Impact of Agricultural Land Changes on Farmers’ Income in Cirasea Watershed, Bandung Regency, West Java

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Abstract
Changes from agricultural land to non-agricultural land are continuously occurring, especially in areas adjacent to cities. Land changes from agricultural to non-agricultural land will eliminate crops’ hydrological function, impacting rivers, including the Cirasea River. Besides, changes in agricultural land have an impact on the resulting agricultural productivity and income. This study’s main objective is to determine land area changes, productivity, and farmers’ income in 2011 - 2018 in the Cirasea watershed. A literature study was applied to this study. Secondary data were obtained from the Central Bureau of Statistics of Ciparay, Ibun, Kertasari, Majalaya, Pacet, and Paseh Districts, Bandung Regency in Cirasea River Upstream. The study results showed an increase in land area, productivity, and agricultural income for vegetables (75%, 50%, and 68%, respectively) and rice field (16%, 0.32%, and 0.32%). In addition, there was a decrease in land area followed by a decrease in agricultural productivity and income for fruit commodities (-88%, -35%, -33%) and plantations (-97%, -1%, -1%). For eight years, farmers have relied on their income from vegetable commodities in Cirasea Watershed.

Keywords
Agricultural Productivity, Citarum Upstream, Land Use

1. INTRODUCTION
Land use and land cover change are significant environmental changes occurring around the globe today. The interaction of land use and land cover change with climate, ecosystem processes, biogeochemical cycles, biodiversity, and human activities is paramount (Guida-Johnson and Zuleta, 2013). Land-use change and land cover are closely linked with socio-economic development sustainability. They affect essential parts of our natural capital, such as vegetation, water resources, and biodiversity (Keller et al., 2015).

Land is one of the vital aspects of life. In agricultural production, the land role, as the primary input, is irreplaceable. Economically, the land is the most efficient wealth-generating asset for farmers (Sitko and Jayne, 2014; Muyanga et al., 2013) and is also an essential factor for economic growth (Li, 2014). However, the limited and unrenewable land supply creates fierce land-use competition between the agricultural and non-agricultural sectors. These give rise to Agricultural Land Conversion (ALC), which significantly reduces cropland availability and threatens food security (Azadi et al., 2010).

The development of cities and infrastructure is often observed in areas with high-quality cropland, which as a consequence, leads to irreversible losses in the productivity of agriculture, such as in the European Union (van der Putten et al., 2018; Vejchodská and Pelucha, 2019). The European landscape is, to a large extent, dominated by crops. More than 35% of all land in the EU has agricultural use. Thus, cropland utilization plays a vital role in the potential effect of land use on Europe’s environment’s sustainable development. Hence, understanding the spatial dynamics of cropland coverage is of crucial importance. The more
than changes in land use are closely connected with multiple economic, social, political, and environmental processes (Ustaoglu et al., 2016; Strek and Noga, 2020). Therefore, it is necessary to monitor land-use changes (Noszczyk et al., 2017; Noszczyk, 2018).

The previous study conducted by Nuryartono et al. (2017) revealed that the increasing land conversion into non-agricultural lands, such as the expansion of housing, shops, industrial estates, and roads, has led to reducing paddy fields area and will ultimately reduce the rice production from West Java. Beau et al. (2013) study the factors that affect the conversion of land function in Tomohon. They conclude that the factors influencing land conversion from economic aspects are farmers' income level, financial activities, and land price. The factors that affect the land conversion from the food safety aspect are the diversity of foods, land productivity, and fertility. Halim et al. (2014) conduct a study on the land conversion function in metropolitan city Rajshahi, Bangladesh. They conclude that the variables that positively affect conversion rate are population growth, infrastructure, business profit, price, and business cost. In contrast, the variables that negatively affect conversion are civil facility, institution, and tax.

Based on a previous study in Bogor Regency, Agricultural Land Conversion (ALC) tends to increase from time to time. The factors that influence agricultural land conversion, including cropland location adjacent to urban, industrial, real estate, and growing populations, influence private parties (transfer of rights) (Sejati et al., 2020). In Indonesia, rapid urbanization increases housing demand, resulting in high demand for land for housing development, thus increasing cropland value for non-agricultural land use. The rise in land economic value for housing is translated into massive ALC and creates an area called a peri-urban area (Pribadi and Pauleit, 2015).

