, 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 & 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 & 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 08.

Table 08. 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 (29.5 kg/day /head) **	Beef cattle Urine (14,1 liter/day)**	Beef cattle Manure One month (ton)	Beef cattle Urine One month (liter)	Beef cattle Manure year (ton)	Beef cattle Urine 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 07. ** Widiati and Widi, 2016.

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

The data in Table 08 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 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 (8-20percent), P (22-23percent), 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 07), 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 $month^{-1}$, and 1,150.43 ha $year^{-1}$. According to [40], 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 09.

Table 09. 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 07. ** Widiati and Widi, 2016. *** The Cental Bureau of Statistics (CBS) Indramayu District, 2018.

Area of Rice Fields and Beef Cattle Manure

The data in Table 09 also was 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.

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.

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REFERENCES

Agriculture and Horticulture Office in Indramayu District (2017). Agriculture Office Number of farmer groups in Indramayu District (2017-2018). Agricultural Service

Report in Indramayu District. Retrieved from: http://distan.indramayukab.go.id/dinas-pertanian-menyelenggarakan-kontes-mangga/ accessed 7 August 2019.

Agus, C., Sunarminto, B. H., & Suhartanto, B. (2011). Integrated Bio-cycles Farming System for Production of Bio-gas through Gama Digester, Gama Purification and Gama Compressing. *Journla of the Japan of Energy*, *90*(10), 1086–1090. https://www.rcenetwork.org/portal/sites/default/files/CAH-JIE-IBFS for 4F.pdf

Budi Kusumo, R. A., Kurnia, G., Setiawan, I., & Tirtosudarmo, R. (2023). Migration and Farmer Household Livelihood Strategies: Factors Influencing the Decision to Migrate. *Pertanika Journal of Social Sciences and Humanities*, *31*(1), 57–79. https://doi.org/10.47836/pjssh.31.1.04

Burchfield, E. K., & Poterie, A. T. de la. (2018). Determinants of crop diversification in rice-dominated Sri Lankan agricultural systems. *Journal of Rural Studies*, *xx*(x), 1–10. https://doi.org/10.1016/j.jrurstud.2018.05.010

Conway, G. R., & Chambers, R. (1992). Sustainable rural livelihoods: practical concepts for the 21st century. *IDS Discussion Paper*, *296*(January 1992), 1–28. https://www.researchgate.net/publication/248535825%0ASustainable

Ekowati, T., Prasetyo, E., & Handayani, M. (2018). The factors influencing production and economic efficiency of beef cattle farm in Grobogan Region, Central Java. *Journal of the Indonesian Tropical Animal Agriculture*, *43*(1), 76–84. https://doi.org/10.14710/jitaa.43.1.76-84

Ellis, F. (2000). Rural Livelihood Diversity in Developing Countries. *Oxford University Press*, *40*, 1–10.

FAO. (2017). Productivity and Efficiency Measurement in Agriculture. *Food and Agriculture Organization of the United Nations*, *February*, 77. http://gsars.org/wp-content/uploads/2017/02/TR-17.02.2017-Productivity-and-Efficiency-Measurement-in-Agriculture.pdf

Gasson, R. (1988). Farm Diversification and Rural Development. *Journal of Agricultural Economics*, *39*(2), 175–182. https://doi.org/10.1111/j.1477-9552.1988.tb00575.x

Islam, A. H. S. M., Barman, B. K., & Murshed-e-Jahan, K. (2015). Adoption and impact of integrated rice-fish farming system in Bangladesh. *Aquaculture*, *447*, 76–85. https://doi.org/10.1016/j.aquaculture.2015.01.006

Kamdi, P. J., Swain, D. K., & Wani, S. P. (2020). Efficient land water management practice and cropping system for increasing water and crop productivity in semi-arid tropics. *Agronomy Journal*, *112*(4), 2552–2568. https://doi.org/10.1002/agj2.20207

Karunarathna, M., & Wilson, C. (2017). Agricultural biodiversity and farm level technical efficiency: An empirical investigation. *Journal of Forest Economics*, 1–9. https://doi.org/10.1016/j.jfe.2017.08.002

Kremen, C., Iles, A., & Bacon, C. (2012). Diversified Farming Systems : An Agroecological , Systems-based Alternative to Modern Industrial Agriculture. *Ecology and Society*, *17*(4), 1–19. https://doi.org/http://dx.doi.org/10.5751/ES-05103-170444

Kremen, C., & Miles, A. (2012). Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities, and Trade-Offs. *Ecology and Society*, *17*(4), 40:1-25. https://doi.org/10.5751/ES-05035-170440

Kurniawati, M. (2013). *Stabilized Rice Bran and Its Application in Analog Rice Formulation Supervised (Stabilisasi Bekatul dan Penerapannya)* [Institut Pertanian Bogor]. https://repository.ipb.ac.id/jspui/bitstream/123456789/65881/1/2013mku.pdf

Kusumastuti, T. A., Sarim, S., & Masyhuri, M. (2015). Integrated farming model of small ruminants in deli serdang, north sumatra - Indonesia. *Journal of the Indonesian Tropical Animal Agriculture*, *40*(2), 115–120. https://doi.org/10.14710/jitaa.40.2.115-120

Lindawati, L., Sibuea, B. M., Noita, D., Riyadh, M. I., Hasibuan, A., & Al, E. (2018). A Comparative Analysis of Economic Farming Activity of Farmers Rice-Livestock Integrated Farming System (RLIFS) and Non RLIFS. *International Journal of Engineering & Technology*, *7*(3.2), 792–795. https://doi.org/10.14419/ijet.v7i3.2.18759

Makate, C., Wang, R., Makate, M., & Mango, N. (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: adaptive management for environmental change. *SpringerPlus*, *5*(1), 1135. https://doi.org/10.1186/s40064-016-2802-4

Martmono, A. A., Mappamiring, M., & Malik, I. (2013). The Role of the Village Government in Managing the Organic Fertilizer Processing Unit (OFPU) in Kolai Village, Malua District, Enrekang Regency Peran Pemerintah Desa Dalam Pengelolaan Program Usaha Pengelolaan Pupuk Organik (UPPO) di Desa Kolai Kecamatan . *Otoritas : Jurnal Ilmu Pemerintahan*, *3*(2), 75–87. https://doi.org/10.26618/ojip.v3i2.65

Meena, B. P., Shirale, A. O., Biswas, A. K., Lakaria, B. L., Jha, P., Gurav, P. P., Wanjari, R. H., & Patra, A. K. (2018). Diversified agriculture for higher productivity and profitability–A review. *Agricultural Reviews*, *39*(2), 104–112. https://doi.org/10.18805/ag.r-1679

Ministry of Agriculture. (2018). *Instructions for the implementation of Organic Fertilizer Processing Unit (OFPU). Petunjuk Pelaksanaan Kegiatan unit Pengolah Pupuk Organik (UPPO)*. http://tanamanpangan.pertanian.go.id/assets/front/uploads/document/JUKLAK UPPO 2018.pdf

Ministry of Agriculture Republic of Indonesia. (2017). *Agricultural Statistics 2017 Statistik Pertanian 2017* (A. A. Susanti & B. Waryanto (eds.)). center for Agricultural Data and Information SystemMinistry of Agriculture Republic of Indonesia.

Mishra, A. K., & Goodwin, B. K. (1997). Farm Income Variability and the Supply of Off-Farm Labor. *American Journal of Agricultural Economics*, *79*(3), 880–887. https://doi.org/10.2307/1244429

Nainggolan, H. L., Aritonang, J., Sihombing, M., Supriana, T., & Tafsin, M. (2019). Structural modelling of rice fields-buffalo livestock based integrated agricultural systems in the context of regional development in Humbang Hasundutan , Indonesia. *Journal on Food, Agriculture and Society*, *106*, 1–17. https://doi.org/10.17170/kobra-20190709595

Nayak, P. K., Nayak, A. K., Panda, B. B., Lal, B., Gautam, P., Poonam, A., Shahid, M., Tripathi, R., Kumar, U., Mohapatra, S. D., & Jambhulkar, N. N. (2018). Ecological mechanism and diversity in rice based integrated farming system. *Ecological Indicators*, *91*(May 2017), 359–375. https://doi.org/10.1016/j.ecolind.2018.04.025

Noviasari, S., Kusnandar, F., Setiyono, A., & Budijanto, S. (2015). Rice analogues as functional food with low glycemic index (Beras Analog Sebagai Pangan Fungsional Dengan Indeks Glikemik Rendah). *Jurnal Gizi Dan Pangan*, *10*(3), 225–232. https://doi.org/10.25182/jgp.2015.10.3.

Nuraisah, G., & Kusumo, R. A. B. (2019). Impact Of Climate Change On Paddy Farming In Wanguk Village Anjatan Subdistrict Indramayu District. *Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, *5*(1), 60–71. https://jurnal.unigal.ac.id/index.php/mimbaragribisnis/article/view/1639

Odoh, N. E., Nwibo, S. U., Eze, A. V., & Igberi, C. O. (2019). Farm and non-farm income diversification activities among rural households in Southeast, Nigeria. *Journal of Agricultural Extension*, *23*(2), 113–121. https://doi.org/10.4314/jae.v23i2.12

OECD. (2001a). *The well-being of nations: The role of human and social capital*. OECD. http://www.oecd.org/site/worldforum/33703702.pdf

OECD. (2001b). Measuring Productivity - Measurement of Aggregate and Industry Growth. In *OECD Manual*. OECD. https://doi.org/10.1787/9789264194519-en

Ponnusamy, K., & Devi, M. K. (2017). Impact of Integrated Farming System Approach on Doubling Farmers' Income. *Agricultural Economics Research Review*, *30*(conference number), 233–240. https://doi.org/10.5958/0974-0279.2017.00037.4

Prajanti, S. D. W., & Susilowati, I. (2016). The prospect of integrated farming system of crops-fish-husbandary as the survival strategy to secure the farmers economy: Case study in Magelang - Indonesia. *International Journal of Economics and Financial Issues*, *6*(6Special Issue), 84–87. https://www.econjournals.com/index.php/ijefi/article/view/3121/pdf

Prasetyo, Y. E., & Mauludin, M. A. (2016). Community Development Planning : Introduction of Integrated Farming System (IFS) to the Rural Community. *Jurnal Ilmu Ternak*, *16*(2), 78–88. http://jurnal.unpad.ac.id/jurnalilmuternak/article/view/11580/5378

Rahimabadi, T. E., Anssari, M. H., & Nematollahi, Razavi, A. (2018). Influence of cow manure and its vermicomposting on the improvement of grain yield and quality of rice (Oryza sativa L.) in field conditions. *Applied Ecology and Environmental Research*, *16*(1), 97–110. https://doi.org/10.15666/aeer/1601_097110

Rapsomanikis, G. (2015). The economic lives of smallholder farmers. An anlysis based on household data from nine countries. *Www.Fao.Org.*, 1–40. http://www.fao.org/3/a-i5251e.pdf

Rehman, A., Chandio, A. A., Hussain, I., & Jingdong, L. (2019). Fertilizer consumption, water availability and credit distribution: Major factors affecting agricultural productivity in Pakistan. *Journal of the Saudi Society of Agricultural Sciences*, *18*(3), 269–274. https://doi.org/10.1016/j.jssas.2017.08.002

Roy, R., Weng, N., & Ruslan, C. (2014). Rice farming sustainability assessment in Bangladesh. *Sustain Sci*, *9*, 31–44. https://doi.org/10.1007/s11625-013-0234-4

Rundengan, M. L., Fanani, Z., Subagiyo, I., & Elly, F. H. (2014). Integrated Farming System Model in South Minahasa Regency- North Sulawesi. *IOSR Journal of Agriculture and Veterinary Science*, *5*(6), 01–07. https://doi.org/10.9790/2380-0560107

Sardjono, N., Susilo, B., & Wignyanto. (2012). Strategi Pengembangan Sistem Produksi Pupuk Organik Pada Unit Pengolahan Pupuk Organik (UPPO) di desa bangunsari Kabupaten Ciamis. *Jurnal Teknologi Pertanian*, *13*(2), 138–148. https://www.academia.edu/5367487/STRATEGI_PENGEMBANGAN_SISTEM_PRODUKSI_PUPUK_ORGANIK_PADA_UNIT_PENGOLAHAN_PUPUK_ORGANIK_UPPO_DI_DESA_BANGUNSARI_KABUPATEN_CIAMIS_The_Strategy_of_Organic_Fertilizer_Production_System_Development_on_Organic_Fertilizer_Process

Sari, N. M., Nisa, K., Mahdie, M. F., & Ulfah, D. (2017). The Utilization of Rice Husk Waste for Mixed Bokashi Fertilizer and Biobriket Making As Biofuels). *PengabdianMu*, *2*(September), 90–97. http://jurnal.umpalangkaraya.ac.id/ejurnal/pgbmu

Scoones, I. (1998). Sustainable Rural Livelihoods A Framework For Analysis: IDS Working Paper 72. *Development (Basingstoke)*, *42*(2), 1–22. https://doi.org/10.1057/palgrave.development.1110037

Shilomboleni, H., Owaygen, M., De Plaen, R., Manchur, W., & Husak, L. (2019). Scaling up innovations in smallholder agriculture: Lessons from the Canadian international food security research fund. *Agricultural Systems*, *175*(May 2019), 58–65. https://doi.org/10.1016/j.agsy.2019.05.012

Soemantri, A. S., Luna, P., & Jamal, B. (2016). Strategy to increase rice production with the emphasis on the losses during harvest and posth (Strategi Peningkatan Produksi Beras Melalui Penekanan Susut Panen Dan Pascapanen Dengan Pendekatan Sistem Modeling: Studi Kasus Kabupaten Indramayu, Jawa Barat). *Informatika Pertanian*, *25*(2), 249–260. http://ejurnal.litbang.pertanian.go.id/index.php/IP/article/view/8494

Soni, R. P., Katoch, M., & Ladohia, R. (2014). Integrated Farming Systems - A Review. *IOSR Journal of Agriculture and Veterinary Science*, *7*(10), 36–42. https://doi.org/10.9790/2380-071013642

Stür, W., Khanh, T. T., & Duncan, A. (2013). Transformation of smallholder beef cattle production in Vietnam. *International Journal of Agricultural Sustainability*, *11*(4), 363–381. https://doi.org/10.1080/14735903.2013.779074

Suh, J. (2014). Theory and reality of integrated rice-duck farming in Asian developing countries: A systematic review and SWOT analysis. *Agricultural Systems*, *125*, 74–81. https://doi.org/10.1016/j.agsy.2013.11.003

Teng, Q., Hu, X. F., Cheng, C., Luo, Z., Luo, F., Xue, Y., Jiang, Y., Mu, Z., Liu, L., & Yang, M. (2016). Ecological effects of rice-duck integrated farming on soil fertility and weed and pest control. *Journal of Soils and Sediments*, *16*(10), 2395–2407. https://doi.org/10.1007/s11368-016-1455-9

The Central Bureau of Statistics (CBS) Indramayu District. 2014. *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2014/12/19/afc6f1f2ee42116e0f53a627/kabupaten-indramayu-dalam-angka-2014.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District. 2015. *Indramayu District in Figure*. BPS Indramayu District.

https://indramayukab.bps.go.id/publication/2016/01/26/c1d5953cdbd0728c77f53f6c/kabupaten-indramayu-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District. 2016. *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/07/15/551c0bc293bd22b3d00c42db/kabupaten-indramayu-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District. 2017. *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2017/08/18/07cf633d10b42aed1ae87fcb/kabupaten-indramayu-dalam-angka-2017.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District. 2018. *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2018/08/16/99305d123f315f796f19b6d4/kabupaten-indramayu-dalam-angka-2018.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District. 2014. *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2014/12/15/a197964d9427671924d37063/kabupaten-majalengka-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District. 2015. *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/01/27/b47b2662d498f8d17ce2b34d/kabupaten-majalengka-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District. 2016. *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/07/15/627c3a92e166c355de65e373/kabupaten-majalengka-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District. 2017. *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2017/08/11/1619e71644b63facf2aa53f5/kabupaten-majalengka-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District. 2018. *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2018/08/16/7a08032d613c4bcc2c203b16/kabupaten-majalengka-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District. 2014. *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2015/08/13/6c56c4ad7e26832d763db710/subang-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District. 2015. *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/03/02/95d8a1ea348e816703b71a41/kabupaten-subang-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District. 2016. *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/07/15/53ebb793a6e8a54fedf183f8/kabupaten-subang-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District. 2017. *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2017/08/10/21462f2a7958ef3555b86b9e/kabupaten-subang-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District. 2018. *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2018/08/16/fbf586fd952afd9aa9db7052/kabupaten-subang-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District. 2014.*Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikota.bps.go.id/publication/2015/08/13/196a62fc4d9695b2ca1e16ed/kota-sukabumi-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District. 2015. *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2015/12/12/0f835f3344a10af477f71341/sukabumi-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District. 2016. *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/04/5ac28d5fefb8e7a6de6bf7ab/kabupaten-sukabumi-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District. 2017. *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/11/1a2410e17b16e8209db31c1b/kabupaten-sukabumi-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District. 2018. *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2018/08/16/c20ed4d909fede7ac131ad41/kabupaten-sukabumi-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) West Java Province. 2015. *West Java Province in Figure*. *BPS Provinsi Jawa Barat.* https://jabar.bps.go.id/publication/2016/02/29/303b35c34730fbed908ef272/provinsi-jawa-barat-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province. 2016. *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2016/07/15/2297a52073f5f32eca26eb8a/provinsi-jawa-barat-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province. 2017. *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2017/08/12/62379e17bcc20052a7991d35/provinsi-jawa-barat-dalam-angka-2017.html. Accessed 4 October 2019.