Cirasea Watershed, as one of the Citarum River upstream, influenced the entire Citarum Watershed environment. Cirasea Watershed can support the agricultural needs, primarily agricultural land in Ciparay, Ibn, Kertasari, Majalaya, Pacet, and Paseh District. The high rate of conversion of agricultural land to development and infrastructure impacts food security. Besides, the decline in the farmland area will also affect the farm economy’s decline and, at worst, the loss of livelihood as a farmer. Therefore, it is necessary to reveal the agricultural economy due to changes in agricultural land area. Based on the introduction, this study was conducted to show the changes in land area, productivity, and farmers’ income that occurred in the Cirasea watershed, Bandung Regency, West Java.

2. EXPERIMENTAL SECTION

2.1. Study Area

Cirasea Watershed is one of the sub-catchment of the Citarum River in Bandung Regency. The Upper Citarum River covers West Bandung Regency, Bandung Regency, Bandung City, Cimahi City, and Sumedang Regency. The upper Citarum area is in the Bandung with an elevation of 625-2600 m asl. The northern region of the upper Citarum is Mount Tangkuban Perahu. The eastern part is Mount Munggang and Mandalawangi. The southern region is Mount Malabar, Puncak Besar, Puntang, Haruman, Mount Tili, Mount Tikukur, and Mount Guha. The western region has irregular mountain ridges (BBWS Citarum, 2016). Most of the Bandung Regency is a mountainous area with a tropical climate and an average rainfall of 207.4 mm per year in 2018 (Statistics of Bandung Regency, 2019). Cirasea Watershed covers six districts in Bandung Regency, including Ciparay, Ibn, Kertasari, Majalaya, Pacet, and Paseh Districts. Information on the area of Districts can be seen in Table 1.

2.2. Methods

A literature study was conducted to obtain data on crop-land and agricultural productivity at the district level in the Cirasea watershed during 2012 - 2019. Secondary data were obtained from the Statistics Central Bureau of Ciparay, Ibn, Kertasari, Majalaya, Pacet, and Paseh Districts. Besides, information on the agricultural income in the Cirasea Watershed is known based on the prices of agricultural and plantation commodities at the West Java and National levels in 2017 - 2019. Although the data series used are from 2012 to 2019, this study’s commodity prices are from 2017 – 2019. Data was performed as the table and analyzed qualitatively.

3. RESULTS AND DISCUSSION

3.1 RESULT

Farmers plant various agricultural commodities, including rice, vegetables, fruit, plantations, and biopharma, in the
Table 1. Land Area and Total Villages in Cirasea Watershed

| Districts     | Ciparay | Ibun | Kertasari | Majalaya | Pacet | Paseh |
|---------------|---------|------|-----------|----------|-------|-------|
| Number of Villages | 14      | 12   | 8         | 11       | 13    | 12    |
| Land Areas (km²)  | 46.18   | 54.57| 152.07    | 25.36    | 91.94 | 51.03 |

Source: Statistics of Bandung Regency (2019)

Table 2. Commodities in Cirasea Watershed

| Ricefields       | Commodities | Vegetables | Fruits | Plantations |
|------------------|-------------|------------|--------|-------------|
| Dry-ricefield    | Shallots    | Potato     | Avocado| Clove       |
| Wet-ricefield    | Garlic      | Cabbage    | Starfruit| Coconut    |
|                  | Broccoli    | Chinese Cabbage | Orange | Coffee |
|                  | Beans       | Napa Cabbage| Mango | Tea        |
|                  | Chili       | Choy Sum   | Jackfruit| Tobacco    |
|                  | Maize       | Eggplants  | Papaya |            |
|                  | Soybeans    | Tomato     | Banana |            |
|                  | Red Beans   | Sweet Potato| Snake Fruit | |
|                  | Long Beans  | Cassava    | Sapodilla|            |
|                  | Peanuts     | Carrot     |        |            |

Sources: Statistics of Ciparay, Ibun, Kertasari, Majalaya, Pacet, and Paseh Districts in 2012 – 2019

The area of land, productivity, and agricultural economic value in the Cirasea watershed tended to fluctuate (Table 3) during 2011 - 2018. During 2011 - 2018, ricefield and vegetable commodities increased land area by 16% and 75%. This increase in size was followed by an increase in agricultural productivity and vice versa. Based on the percentage change in economic value in the Cirasea watershed, vegetable commodities increased by 68% from 2011, followed by ricefields with an increase in farmers’ income by 32% (Figure 2). When viewed by livelihood aspect, the agricultural sector has decreased compared to other (non-agricultural) livelihoods (Figure 3).