Van, N. P. H., NGa, T. T., ARai, H., Hosen, Y., CHiem, N. H., & Inubushi, K. (2014). Rice Straw Management by Farmers in a Triple Rice Production System in the Mekong Delta, Viet Nam. *Tropical Agriculture and Development*, *58*(4), 155–162. https://doi.org/10.11248/jsta.58.155

Wariyah, C. (2010). Restructured Fine Grain Rice to High Calcium Rice by Extrusion Method (Restrukturisasi Menir Menjadi Beras Berkalsium Tinggi dengan Metode Ekstrusi). *Agritech*, *30*(3), 135–140. https://doi.org/DOI: https://doi.org/10.22146/agritech.9664

Widiati, R., & Widi, T. S. M. (2016). Production Systems And Income Generation From The Smallholder Beef Cattle Farming In Yogyakarta Province, Indonesia. *Animal Production*, *18*(1), 51. https://doi.org/10.20884/1.anprod.2016.18.1.524

Widowati, S. (2000). Pemanfaatan Hasil Samping Penggilingan Padi dalam Menunjang Sistem Agroindustri di Pedesaan. *Buletin Agrobio*, *4*(1), 33–38. http://biogen.litbang.pertanian.go.id/wp/terbitan/pdf/agrobio_4_1_33-38.pdf

Wiyatna, M. F., Gurnadi, E, A., & Mudikdjo, K. (2012). Productivity of Peranakan Ongole Cattle on traditional farm system in Sumedang Region (Produktivitas Sapi Peranakan Ongole pada Peternakan Rakyat di Kabupaten Sumedang). *Jurnal Ilmu Ternak*, *12*(2), 22–25. http://journal.unpad.ac.id/jurnalilmuternak/article/viewFile/5124/2552

Wulandari, E., Ernah, & Supyandi, D. (2018). Agricultural Production and Access to In-

kind Finance from Government: A Study of Banana Farms in Cianjur District, West Java. *IOP Conference Series: Earth and Environmental Science*, *166*(1), 012042. https://doi.org/10.1088/1755-1315/166/1/012042

Xu, G., Liu, X., Wang, Q., Yu, X., & Hang, Y. (2017). Integrated rice-duck farming mitigates the global warming potential in rice season. *Science of the Total Environment*, *575*, 58–66. https://doi.org/10.1016/j.scitotenv.2016.09.233

Yuniarti, A., Damayani, M., & Nur, D. M. (2019). Efek Pupuk Organik dan Puuk N,P,K Terhadap C-Organik, N-Total, C/N, Serapan N, Serta Hasil Padi Hitam (Oryza sativa L. indica) Pada Inceptisols. *Jurnal Pertanian Presisi (Journal of Precision Agriculture)*, *3*(2), 90–105. https://doi.org/10.35760/jpp.2019.v3i2.2205

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Diversification of Rice system to increase farming productivity: An alternative solution for farmers in Indramayu District, West Java, Indonesia

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ABSTRACT
Rice is the staple food of the Indonesian people that has not been replaced by others. The purpose of this research is to explain rice system diversification in increasing farming productivity as an alternative solution for farming in Indramayu District, West Java. The method used was a **qualitative** descriptive approach. The critical **information** used from 62 groups of rice farmers amounted to 620 farmers, who have received assistance from the Organic Fertilizer Processing Unit (OFPU) to inform the beef cattle, and organic fertilizer had making equipment. Secondary data were from the Indramayu District Agriculture and Horticulture Office and the Central Statistics Agency. Data were analyzed descriptively. **The conclusion of this study occurs two improvements, namely the increase in cattle population and the provider of organic fertilizer in the Indramayu District.** This research suggests the need to increase agricultural productivity through a rice diversification system in OFPU assistance from the Indonesian government for farmers through farmer groups.

Keywords: farming productivity, integrated farming, Organic Fertilizer Processing Unit Program, rice system diversification

1. Introduction

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 rice system [1]. 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 [2]–[4]; fish-paddy [5], [6]; rice-fish-duck [7]; rice-cattle or buffalo [8], [9]. 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 [10].

Diversification of rice systems provides increased productivity as a source of income for small family farmers [11]. Sustainable food systems from diversification of rice systems through integrated farming with the technological transfer so that more holistic objectives can be considered [12]. Besides, innovations provided by human resources are the main drivers of sustainable rice farming [13]. 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 can be seen in Table 1.

Table 1. The Rice Production (Tons) by The Province in Indonesia

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 [42, 43].

Data in Table 1 shows that rice production experienced positive growth in Indonesia by 14.17percent 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 3.60percent. Rice production by the district in West Java can be seen in Table 2.

Table 2. The Rice Production (Tons) by The District in West Java

District	Production (tons)					**Average**	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 [42,43]; The Central Bureau of Statistics (CBS) West Java Province, 2015, 2016, and 2017 [44,45,46]; The Central Bureau of Statistics (CBS) Indramayu District, 2014, 2015, 2016, 2017, and 2018 [47,48,49,50,51]; The Central Bureau of Statistics (CBS) Majalengka District, 2014, 2015, 2016, 2017, and 2018 [52,53,54,55,56]; The Central Bureau of Statistics (CBS) Subang District. 2014, 2015, 2016, 2017, and 2018 [57,58,59,60,61]; The Central Bureau of Statistics (BPS) Sukabumi District, 2014, 2015, 2016, 2017, and 2018 [62,63,64,65,66]

Table 2 shows that rice production increased in West Java from 2013 to 2017. Indramayu produced the highest rice production with an average value of 1.594.177.60 tons over the past five years. However, the growth of rice production decreased by 17.21percent in Indramayu from 2013 to 2017. The decline in rice production will have an impact on the income of rice farmers. Rice production is declining due to global climate change. Climate change that farmers feel is changes in temperature, rainfall, planting time, and attacks on crop pests. Global climate change has an impact on the risk of crop failure occurring, pest attacks increase, rice yields decrease, and farmers' incomes decrease [14]. Besides, improper handling of harvest and post-harvest can increase the shrinkage of rice production so that rice production will decrease [15].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 [5]. **Likewise, integrated farming systems on coconut and cow systems involving food crops produce higher revenues, 117.22percent to 129.17percent than coconut-cow systems, or 215.05percent to 236.97percent uninterested coconut and cow systems in Minahasa** [16].

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 [17]. 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 [18]. 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 [19].

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 [20]. Diversification of the agricultural system provides a better environment and does not harm the community than the conventional Peruvian system. Better environment, 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 [21]. Integration of several crops and livestock, which in agricultural production systems for food production and high agricultural profitability, is a form of diversified farming done in India [22]. The combination of business in the system of diversification of agriculture is profitable and feasible to be troubled, namely: (I) Plantation of paddy + irrigation + betel vines (B:C ratio, 2.02), (II) Paddy + pulse + dairying + poultry (B: C ratio, 1.74), (III) Paddy + vegetables + dairying (B:C ratio, 1.62), (IV) Paddy + irrigation Plantation + Rain Plantation + dairying (B: C ratio, 1.57), (v) Irrigation Plantation + dairying (b:c ratio, 1.56), and (VI) PADI + irrigation + flowers (b : C, 1.42) [23]. The family experience of ranchers affects the survival of family partners working in off-farm. The 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 [24].

Capital assistance from government programs to small family breeders has done previous research. This research uses the data of government assistance programs, namely the Program of Organic Fertilizer Processing Units (OFPU) aimed at rice farmers in the rice group. The purpose of this research is to increase agricultural productivity through an indispensable rice diversification system, especially for people in Indramayu district, West Java. Therefore, with the above background, this **study** is important to do.

2. Materials and Methods

The research method used **was** the **qualitative** descriptive approach. The **critical informant** used came from 62 groups of rice farmers amounted to 620 farmers, who have received assistance from the Organic Fertilizer Processing Unit **(OFPU)** to inform the beef cattle, and organic fertilizer had making equipment. These groups were spread in 31 districts of Indramayu District gradually, from 2013-2017. I was obtaining OFPU assistance. Secondary data, rice group data was taken from the Agriculture and Horticulture Office of Indramayu District. Rice production data and beef cattle production **were** taken from the Central Statistics Agency. Data **were** analyzed descriptively. Research results from the analysis have been carried out then discussed using appropriate literature and starting research findings.

3. Result 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 1,594,177.60 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 7.30percent of all rice production in the Indramayu District. The second and third highest rice contributors after Gantar District were Kroya and Cikedung in Indramayu District from 2013-2017. Kroya contributed was to rice production by 6.09percent. Cikedung contributed was to rice production by 5.7percent. The growth of rice production in the Indramayu District decreased by 17.21percent 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 (8percent), Cantigi (15.12percent), Pasekan (10.54percent), Arahan (16.37percent), and Sukra (1.21percent). Rice Production in Indramayu District from 2013 to 2017 can see in Table 3.

Table 3. The Rice Production **(Tons)** by Sub-District in Indramayu District

Sub-District	Production (tons)					Average	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

Sub-District	Production (tons)					Average	Growth 2017 over 2013 (%)
	2013	2014	2015	2016	2017		
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	-17.21

Source: The Cental Bureau of Statistics (CBS) Indramayu District, 2014, 2015, 2016, 2017, and 2018 [47,48,49,50, and 51].

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) [25]**.** 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 [26]. 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 (2013-2017).

Table 4. The average amount of rice straw and potential population of beef cattle

No	Sub-District	Average rice production, 2013-2017 (kg of GKG per year)	The average amount of rice straw (kg)	The average number of cows	Use of rice straws		remaining rice straw		Potential of the beef cattle population
			one time of rice production *	(tails)	3.51 kg / head/day	(365 days) kg /total/ year	kg/total/day	kg/total/year	(tails)
1	Gantar	116,408,170.00	116,408,170.00	3,249.80	11,406.80	4,163,481.27	116,396,763.20	112,244,688.73	90,862.25
2	Cikedung	91,031,150.00	91,031,150.00	1,432.60	5,028.43	1,835,375.49	91,026,121.57	89,195,774.51	71,054.25
3	Terisi	78,677,550.00	78,677,550.00	2,132.20	7,484.02	2,731,668.03	78,670,065.98	75,945,881.97	61,411.66
4	Indramayu	1,594,177,600.,00	1,594,177,600.00	11,011.60	38,650.72	14,107,511.34	1,594,138,949.28	1,580,070,088.66	1,244,333.29

Source: *Mishra and Goodwin, 1997[24], taken the lowest figure and processed it by authors.

Bran, Groats, and rice husks of the Rice Mill

Rice milling in the form of unhulled dry rice (UDR). The dried unhulled rice ground that has **produces waste**. Rice husk (15-20percent), Rice Bran (8-12percent), and Rice Brewer (± 5percent) are the side products made from rice milling [27]. The average amount of each GKG waste per year

(2013-2017) in the three highest rice-producing districts and Indramayu District is presented in Table 5.

Table 5. Types of GKG Waste from Rice Milling Per Year (2013-2017)

No	Sub-district/District	Average rice production (tonnes of GKG per year)	Average production of husks (tons) (15-20%) *	Average production of bran/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[26], taken the lowest figure and processed it by authors.

The data in Table 5 shows that rice waste in the form of milled, dried grain (GKG) is abundant in Indramayu District. Average GKG waste production over the last five years (2013-2017) amounted to 239,126.64 tons of chaff, 127,534.21 tons of bran/ bran 79,708.88 tons of menir in Indramayu District. GKG 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 fertilizers**.** Rice groats can be used as a mixture to make the ultra rice containing high calcium, hard-made texture, and the rice was soft to fulfil the spasm iciness of calcium nutrient intake for Indonesian people [28]. Rice bran becomes a mixture to make the analogue rice rich in protein and has a high fibre content [29]. Also, rice bran can be processed as a mixed ingredient to make functional food, which is analogue rice that has low glycemic content [30]. Rice bran as a source of protein for beef feed as much as 2 kg plus 1 kg Indigofera zollingeriana produces the best performance (Suherman et al., 2018). Waste rice husk can be utilized as husk charcoal, biobriket, and bokashi to make dependence on chemical fertilizers, and wood fuels decreased [31]. Thus, rice waste, both rice straw, and paddy rice, is not wasted and becomes a useful byproduct 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 17.21percent. 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 ar presented in Table 6.

Table 6. Number of Farmers Groups that Received OFPU Activities in Indramayu

Tahun	Number of Farmers Groups	OFPU assistance in the form of Beef Cattle (tails) Activities
2013[a]	3	30
2014 [a]	9	90
2015 [a]	9	90
2016 [a]	12	120
2017 [b]	29	290
Jumlah	62	620

Source: [a]Indramayu District Animal Husbandry and Animal Health Service (2013-2016) [67]
[b] Indramayu District Agriculture and Horticulture Office (2017)[68]

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 2018. 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 [32]. 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 [33]. An integrated farming system is an alternative 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 [34]. 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.

Table 7. The Beef Cattle of Population (Tails) in Indramayu District

Sub-District	Population (tails)					Average	Growth 2017over 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	10,044	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[46, 47,48, 49, 50, and 51]

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 462.11percent, followed by Karangampel (380percent), Sukagumiwang (282.45percent), Lelea (151.17percent), 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** [35]**. 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** [36]**.**

The production system of cattle breeding provides cow dung production as a waste that has added value for farmers, so cow dung processing technology becomes an indispensable fertilizer [37]. 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 cow 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 [38]. The highest amount of cow dung based on the highest number of cows in the three sub-districts in Indramayu were Gantar, Cikedung, and Terisi Sub-Districts is presented in Table 8.

Table 8. Number of Cow Dung in Three Districts and Indramayu District (2013-2017)

No	Sub-District/District	Cow population (tails) *	Cow Manure	Cow Urine	Cow Manure	Cow Urine	Cow Manure	Cow Urine
			29.5 (kg/day /head) **	14,1 (liter/day)**	One month (kg)	One month (liter)	year (kg)	year (liter)
1	Gantar	3.249,80	95.869,10	45.822,18	2.876.073,00	1.374.665,40	34.512.876,00	16.495.984,80
2	Cikedung	1.432,60	42.261,70	20.199,66	1.267.851,00	605.989,80	15.214.212,00	7.271.877,60
3	Terisi	2.132,20	62.899,90	30.064,02	1.886.997,00	901.920,60	22.643.964,00	10.823.047,20
4	Indramayu	11.011,60	324.842,20	155.263,56	9.745.266,00	4.657.906,80	116.943.192,00	55.894.881,60

Source: * Table 7; ** Widiati and Widi, 2016[37]

The data in Table 8 shows the average amount of solid and liquid cow (urine) in Gantar, Cikedunag, Terisi, and Indramayu Districts, for five years (2013-2017). The benefits of cow manure 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 cow 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 (8-20percent), P (22-23percent), and K (20 – 33percent), but reduced starch levels by 3 – 7% [39].

Table 9. Area of Rice Fields and Cow Manure Absorbed in Gantar, Cikedung, and Terisi Sub District in Indramayu District

No	Sub-District/District	Cow population (tails) *	Cow manure/year (kg)	rice field area that can absorb the availability of solid manure cow (ha/year)	Rice field area (ha) ***	The land area that absorbs solid cow dung (%)
1	Gantar	3,249.80	34,512,876.00	1150.4292	6,096.00	18.87
2	Cikedung	1,432.60	15,214,212.00	507.1404	5,660.00	8.96
3	Terisi	2,132.20	22,643,964.00	754.7988	5,099.00	14.80
4	Indramayu	11,011.60	116,943,192.00	3898.1064	116,245.00	3.35

Source: *Table 7; ** Widiati and Widi, 2016 [37]), *** The Cental Bureau of Statistics (CBS) Indramayu District. 2018 [51]

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 cow dung is also the highest compared to other areas in Indramayu District. If 29.5 kg of stable cow dung is produced, then cows can produce 95,869.10 kg of stable cow manure in Gantar per day. If as much as 30 t ha^{-1} cow 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 $month^{-1}$, and 1,150.43 ha $year^{-1}$. According to [40], Gantar's land is 6,096 ha, so Gantar is only able to provide cow dung in a year for 18.87 per cent. Thus, Gantar still requires a cow population of 48,411.2 heads to fulfil 4,945.57 ha of paddy fields that have not been applied cow dung. The area of lowland rice land, which can absorb cow dung in three sub-districts of Indramayu District, is presented in Table 9.

The data in Table 9 also was shows that the Cikedung sub-district, Terisi sub-district, and Indramayu district, each of which is only able to provide cow dung 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 [40], [41].

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

4. Conclusion

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 cow dung is rising. Cows 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 cows in the dry season. Cows are producing waste in the form of solid and liquid cow dung. Cow manure is processed into organic fertilizer, which is useful for soil fertility. The government hopes that this organic cow 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. The request for further research is to see how much cow manure is used as organic manure to the rice fields in Indramayu District.

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References:

[1] Ministry of Agriculture Republic of Indonesia, *Agricultural Statistics 2017 Statistik Pertanian 2017*. Jakarta, Indonesia: center for Agricultural Data and Information SystemMinistry of Agriculture Republic of Indonesia, 2017.

[2] Q. Teng *et al*., "Ecological effects of rice-duck integrated farming on soil fertility and weed and pest control," *J. Soils Sediments*, vol. 16, no. 10, pp. 2395–2407, 2016.

[3] G. Xu, X. Liu, Q. Wang, X. Yu, and Y. Hang, "Integrated rice-duck farming mitigates the global warming potential in rice season," *Sci. Total Environ.*, vol. 575, pp. 58–66, 2017.

[4] J. Suh, "Theory and reality of integrated rice-duck farming in Asian developing countries: A systematic review and SWOT analysis," *Agric. Syst.*, vol. 125, pp. 74–81, 2014.

[5] S. D. W. Prajanti and I. Susilowati, "The prospect of integrated farming system of crops-fish-husbandary as the survival strategy to secure the farmers economy: Case study in Magelang - Indonesia," *Int. J. Econ. Financ. Issues*, vol. 6, no. 6Special Issue, pp. 84–87, 2016.

[6] A. H. S. M. Islam, B. K. Barman, and K. Murshed-e-Jahan, "Adoption and impact of integrated rice-fish farming system in Bangladesh," *Aquaculture*, vol. 447, pp. 76–85, 2015.

[7] P. K. Nayak *et al*., "Ecological mechanism and diversity in rice based integrated farming system," *Ecol. Indic.*, vol. 91, no. May 2017, pp. 359–375, 2018.

[8] L. Lindawati, B. M. Sibuea, D. Noita, M. I. Riyadh, A. Hasibuan, and E. Al, "A Comparative Analysis of Economic Farming Activity of Farmers Rice-Livestock Integrated Farming System (RLIFS) and Non RLIFS," *Int. J. Eng. Technol.*, vol. 7, no. 3.2, pp. 792–795, 2018.

[9] H. L. Nainggolan, J. Aritonang, M. Sihombing, T. Supriana, and M. Tafsin, "Structural modelling of rice fields-buffalo livestock based integrated agricultural systems in the context of regional development in Humbang Hasundutan , Indonesia," *J. Food, Agric. Soc.*, no. 106, pp. 1–17, 2019.

[10] R. P. Soni, M. Katoch, and R. Ladohia, "Integrated Farming Systems - A Review," *IOSR J. Agric. Vet. Sci.*, vol. 7, no. 10, pp. 36–42, 2014.

[11] G. Rapsomanikis, "The economic lives of smallholder farmers. An anlysis based on household data from nine countries," *www.fao.org*., pp. 1–40, 2015.

[12] H. Shilomboleni, M. Owaygen, R. De Plaen, W. Manchur, and L. Husak, "Scaling up innovations in smallholder agriculture: Lessons from the Canadian international food security research fund," *Agric. Syst.*, vol. 175, no. May 2019, pp. 58–65, 2019.

[13] R. Roy, N. Weng, and C. Ruslan, "Rice farming sustainability assessment in Bangladesh," pp. 31–44, 2014.

[14] G. Nuraisah and R. A. B. Kusumo, "Impact Of Climate Change On Paddy Farming In Wanguk Village Anjatan Subdistrict Indramayu District," *J. Pemikir. Masy. Ilm. Berwawasan Agribisnis*, vol. 5, no. 1, pp. 60–71, 2019.

[15] A. S. Soemantri, P. Luna, and B. Jamal, "Strategy to increase rice production with the emphasis on the losses during harvest and posth (Strategi Peningkatan Produksi Beras Melalui Penekanan Susut Panen Dan Pascapanen Dengan Pendekatan Sistem Modeling: Studi Kasus Kabupaten Indramayu, Jawa Barat)," *Inform. Pertan.*, vol. 25, no. 2, pp. 249–260, 2016.
[16] M. L. Rundengan, Z. Fanani, I. Subagiyo, and F. H. Elly, "Integrated Farming System Model in South Minahasa Regency- North Sulawesi," *IOSR J. Agric. Vet. Sci.*, vol. 5, no. 6, pp. 01–07, 2014.
[17] A. A. Martmono, M. Mappamiring, and I. Malik, "The Role of the Village Government in Managing the Organic Fertilizer Processing Unit (OFPU) in Kolai Village, Malua District, Enrekang Regency Peran Pemerintah Desa Dalam Pengelolaan Program Usaha Pengelolaan Pupuk Organik (UPPO) di Desa Kolai Kecamatan ," *Otoritas J. Ilmu Pemerintah.*, vol. 3, no. 2, pp. 75–87, 2013.
[18] Ministry of Agriculture, "Instructions for the implementation of Organic Fertilizer Processing Unit (OFPU). Petunjuk Pelaksanaan Kegiatan unit Pengolah Pupuk Organik (UPPO)," Jakarta, Indonesia, 2018.
[19] C. Agus, B. H. Sunarminto, and B. Suhartanto, "Integrated Bio-cycles Farming System for Production of Bio-gas through Gama Digester, Gama Purification and Gama Compressing," *Journla of the Japan of energy*, vol. 90, no. 10, pp. 1086–1090, 2011.
[20] C. Kremen, A. Iles, and C. Bacon, "Diversified Farming Systems : An Agroecological , Systems-based Alternative to Modern Industrial Agriculture," *Ecol. Soc.*, vol. 17, no. 4, pp. 1–19, 2012.
[21] C. Kremen and A. Miles, "Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities, and Trade-Offs," *Ecol. Soc.*, vol. 17, no. 4, pp. 40:1–25, 2012.
[22] B. P. Meena *et al.*, "Diversified agriculture for higher productivity and profitability–A review," *Agric. Rev.*, vol. 39, no. 2, pp. 104–112, 2018.
[23] R. Gasson, "Farm Diversification and Rural Development," *J. Agric. Econ.*, vol. 39, no. 2, pp. 175–182, 1988.
[24] A. K. Mishra and B. K. Goodwin, "Farm Income Variability and the Supply of Off-Farm Labor," *Am. J. Agric. Econ.*, vol. 79, no. 3, pp. 880–887, 1997.
[25] N. P. H. Van, T. T. NGa, H. ARai, Y. Hosen, N. H. CHiem, and K. Inubushi, "Rice Straw Management by Farmers in a Triple Rice Production System in the Mekong Delta, Viet Nam," *Trop. Agric. Dev.*, vol. 58, no. 4, pp. 155–162, 2014.
[26] M. F. Wiyatna, A. Gurnadi, E, and K. Mudikdjo, "Productivity of Peranakan Ongole Cattle on traditional farm system in Sumedang Region (Produktivitas Sapi Peranakan Ongole pada Peternakan Rakyat di Kabupaten Sumedang)," *J. Ilmu Ternak*, vol. 12, no. 2, pp. 22–25, 2012.
[27] S. Widowati, "Utilization of Rice Milling By-Products in Support of the Agro-Industry System in Rural Sri (Pemanfaatan Hasil Samping Penggilingan Padi dalam Menunjang Sistem Agroindustri di Pedesaan)," *Bul. Agrobio*, vol. 4, no. 1, pp. 33–38, 2000.
[28] C. Wariyah, "Restructured Fine Grain Rice to High Calcium Rice by Extrusion Method (Restrukturisasi Menir Menjadi Beras Berkalsium Tinggi dengan Metode Ekstrusi)," *Agritech*, vol. 30, no. 3, pp. 135–140, 2010.
[29] M. Kurniawati, "Stabilized Rice Bran and Its Application in Analog Rice Formulation Supervised (Stabilisasi Bekatul dan Penerapannya)," Institut Pertanian Bogor, 2013.
[30] S. Noviasari, F. Kusnandar, A. Setiyono, and S. Budijanto, "Rice analogues as functional food with low glycemic index (Beras Analog Sebagai Pangan Fungsional Dengan Indeks Glikemik Rendah)," *J. Gizi dan Pangan*, vol. 10, no. 3, pp. 225–232, 2015.
[31] N. M. Sari, K. Nisa, M. F. Mahdie, and D. Ulfah, "The Utilization of Rice Husk Waste for Mixed Bokashi Fertilizer and Biobriket Making As Biofuels)," *PengabdianMu*, vol. 2, no.

September, pp. 90–97, 2017.
[32] E. Wulandari, Ernah, and D. Supyandi, "Agricultural Production and Access to In-kind Finance from Government: A Study of Banana Farms in Cianjur District, West Java," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 166, no. 1, p. 012042, Jun. 2018.
[33] N. Sardjono, B. Susilo, and Wignyanto, "Strategy of Organic Fertilizer Production System Development on Organic Fertilizer Processing (Strategi Pengembangan Sistem Produksi Pupuk Organik Pada Produksi Pupuk Organik Pada Unit Pengolahan Pupuk Organik (UPPO) dI Desa Bangunsari Kabupaten Ciamis)," *J. Teknol. Pertan.*, vol. 13, no. 2, pp. 138–148, 2012.
[34] Y. E. Prasetyo and M. A. Mauludin, "Community Development Planning : Introduction of Integrated Farming System (IFS) to the Rural Community," *J. Ilmu Ternak*, vol. 16, no. 2, pp. 78–88, 2016.
[35] T. Ekowati, E. Prasetyo, and M. Handayani, "The factors influencing production and economic efficiency of beef cattle farm in Grobogan Region, Central Java," *J. Indones. Trop. Anim. Agric.*, vol. 43, no. 1, pp. 76–84, 2018.
[36] W. Stür, T. T. Khanh, and A. Duncan, "Transformation of smallholder beef cattle production in Vietnam," *Int. J. Agric. Sustain.*, vol. 11, no. 4, pp. 363–381, 2013.
[37] R. Widiati and T. S. M. Widi, "Production Systems And Income Generation From The Smallholder Beef Cattle Farming In Yogyakarta Province, Indonesia," *Anim. Prod.*, vol. 18, no. 1, p. 51, 2016.
[38] K. Ponnusamy and M. K. Devi, "Impact of Integrated Farming System Approach on Doubling Farmers' Income," *Agric. Econ. Res. Rev.*, vol. 30, no. conference number, pp. 233–240, 2017.
[39] T. E. Rahimabadi, M. H. Anssari, and A. Nematollahi, Razavi, "Influence of cow manure and its vermicomposting on the improvement of grain yield and quality of rice (Oryza sativa L.) in field conditions," *Appl. Ecol. Environ. Res.*, vol. 16, no. 1, pp. 97–110, 2018.
[40] T. A. Kusumastuti, S. Sarim, and M. Masyhuri, "Integrated farming model of small ruminants in deli serdang, north sumatra - Indonesia," *J. Indones. Trop. Anim. Agric.*, vol. 40, no. 2, pp. 115–120, 2015.
[41] N. E. Odoh, S. U. Nwibo, A. V. Eze, and C. O. Igberi, "Farm and non-farm income diversification activities among rural households in Southeast, Nigeria," *J. Agric. Ext.*, vol. 23, no. 2, pp. 113–121, 2019.
[42] Ministry of Agriculture. 2017. Agricultural Statistics. Publisher Center for Data and Information Systems. http://epublikasi.setjen.pertanian.go.id/arsip-perstatistikan/160-statistik/statistik-pertanian. Accessed 1 October 2019.
[43] Ministry of Agriculture. 2018. Agricultural Statistics. Publisher Center for Data and Information Systems. http://epublikasi.setjen.pertanian.go.id/arsip-perstatistikan/160-statistik/statistik-pertanian. Accessed 1 October 2019.
[44] The Central Bureau of Statistics (CBS) West Java Province. 2015. West Java Province in Figure. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2016/02/29/303b35c34730fbed908ef272/provinsi-jawa-barat-dalam-angka-2015.html. accessed 4 October 2019.
[45] The Central Bureau of Statistics (CBS) West Java Province. 2016. West Java Province in Figure. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2016/07/15/2297a52073f5f32eca26eb8a/provinsi-jawa-barat-dalam-angka-2016.html. accessed 4 October 2019.
[46] The Central Bureau of Statistics (CBS) West Java Province. 2017. West Java Province in Figure. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2017/08/12/62379e17bcc20052a7991d35/provinsi-jawa-barat-dalam-angka-2017.html. Accessed 4 October 2019.

[47] The Central Bureau of Statistics (CBS) Indramayu District. 2014. Indramayu District in Figure. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2014/12/19/afc6f1f2ee42116e0f53a627/kabupaten-indramayu-dalam-angka-2014.html. Accessed 4 October 2019.
[48] The Central Bureau of Statistics (CBS) Indramayu District. 2015. Indramayu District in Figure. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/01/26/c1d5953cdbd0728c77f53f6c/kabupaten-indramayu-dalam-angka-2015.html. accessed 4 October 2019.
[49] The Central Bureau of Statistics (CBS) Indramayu District. 2016. Indramayu District in Figure. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/07/15/551c0bc293bd22b3d00c42db/kabupaten-indramayu-dalam-angka-2016.html. Accessed 4 October 2019.
[50] The Central Bureau of Statistics (CBS) Indramayu District. 2017. Indramayu District in Figure. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2017/08/18/07cf633d10b42aed1ae87fcb/kabupaten-indramayu-dalam-angka-2017.html. Accessed 4 October 2019.
[51] The Central Bureau of Statistics (CBS) Indramayu District. 2018. Indramayu District in Figure. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2018/08/16/99305d123f315f796f19b6d4/kabupaten-indramayu-dalam-angka-2018.html. Accessed 4 October 2019.
[52] The Central Bureau of Statistics (CBS) Majalengka District. 2014. Majalengka District in Figure. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2014/12/15/a197964d9427671924d37063/kabupaten-majalengka-dalam-angka-2014.html. Accessed 5 October 2019.
[53] The Central Bureau of Statistics (CBS) Majalengka District. 2015. Majalengka District in Figure. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/01/27/b47b2662d498f8d17ce2b34d/kabupaten-majalengka-dalam-angka-2015.html. Accessed 5 October 2019.
[54] The Central Bureau of Statistics (CBS) Majalengka District. 2016. Majalengka District in Figure. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/07/15/627c3a92e166c355de65e373/kabupaten-majalengka-dalam-angka-2016.html. Accessed 5 October 2019.
[55] The Central Bureau of Statistics (CBS) Majalengka District. 2017. Majalengka District in Figure. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2017/08/11/1619e71644b63facf2aa53f5/kabupaten-majalengka-dalam-angka-2017.html. Accessed 5 October 2019.
[56] The Central Bureau of Statistics (CBS) Majalengka District. 2018. Majalengka District in Figure. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2018/08/16/7a08032d613c4bcc2c203b16/kabupaten-majalengka-dalam-angka-2018.html. Accessed 5 October 2019.
[57] The Central Bureau of Statistics (CBS) Subang District. 2014. Subang District in Figure BPS Subang District. https://subangkab.bps.go.id/publication/2015/08/13/6c56c4ad7e26832d763db710/subang-dalam-angka-2014.html. Accessed 5 October 2019.
[58] The Central Bureau of Statistics (CBS) Subang District. 2015. Subang District in Figure. BPS Subang District. https://subangkab.bps.go.id/publication/2016/03/02/95d8a1ea348e816703b71a41/kabupaten-subang-dalam-angka-2015.html. Accessed 5 October 2019.
[59] The Central Bureau of Statistics (CBS) Subang District. 2016. Subang District in Figure. BPS Subang District.

https://subangkab.bps.go.id/publication/2016/07/15/53ebb793a6e8a54fedf183f8/kabupaten-subang-dalam-angka-2016.html. Accessed 5 October 2019.
[60] The Central Bureau of Statistics (CBS) Subang District. 2017. Subang District in Figure. BPS Subang District. https://subangkab.bps.go.id/publication/2017/08/10/21462f2a7958ef3555b86b9e/kabupaten-subang-dalam-angka-2017.html. Accessed 5 October 2019.
[61] The Central Bureau of Statistics (CBS) Subang District. 2018. Subang District in Figure. BPS Subang District. https://subangkab.bps.go.id/publication/2018/08/16/fbf586fd952afd9aa9db7052/kabupaten-subang-dalam-angka-2018.html. accessed 5 October 2019.
[62] The Central Bureau of Statistics (CBS) Sukabumi District. 2014.Sukabumi District in Figure. BPS Sukabumi District. https://sukabumikota.bps.go.id/publication/2015/08/13/196a62fc4d9695b2ca1e16ed/kota-sukabumi-dalam-angka-2014.html. Accessed 5 October 2019.
[63] The Central Bureau of Statistics (CBS) Sukabumi District. 2015. Sukabumi District in Figure. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2015/12/12/0f835f3344a10af477f71341/sukabumi-dalam-angka-2015.html. Accessed 5 October 2019.
[64] The Central Bureau of Statistics (CBS) Sukabumi District. 2016. Sukabumi District in Figure. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/04/5ac28d5fefb8e7a6de6bf7ab/kabupaten-sukabumi-dalam-angka-2016.html. Accessed 5 October 2019.
[65] The Central Bureau of Statistics (CBS) Sukabumi District. 2017. Sukabumi District in Figure. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/11/1a2410e17b16e8209db31c1b/kabupaten-sukabumi-dalam-angka-2017.html. Accessed 5 October 2019.
[66] The Central Bureau of Statistics (CBS) Sukabumi District. 2018. Sukabumi District in Figure. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2018/08/16/c20ed4d909fede7ac131ad41/kabupaten-sukabumi-dalam-angka-2018.html. Accessed 5 October 2019.
[67] Animal Husbandry and Animal Health Service Office in Indramayu District (2013-2016). Indramayu District.
[68] Agriculture and Horticulture Office in Indramayu District (2017). Agriculture Office Number of farmer groups in Indramayu District (2017-2018). Agricultural Service Report in Indramayu District. Retrieved from http://distan.indramayukab.go.id/dinas-pertanian-menyelenggarakan-kontes-mangga/ accessed 7 August 2019.

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2

Process Reviewer

2. Process Review Manuscript by Reviewer
(24 August 2023 – 07 January 2024)

WIWIK AMBARSARI <wiwik19001@mail.unpad.ac.id> Fri, Aug 25, 2023, 11:54 AM

to ram
Dear,
Prof. Ram Kishan
Chief Editor, International Journal of Agricultural and Statistical Sciences

Thank you for the attention from Prof. Ram. I submitted names to be considered for reviewing my article, ***Prof***. ***Ir***. ***Vitus Dwi Yunianto Budi Ismadi***, M.S., M.Sc., Ph.D.
(email: vitus.dbi@gmail.com).
This article is a graduation requirement in the agricultural science doctoral study program. I hope that the editors will consider my article.
Thank You.