3.2 DISCUSSION

3.2.1 AGRICULTURAL LAND AND PRODUCTIVITY

Based on the percentage in Figure 2, it is known that most of the changes in the cropland area are in line with changes in agricultural productivity in the Cirasea Watershed. Besides, it is assumed that the farming community in the Cirasea Watershed, Bandung Regency, relies on their income on vegetable commodities, as evidenced by the increase in agricultural area and productivity after eight years.
### Table 3. Land Area and Agricultural Productivity in Cirasea Watershed

| Commodities — Districts | 2011 Area | 2011 Yield | 2012 Area | 2012 Yield | 2013 Area | 2013 Yield | 2014 Area | 2014 Yield |
|-------------------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|
| Ricefields              | 2,680     | 5,383      | 320,019   | 7,390      | 194,720   | 2,955      | 144,323   | 0          |
| Vegetables              | 246       | 352,916    | 93,641    | 206        | 27,530    | 151        | 22,507    | 2         |
| Fruits                  | 5         | 460        | 0         | 0          | 0         | 0          | 0         | 0          |
| Ibun                    | 1,589     | 61,621     | 97,073    | 2,709      | 175,010   | 290        | 27,530    | 931        |
| Ricefields              | 497       | 18,173     | 65,568    | 20         | 931       | 20         | 931       | 0          |
| Vegetables              | 0         | 0          | 0         | 0          | 0         | 0          | 0         | 0          |
| Fruits                  | 425       | 93,641     | 65,568    | 20         | 931       | 20         | 931       | 0          |
| Plantations             | 64        | 1,197      | 5,914     | 170        | 5,914     | 170        | 5,914     | 0          |
| Majalaya                | 0         | 0          | 0         | 0          | 0         | 0          | 0         | 0          |
| Ricefields              | 1,656     | 86,616     | 144,323   | 0          | 0         | 0          | 0         | 0          |
| Vegetables              | 774       | 13,369     | 132,373   | 1         | 3         | 12         | 2         | 0          |
| Fruits                  | 467       | 903,28     | 931       | 20         | 931       | 20         | 931       | 0          |
| Plantations             | 2,322     | 136        | 371       | 3          | 3         | 31         | 31        | 0          |
| Pacet                   | 1,444     | 5,544      | 134,806   | 3,005      | 190,410   | 151        | 22,507    | 0          |
| Ricefields              | 593       | 20,929     | 44,960    | 729        | 82,364    | 729        | 82,364    | 2          |
| Vegetables              | 1,714     | 4,957      | 4,957     | 247        | 4,957     | 247        | 4,957     | 0          |
| Fruits                  | 537       | 15,195     | 353       | 395        | 3,707     | 395        | 3,707     | 0          |
| Plantations             | 563,420   | 3,531      | 3,707     | 3         | 3         | 31         | 31        | 0          |
| Kertasari               | 5         | 70         | 13        | 33         | 107,160   | 564        | 10,706    | 0          |
| Ricefields              | 537       | 118,599    | 184,503   | 119        | 582       | 119        | 582       | 0          |
| Vegetables              | 5,696     | 16,273     | 56        | 0          | 0         | 0          | 0         | 0          |
| Fruits                  | 331,815   | 6,640      | 6,108,164 | 0          | 0         | 0          | 0         | 0          |