Greetings,
Wiwik Ambarsari
Correspondence

WIWIK AMBARSARI <wiwik19001@mail.unpad.ac.id> Dec 17, 2023, 7:44 PM

to ram
Dear,
Prof. Ram Kishan
Chief Editor, International Journal of Agricultural and Statistical Sciences

We apologize. How did the continuation of the article we submitted?
Is it being processed further because there has been no news for fourth months? We are waiting for a response from Prof. Ram. Thank You.

Greetings,
Wiwik Ambarsari
Correspondence

ram kishan <rkishan05@rediffmail.com> Dec 18, 2023, 8:37 PM

to me
Dear Author,
Your paper is **still under review process**. I am just sending the reminder to the reviewer. So let us wait for reviewers reply.

Thanks

Prof. Ram Kishan
Chief Editor, International Journal of Agricultural and Statistical Sciences

WIWIK AMBARSARI <wiwik19001@mail.unpad.ac.id> Jan 5, 2024, 6:14 AM

to ram

Dear
Prof. Ram Kishan
Chief Editor International Journal of Agricultural and Statistical Sciences

Thank you for your information.
We are sorry. My number is MS# 10598 for correspondence.
How is the progress of our paper among reviewers?
Thank you.

Best regards
Author and correspondence
Wiwik Ambarsari

ram kishan <rkishan05@rediffmail.com> Sun, Jan 7,2024 5:21 AM

to me

Dear Author,

I have not received the reviewer comments till date. I am just sending a reminder to him. So please wait for some time.

Thanks

Prof. Ram Kishan
Chief Editor, International Journal of Agricultural and Statistical Sciences

3

Accepted

3. Acceptance letter

(22 January 2024)

ram kishan <rkishan05@rediffmail.com> Mon, Jan 22,2024 12:55 PM

to me

Dear Author,

I am pleased to inform you that on recommendations of referees your research article entitled " Diversification of rice system: a sustainable livelihood for rice farming households in Indramayu District, West Java, Indonesia (ref.no.10598)" coauthored with Lies Sulistyowati, TrisnaInsan Noor and Eliana Wulandari has been **accepted for publication in International Journal of Agricultural and Statistical Sciences and will be published in Vol. 20, No.1, June 2024**.

Kindly deposit $ 500 towards the publication cost as per the following specifications:

Beneficiary Name	: International journal of Agricultural and Statistical Sciences
Beneficiary A/C No.	: 517901010180073
Beneficiary Mobile Number	: 09458278524
Beneficiary Bank	: Union Bank of India,
Branch	: D A V College Branch, Muzaffarnagar - 251 001, India
IFSC Code	: UBIN0551791
Swift code	: UBIN IN BB MRT
Purpose code of remittance	: P0806

Thanking you

Prof. Ram Kishan
Chief Editor, International Journal of Agricultural and Statistical Sciences

WIWIK AMBARSARI <wiwik19001@mail.unpad.ac.id>

Acceptance letter

ram kishan <rkishan05@rediffmail.com> Mon, Jan 22, 2024 at 11:55 AM
To: WIWIK AMBARSARI <wiwik19001@mail.unpad.ac.id>

Dear Author,

I am pleased to inform you that on recommendations of referees your research article entitled " Diversification of rice system: a sustainable livelihood for rice farming households in Indramayu District, West Java, Indonesia (ref.no.10598)" coauthored with Lies Sulistyowati, TrisnaInsan Noor and Eliana Wulandari has been accepted for publication in International Journal of Agricultural and Statistical Sciences and will be published in Vol. 20, No.1, June 2024.

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Swift code	: UBIN IN BB MRT
Purpose code of remittance	: P0806

Thanking you

Prof. Ram Kishan
Chief Editor, International Journal of Agricultural and Statistical Sciences

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International Journal of Agricultural and Statistical Sciences

Dr. Ram Kishan
Chief Editor

Department of Statistics
D.A.V. (P.G.) College
Muzaffanagar-251 001, India

Date ....22.01.2024.....

Dr. Wiwik Ambarsari
Department of Agribusiness,
Faculty of Agriculture,
Universitas Wiralodra,
Indramayu, Indonesia

Sub: Acceptance letter

Dear Author,

I am pleased to inform you that on recommendations of referees your research article entitled " Diversification of rice system: a sustainable livelihood for rice farming households in Indramayu District, West Java, Indonesia (ref.no.10598)" coauthored with Lies Sulistyowati, TrisnaInsan Noor and Eliana Wulandari has been accepted for publication in International Journal of Agricultural and Statistical Sciences and will be published in Vol. 20, No.1, June 2024.

Thanking you

Yours truly

(RAM KISHAN)

BNI

Validasi :

Tanggal/ *Date* : 22/03/2024

Formulir Kiriman Uang

Remittance Application

Penerima/*Beneficiary* ☐ Penduduk/*Resident* ☐ Bukan Penduduk/*Non Resident*

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Nama/*Name* : International Journal of Agricultural and Statistical Sciences

Alamat/*Address* :

Telepon/*Phone* : 09458270574

Kota/*City* : Muzaffarnagar Negara/*Country* : India 251001

Bank Penerima/*Beneficiary Bank* : Union Bank of India

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☑ Perorangan/*Personal* ☐ Perusahaan/*Company*

☐ Pemerintah/*Government* ☐ *Remittance*

Nama/*Name* : Wimi Ambarsari

Nama Alias/*Alias Name* :

No. ID :

KTP/SIM/*Passport*/KITAS 3204 2845 0873 0018

Alamat/*Address* : Jln Ta Abdi Karya Blok C4 no 8

Telepon/*Phone* : 0821-1386 7448

Kota/*City* : Indramayu Negara/*Country* : Indonesia

Jenis Pengiriman/*Type of Transfer* ☐ LLG/*Clearing* ☐ Draft ☐ .....
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Sumber Dana/ *Source of fund*

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Mata Uang/*Currency* : ☐ IDR ☑ USD ☐ .....

Jumlah Dana yang dikirim/*Amount Transfer* :

Jumlah/*Amount*	Kurs/*Rate*	Nilai/*Total Amount*
300 USD		

Biaya/*Charge*	Valas/*Amount in Foreign Exchange*	Kurs/ *Amount*	Nilai/ *Total Amount*
Komisi/*Commision* Pengiriman/*Handling* Bank Koresponden/*Correspondent Bank*	Rupiah 25 USD		Rp 35.000
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- Transaksi oleh bukan penduduk di atas USD 10.000 atau ekuivalen wajib mengisi Form LLD1/*Transactional by non-resident amounting over US $ 10,000 or its equivalent must fill in LLD1 Form.*

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CABANG : INDRAMAYU

IBOC - Maintenance (S10)

Teller ID : 88166
Date : 22/03/2024
Time : 12:54:17

Sender's Reference:
:20:S10IDR00002624
Bank Operation Code:
:23B:CRED
Value Date/Currency/Interbank Settled Amount:
:32A:240322USD500,
Ordering Customer:
:50K:/0000000287107275
WIWIK AMBARSARI
GRIYA ABDI KARYA BLOK C-4
TERUSAN SINDANG INDRAMAYU
082113867448
Ordering Institution:
:52A:BNINIDJAXXX
Account With Institution:
:57D:UNION BANK OF INDIA
DAV COLLEGE BRANCH
INDIA 251 001
Beneficiary Customer:
:59:/517901010180073
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MUZZAFARNAGAR INDIA 251 001
Remittance Information:
:70:PAYMENT JOURNAL IJASS PAPER
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PAYMENT PUBLICATION VOL 20 NO
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Details of Charges:
:71A:OUR
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KANTOR CABANG
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REFERENCE : S10IDR00002624

NO. TRX. : 88166 920165 96962 TRAN 22/03/2024 11:23:15
NO. REK. : 0000002871072?5 WIWIK AMBARSARI
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118 - INDRAMAYU

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NO. REK. : 1183604Z0801001 PENDAPATAN PROPISI KU
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JUMLAH : IDR 7,972,500- 1568
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118 - INDRAMAYU

PT BANK NEGARA INDONESIA (PERSERO) TBK
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4

Proof to publish

4. Proof to Publish
(29 March – 4 April 2024)

ram kishan <rkishan05@rediffmail.com>

Fri, Mar 29,2024
2:41 PM

to me

Prof. Ram Kishan
Chief Editor, International Journal of Agricultural and Statistical Sciences

WIWIK AMBARSARI <wiwik19001@mail.unpad.ac.id>

Tue, Apr 2,
3:17 AM

to ram
Dear
Prof. Ram Kishan
Chief Editor, International Journal of Agricultural and Statistical Sciences

Thank you very much for correcting our paper. Some corrections:
1. The correspondent email we sent was wrong: wiwik19001@gmail.ac.id. The correct one is: **wiwik19001@mail.unpad.ac.id**

2. **Orcid** correspondent: **https://orcid.org/0000-0003-0665-3590**

3. write 1-2 Keywords:
Livelihood sustainability; Farmer household

4. Our errors in the literature: BPS (2013-2017), correct: **Ministry of Agriculture (2017 and 2018)**
5. Repaired File

Greetings,
Wiwik Ambarsari
Corresponding author

Int. J. Agricult. Stat. Sci. Vol. 20, No. 1, pp. ... , 2024
DOI: https://doi.org/10.59467/IJASS.2024.20.
www.connectjournals.com/ijass
ISSN : 0973-1903, e-ISSN : 0976-3392
ORIGINAL ARTICLE

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

Wiwik Ambarsari[1,2,*], Lies Sulistyowati[3], TrisnaInsan Noor[3] and Eliana Wulandari[3]

[1]Program Study of Agriculture Science (Postgraduate), Padjadjaran University, Sumedang, Indonesia.
[2]Department of Agribusiness, Faculty of Agriculture, Universitas Wiralodra, Indramayu, Indonesia.
[3]Departement of Social Economic. Faculty of Agriculture, Padjadjaran University, Sumedang, Indonesia.
E-mail:wiwik19001@gmail.ac.id
ORCID:

Commented [wa1]: I am sorry, this email wrong. Email is correct: wiwik19001@mail.unpad.ac.id

Commented [wa2]: Orcid: https://orcid.org/0000-0003-0665-3590

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

Commented [wa3]: 1-2 keywords: Livelihood sustainability; Farmer household

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2024-03-29 13:09:37
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write 1-2 keywords
Livelihood sustainability;
Farmer household

Cite this article

Wiwik Ambarsari, Lies Sulistyowati, TrisnaInsan Noor and Eliana Wulandari (2024). Div... System: A Sustainable Livelihood for Rice Farming Households in Indramayu District, West Java, Indo... *International Journal of Agricultural and Statistical Sciences.* DOI: https://doi.org/10.59467/IJASS.2024.20.

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 **[BPS (2013-2017)].** 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 **[BPS (2013-2017)]** can be seen i

Data in Table experienced positive percent from 2013 to has reached 75.652.2 in Indonesia. West J which experienced a percent. Rice produ 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 to 2017 (Table 2). The decline in rice production will

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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.

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 (2013-2017).

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.

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 fertilizers. Rice groats can be used as a mixture to make

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 (ton of MDG per year)	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
			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.

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 [**Sardjono *et al*. (2012)].** An integrated farming system is an alternative to rural community

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)

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 can be made into organic fertilizer, which functions to

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.

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 $month^{-1}$, and 1,150.43 ha $year^{-1}$. According to Sari *et al*. (2017),

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 (29.5 kg/day/ head)**	Beef cattle Urine (14,1 liter/day)**	Beef cattle Manure One month (ton)	Beef cattle Urine One month (liter)	Beef cattle Manure year (ton)	Beef cattle Urine 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.

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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References

Agriculture and Horticulture Office in Indramayu District (2017). Agriculture Office Number of farmer groups in Indramayu District (2017-2018). *Agricultural Service Report in Indramayu District*. Retrieved from:http:// distan.indramayukab.go.id/dinas-pertanian-menyelenggarakan-kontes-mangga/ accessed 7 August 2019.

Agus, C., B.H. Sunarminto and B. Suhartanto (2011). Integrated Bio-cycles Farming System for Production of Bio-gas through Gama Digester, Gama Purification and Gama Compressing. *J. Japan Energy*, **90(10)**, 1086-

1090. https://www.rcenetwork.org/portal/sites/default/files/CAH-JIE-IBFS for 4F.pdf

Budi Kusumo, R.A., G. Kurnia, I. Setiawan and R. Tirtosudarmo (2023). Migration and Farmer Household Livelihood Strategies: Factors Influencing the Decision to Migrate. *Pertanika J. Soc. Sci. Human.*, **31(1)**, 57-79. https://doi.org/10.47836/pjssh.31.1.04

Burchfield, E.K. and A.T. Poterie de la (2018). Determinants of crop diversification in rice-dominated Sri Lankan agricultural systems. *J. Rural Studies*, **xx(x)**, 1-10. https://doi.org/10.1016/j.jrurstud.2018.05.010

Conway, G.R. and R. Chambers (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. *IDS Discussion Paper*, **296(January 1992)**, 1-28.

Ekowati, T., E. Prasetyo and M. Handayani (2018). The factors influencing production and economic efficiency of beef cattle farm in Grobogan Region, Central Java. *J. Indonesian Trop. Anim. Agricult.*, **43(1)**, 76-84. https://doi.org/10.14710/jitaa.43.1.76-84

Ellis, F. (2000). Rural Livelihood Diversity in Developing Countries. *Oxford University Press*, **40**, 1-10.

FAO (2017). Productivity and Efficiency Measurement in Agriculture. *Food and Agriculture Organization of the United Nations*, *February*, 77. http://gsars.org/wp-content/uploads/2017/02/TR-17.02.2017-Productivity-and-Efficiency-Measurement-in-Agriculture.pdf

Gasson, R. (1988). Farm Diversification and Rural Development. *J. Agricult. Econ.*, **39(2)**, 175-182. https://doi.org/10.1111/j.1477-9552.1988.tb00575.x

Islam, A.H.S.M., B.K. Barman and K. Murshed-e-Jahan (2015). Adoption and impact of integrated rice-fish farming system in Bangladesh. *Aquaculture*, **447**, 76-85. https://doi.org/10.1016/j.aquaculture.2015.01.006

Kamdi, P.J., D.K. Swain and S.P. Wani (2020). Efficient land water management practice and cropping system for increasing water and crop productivity in semi-arid tropics. *Agron. J.*, **112(4)**, 2552-2568. https://doi.org/10.1002/agj2.20207

Karunarathna, M. and C. Wilson (2017). Agricultural biodiversity and farm level technical efficiency: An empirical investigation. *J. Forest Econ.*, https://doi.org/10.1016/j.jfe.2017.08.002

Kremen, C., A. Iles and C. Bacon (2012). Diversified Farming Systems/:An Agroecological, Systems-based Alternative to Modern Industrial Agriculture. *Ecology and Society*, **17(4)**, 1-19. https://doi.org/http://dx.doi.org/10.5751/ES-05103-170444

Kremen, C. and A. Miles (2012). Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities and Trade-Offs. *Ecology and Society*, **17(4)**, 1-25. https://doi.org/10.5751/ES-05035-170440

Kurniawati, M. (2013). *Stabilized Rice Bran and Its Application in Analog Rice Formulation Supervised (Stabilisasi Bekatul dan Penerapannya)* [Institut Pertanian Bogor]. https://repository.ipb.ac.id/jspui/bitstream/123456789/65881/1/2013mku.pdf

Kusumastuti, T.A., S. Sarim and M. Masyhuri (2015). Integrated farming model of small ruminants in deli serdang, north sumatra - Indonesia. *J. Indonesian Trop. Anim. Agricult.*, **40(2)**, 115-120. https://doi.org/10.14710/jitaa.40.2.115-120

Lindawati, L., B.M. Sibuea, D. Noita, M.I. Riyadh, A. Hasibuan and E. Al (2018). A Comparative Analysis of Economic Farming Activity of Farmers Rice-Livestock Integrated Farming System (RLIFS) and non RLIFS. *Int. J. Engg Tech.*, **7(3.2)**, 792-795. https://doi.org/10.14419/ijet.v7i3.2.18759

Makate, C., R. Wang, M. Makate and N. Mango (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: Adaptive management for environmental change. *SpringerPlus*, **5(1)**, 1135. https://doi.org/10.1186/s40064-016-2802-4

Martmono, A.A., M. Mappamiring and I. Malik (2013). The Role of the Village Government in Managing the Organic Fertilizer Processing Unit (OFPU) in Kolai Village, Malua District, Enrekang Regency Peran Pemerintah Desa Dalam Pengelolaan Program Usaha Pengelolaan Pupuk Organik (UPPO) di Desa Kolai Kecamatan. *Otoritas/ : Jurnal Ilmu Pemerintahan*, **3(2)**, 75-87. https://doi.org/10.26618/ojip.v3i2.65

Meena, B.P., A.O. Shirale, A.K. Biswas, B.L. Lakaria, P. Jha, P.P. Gurav, R.H. Wanjari and A.K. Patra (2018). Diversified agriculture for higher productivity and profitability–A review. *Agricultural Reviews*, **39(2)**, 104-112. https://doi.org/10.18805/ag.r-1679

Ministry of Agriculture (2018). *Instructions for the implementation of Organic Fertilizer Processing Unit (OFPU). Petunjuk Pelaksanaan Kegiatan unit Pengolah Pupuk Organik (UPPO)*. http://tanamanpangan.pertanian.go.id/assets/front/uploads/document/JUKLAK UPPO 2018.pdf

Ministry of Agriculture Republic of Indonesia (2017). *Agricultural Statistics 2017 Statistik Pertanian 2017* (Susanti, A.A. and B. Waryanto eds.). Center for Agricultural Data and Information System Ministry of Agriculture Republic of Indonesia.

Mishra, A.K. and B.K. Goodwin (1997). Farm Income Variability and the Supply of Off Farm Labor. *Amer. J. Agricult. Econ.*, **79(3)**, 880-887. https://doi.org/10.2307/1244429

Nainggolan, H.L., J. Aritonang, M. Sihombing, T. Supriana

and M. Tafsin (2019). Structural modelling of rice fields-buffalo livestock based integrated agricultural systems in the context of regional development in Humbang Hasundutan, Indonesia. *J. Food, Agricult. Soc.*, **106**, 1-17. https://doi.org/10.17170/kobra-20190709595

Nayak, P.K., A.K. Nayak, B.B. Panda, B. Lal, P. Gautam, A. Poonam, M. Shahid, R. Tripathi, U. Kumar, S.D. Mohapatra and N.N. Jambhulkar (2018). Ecological mechanism and diversity in rice based integrated farming system. *Ecological Indicators*, **91(May 2017)**, 359-375. https://doi.org/10.1016/j.ecolind.2018.04.025

Noviasari, S., F. Kusnandar, A. Setiyono and S. Budijanto (2015). Rice analogues as functional food with low glycemic index (Beras Analog Sebagai Pangan Fungsional Dengan Indeks Glikemik Rendah). *Jurnal Gizi Dan Pangan*, **10(3)**, 225-232. https://doi.org/10.25182/jgp.2015.10.3.

Nuraisah, G. and R.A.B. Kusumo (2019). Impact of Climate Change on Paddy Farming in Wanguk Village, Anjatan Subdistrict, Indramayu District. *Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, **5(1)**, 60-71.

Odoh, N.E., S.U. Nwibo, A.V. Eze and C.O. Igberi (2019). Farm and non-farm income diversification activities among rural households in Southeast, Nigeria. *J. Agricult. Ext.*, **23(2)**, 113-121. https://doi.org/10.4314/jae.v23i2.12

OECD (2001a). *The well-being of nations: The role of human and social capital*. OECD. http://www.oecd.org/site/worldforum/33703702.pdf

OECD (2001b). Measuring Productivity - Measurement of Aggregate and Industry Growth. In: *OECD Manual*. OECD. https://doi.org/10.1787/9789264194519-en

Ponnusamy, K. and M.K. Devi (2017). Impact of Integrated Farming System Approach on Doubling Farmers' Income. *Agricult. Econ. Res. Rev.*, 30(conference number), 233-240. https://doi.org/10.5958/0974-0279.2017.00037.4

Prajanti, S.D.W. and I. Susilowati (2016). The prospect of integrated farming system of crops-fish-husbandary as the survival strategy to secure the farmers economy: Case study in Magelang - Indonesia. *Int. J. Econ. Financial Issues*, **6(Special Issue)**, 84-87. https://www.econjournals.com/index.php/ijefi/article/view/3121/pdf

Prasetyo, Y.E. and M.A. Mauludin (2016). Community Development Planning/ : Introduction of Integrated Farming System (IFS) to the Rural Community. *Jurnal Ilmu Ternak*, **16(2)**, 78-88. http://jurnal.unpad.ac.id/jurnalilmuternak/article/view/11580/5378

Rahimabadi, T.E., M.H. Anssari amd A. Nematollahi, Razavi (2018). Influence of cow manure and its vermicomposting on the improvement of grain yield and quality of rice (*Oryza sativa* L.) in field conditions. *Appl. Ecol. Environ. Res.*, **16(1)**, 97-110. https://doi.org/10.15666/aeer/1601_097110

Rapsomanikis, G. (2015). The economic lives of smallholder farmers. An analysis based on household data from nine countries. *Www.Fao.Org.*, http://www.fao.org/3/a-i5251e.pdf

Rehman, A., A.A. Chandio, I. Hussain and L. Jingdong (2019). Fertilizer consumption, water availability and credit distribution: Major factors affecting agricultural productivity in Pakistan. *J. Saudi Soc. Agricult. Sci.*, **18(3)**, 269-274. https://doi.org/10.1016/j.jssas.2017.08.002

Roy, R., N. Weng and C. Ruslan (2014). Rice farming sustainability assessment in Bangladesh. *Sustain Sci.*, **9**, 31-44. https://doi.org/10.1007/s11625-013-0234-4

Rundengan, M.L., Z. Fanani, I. Subagiyo and F.H. Elly (2014). Integrated Farming System Model in South Minahasa Regency- North Sulawesi. *IOSR J. Agricult. Vet. Sci.*, **5(6)**, 1-7. https://doi.org/10.9790/2380-0560107

Sardjono, N., B. Susilo and Wignyanto (2012). Strategi Pengembangan Sistem Produksi Pupuk Organik Pada Unit Pengolahan Pupuk Organik (UPPO) di desa bangunsari Kabupaten Ciamis. *Jurnal Teknologi Pertanian*, **13(2)**, 138-148.

Sari, N.M., K. Nisa, M.F. Mahdie and D. Ulfah (2017). The Utilization of Rice Husk Waste for Mixed Bokashi Fertilizer and Biobriket Making as Biofuels. *PengabdianMu*, **2(September)**, 90-97. http://jurnal.umpalangkaraya.ac.id/ejurnal/pgbmu

Scoones, I. (1998). Sustainable Rural Livelihoods : A Framework for Analysis: IDS Working Paper 72. *Development (Basingstoke)*, **42(2)**, 1-22. https://doi.org/10.1057/palgrave.development.1110037

Shilomboleni, H., M. Owaygen, R. De Plaen, W. Manchur and L. Husak (2019). Scaling up innovations in smallholder agriculture: Lessons from the Canadian international food security research fund. *Agricultural Systems*, **175(May 2019)**, 58-65. https://doi.org/10.1016/ j.agsy.2019.05.012

Soemantri, A.S., P. Luna and B. Jamal (2016). Strategy to increase rice production with the emphasis on the losses during harvest and posth (Strategi Peningkatan Produksi Beras Melalui Penekanan Susut Panen Dan Pascapanen Dengan Pendekatan Sistem Modeling: Studi Kasus Kabupaten Indramayu, Jawa Barat). *Informatika Pertanian*, **25(2)**, 249-260.

Soni, R.P., M. Katoch and R. Ladohia (2014). Integrated Farming Systems - A Review. *IOSR J. Agricult. Vet. Sci.*, **7(10)**, 36-42. https://doi.org/10.9790/2380-071013642

Stür, W., T.T. Khanh and A. Duncan (2013). Transformation

of smallholder beef cattle production in Vietnam. *Int. J. Agricult. Sust.*, **11(4)**, 363-381. https://doi.org/10.1080/14735903.2013.779074

Suh, J. (2014). Theory and reality of integrated rice-duck farming in Asian developing countries: A systematic review and SWOT analysis. *Agricultural Systems*, **125**, 74-81. https://doi.org/10.1016/j.agsy.2013.11.003

Teng, Q., X.F. Hu, C. Cheng, Z. Luo, F. Luo, Y. Xue, Y. Jiang, Z. Mu, L. Liu and M. Yang (2016). Ecological effects of rice-duck integrated farming on soil fertility and weed and pest control. *J. Soils and Sediments*, **16(10)**, 2395- 2407. https://doi.org/10.1007/s11368-016-1455-9

The Central Bureau of Statistics (CBS) Indramayu District (2014). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2014/12/19/afc6f1f2ee42116e0f53a627/kabupaten-indramayu-dalam-angka-2014.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2015). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/01/26/c1d5953cdbd0728c77f53f6c/kabupaten-indramayu-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2016). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/07/15/551c0bc293bd22b3d00c42db/kabupaten-indramayu-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2017). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2017/08/18/07cf633d10b42aed1ae87fcb/kabupaten-indramayu-dalam-angka-2017.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2018). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2018/08/16/99305d123f315f796f19b6d4/kabupaten-indramayu-dalam-angka-2018.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2014). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2014/12/15/a197964d9427671924d37063/kabupaten-majalengka-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2015). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/01/27/b47b2662d498f8d17ce2b34d/kabupaten-majalengka-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2016). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/07/15/627c3a92e166c355de65e373/kabupaten-majalengka-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2017). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2017/08/11/1619e71644b63facf2aa53f5/kabupaten-majalengka-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2018). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2018/08/16/7a08032d613c4bcc2c203b16/kabupaten-majalengka-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2014). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2015/08/13/6c56c4ad7e26832d763db710/subang-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2015). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/03/02/95d8a1ea348e816703b71a41/kabupaten-subang-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2016). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/07/15/53ebb793a6e8a54fedf183f8/kabupaten-subang-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2017). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2017/08/10/21462f2a7958ef3555b86b9e/kabupaten-subang-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2018). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2018/08/16/fbf586fd952afd9aa9db7052/kabupaten-subang-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2014). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikota.bps.go.id/publication/2015/08/13/196a62fc4d9695b2ca1e16ed/kota-sukabumi-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District

(2015). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2015/12/12/0f835f3344a10af477f71341/sukabumi-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2016). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/04/5ac28d5fefb8e7a6de6bf7ab/kabupaten-sukabumi-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2017). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/11/1a2410e17b16e8209db31c1b/kabupaten-sukabumi-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2018). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2018/08/16/c20ed4d909fede7ac131ad41/kabupaten-sukabumi-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2015). *West Java Province in Figure*. *BPS Provinsi Jawa Barat.*https://jabar.bps.go.id/publication/2016/02/29/303b35c34730fbed908ef272/provinsi-jawa-barat-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2016). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2016/07/15/2297a52073f5f32eca26eb8a/provinsi-jawa-barat-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2017). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2017/08/12/62379e17bcc20052a7991d35/provinsi-jawa-barat-dalam-angka-2017.html. Accessed 4 October 2019.

Van, N.P.H., T.T. NGa, H. ARai, Y. Hosen, N.H. CHiem and K. Inubushi (2014). Rice Straw Management by Farmers in a Triple Rice Production System in the Mekong Delta, Viet Nam. *Trop. Agricult. Develop.*, **58(4)**, 155-162. https://doi.org/10.11248/jsta.58.155

Wariyah, C. (2010). Restructured Fine Grain Rice to High Calcium Rice by Extrusion Method (Restrukturisasi Menir Menjadi Beras Berkalsium Tinggi dengan Metode Ekstrusi). *Agritech*, 30(3), 135-140. https://doi.org/DOI: https://doi.org/10.22146/agritech.9664

Widiati, R. and T.S.M. Widi (2016). Production Systems and Income Generation from the Small holder Beef Cattle Farming in Yogyakarta Province, Indonesia. *Animal Production*, **18(1)**, 51. https://doi.org/10.20884/1.anprod.2016.18.1.524

Widowati, S. (2000). Pemanfaatan Hasil Samping Penggilingan Padi dalam Menunjang Sistem Agroindustri di Pedesaan. *Buletin Agrobio*, **4(1)**, 33-38. http://biogen.litbang.pertanian.go.id/wp/terbitan/pdf/agrobio_4_1_33-38.pdf

Wiyatna, M.F., E.A. Gurnadi and K. Mudikdjo (2012). Productivity of Peranakan Ongole Cattle on traditional farm system in Sumedang Region (Produktivitas Sapi Peranakan Ongole pada Peternakan Rakyat di Kabupaten Sumedang). *Jurnal Ilmu Ternak*, **12(2)**, 22-25. http://journal.unpad.ac.id/jurnalilmuternak/article/viewFile/5124/2552

Wulandari, E., Ernah and D. Supyandi (2018). Agricultural Production and Access to In-kind Finance from Government: A Study of Banana Farms in Cianjur District, West Java. *IOP Conf. Ser.: Earth Environ. Sci.*, **166(1)**, 012042. https://doi.org/10.1088/1755-1315/166/1/012042

Xu, G., X. Liu, Q. Wang, X. Yu and Y. Hang (2017). Integrated rice-duck farming mitigates the global warming potential in rice season. *Sci. Total Environ.*, **575**, 58-66. https://doi.org/10.1016/j.scitotenv.2016.09.233

Yuniarti, A., M. Damayani and D.M. Nur (2019). Efek Pupuk Organik dan Puuk N,P,K Terhadap C-Organik, N-Total, C/N, Serapan N, Serta Hasil Padi Hitam (*Oryza sativa* L. *indica*) Pada Inceptisols. *Jurnal Pertanian Presisi (Journal of Precision Agriculture)*, **3(2)**, 90-105. https://doi.org/10.35760/jpp.2019.v3i2.2205

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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

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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 **[BPS (2013-2017)].** 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 **[BPS (2013-2017)]** 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 to 2017 (Table 2). The decline in rice production will

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.

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 (2013-2017).

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.

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 fertilizers. Rice groats can be used as a mixture to make

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 (ton of MDG per year)	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
			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.

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 [**Sardjono *et al*. (2012)].** An integrated farming system is an alternative to rural community

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)

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 can be made into organic fertilizer, which functions to

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.

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 $month^{-1}$, and 1,150.43 ha $year^{-1}$. According to Sari *et al*. (2017),

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 (29.5 kg/day/ head)**	Beef cattle Urine (14,1 liter/day)**	Beef cattle Manure One month (ton)	Beef cattle Urine One month (liter)	Beef cattle Manure year (ton)	Beef cattle Urine 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.

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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References

Agriculture and Horticulture Office in Indramayu District (2017). Agriculture Office Number of farmer groups in Indramayu District (2017-2018). *Agricultural Service Report in Indramayu District*. Retrieved from:http://distan.indramayukab.go.id/dinas-pertanian-menyelenggarakan-kontes-mangga/ accessed 7 August 2019.

Agus, C., B.H. Sunarminto and B. Suhartanto (2011). Integrated Bio-cycles Farming System for Production of Bio-gas through Gama Digester, Gama Purification and Gama Compressing. *J. Japan Energy*, **90(10)**, 1086-

1090. https://www.rcenetwork.org/portal/sites/default/files/CAH-JIE-IBFS for 4F.pdf

Budi Kusumo, R.A., G. Kurnia, I. Setiawan and R. Tirtosudarmo (2023). Migration and Farmer Household Livelihood Strategies: Factors Influencing the Decision to Migrate. *Pertanika J. Soc. Sci. Human.*, **31(1)**, 57-79. https://doi.org/10.47836/pjssh.31.1.04

Burchfield, E.K. and A.T. Poterie de la (2018). Determinants of crop diversification in rice-dominated Sri Lankan agricultural systems. *J. Rural Studies*, **xx(x)**, 1-10. https://doi.org/10.1016/j.jrurstud.2018.05.010

Conway, G.R. and R. Chambers (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. *IDS Discussion Paper*, **296(January 1992)**, 1-28.

Ekowati, T., E. Prasetyo and M. Handayani (2018). The factors influencing production and economic efficiency of beef cattle farm in Grobogan Region, Central Java. *J. Indonesian Trop. Anim. Agricult.*, **43(1)**, 76-84. https://doi.org/10.14710/jitaa.43.1.76-84

Ellis, F. (2000). Rural Livelihood Diversity in Developing Countries. *Oxford University Press*, **40**, 1-10.

FAO (2017). Productivity and Efficiency Measurement in Agriculture. *Food and Agriculture Organization of the United Nations, February*, 77. http://gsars.org/wp-content/uploads/2017/02/TR-17.02.2017-Productivity-and-Efficiency-Measurement-in-Agriculture.pdf

Gasson, R. (1988). Farm Diversification and Rural Development. *J. Agricult. Econ.*, **39(2)**, 175-182. https://doi.org/10.1111/j.1477-9552.1988.tb00575.x

Islam, A.H.S.M., B.K. Barman and K. Murshed-e-Jahan (2015). Adoption and impact of integrated rice-fish farming system in Bangladesh. *Aquaculture*, **447**, 76-85. https://doi.org/10.1016/j.aquaculture.2015.01.006

Kamdi, P.J., D.K. Swain and S.P. Wani (2020). Efficient land water management practice and cropping system for increasing water and crop productivity in semi-arid tropics. *Agron. J.*, **112(4)**, 2552-2568. https://doi.org/10.1002/agj2.20207

Karunarathna, M. and C. Wilson (2017). Agricultural biodiversity and farm level technical efficiency: An empirical investigation. *J. Forest Econ.*, https://doi.org/10.1016/j.jfe.2017.08.002

Kremen, C., A. Iles and C. Bacon (2012). Diversified Farming Systems/:An Agroecological, Systems-based Alternative to Modern Industrial Agriculture. *Ecology and Society*, **17(4)**, 1-19. https://doi.org/http://dx.doi.org/10.5751/ES-05103-170444

Kremen, C. and A. Miles (2012). Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities and Trade-Offs. *Ecology and Society*, **17(4)**, 1-25. https://doi.org/10.5751/ES-05035-170440

Kurniawati, M. (2013). *Stabilized Rice Bran and Its Application in Analog Rice Formulation Supervised (Stabilisasi Bekatul dan Penerapannya)* [Institut Pertanian Bogor]. https://repository.ipb.ac.id/jspui/bitstream/123456789/65881/1/2013mku.pdf

Kusumastuti, T.A., S. Sarim and M. Masyhuri (2015). Integrated farming model of small ruminants in deli serdang, north sumatra - Indonesia. *J. Indonesian Trop. Anim. Agricult.*, **40(2)**, 115-120. https://doi.org/10.14710/jitaa.40.2.115-120

Lindawati, L., B.M. Sibuea, D. Noita, M.I. Riyadh, A. Hasibuan and E. Al (2018). A Comparative Analysis of Economic Farming Activity of Farmers Rice-Livestock Integrated Farming System (RLIFS) and non RLIFS. *Int. J. Engg Tech.*, **7(3.2)**, 792-795. https://doi.org/10.14419/ijet.v7i3.2.18759

Makate, C., R. Wang, M. Makate and N. Mango (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: Adaptive management for environmental change. *SpringerPlus*, **5(1)**, 1135. https://doi.org/10.1186/s40064-016-2802-4

Martmono, A.A., M. Mappamiring and I. Malik (2013). The Role of the Village Government in Managing the Organic Fertilizer Processing Unit (OFPU) in Kolai Village, Malua District, Enrekang Regency Peran Pemerintah Desa Dalam Pengelolaan Program Usaha Pengelolaan Pupuk Organik (UPPO) di Desa Kolai Kecamatan. *Otoritas/ : Jurnal Ilmu Pemerintahan*, **3(2)**, 75-87. https://doi.org/10.26618/ojip.v3i2.65

Meena, B.P., A.O. Shirale, A.K. Biswas, B.L. Lakaria, P. Jha, P.P. Gurav, R.H. Wanjari and A.K. Patra (2018). Diversified agriculture for higher productivity and profitability–A review. *Agricultural Reviews*, **39(2)**, 104-112. https://doi.org/10.18805/ag.r-1679

Ministry of Agriculture (2018). *Instructions for the implementation of Organic Fertilizer Processing Unit (OFPU). Petunjuk Pelaksanaan Kegiatan unit Pengolah Pupuk Organik (UPPO)*. http://tanamanpangan.pertanian.go.id/assets/front/uploads/document/JUKLAK UPPO 2018.pdf

Ministry of Agriculture Republic of Indonesia (2017). *Agricultural Statistics 2017 Statistik Pertanian 2017* (Susanti, A.A. and B. Waryanto eds.). Center for Agricultural Data and Information System Ministry of Agriculture Republic of Indonesia.