After eight years, the Cirasea Watershed experienced an increase in ricefield by 69,511.81 ha (16%), while the land for vegetable commodities had an additional land area of 114,616.5 ha (75%). The highest reduction in the area occurred in plantation land, amounting to 897,620.25 ha (97%), followed by a decrease in fruit land area by 7,882 ha (88%). It is assumed that the decline in fruit and plantation land has occurred because it has been converted into residential, infrastructure land, or another agricultural land. According to Ali et al. (2020), the farmers in Tadokkong Village, South Sulawesi, chose to convert land (into paddy fields) because the condition of garden land was previously less productive anymore. According to Wati and Munir (2016), land conversion activities can increase land use due to less productive land regeneration. Thus, the existence of land conversion activities is considered to be able to make land productive again. According to Murdaningsih et al. (2017), land improvement can result in favorable land quality changes.
| Commodities — Districts | 2015 | 2016 | 2017 | 2018 |
|-------------------------|------|------|------|------|
|                        | Area | Yield | Area | Yield | Area | Yield | Area | Yield |
| Ricefields              | 7,562| 505,070| 7,390| 458,435| 0   | 0     | 0   | 0     |
| Vegetables              | 1,031| 144,456| 642  | 114,168| 10  | 19,240|
| Fruits                  | 0    | 0     | 0    | 0     | 0   | 0     | 0   | 0     |
|                        |      |       |      |       |      |       |      |       |
|                        | 2,576| 161,220| 2,576| 160,879| 2,576| 151,489| 3,033| 192,810|
| Vegetables              | 379  | 32,056| 312  | 31,853| 312  | 42,217| 277  | 48,640|
| Fruits                  | 20   | 931   | 20   | 931   | 20   | 931   | 0    | 0     |
|                        |      |       |      |       |      |       |      |       |
|                        | 170  | 5,914 | 170  | 5,914 | 170  | 5,914 | 0    | 0     |
| Vegetables              |      |       |      |       |      |       |      |       |
| Fruits                  | 170  | 5,914 | 170  | 5,914 | 170  | 5,914 | 0    | 0     |
|                        |      |       |      |       |      |       |      |       |
|                        | 3,697| 244,330| 3,697| 194,720| 3,697| 194,720| 1,481| 62,670|
| Vegetables              | 21   | 332   | 109  | 1,925 | 109  | 1,925 | 407  | 111,550|
| Plantations             | 170  | 5,914 | 170  | 5,914 | 170  | 5,914 | 0    | 0     |
|                        |      |       |      |       |      |       |      |       |
|                        | 4,081| 261,060| 4,081| 261,060| 4,081| 269,134| 8,150| 503,900|
| Vegetables              | 1,691| 87,841| 1,691| 87,841| 1,691| 421,098| 1,607| 2,247,120|
| Fruits                  | 12   | 1,999 | 12   | 1,999 | 12   | 1,984,80| 0    | 0     |
|                        |      |       |      |       |      |       |      |       |
|                        | 371  | 4,797 | 371  | 4,797 | 371  | 6,491 | 0    | 0.03  |
| Vegetables              |      |       |      |       |      |       |      |       |
| Fruits                  | 123  | 46,921| 123  | 46,921| 123  | 46,921| 927  | 1,700,930|
|                        |      |       |      |       |      |       |      |       |
|                        | 142  | 2,291 | 142  | 2,291| 142  | 2,291 | 0    | 0     |
| Vegetables              |      |       |      |       |      |       |      |       |
| Fruits                  |      |       |      |       |      |       |      |       |
|                        |      |       |      |       |      |       |      |       |
|                        | 208  | 19,839| 15   | 616   | 15   | 9,240 | 0    | 0     |
| Vegetables              | 2,373| 319,407| 1,103| 280,010| 3,398| 910,717| 2,893| 639,269|
| Fruits                  | 14   | 56    | 35   | 27,749| 35   | 27,712| 0    | 0     |
|                        |      |       |      |       |      |       |      |       |
|                        | 6,640| 6,108,164| 4,118| 95,823| 5,368| 95,823| 0    | 0     |

Sources: Statistics of Ciparay, Ibun, Kertasari, Majalaya, Pacet, and Paseh Districts in 2012 – 2019; Area (hectares); Yield (quintals)

To determine the improvement effort type that can be carried out, we must consider the land characteristics incorporated in each land quality. In other words, the conversion of garden land into paddy fields can increase land potential. Land potential has an essential meaning in land management and use. Land that has a high potential for agriculture can produce high-quality plants and more agricultural crop production. Land use should be following the potential of the land owned. Each land has different characteristics. It needs a more in-depth understanding to study the potency of land use. A high potential land certainly has a positive impact on land use results. Potential land in paddy fields illustrates the ideal and suitable conditions for paddy fields. It is expected to produce high-quality rice and has high economic value (Hamranani, 2014).

Apart from turning unproductive land into productive land, the land price is another reason for agricultural land changes. The other factors that affect the conversion of agricultural lands function are the area of the land Quasem (2011), farmer’s income (Azadi et al., 2010; Quasem, 2011), location of land Quasem (2011), and farmer education level (Quasem, 2011). According to Harini et al. (2012), the area adjacent to the downtown land prices would be higher than the far to the city center. It indicates that the location is a factor affecting the level of land prices. Besides, the region located near the city center will save transport costs. The farmer who owns the land close to the city center will convert the land to obtain a more favorable outcome. The conversion can be done directly or indirectly, like by selling land belonging to other parties. Abelairas-Etxebarria and Astorkiza (2012) mentioned that the agricultural land conversion to housing in the peri-urban area increased land prices. Land conversion can increase the price a hundred times more than the land’s initial cost, which strongly incites landowners to convert agricultural lands for non-agricultural uses (Neimark et al., 2018). Farmers often converted their land because the agricultural sector’s incentive is much less enticing than other
Table 4. Farmers’ income in Cirasea Watershed

| Commodities — Districts | 2011                  | 2012                  | 2013                  | 2014                  |
|-------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Ciparay                 | IDR 14,047,817.40     | IDR 19,364,473.49     | IDR 17,559,428.81     | IDR 25,154,601.70     |
| Ricefields              | IDR 1,487,543.10      | IDR 526,480.24        | IDR 1,840,735.66      | IDR 793,690.88        |
| Vegetables              | IDR 11,558.40         | IDR -                 | IDR -                 | IDR -                 |
| Fruits Ibun             | IDR 4,379,064.96      | IDR 3,811,442.77      | IDR 5,326,416.36      | IDR 9,602,798.70      |
| Ricefields              | IDR 2,347,227.90      | IDR 231,664.79        | IDR 1,915,370.31      | IDR 454,922.50        |
| Vegetables              | IDR -                 | IDR -                 | IDR 22,840.29         | IDR 22,840.29         |
| Fruits                  | IDR 1,332,146.68      | IDR 25,421.71         | IDR 25,421.71         | IDR -                 |
| Plantations Majalaya    | IDR -                 | IDR 4,112,728.72      | IDR 7,803,011.12      | IDR 10,684,286.40     |
| Ricefields              | IDR 933,185.24        | IDR 2,796,966.82      | IDR 7,132,100.83      | IDR 9,875,506.79      |
| Vegetables              | IDR 17,581.84         | IDR 917.00            | IDR 44,246.66         | IDR 44,246.66         |
| Fruits                  | IDR 16,931.93         | IDR -                 | IDR 36,670.45         | IDR 36,670.45         |
| Plantations Pacet       | IDR 531,470.82        | IDR 3,042,486.63      | IDR 7,396,826.62      | IDR 10,447,796.15     |
| Ricefields              | IDR 4,365,142.60      | IDR 24,533,899.76     | IDR 10,344,224.60     | IDR 6,416.76          |
| Vegetables              | IDR 646,524.88        | IDR 55,085.28         | IDR 1,027.04          | IDR -                 |
| Fruits                  | IDR 344,582.40        | IDR 20,782.05         | IDR 133,209,089.44    | IDR -                 |

sectors. Moreover, farmers are motivated to sell it for cash because of the high land price for housing (Nguyen et al., 2016). Based on a previous study in East Java, agricultural land yielded a higher economic value after being converted. On average, converted agricultural land produced IDR 7,917/m²/year, ranging between IDR 7,917/m²/year and IDR 42,230/m²/year. These are significantly higher than retained agricultural land. It gives them more significant financial benefits to converting their land than if they remain in agriculture (Rondhi et al., 2018).

Education grade has a positive and significant effect on farmers’ decision to convert their land. Farmers who graduated from senior high school and higher education grades tend to convert their agricultural lands’ function compared to farmers who graduated from junior high school. It is assumed that the higher the education grade means that someone can work in the other sector besides agriculture, they tend to convert their agricultural lands (Tsani et al., 2018).

The increase in vegetable land was followed by an increase in productivity by 4,513,618.46 quintals (50%) after eight years, followed by ricefield commodities with an increase in 24,084.9 quintals (0.32%). With increased agricultural productivity, labor employed will be declined. If the few workforces in agriculture can produce higher output, the surplus agricultural labor will migrate to other stages of the value chains (Madi et al., 2020).

The fruit commodities experienced a decrease in productivity of 48,772.28 quintals (35%), followed by plantation commodities with a reduction in productivity of 169,941.2 quintals (1%). Differences in agricultural land productivity are influenced by climatic conditions, geographic characteristics, and location biophysics. Often farmers experience weather constraints that result in crop failure and impact, reducing annual agricultural productivity. According to Tarigan and Tukayo (2013), the wet season’s water supply usually is sufficient in years with average rainfall. However, in the dry season, a water deficit occurs typically. The agricultural sector’s productivity is critically essential if agricultural production increases at a sufficiently rapid rate.
to meet escalating demands for food (Begum and D’Haese, 1970). Climate change has been proven to have negative impacts on agricultural productivity. The sector is regarded as the primary contributor to the scourge (Pye-Smith, 2011). Several studies have noted that climate change impacts low agricultural production and increased food insecurity (Pereira et al., 2014; Maponya et al., 2013). Nwachukwu and Shisanya (2017) predicted that climate change could significantly decrease agricultural productivity in Africa.

3.2.2 FARMERS’ INCOME

In 2018, vegetable farmers experienced an income of IDR 436,531,323.73 (68%) from 2011 while ricefield farmers received an income of IDR 1,321,538.46 (0.32%). The decline in agricultural income occurred in fruit farmers amounting to IDR 1,126,135.07 (-33%) and plantations of IDR 2,620,565.89 (-1%). The level of farmers’ income depends on the area of land, land ownership, production costs, selling price, the length of time to work on farming, capital, and working hours. The selling price of a type of commodity tends to fluctuate, one of which is influenced by the high harvest season, which causes commodity prices to fall. The higher the farmer’s income, the more welfare the farmer will be. An increase in farmers affects meeting the needs of their daily lives.