Mishra, A.K. and B.K. Goodwin (1997). Farm Income Variability and the Supply of Off Farm Labor. *Amer. J. Agricult. Econ.*, **79(3)**, 880-887. https://doi.org/10.2307/1244429

Nainggolan, H.L., J. Aritonang, M. Sihombing, T. Supriana

and M. Tafsin (2019). Structural modelling of rice fields-buffalo livestock based integrated agricultural systems in the context of regional development in Humbang Hasundutan, Indonesia. *J. Food, Agricult. Soc.*, **106**, 1-17. https://doi.org/10.17170/kobra-20190709595

Nayak, P.K., A.K. Nayak, B.B. Panda, B. Lal, P. Gautam, A. Poonam, M. Shahid, R. Tripathi, U. Kumar, S.D. Mohapatra and N.N. Jambhulkar (2018). Ecological mechanism and diversity in rice based integrated farming system. *Ecological Indicators*, **91(May 2017)**, 359-375. https://doi.org/10.1016/j.ecolind.2018.04.025

Noviasari, S., F. Kusnandar, A. Setiyono and S. Budijanto (2015). Rice analogues as functional food with low glycemic index (Beras Analog Sebagai Pangan Fungsional Dengan Indeks Glikemik Rendah). *Jurnal Gizi Dan Pangan*, **10(3)**, 225-232. https://doi.org/10.25182/jgp.2015.10.3.

Nuraisah, G. and R.A.B. Kusumo (2019). Impact of Climate Change on Paddy Farming in Wanguk Village, Anjatan Subdistrict, Indramayu District. *Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, **5(1)**, 60-71.

Odoh, N.E., S.U. Nwibo, A.V. Eze and C.O. Igberi (2019). Farm and non-farm income diversification activities among rural households in Southeast, Nigeria. *J. Agricult. Ext.*, **23(2)**, 113-121. https://doi.org/10.4314/jae.v23i2.12

OECD (2001a). *The well-being of nations: The role of human and social capital*. OECD. http://www.oecd.org/site/worldforum/33703702.pdf

OECD (2001b). Measuring Productivity - Measurement of Aggregate and Industry Growth. In: *OECD Manual*. OECD. https://doi.org/10.1787/9789264194519-en

Ponnusamy, K. and M.K. Devi (2017). Impact of Integrated Farming System Approach on Doubling Farmers' Income. *Agricult. Econ. Res. Rev.*, 30(conference number), 233-240. https://doi.org/10.5958/0974-0279.2017.00037.4

Prajanti, S.D.W. and I. Susilowati (2016). The prospect of integrated farming system of crops-fish-husbandary as the survival strategy to secure the farmers economy: Case study in Magelang - Indonesia. *Int. J. Econ. Financial Issues*, **6(Special Issue)**, 84-87. https://www.econjournals.com/index.php/ijefi/article/view/3121/pdf

Prasetyo, Y.E. and M.A. Mauludin (2016). Community Development Planning/ : Introduction of Integrated Farming System (IFS) to the Rural Community. *Jurnal Ilmu Ternak*, **16(2)**, 78-88. http://jurnal.unpad.ac.id/jurnalilmuternak/article/view/11580/5378

Rahimabadi, T.E., M.H. Anssari amd A. Nematollahi, Razavi (2018). Influence of cow manure and its vermicomposting on the improvement of grain yield and quality of rice (*Oryza sativa* L.) in field conditions. *Appl. Ecol. Environ. Res.*, **16(1)**, 97-110. https://doi.org/10.15666/aeer/1601_097110

Rapsomanikis, G. (2015). The economic lives of smallholder farmers. An analysis based on household data from nine countries. *Www.Fao.Org.*, http://www.fao.org/3/a-i5251e.pdf

Rehman, A., A.A. Chandio, I. Hussain and L. Jingdong (2019). Fertilizer consumption, water availability and credit distribution: Major factors affecting agricultural productivity in Pakistan. *J. Saudi Soc. Agricult. Sci.*, **18(3)**, 269-274. https://doi.org/10.1016/j.jssas.2017.08.002

Roy, R., N. Weng and C. Ruslan (2014). Rice farming sustainability assessment in Bangladesh. *Sustain Sci.*, **9**, 31-44. https://doi.org/10.1007/s11625-013-0234-4

Rundengan, M.L., Z. Fanani, I. Subagiyo and F.H. Elly (2014). Integrated Farming System Model in South Minahasa Regency- North Sulawesi. *IOSR J. Agricult. Vet. Sci.*, **5(6)**, 1-7. https://doi.org/10.9790/2380-0560107

Sardjono, N., B. Susilo and Wignyanto (2012). Strategi Pengembangan Sistem Produksi Pupuk Organik Pada Unit Pengolahan Pupuk Organik (UPPO) di desa bangunsari Kabupaten Ciamis. *Jurnal Teknologi Pertanian*, **13(2)**, 138-148.

Sari, N.M., K. Nisa, M.F. Mahdie and D. Ulfah (2017). The Utilization of Rice Husk Waste for Mixed Bokashi Fertilizer and Biobriket Making as Biofuels. *PengabdianMu*, **2(September)**, 90-97. http://jurnal.umpalangkaraya.ac.id/ejurnal/pgbmu

Scoones, I. (1998). Sustainable Rural Livelihoods : A Framework for Analysis: IDS Working Paper 72. *Development (Basingstoke)*, **42(2)**, 1-22. https://doi.org/10.1057/palgrave.development.1110037

Shilomboleni, H., M. Owaygen, R. De Plaen, W. Manchur and L. Husak (2019). Scaling up innovations in smallholder agriculture: Lessons from the Canadian international food security research fund. *Agricultural Systems*, **175(May 2019)**, 58-65. https://doi.org/10.1016/j.agsy.2019.05.012

Soemantri, A.S., P. Luna and B. Jamal (2016). Strategy to increase rice production with the emphasis on the losses during harvest and posth (Strategi Peningkatan Produksi Beras Melalui Penekanan Susut Panen Dan Pascapanen Dengan Pendekatan Sistem Modeling: Studi Kasus Kabupaten Indramayu, Jawa Barat). *Informatika Pertanian*, **25(2)**, 249-260.

Soni, R.P., M. Katoch and R. Ladohia (2014). Integrated Farming Systems - A Review. *IOSR J. Agricult. Vet. Sci.*, **7(10)**, 36-42. https://doi.org/10.9790/2380-071013642

Stür, W., T.T. Khanh and A. Duncan (2013). Transformation

of smallholder beef cattle production in Vietnam. *Int. J. Agricult. Sust.*, **11(4)**, 363-381. https://doi.org/10.1080/14735903.2013.779074

Suh, J. (2014). Theory and reality of integrated rice-duck farming in Asian developing countries: A systematic review and SWOT analysis. *Agricultural Systems*, **125**, 74-81. https://doi.org/10.1016/j.agsy.2013.11.003

Teng, Q., X.F. Hu, C. Cheng, Z. Luo, F. Luo, Y. Xue, Y. Jiang, Z. Mu, L. Liu and M. Yang (2016). Ecological effects of rice-duck integrated farming on soil fertility and weed and pest control. *J. Soils and Sediments*, **16(10)**, 2395-2407. https://doi.org/10.1007/s11368-016-1455-9

The Central Bureau of Statistics (CBS) Indramayu District (2014). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2014/12/19/afc6f1f2ee42116e0f53a627/kabupaten-indramayu-dalam-angka-2014.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2015). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/01/26/c1d5953cdbd0728c77f53f6c/kabupaten-indramayu-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2016). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/07/15/551c0bc293bd22b3d00c42db/kabupaten-indramayu-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2017). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2017/08/18/07cf633d10b42aed1ae87fcb/kabupaten-indramayu-dalam-angka-2017.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2018). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2018/08/16/99305d123f315f796f19b6d4/kabupaten-indramayu-dalam-angka-2018.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2014). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2014/12/15/a197964d9427671924d37063/kabupaten-majalengka-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2015). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/01/27/b47b2662d498f8d17ce2b34d/kabupaten-majalengka-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2016). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/07/15/627c3a92e166c355de65e373/kabupaten-majalengka-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2017). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2017/08/11/1619e71644b63facf2aa53f5/kabupaten-majalengka-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2018). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2018/08/16/7a08032d613c4bcc2c203b16/kabupaten-majalengka-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2014). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2015/08/13/6c56c4ad7e26832d763db710/subang-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2015). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/03/02/95d8a1ea348e816703b71a41/kabupaten-subang-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2016). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/07/15/53ebb793a6e8a54fedf183f8/kabupaten-subang-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2017). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2017/08/10/21462f2a7958ef3555b86b9e/kabupaten-subang-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2018). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2018/08/16/fbf586fd952afd9aa9db7052/kabupaten-subang-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2014). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikota.bps.go.id/publication/2015/08/13/196a62fc4d9695b2ca1e16ed/kota-sukabumi-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District

(2015). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2015/12/12/0f835f3344a10af477f71341/sukabumi-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2016). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/04/5ac28d5fefb8e7a6de6bf7ab/kabupaten-sukabumi-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2017). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/11/1a2410e17b16e8209db31c1b/kabupaten-sukabumi-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2018). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2018/08/16/c20ed4d909fede7ac131ad41/kabupaten-sukabumi-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2015). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*.https://jabar.bps.go.id/publication/2016/02/29/303b35c34730fbed908ef272/provinsi-jawa-barat-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2016). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2016/07/15/2297a52073f5f32eca26eb8a/provinsi-jawa-barat-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2017). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2017/08/12/62379e17bcc20052a7991d35/provinsi-jawa-barat-dalam-angka-2017.html. Accessed 4 October 2019.

Van, N.P.H., T.T. NGa, H. ARai, Y. Hosen, N.H. CHiem and K. Inubushi (2014). Rice Straw Management by Farmers in a Triple Rice Production System in the Mekong Delta, Viet Nam. *Trop. Agricult. Develop.*, **58(4)**, 155-162. https://doi.org/10.11248/jsta.58.155

Wariyah, C. (2010). Restructured Fine Grain Rice to High Calcium Rice by Extrusion Method (Restrukturisasi Menir Menjadi Beras Berkalsium Tinggi dengan Metode Ekstrusi). *Agritech*, 30(3), 135-140. https://doi.org/DOI: https://doi.org/10.22146/agritech.9664

Widiati, R. and T.S.M. Widi (2016). Production Systems and Income Generation from the Small holder Beef Cattle Farming in Yogyakarta Province, Indonesia. *Animal Production*, **18(1)**, 51. https://doi.org/10.20884/1.anprod.2016.18.1.524

Widowati, S. (2000). Pemanfaatan Hasil Samping Penggilingan Padi dalam Menunjang Sistem Agroindustri di Pedesaan. *Buletin Agrobio*, **4(1)**, 33-38. http://biogen.litbang.pertanian.go.id/wp/terbitan/pdf/agrobio_4_1_33-38.pdf

Wiyatna, M.F., E.A. Gurnadi and K. Mudikdjo (2012). Productivity of Peranakan Ongole Cattle on traditional farm system in Sumedang Region (Produktivitas Sapi Peranakan Ongole pada Peternakan Rakyat di Kabupaten Sumedang). *Jurnal Ilmu Ternak*, **12(2)**, 22-25. http://journal.unpad.ac.id/jurnalilmuternak/article/viewFile/5124/2552

Wulandari, E., Ernah and D. Supyandi (2018). Agricultural Production and Access to In-kind Finance from Government: A Study of Banana Farms in Cianjur District, West Java. *IOP Conf. Ser.: Earth Environ. Sci.*, **166(1)**, 012042. https://doi.org/10.1088/1755-1315/166/1/012042

Xu, G., X. Liu, Q. Wang, X. Yu and Y. Hang (2017). Integrated rice-duck farming mitigates the global warming potential in rice season. *Sci. Total Environ.*, **575**, 58-66. https://doi.org/10.1016/j.scitotenv.2016.09.233

Yuniarti, A., M. Damayani and D.M. Nur (2019). Efek Pupuk Organik dan Puuk N,P,K Terhadap C-Organik, N-Total, C/N, Serapan N, Serta Hasil Padi Hitam (*Oryza sativa* L. *indica*) Pada Inceptisols. *Jurnal Pertanian Presisi (Journal of Precision Agriculture)*, **3(2)**, 90-105. https://doi.org/10.35760/jpp.2019.v3i2.2205

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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 (ton of MDG per year)	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
			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 [**Sardjono *et al*. (2012)].** An integrated

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)

farming system is an alternative 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

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 (29.5 kg/day/ head)**	Beef cattle Urine (14,1 liter/day)**	Beef cattle Manure One month (ton)	Beef cattle Urine One month (liter)	Beef cattle Manure year (ton)	Beef cattle Urine 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.

field area can be given 3.2 ha day^{-1}, 95.87 ha $month^{-1}$, 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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References

Agriculture and Horticulture Office in Indramayu District (2017). Agriculture Office Number of farmer groups in Indramayu District (2017-2018). *Agricultural Service Report in Indramayu District*. Retrieved from:http://distan.indramayukab.go.id/dinas-pertanian-menyelenggarakan-kontes-mangga/ accessed 7 August 2019.

Agus, C., B.H. Sunarminto and B. Suhartanto (2011).

Integrated Bio-cycles Farming System for Production of Bio-gas through Gama Digester, Gama Purification and Gama Compressing. *J. Japan Energy*, **90(10)**, 1086-1090. https://www.rcenetwork.org/portal/sites/default/files/CAH-JIE-IBFS for 4F.pdf

Budi Kusumo, R.A., G. Kurnia, I. Setiawan and R. Tirtosudarmo (2023). Migration and Farmer Household Livelihood Strategies: Factors Influencing the Decision to Migrate. *Pertanika J. Soc. Sci. Human.*, **31(1)**, 57-79. https://doi.org/10.47836/pjssh.31.1.04

Burchfield, E.K. and A.T. Poterie de la (2018). Determinants of crop diversification in rice-dominated Sri Lankan agricultural systems. *J. Rural Studies*, **xx(x)**, 1-10. https://doi.org/10.1016/j.jrurstud.2018.05.010

Conway, G.R. and R. Chambers (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. *IDS Discussion Paper*, **296(January 1992)**, 1-28.

Ekowati, T., E. Prasetyo and M. Handayani (2018). The factors influencing production and economic efficiency of beef cattle farm in Grobogan Region, Central Java. *J. Indonesian Trop. Anim. Agricult.*, **43(1)**, 76-84. https://doi.org/10.14710/jitaa.43.1.76-84

Ellis, F. (2000). Rural Livelihood Diversity in Developing Countries. *Oxford University Press*, **40**, 1-10.