The cost of production and fair price of agricultural produce are the two most important topics related to farm products’ smooth marketing, significantly impacting a particular crop’s production in successive years. Farmers always try to maximize their farm-gate price with the minimum cost of production. This controversial situation also affects the cultivation procedure as well as the overall production of agricultural products. Small and medium farmers in the remote rural areas remain ignorant about their products’ current price in the market, their trends, demand, and supply, which create obstacles for the farmers in getting a fair price for their products. Consequently, the situation discourages farmers from producing agricultural products (Yeasmin et al., 2020).

Apart from those mentioned above, changes in farmers’ income can also be affected by livelihoods changes. It can be assumed that some farmers sell their agricultural land,
Table 5. Percentage of Livelihoods in 2011-2018

| Livelihoods         | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | Changes (%) |
|---------------------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| Agricultural        | 116565 | 115118 | 109911 | 132419 | 106501.1| 107741.5| 109174.9| 106022.2| -10%        |
| Mining              | 639    | 632    | 632    | 632    | 632    | 632    | 814    | 916    | 30%         |
| Industry            | 60122  | 66430  | 66259  | 65448  | 65448  | 65051.03| 77468.03| 102139 | 38%         |
| Building            | 7450   | 8731   | 8593   | 8612   | 8612   | 8496.028| 8718.03 | 10249.03| 27%         |
| Trading             | 28619  | 28719  | 28743  | 32102  | 30109.39| 30389.42| 36298.05| 46167.05| 38%         |
| Hotel and Restaurant| 2725   | 2621   | 2621   | 2621   | 2621   | 2621   | 5022   | 7414   | 63%         |
| Transportation      | 7195   | 7195   | 7195   | 7235   | 6770.091| 7315    | 9134   | 11513  | 38%         |
| Communication       | 554    | 485    | 485    | 488    | 488    | 488    | 830    | 1151   | 52%         |
| Government          | 15125  | 15246  | 15246  | 15246  | 15246  | 15246  | 16966  | 22286  | 32%         |
| Others              | 10103  | 9852   | 9852   | 9877   | 9866   | 13890  | 18726  | 20891  | 52%         |

Sources: Statistics of Ciparay, Ibun, Kertasari, Majalaya, Pacet, and Paseh Districts in 2012 – 2019

then look for other jobs to get a higher income. As shown in Table 5 and Figure 3, the Cirasea watershed community is predominantly a farmer, followed by livelihoods in the industrial sector. Despite being the highest, agricultural livelihoods decreased (-10%), while other non-agricultural livelihoods increased. When viewed based on the percentage of livelihoods changes, the hotel and restaurant sector experienced the highest increase by 63%, followed by the communications sector and 52% each. It is assumed that during the eight years, there was an increase in the construction of hotels, restaurants, and communications followed by changes in livelihoods from farmers to employees in these sectors. However, some farmers also switched to other sectors, such as industry, with the highest number after the agricultural sector. Further studies are needed to determine changes in the livelihoods of communities around the Cirasea watershed.

Some suggestions could be applied to increase the farmer exchange rate, including decrease agricultural land conversion and increase agricultural productivity to decrease agricultural sector poverty in Indonesia. The recommendation can be formulated, such as increasing agricultural product price to increase farmer exchange rate. Hence, the government has a role in the price guarantee of farming products. The farm product’s increasing price can be done if the farm product has competitive export value, so it needs to be done by improving the quality with export competitive. To increase agricultural productivity, we need to increase the total production of a farming result. The increase of the total output in agriculture can be increased by improving human resources quality, doing training and acknowledging the new technology toward farmers, and doing training from professional labor to each farmers group in the rural area. The development of ultimate seeds can increase the total production maximally, improving the whole production, affecting farmers’ exchange rate and productivity. The agricultural land conversion control can be done to strengthen land conservation rule in the agricultural sector, mainly for the land that is high in quality and still productive. The maximally land preparation by taking attention toward land productivity and high-quality inland molding program can increase agricultural productivity progress (Setiyowati et al., 2018).

4. CONCLUSIONS

In conclusion, changes in agricultural land affect the productivity and income of farmers in the Cirasea watershed. The smaller the cropland area or the higher the conversion of agricultural land to non-agricultural land, the lower the farmer’s income will result in a loss of livelihood. After eight years, the vegetable commodity in the Cirasea watershed has a more significant influence than other commodities on farmers’ income. The vegetable commodities area has increased by 75%, with an increase in production by 50% and an increase in income by 68%. Another addition to the land area that occurs is ricefield land. The decrease in the land area also happened in the Cirasea watershed, namely fruit and plantation commodities.