FAO (2017). Productivity and Efficiency Measurement in Agriculture. *Food and Agriculture Organization of the United Nations*, *February*, 77. http://gsars.org/wp-content/uploads/2017/02/TR-17.02.2017-Productivity-and-Efficiency-Measurement-in-Agriculture.pdf

Gasson, R. (1988). Farm Diversification and Rural Development. *J. Agricult. Econ.*, **39(2)**, 175-182. https://doi.org/10.1111/j.1477-9552.1988.tb00575.x

Islam, A.H.S.M., B.K. Barman and K. Murshed-e-Jahan (2015). Adoption and impact of integrated rice-fish farming system in Bangladesh. *Aquaculture*, **447**, 76-85. https://doi.org/10.1016/j.aquaculture.2015.01.006

Kamdi, P.J., D.K. Swain and S.P. Wani (2020). Efficient land water management practice and cropping system for increasing water and crop productivity in semi-arid tropics. *Agron. J.*, **112(4)**, 2552-2568. https://doi.org/10.1002/agj2.20207

Karunarathna, M. and C. Wilson (2017). Agricultural biodiversity and farm level technical efficiency: An empirical investigation. *J. Forest Econ.*, https://doi.org/10.1016/j.jfe.2017.08.002

Kremen, C., A. Iles and C. Bacon (2012). Diversified Farming Systems/:An Agroecological, Systems-based Alternative to Modern Industrial Agriculture. *Ecology and Society*, **17(4)**, 1-19. https://doi.org/http://dx.doi.org/10.5751/ES-05103-170444

Kremen, C. and A. Miles (2012). Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities and Trade-Offs. *Ecology and Society*, **17(4)**, 1-25. https://doi.org/10.5751/ES-05035-170440

Kurniawati, M. (2013). *Stabilized Rice Bran and Its Application in Analog Rice Formulation Supervised (Stabilisasi Bekatul dan Penerapannya)* [Institut Pertanian Bogor]. https://repository.ipb.ac.id/jspui/bitstream/123456789/65881/1/2013mku.pdf

Kusumastuti, T.A., S. Sarim and M. Masyhuri (2015). Integrated farming model of small ruminants in deli serdang, north sumatra - Indonesia. *J. Indonesian Trop. Anim. Agricult.*, **40(2)**, 115-120. https://doi.org/10.14710/jitaa.40.2.115-120

Lindawati, L., B.M. Sibuea, D. Noita, M.I. Riyadh, A. Hasibuan and E. Al (2018). A Comparative Analysis of Economic Farming Activity of Farmers Rice-Livestock Integrated Farming System (RLIFS) and non RLIFS. *Int. J. Engg Tech.*, **7(3.2)**, 792-795. https://doi.org/10.14419/ijet.v7i3.2.18759

Makate, C., R. Wang, M. Makate and N. Mango (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: Adaptive management for environmental change. *SpringerPlus*, **5(1)**, 1135. https://doi.org/10.1186/s40064-016-2802-4

Martmono, A.A., M. Mappamiring and I. Malik (2013). The Role of the Village Government in Managing the Organic Fertilizer Processing Unit (OFPU) in Kolai Village, Malua District, Enrekang Regency Peran Pemerintah Desa Dalam Pengelolaan Program Usaha Pengelolaan Pupuk Organik (UPPO) di Desa Kolai Kecamatan. *Otoritas/ : Jurnal Ilmu Pemerintahan*, **3(2)**, 75-87. https://doi.org/10.26618/ojip.v3i2.65

Meena, B.P., A.O. Shirale, A.K. Biswas, B.L. Lakaria, P. Jha, P.P. Gurav, R.H. Wanjari and A.K. Patra (2018). Diversified agriculture for higher productivity and profitability–A review. *Agricultural Reviews*, **39(2)**, 104-112. https://doi.org/10.18805/ag.r-1679

Ministry of Agriculture (2018). *Instructions for the implementation of Organic Fertilizer Processing Unit (OFPU). Petunjuk Pelaksanaan Kegiatan unit Pengolah Pupuk Organik (UPPO)*. http://tanamanpangan.pertanian.go.id/assets/front/uploads/document/JUKLAK UPPO 2018.pdf

Ministry of Agriculture Republic of Indonesia (2017). *Agricultural Statistics 2017 Statistik Pertanian 2017* (Susanti, A.A. and B. Waryanto eds.). Center for Agricultural Data and Information System Ministry of Agriculture Republic of Indonesia.

Mishra, A.K. and B.K. Goodwin (1997). Farm Income Variability and the Supply of Off Farm Labor. *Amer. J. Agricult. Econ.*, **79(3)**, 880-887. https://doi.org/10.2307/

1244429

Nainggolan, H.L., J. Aritonang, M. Sihombing, T. Supriana and M. Tafsin (2019). Structural modelling of rice fields-buffalo livestock based integrated agricultural systems in the context of regional development in Humbang Hasundutan, Indonesia. *J. Food, Agricult. Soc.*, **106**, 1-17. https://doi.org/10.17170/kobra-20190709595

Nayak, P.K., A.K. Nayak, B.B. Panda, B. Lal, P. Gautam, A. Poonam, M. Shahid, R. Tripathi, U. Kumar, S.D. Mohapatra and N.N. Jambhulkar (2018). Ecological mechanism and diversity in rice based integrated farming system. *Ecological Indicators*, **91(May 2017)**, 359-375. https://doi.org/10.1016/j.ecolind.2018.04.025

Noviasari, S., F. Kusnandar, A. Setiyono and S. Budijanto (2015). Rice analogues as functional food with low glycemic index (Beras Analog Sebagai Pangan Fungsional Dengan Indeks Glikemik Rendah). *Jurnal Gizi Dan Pangan*, **10(3)**, 225-232. https://doi.org/10.25182/jgp.2015.10.3.

Nuraisah, G. and R.A.B. Kusumo (2019). Impact of Climate Change on Paddy Farming in Wanguk Village, Anjatan Subdistrict, Indramayu District. *Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, **5(1)**, 60-71.

Odoh, N.E., S.U. Nwibo, A.V. Eze and C.O. Igberi (2019). Farm and non-farm income diversification activities among rural households in Southeast, Nigeria. *J. Agricult. Ext.*, **23(2)**, 113-121. https://doi.org/10.4314/jae.v23i2.12

OECD (2001a). *The well-being of nations: The role of human and social capital*. OECD. http://www.oecd.org/site/worldforum/33703702.pdf

OECD (2001b). Measuring Productivity - Measurement of Aggregate and Industry Growth. In: *OECD Manual*. OECD. https://doi.org/10.1787/9789264194519-en

Ponnusamy, K. and M.K. Devi (2017). Impact of Integrated Farming System Approach on Doubling Farmers' Income. *Agricult. Econ. Res. Rev.*, 30(conference number), 233-240. https://doi.org/10.5958/0974-0279.2017.00037.4

Prajanti, S.D.W. and I. Susilowati (2016). The prospect of integrated farming system of crops-fish-husbandary as the survival strategy to secure the farmers economy: Case study in Magelang - Indonesia. *Int. J. Econ. Financial Issues*, **6(Special Issue)**, 84-87. https://www.econjournals.com/index.php/ijefi/article/view/3121/pdf

Prasetyo, Y.E. and M.A. Mauludin (2016). Community Development Planning/ : Introduction of Integrated Farming System (IFS) to the Rural Community. *Jurnal Ilmu Ternak*, **16(2)**, 78-88. http://jurnal.unpad.ac.id/jurnalilmuternak/article/view/11580/5378

Rahimabadi, T.E., M.H. Anssari amd A. Nematollahi, Razavi (2018). Influence of cow manure and its vermicomposting on the improvement of grain yield and quality of rice (*Oryza sativa* L.) in field conditions. *Appl. Ecol. Environ. Res.*, **16(1)**, 97-110. https://doi.org/10.15666/aeer/1601_097110

Rapsomanikis, G. (2015). The economic lives of smallholder farmers. An analysis based on household data from nine countries. *Www.Fao.Org.*, http://www.fao.org/3/a-i5251e.pdf

Rehman, A., A.A. Chandio, I. Hussain and L. Jingdong (2019). Fertilizer consumption, water availability and credit distribution: Major factors affecting agricultural productivity in Pakistan. *J. Saudi Soc. Agricult. Sci.*, **18(3)**, 269-274. https://doi.org/10.1016/j.jssas.2017.08.002

Roy, R., N. Weng and C. Ruslan (2014). Rice farming sustainability assessment in Bangladesh. *Sustain Sci.*, **9**, 31-44. https://doi.org/10.1007/s11625-013-0234-4

Rundengan, M.L., Z. Fanani, I. Subagiyo and F.H. Elly (2014). Integrated Farming System Model in South Minahasa Regency- North Sulawesi. *IOSR J. Agricult. Vet. Sci.*, **5(6)**, 1-7. https://doi.org/10.9790/2380-0560107

Sardjono, N., B. Susilo and Wignyanto (2012). Strategi Pengembangan Sistem Produksi Pupuk Organik Pada Unit Pengolahan Pupuk Organik (UPPO) di desa bangunsari Kabupaten Ciamis. *Jurnal Teknologi Pertanian*, **13(2)**, 138-148.

Sari, N.M., K. Nisa, M.F. Mahdie and D. Ulfah (2017). The Utilization of Rice Husk Waste for Mixed Bokashi Fertilizer and Biobriket Making as Biofuels. *PengabdianMu*, **2(September)**, 90-97. http://jurnal.umpalangkaraya.ac.id/ejurnal/pgbmu

Scoones, I. (1998). Sustainable Rural Livelihoods : A Framework for Analysis: IDS Working Paper 72. *Development (Basingstoke)*, **42(2)**, 1-22. https://doi.org/10.1057/palgrave.development.1110037

Shilomboleni, H., M. Owaygen, R. De Plaen, W. Manchur and L. Husak (2019). Scaling up innovations in smallholder agriculture: Lessons from the Canadian international food security research fund. *Agricultural Systems*, **175(May 2019)**, 58-65. https://doi.org/10.1016/j.agsy.2019.05.012

Soemantri, A.S., P. Luna and B. Jamal (2016). Strategy to increase rice production with the emphasis on the losses during harvest and posth (Strategi Peningkatan Produksi Beras Melalui Penekanan Susut Panen Dan Pascapanen Dengan Pendekatan Sistem Modeling: Studi Kasus Kabupaten Indramayu, Jawa Barat). *Informatika Pertanian*, **25(2)**, 249-260.

Soni, R.P., M. Katoch and R. Ladohia (2014). Integrated Farming Systems - A Review. *IOSR J. Agricult. Vet. Sci.*,

7(10), 36-42. https://doi.org/10.9790/2380-071013642

Stür, W., T.T. Khanh and A. Duncan (2013). Transformation of smallholder beef cattle production in Vietnam. *Int. J. Agricult. Sust.*, **11(4)**, 363-381. https://doi.org/10.1080/14735903.2013.779074

Suh, J. (2014). Theory and reality of integrated rice-duck farming in Asian developing countries: A systematic review and SWOT analysis. *Agricultural Systems*, **125**, 74-81. https://doi.org/10.1016/j.agsy.2013.11.003

Teng, Q., X.F. Hu, C. Cheng, Z. Luo, F. Luo, Y. Xue, Y. Jiang, Z. Mu, L. Liu and M. Yang (2016). Ecological effects of rice-duck integrated farming on soil fertility and weed and pest control. *J. Soils and Sediments*, **16(10)**, 2395-2407. https://doi.org/10.1007/s11368-016-1455-9

The Central Bureau of Statistics (CBS) Indramayu District (2014). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2014/12/19/afc6f1f2ee42116e0f53a627/kabupaten-indramayu-dalam-angka-2014.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2015). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/01/26/c1d5953cdbd0728c77f53f6c/kabupaten-indramayu-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2016). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/07/15/551c0bc293bd22b3d00c42db/kabupaten-indramayu-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2017). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2017/08/18/07cf633d10b42aed1ae87fcb/kabupaten-indramayu-dalam-angka-2017.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2018). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2018/08/16/99305d123f315f796f19b6d4/kabupaten-indramayu-dalam-angka-2018.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2014). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2014/12/15/a197964d9427671924d37063/kabupaten-majalengka-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2015). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/01/27/b47b2662d498f8d17ce2b34d/kabupaten-majalengka-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2016). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/07/15/627c3a92e166c355de65e373/kabupaten-majalengka-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2017). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2017/08/11/1619e71644b63facf2aa53f5/kabupaten-majalengka-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2018). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2018/08/16/7a08032d613c4bcc2c203b16/kabupaten-majalengka-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2014). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2015/08/13/6c56c4ad7e26832d763db710/subang-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2015). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/03/02/95d8a1ea348e816703b71a41/kabupaten-subang-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2016). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/07/15/53ebb793a6e8a54fedf183f8/kabupaten-subang-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2017). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2017/08/10/21462f2a7958ef3555b86b9e/kabupaten-subang-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2018). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2018/08/16/fbf586fd952afd9aa9db7052/kabupaten-subang-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2014). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikota.bps.go.id/publication/2015/08/13/196a62fc4d9695b2ca1e16ed/kota-sukabumi-

dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2015). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2015/12/12/0f835f3344a10af477f71341/sukabumi-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2016). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/04/5ac28d5fefb8e7a6de6bf7ab/kabupaten-sukabumi-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2017). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/11/1a2410e17b16e8209db31c1b/kabupaten-sukabumi-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2018). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2018/08/16/c20ed4d909fede7ac131ad41/kabupaten-sukabumi-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2015). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*.https://jabar.bps.go.id/publication/2016/02/29/303b35c34730fbed908ef272/provinsi-jawa-barat-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2016). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2016/07/15/2297a52073f5f32eca26eb8a/provinsi-jawa-barat-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2017). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2017/08/12/62379e17bcc20052a7991d35/provinsi-jawa-barat-dalam-angka-2017.html. Accessed 4 October 2019.

Van, N.P.H., T.T. NGa, H. ARai, Y. Hosen, N.H. CHiem and K. Inubushi (2014). Rice Straw Management by Farmers in a Triple Rice Production System in the Mekong Delta, Viet Nam. *Trop. Agricult. Develop.*, **58(4)**, 155-162. https://doi.org/10.11248/jsta.58.155

Wariyah, C. (2010). Restructured Fine Grain Rice to High Calcium Rice by Extrusion Method (Restrukturisasi Menir Menjadi Beras Berkalsium Tinggi dengan Metode Ekstrusi). *Agritech*, 30(3), 135-140. https://doi.org/DOI: https://doi.org/10.22146/agritech.9664

Widiati, R. and T.S.M. Widi (2016). Production Systems and Income Generation from the Small holder Beef Cattle Farming in Yogyakarta Province, Indonesia. *Animal Production*, **18(1)**, 51. https://doi.org/10.20884/1.anprod.2016.18.1.524

Widowati, S. (2000). Pemanfaatan Hasil Samping Penggilingan Padi dalam Menunjang Sistem Agroindustri di Pedesaan. *Buletin Agrobio*, **4(1)**, 33-38. http://biogen.litbang.pertanian.go.id/wp/terbitan/pdf/agrobio_4_1_33-38.pdf

Wiyatna, M.F., E.A. Gurnadi and K. Mudikdjo (2012). Productivity of Peranakan Ongole Cattle on traditional farm system in Sumedang Region (Produktivitas Sapi Peranakan Ongole pada Peternakan Rakyat di Kabupaten Sumedang). *Jurnal Ilmu Ternak*, **12(2)**, 22-25. http://journal.unpad.ac.id/jurnalilmuternak/article/viewFile/5124/2552

Wulandari, E., Ernah and D. Supyandi (2018). Agricultural Production and Access to In-kind Finance from Government: A Study of Banana Farms in Cianjur District, West Java. *IOP Conf. Ser.: Earth Environ. Sci.*, **166(1)**, 012042. https://doi.org/10.1088/1755-1315/166/1/012042

Xu, G., X. Liu, Q. Wang, X. Yu and Y. Hang (2017). Integrated rice-duck farming mitigates the global warming potential in rice season. *Sci. Total Environ.*, **575**, 58-66. https://doi.org/10.1016/j.scitotenv.2016.09.233

Yuniarti, A., M. Damayani and D.M. Nur (2019). Efek Pupuk Organik dan Puuk N,P,K Terhadap C-Organik, N-Total, C/N, Serapan N, Serta Hasil Padi Hitam (*Oryza sativa* L. *indica*) Pada Inceptisols. *Jurnal Pertanian Presisi (Journal of Precision Agriculture)*, **3(2)**, 90-105. https://doi.org/10.35760/jpp.2019.v3i2.2205

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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 (ton of MDG per year)	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
			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 (29.5 kg/day/ head)**	Beef cattle Urine (14,1 liter/day)**	Beef cattle Manure One month (ton)	Beef cattle Urine One month (liter)	Beef cattle Manure year (ton)	Beef cattle Urine 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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References

Agriculture and Horticulture Office in Indramayu District (2017). Agriculture Office Number of farmer groups in Indramayu District (2017-2018). *Agricultural Service Report in Indramayu District*. Retrieved from:http://distan.indramayukab.go.id/dinas-pertanian-menyelenggarakan-kontes-mangga/ accessed 7 August 2019.

Agus, C., B.H. Sunarminto and B. Suhartanto (2011). Integrated Bio-cycles Farming System for Production

of Bio-gas through Gama Digester, Gama Purification and Gama Compressing. *J. Japan Energy*, **90(10)**, 1086-1090. https://www.rcenetwork.org/portal/sites/default/files/CAH-JIE-IBFS for 4F.pdf

Budi Kusumo, R.A., G. Kurnia, I. Setiawan and R. Tirtosudarmo (2023). Migration and Farmer Household Livelihood Strategies: Factors Influencing the Decision to Migrate. *Pertanika J. Soc. Sci. Human.*, **31(1)**, 57-79. https://doi.org/10.47836/pjssh.31.1.04

Burchfield, E.K. and A.T. Poterie de la (2018). Determinants of crop diversification in rice-dominated Sri Lankan agricultural systems. *J. Rural Studies*, **xx(x)**, 1-10. https://doi.org/10.1016/j.jrurstud.2018.05.010

Conway, G.R. and R. Chambers (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. *IDS Discussion Paper*, **296(January 1992)**, 1-28.

Ekowati, T., E. Prasetyo and M. Handayani (2018). The factors influencing production and economic efficiency of beef cattle farm in Grobogan Region, Central Java. *J. Indonesian Trop. Anim. Agricult.*, **43(1)**, 76-84. https://doi.org/10.14710/jitaa.43.1.76-84

Ellis, F. (2000). Rural Livelihood Diversity in Developing Countries. *Oxford University Press*, **40**, 1-10.