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REFERENCES

Abelairas-Etxebarria, P., and I. Astorkiza (2012). Farm-Land Prices and Land-Use Change in Periurban Protected Natural Areas. Land Use Policy, 29(3); 674–683
Ali, M. S. S., R. Bakri, D. Rukmana, E. B. Demmallino, D. Salman, and Marsuka (2020). Farmers Rationality in Doing Land Conversion. IOP Conference Series: Earth and Environmental Science, 486; 012017
Azadi, H., P. Ho, and L. Hasfiati (2010). Agricultural Land Conversion Drivers: a Comparison Between Less
Developed, Developing, and Developed Countries. *Land Degradation & Development*, 22(6): 596–604

 Begum, M. and L. D’Haese (1970). Supply and Demand Situations for Major Crops and Food Items in Bangladesh. *Journal of the Bangladesh Agricultural University*, 8(1): 91–102

 Benu, N. M., S. Maryunani, and P. Kindangen (2013). Analysis of Land Conversion and its Impacts and Strategies in Managing Them in City of Tomohon, Indonesia. *Asian Transactions on Basic and Applied Sciences*, 3(02): 65–72

 BBWS Citarum. (2016). *The Citarum River Basin Management Plan*. BBWS Citarum. BBWS Citarum

 Fajar, M. (2019). Penentuan Harga Pokok Penjualan Beberapa Komoditas Hortikultura

 Guida-Johnson, B. and G. A. Zuleta (2013). Land-use land-cover change and ecosystem loss in the Espinal ecoregion, Argentina. *Agriculture, Ecosystems & Environment*, 181(3): 31–40

 Halim, M. A., M. M. Rahman, and M. Z. Hassan (2014). Agricultural Land Conversion in the Sub-Urban Area: A Case Study of Rajshahi Metropolitan City. *Journal of Life and Earth Science*, 8: 21–30

 Hamranani, G. (2014). *Analisis Potensi Lahan Pertanian Sawah Berdasarkan Indeks Potensi Lahan (Ipl) Di Kabupaten Wonosobo HAL AMAN*. Ph.D. thesis, Universitas Muhammadiyah Surakarta

 Harini, R., H. S. Yunus, S. Hartono, et al. (2012). Agricultural land conversion: determinants and impact for food sufficiency in Sleman Regency. *Indonesian Journal of Geography*, 44(2): 120–133

 Keller, A. A., E. Fournier, and J. Fox (2015). Minimizing impacts of land use change on ecosystem services using multi-criteria heuristic analysis. *Journal of Environmental Management*, 156: 23–30

 Li, J. (2014). Land sale venue and economic growth path: Evidence from China's urban land market. *Habitat International*, 41: 307–313

 Madi, M. S. A., J. Gong, K. W. Tozo, et al. (2020). Impact of Agricultural Productivity on Economic Growth and Poverty Alleviation in ECOWAS Countries: An Empirical Analysis. *Journal of Scientific Reports*, 2(1): 97–125

 Maponya, P., S. Mpandeli, and S. Oduniyi (2013). Climate Change Awareness in Mpumalanga Province, South Africa. *Journal of Agricultural Science*, 5(10): 273

 Mordaningsih, W., L. Munibah, and W. Ambarwulan (2017). Analisis Spasial Perubahan Penggunaan Lahan Pertanian Di Kabupaten Indramayu. *Majalah Ilmiah Globe*, 19(2): 175–184

 Muyanga, M., T. S. Jayne, and W. J. Burke (2013). Pathways into and out of Poverty: A Study of Rural Household Wealth Dynamics in Kenya. *Journal of Development Studies*, 49(10): 1358–1374

 Neimark, B., C. Toulmin, and S. Batterbury (2018). Peri-urban land grabbing? dilemmas of formalising tenure and land acquisitions around the cities of Bamako and Ségou, Mali. *Journal of Land Use Science*, 13(3): 319–324

 Nguyen, T. H. T., V. T. Tran, Q. T. Bui, Q. H. Man, and T. de Vries Walter (2016). Socio-economic effects of agricultural land conversion for urban development: Case study of Hanoi, Vietnam. *Land Use Policy*, 54: 583–592

 Noszczyk, T. (2018). Land use change monitoring as a task of local government administration in Poland. *Journal of Ecological Engineering*, 19(1): 170–176

 Noszczyk, T., A. Rutkowska, and J. Hernik (2017). Determining Changes in Land Use Structure in Malopolska Using Statistical Methods. *Polish Journal of Environmental Studies*, 26(1): 211–220