FAO (2017). Productivity and Efficiency Measurement in Agriculture. *Food and Agriculture Organization of the United Nations, February*, 77. http://gsars.org/wp-content/uploads/2017/02/TR-17.02.2017-Productivity-and-Efficiency-Measurement-in-Agriculture.pdf

Gasson, R. (1988). Farm Diversification and Rural Development. *J. Agricult. Econ.*, **39(2)**, 175-182. https://doi.org/10.1111/j.1477-9552.1988.tb00575.x

Islam, A.H.S.M., B.K. Barman and K. Murshed-e-Jahan (2015). Adoption and impact of integrated rice-fish farming system in Bangladesh. *Aquaculture*, **447**, 76-85. https://doi.org/10.1016/j.aquaculture.2015.01.006

Kamdi, P.J., D.K. Swain and S.P. Wani (2020). Efficient land water management practice and cropping system for increasing water and crop productivity in semi-arid tropics. *Agron. J.*, **112(4)**, 2552-2568. https://doi.org/10.1002/agj2.20207

Karunarathna, M. and C. Wilson (2017). Agricultural biodiversity and farm level technical efficiency: An empirical investigation. *J. Forest Econ.*, https://doi.org/10.1016/j.jfe.2017.08.002

Kremen, C., A. Iles and C. Bacon (2012). Diversified Farming Systems/:An Agroecological, Systems-based Alternative to Modern Industrial Agriculture. *Ecology and Society*, **17(4)**, 1-19. https://doi.org/http://dx.doi.org/10.5751/ES-05103-170444

Kremen, C. and A. Miles (2012). Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities and Trade-Offs. *Ecology and Society*, **17(4)**, 1-25. https://doi.org/10.5751/ES-05035-170440

Kurniawati, M. (2013). *Stabilized Rice Bran and Its Application in Analog Rice Formulation Supervised (Stabilisasi Bekatul dan Penerapannya)* [Institut Pertanian Bogor]. https://repository.ipb.ac.id/jspui/bitstream/123456789/65881/1/2013mku.pdf

Kusumastuti, T.A., S. Sarim and M. Masyhuri (2015). Integrated farming model of small ruminants in deli serdang, north sumatra - Indonesia. *J. Indonesian Trop. Anim. Agricult.*, **40(2)**, 115-120. https://doi.org/10.14710/jitaa.40.2.115-120

Lindawati, L., B.M. Sibuea, D. Noita, M.I. Riyadh, A. Hasibuan and E. Al (2018). A Comparative Analysis of Economic Farming Activity of Farmers Rice-Livestock Integrated Farming System (RLIFS) and non RLIFS. *Int. J. Engg Tech.*, **7(3.2)**, 792-795. https://doi.org/10.14419/ijet.v7i3.2.18759

Makate, C., R. Wang, M. Makate and N. Mango (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: Adaptive management for environmental change. *SpringerPlus*, **5(1)**, 1135. https://doi.org/10.1186/s40064-016-2802-4

Martmono, A.A., M. Mappamiring and I. Malik (2013). The Role of the Village Government in Managing the Organic Fertilizer Processing Unit (OFPU) in Kolai Village, Malua District, Enrekang Regency Peran Pemerintah Desa Dalam Pengelolaan Program Usaha Pengelolaan Pupuk Organik (UPPO) di Desa Kolai Kecamatan. *Otoritas/ : Jurnal Ilmu Pemerintahan*, **3(2)**, 75-87. https://doi.org/10.26618/ojip.v3i2.65

Meena, B.P., A.O. Shirale, A.K. Biswas, B.L. Lakaria, P. Jha, P.P. Gurav, R.H. Wanjari and A.K. Patra (2018). Diversified agriculture for higher productivity and profitability–A review. *Agricultural Reviews*, **39(2)**, 104-112. https://doi.org/10.18805/ag.r-1679

Ministry of Agriculture (2018). *Instructions for the implementation of Organic Fertilizer Processing Unit (OFPU). Petunjuk Pelaksanaan Kegiatan unit Pengolah Pupuk Organik (UPPO).* http://tanamanpangan.pertanian.go.id/assets/front/uploads/document/JUKLAK UPPO 2018.pdf

Ministry of Agriculture Republic of Indonesia (2017). *Agricultural Statistics 2017 Statistik Pertanian 2017* (Susanti, A.A. and B. Waryanto eds.). Center for Agricultural Data and Information System Ministry of Agriculture Republic of Indonesia.

Mishra, A.K. and B.K. Goodwin (1997). Farm Income Variability and the Supply of Off Farm Labor. *Amer. J. Agricult. Econ.*, **79(3)**, 880-887. https://doi.org/10.2307/1244429

Nainggolan, H.L., J. Aritonang, M. Sihombing, T. Supriana and M. Tafsin (2019). Structural modelling of rice fields-buffalo livestock based integrated agricultural systems in the context of regional development in Humbang Hasundutan, Indonesia. *J. Food, Agricult. Soc.*, **106**, 1-17. https://doi.org/10.17170/kobra-20190709595

Nayak, P.K., A.K. Nayak, B.B. Panda, B. Lal, P. Gautam, A. Poonam, M. Shahid, R. Tripathi, U. Kumar, S.D. Mohapatra and N.N. Jambhulkar (2018). Ecological mechanism and diversity in rice based integrated farming system. *Ecological Indicators*, **91(May 2017)**, 359-375. https://doi.org/10.1016/j.ecolind.2018.04.025

Noviasari, S., F. Kusnandar, A. Setiyono and S. Budijanto (2015). Rice analogues as functional food with low glycemic index (Beras Analog Sebagai Pangan Fungsional Dengan Indeks Glikemik Rendah). *Jurnal Gizi Dan Pangan*, **10(3)**, 225-232. https://doi.org/10.25182/jgp.2015.10.3.

Nuraisah, G. and R.A.B. Kusumo (2019). Impact of Climate Change on Paddy Farming in Wanguk Village, Anjatan Subdistrict, Indramayu District. *Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, **5(1)**, 60-71.

Odoh, N.E., S.U. Nwibo, A.V. Eze and C.O. Igberi (2019). Farm and non-farm income diversification activities among rural households in Southeast, Nigeria. *J. Agricult. Ext.*, **23(2)**, 113-121. https://doi.org/10.4314/jae.v23i2.12

OECD (2001a). *The well-being of nations: The role of human and social capital*. OECD. http://www.oecd.org/site/worldforum/33703702.pdf

OECD (2001b). Measuring Productivity - Measurement of Aggregate and Industry Growth. In: *OECD Manual*. OECD. https://doi.org/10.1787/9789264194519-en

Ponnusamy, K. and M.K. Devi (2017). Impact of Integrated Farming System Approach on Doubling Farmers' Income. *Agricult. Econ. Res. Rev.*, 30(conference number), 233-240. https://doi.org/10.5958/0974-0279.2017.00037.4

Prajanti, S.D.W. and I. Susilowati (2016). The prospect of integrated farming system of crops-fish-husbandary as the survival strategy to secure the farmers economy: Case study in Magelang - Indonesia. *Int. J. Econ. Financial Issues*, **6(Special Issue)**, 84-87. https://www.econjournals.com/index.php/ijefi/article/view/3121/pdf

Prasetyo, Y.E. and M.A. Mauludin (2016). Community Development Planning/ : Introduction of Integrated Farming System (IFS) to the Rural Community. *Jurnal Ilmu Ternak*, **16(2)**, 78-88. http://jurnal.unpad.ac.id/jurnalilmuternak/article/view/11580/5378

Rahimabadi, T.E., M.H. Anssari amd A. Nematollahi, Razavi (2018). Influence of cow manure and its vermicomposting on the improvement of grain yield and quality of rice (*Oryza sativa* L.) in field conditions. *Appl. Ecol. Environ. Res.*, **16(1)**, 97-110. https://doi.org/10.15666/aeer/1601_097110

Rapsomanikis, G. (2015). The economic lives of smallholder farmers. An analysis based on household data from nine countries. *Www.Fao.Org.*, http://www.fao.org/3/a-i5251e.pdf

Rehman, A., A.A. Chandio, I. Hussain and L. Jingdong (2019). Fertilizer consumption, water availability and credit distribution: Major factors affecting agricultural productivity in Pakistan. *J. Saudi Soc. Agricult. Sci.*, **18(3)**, 269-274. https://doi.org/10.1016/j.jssas.2017.08.002

Roy, R., N. Weng and C. Ruslan (2014). Rice farming sustainability assessment in Bangladesh. *Sustain Sci.*, **9**, 31-44. https://doi.org/10.1007/s11625-013-0234-4

Rundengan, M.L., Z. Fanani, I. Subagiyo and F.H. Elly (2014). Integrated Farming System Model in South Minahasa Regency- North Sulawesi. *IOSR J. Agricult. Vet. Sci.*, **5(6)**, 1-7. https://doi.org/10.9790/2380-0560107

Sardjono, N., B. Susilo and Wignyanto (2012). Strategi Pengembangan Sistem Produksi Pupuk Organik Pada Unit Pengolahan Pupuk Organik (UPPO) di desa bangunsari Kabupaten Ciamis. *Jurnal Teknologi Pertanian*, **13(2)**, 138-148.

Sari, N.M., K. Nisa, M.F. Mahdie and D. Ulfah (2017). The Utilization of Rice Husk Waste for Mixed Bokashi Fertilizer and Biobriket Making as Biofuels. *PengabdianMu*, **2(September)**, 90-97. http://jurnal.umpalangkaraya.ac.id/ejurnal/pgbmu

Scoones, I. (1998). Sustainable Rural Livelihoods : A Framework for Analysis: IDS Working Paper 72. *Development (Basingstoke)*, **42(2)**, 1-22. https://doi.org/10.1057/palgrave.development.1110037

Shilomboleni, H., M. Owaygen, R. De Plaen, W. Manchur and L. Husak (2019). Scaling up innovations in smallholder agriculture: Lessons from the Canadian international food security research fund. *Agricultural Systems*, **175(May 2019)**, 58-65. https://doi.org/10.1016/j.agsy.2019.05.012

Soemantri, A.S., P. Luna and B. Jamal (2016). Strategy to increase rice production with the emphasis on the losses during harvest and posth (Strategi Peningkatan Produksi Beras Melalui Penekanan Susut Panen Dan Pascapanen Dengan Pendekatan Sistem Modeling: Studi Kasus Kabupaten Indramayu, Jawa Barat). *Informatika Pertanian*, **25(2)**, 249-260.

Soni, R.P., M. Katoch and R. Ladohia (2014). Integrated Farming Systems - A Review. *IOSR J. Agricult. Vet. Sci.*, **7(10)**, 36-42. https://doi.org/10.9790/2380-071013642

Stür, W., T.T. Khanh and A. Duncan (2013). Transformation of smallholder beef cattle production in Vietnam. *Int. J. Agricult. Sust.*, **11(4)**, 363-381. https://doi.org/10.1080/14735903.2013.779074

Suh, J. (2014). Theory and reality of integrated rice-duck farming in Asian developing countries: A systematic review and SWOT analysis. *Agricultural Systems*, **125**, 74-81. https://doi.org/10.1016/j.agsy.2013.11.003

Teng, Q., X.F. Hu, C. Cheng, Z. Luo, F. Luo, Y. Xue, Y. Jiang, Z. Mu, L. Liu and M. Yang (2016). Ecological effects of rice-duck integrated farming on soil fertility and weed and pest control. *J. Soils and Sediments*, **16(10)**, 2395-2407. https://doi.org/10.1007/s11368-016-1455-9

The Central Bureau of Statistics (CBS) Indramayu District (2014). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2014/12/19/afc6f1f2ee42116e0f53a627/kabupaten-indramayu-dalam-angka-2014.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2015). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/01/26/c1d5953cdbd0728c77f53f6c/kabupaten-indramayu-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2016). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2016/07/15/551c0bc293bd22b3d00c42db/kabupaten-indramayu-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2017). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2017/08/18/07cf633d10b42aed1ae87fcb/kabupaten-indramayu-dalam-angka-2017.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Indramayu District (2018). *Indramayu District in Figure*. BPS Indramayu District. https://indramayukab.bps.go.id/publication/2018/08/16/99305d123f315f796f19b6d4/kabupaten-indramayu-dalam-angka-2018.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2014). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2014/12/15/a197964d9427671924d37063/kabupaten-majalengka-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2015). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/01/27/b47b2662d498f8d17ce2b34d/kabupaten-majalengka-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2016). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2016/07/15/627c3a92e166c355de65e373/kabupaten-majalengka-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2017). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2017/08/11/1619e71644b63facf2aa53f5/kabupaten-majalengka-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Majalengka District (2018). *Majalengka District in Figure*. BPS Majalengka District. https://majalengkakab.bps.go.id/publication/2018/08/16/7a08032d613c4bcc2c203b16/kabupaten-majalengka-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2014). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2015/08/13/6c56c4ad7e26832d763db710/subang-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2015). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/03/02/95d8a1ea348e816703b71a41/kabupaten-subang-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2016). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2016/07/15/53ebb793a6e8a54fedf183f8/kabupaten-subang-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2017). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2017/08/10/21462f2a7958ef3555b86b9e/kabupaten-subang-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Subang District (2018). *Subang District in Figure*. BPS Subang District. https://subangkab.bps.go.id/publication/2018/08/16/fbf586fd952afd9aa9db7052/kabupaten-subang-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2014). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikota.bps.go.id/publication/2015/08/13/196a62fc4d9695b2ca1e16ed/kota-sukabumi-dalam-angka-2014.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2015). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2015/12/12/0f835f3344a10af477f71341/sukabumi-dalam-angka-2015.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2016). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/04/5ac28d5fefb8e7a6de6bf7ab/kabupaten-sukabumi-dalam-angka-2016.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2017). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2017/08/11/1a2410e17b16e8209db31c1b/kabupaten-sukabumi-dalam-angka-2017.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) Sukabumi District (2018). *Sukabumi District in Figure*. BPS Sukabumi District. https://sukabumikab.bps.go.id/publication/2018/08/16/c20ed4d909fede7ac131ad41/kabupaten-sukabumi-dalam-angka-2018.html. Accessed 5 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2015). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*.https://jabar.bps.go.id/publication/2016/02/29/303b35c34730fbed908ef272/provinsi-jawa-barat-dalam-angka-2015.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2016). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2016/07/15/2297a52073f5f32eca26eb8a/provinsi-jawa-barat-dalam-angka-2016.html. Accessed 4 October 2019.

The Central Bureau of Statistics (CBS) West Java Province (2017). *West Java Province in Figure*. *BPS Provinsi Jawa Barat*. https://jabar.bps.go.id/publication/2017/08/12/62379e17bcc20052a7991d35/provinsi-jawa-barat-dalam-angka-2017.html. Accessed 4 October 2019.

Van, N.P.H., T.T. NGa, H. ARai, Y. Hosen, N.H. CHiem and K. Inubushi (2014). Rice Straw Management by Farmers in a Triple Rice Production System in the Mekong Delta, Viet Nam. *Trop. Agricult. Develop.*, **58(4)**, 155-162. https://doi.org/10.11248/jsta.58.155

Wariyah, C. (2010). Restructured Fine Grain Rice to High Calcium Rice by Extrusion Method (Restrukturisasi Menir Menjadi Beras Berkalsium Tinggi dengan Metode Ekstrusi). *Agritech*, 30(3), 135-140. https://doi.org/DOI: https://doi.org/10.22146/agritech.9664

Widiati, R. and T.S.M. Widi (2016). Production Systems and Income Generation from the Small holder Beef Cattle Farming in Yogyakarta Province, Indonesia. *Animal Production*, **18(1)**, 51. https://doi.org/10.20884/1.anprod.2016.18.1.524

Widowati, S. (2000). Pemanfaatan Hasil Samping Penggilingan Padi dalam Menunjang Sistem Agroindustri di Pedesaan. *Buletin Agrobio*, **4(1)**, 33-38. http://biogen.litbang.pertanian.go.id/wp/terbitan/pdf/agrobio_4_1_33-38.pdf

Wiyatna, M.F., E.A. Gurnadi and K. Mudikdjo (2012). Productivity of Peranakan Ongole Cattle on traditional farm system in Sumedang Region (Produktivitas Sapi Peranakan Ongole pada Peternakan Rakyat di Kabupaten Sumedang). *Jurnal Ilmu Ternak*, **12(2)**, 22-25. http://journal.unpad.ac.id/jurnalilmuternak/article/viewFile/5124/2552

Wulandari, E., Ernah and D. Supyandi (2018). Agricultural Production and Access to In-kind Finance from Government: A Study of Banana Farms in Cianjur District, West Java. *IOP Conf. Ser.: Earth Environ. Sci.*, **166(1)**, 012042. https://doi.org/10.1088/1755-1315/166/1/012042

Xu, G., X. Liu, Q. Wang, X. Yu and Y. Hang (2017). Integrated rice-duck farming mitigates the global warming potential in rice season. *Sci. Total Environ.*, **575**, 58-66. https://doi.org/10.1016/j.scitotenv.2016.09.233

Yuniarti, A., M. Damayani and D.M. Nur (2019). Efek Pupuk Organik dan Puuk N,P,K Terhadap C-Organik, N-Total, C/N, Serapan N, Serta Hasil Padi Hitam (*Oryza sativa* L. *indica*) Pada Inceptisols. *Jurnal Pertanian Presisi (Journal of Precision Agriculture)*, **3(2)**, 90-105. https://doi.org/10.35760/jpp.2019.v3i2.2205