 Nuryartono, N., A. Tongato, S. Yusdiyanto, S. H. Pasaribu, and T. Angrgraenie (2017). Land conversion and economic development in Jawa Barat Province: Trade off or Synergy? *IOP Conference Series: Earth and Environmental Science*, 54: 012017

 Nwachukwu, I. N. and C. A. Shisanya (2017). Determinants of Agricultural Production in Kenya under Climate Change. *Open Access Library Journal*, 4(05); 1–10

 Pereira, L. M., C. N. Cuneo, and W. C. Twine (2014). Food and cash: Understanding the role of the retail sector in rural food security in South Africa. *Food security*, 6(3): 339–357

 Pribadi, D. O. and S. Pauleit (2015). The dynamics of peri-urban agriculture during rapid urbanization of Jabodetabek Metropolitan Area. *Land Use Policy*, 48: 13–24

 Pye-Smith, C. (2011). Farming’s climate-smart future: placing agriculture at the heart of climate-change policy. *Netherlands Journal of Development Studies*, 34(1): 59–85

 Rondhi, M., P. Pratiwi, V. Handini, A. Sunartomo, and S. Budiman (2018). Agricultural Land Conversion, Land Economic Value, and Sustainable Agriculture: A Case Study in East Java, Indonesia. *Land*, 7(4): 148

 Sejati, L. B., Y. Arifien, and F. Maad (2020). Economic Valuation of Rice Agricultural Structure in Bogor Regency. *Journal of Physics: Conference Series*, 1517, 012024

 Setiyowati, I. L., S. Sasongko, and I. Noor (2018). Farmer Exchange Rate and Agricultural Land Conversion Analysis to Agricultural Sector Poverty in Indonesia. *Jurnal Ekonomi dan Studi Pembangunan*, 10(1): 35–43

 Sítko, N. J. and T. Jayne (2014). Structural transformation or elite land capture? The growth of “emergent” farmers in Zambia. *Food Policy*, 48: 194–202

 Statistics Indonesia. (2017a). *Results of Cost Structure of Paddy Cultivation Household Survey 2017 (SOUT2017-SPD)*. Statistics Indonesia, Jakarta

 Statistics Indonesia. (2017b). *Results of Cost Structure of Secondary Food Crops Cultivation Household Survey 2017 (SOUT2017-SPW)*. Statistics Indonesia, Jakarta

 Statistics Indonesia. (2019). *Booklet of Results of Cost
Structure of Horticulture Cultivation Household Survey, 2018. Statistics Indonesia
Statistics of Bandung Regency. (2019). Bandung Regency in Figures 2019. Statistics of Bandung Regency, Bandung
Strek, Ž. and K. Noga (2020). Production Value of Agricultural Land – a Factor Determining Tea Consolidation of Land – Case Study. E3S Web of Conferences, 171; 02012
Tarigan, S. D. and R. K. Tukayo (2013). Impact of Land Use Change and land Management on Irrigation Water Supply in Northern Java Coast. Journal of Tropical Soils, 18(2); 169–176
Tsani, A. F., Y. Purwaningsih, and A. Daerobi (2018). Factors Affecting Farmer's Decision in Converting The Function of Agricultural Lands. Jurnal Ekonomi Pembangunan: Kajian Masalah Ekonomi dan Pembangunan, 19(1); 1–11
Ustaoglu, E., C. P. Castillo, C. Jacobs-Crisioni, and C. Lavalle (2016). Lavalle, C., 2016. Economic Evaluation of Agricultural Land to Assess Land Use Changes. Land Use Policy, 56; 125–146
van der Putten, W., K. S. Ramirez, J. Poesen, A. Winding, P. Lemanceau, L. Lisa, M. Simek, M. Moora, H. Setala, A. Zaitsev, et al. (2018). Opportunities for soil sustainability in Europe. Technical report, European Academies Science Advisory Council (EASAC)
Vejchodská, E. and M. Pelucha (2019). Environmental Charges as Drivers of Soil Sealing? The Case of The Czech Charge for Agricultural Land Loss. Land Use Policy, 87; 104071
Wati, R. S. and I. M. Munir (2016). Potency Wet Land for Padi’s Development based Agroecological Zone in Serang District, Banten Province. Balitbangtan Kementan
Yeasmin, H., S. B. Sanawar, S. Sharmin, M. A. Islam, H. Yeasmin, S. B. Sanawar, S. Sharmin, and M. A. Islam (2020). Efficient Use of Agricultural Land in Bangladesh: Strategies for Optimization. Bangladesh Journal of Agricultural Economics, 45(1); 35-45