

Revealing the Impact of the Mining Industry on Food Crop Subsector Production in Indonesia; Direction of Human Resource Development in the Agricultural Sector

Saemu Alwi¹, Lapipi¹, Jasman², La Fariki³, Asrul², Hasddin^{4*} and Alfian Ishak⁴

¹Faculty of Economic and Business, Halu Oleo University, Kendari, Indonesia; ²Department of Civil Engineering, Lakidende University, Kendari, Indonesia; ³Southeast Sulawesi Province Regional Research and Innovation Agency, Kendari, Indonesia; ⁴Department of Regional and City Planning, Lakidende University, Indonesia.

*Corresponding author's e-mail: hasddinunilaki@gmail.com

Population growth will continue, so experts predict there will be a threat of a food crisis and famine in the future. At the same time, the extraction of natural resources, such as mining, continues to occur to fulfill energy needs. Something like this happened in Konawe Regency, a national mining area. The research aims to determine and analyze the development of the role of the crop sub-sector during 2014-2022, as well as determine the role of each food crop commodity in the regional economy. This study uses a quantitative research paradigm with a descriptive design to explain the findings based on the results of quantitative data processing. The quantitative data analysis referred to is LQ analysis. The analysis results showed that the commodities processed during 2014-2022 were seven types of commodities: Rice, Corn, Soybeans, Peanuts, Mung Beans, Cassava, and Sweet Potatoes. Food crop production during the observation period showed a decline of up to 40% or 5% every year. Only two commodities are basic and superior in explaining their role in the regional economy, namely Rice and Soybeans. Even though it is a base, rice production is showing a decline, giving rise to the assumption that in the future it will experience pressure and may lose its role as a base. The urgent agenda in answering this gap is that there needs to be immediate and concrete efforts for a green transition with a green industrial park. This concept has become a global agreement in mitigating climate change, in which there is a signal that mining business actors have a social responsibility (CSR) to help farmers be innovative. Regarding the development of human resources in agriculture, women and the millennial generation are the focus of the agenda prepared to ensure agriculture's sustainability, especially food crops.

Keywords: Mining, Sub-Sectors, food crop commodities, regional economy, population growth, food crisis, famine, natural resources, agricultural human resources.

INTRODUCTION

The global population is expected to reach almost 10 billion by 2050, this means that global demand for agricultural products in the broadest sense is expected to grow exponentially (Dijk *et al.*, 2021). Agricultural products that are widely highlighted are related to the availability and fulfillment of global food with energy. Dijk *et al.* (2021) continued that the earth's ability to carry out agricultural activities and to meet food demand is directly threatened by climate change due to the exploitation of natural resources, one of which is mining activities.

The mining industry is emphasized not only to provide raw materials needed for industrial and manufacturing needs but also to be accompanied by mitigation efforts and to ensure

human survival, specifically the sustainability of agriculture for food supply. Therefore, accelerating the green transition is essential not only to combat climate change but also to ensure that humanity can meet its own food needs.

Mining and agriculture are two of the seventeen regional economic sectors (GRDP). The mining sector consists of gas and mineral mining activities, as well as rock mining. Agriculture in the regional economy is referred to as the agriculture, forestry, and fisheries sectors. Specifically, agriculture is formed by five subsectors, namely: (1) food crops, (2) horticultural crops, (3) plantation crops, (4) livestock, and (5) agricultural and hunting services.

In its development, population growth, and exploitation of natural resources, several studies report that by 2050, agricultural production needs to increase by around 35% to

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56% to achieve global food security (Dijk *et al.*, 2021). Then, the risk of hunger becomes 8% in 2050. Then, when climate change is taken into account, the percentage changes to between 30% and 60% (Dijk *et al.*, 2021; Huppmann *et al.*, 2018; Baldos and Hertel, 2016; Hasegawa *et al.*, 2015; Godfray and Robinson, 2015; Ishida *et al.*, 2014; and Dijk and Meijerink, 2014).

The exploitation of land resources through mining activities and food security are issues that always occupy discussions in the public sphere. Academics, practitioners, and policymakers place this issue as crucial in the world of investment. These two issues are especially relevant in Indonesia with its large natural resource potential for the exploration and mining industry. The community group most at risk for unfair exploration of natural resources is farmers (Marlianti *et al.*, 2017; and Sujarwo and Hanani, 2016) because their dependence on nature is very high. For example, land conversion often occurs on agricultural land, making it difficult for farmers to access land. On a macro scale, this results in losses in food production. One way to answer this problem is through innovation, starting with the development of agricultural human resources.

Iskandar *et al.* (2021) stated that to support the sustainability of agriculture and food availability in an era of uncertainty due to the rampant exploration of natural resources (including mining), the development of agricultural human resources is necessary. The point that is emphasized is that human resource development will not be maximized only by relying on the policy arena, it must be supported by empowerment programs from the private sector, namely companies through their Corporate Social Responsibility/CSR, universities and other philanthropies. Iskandar *et al.* (2021) stated that parties who aim to develop agricultural resources can start from increasing farmer competence through agricultural training programs and self-reliant villages.

What was conveyed by Iskandar *et al.* (2021) give a clear impression that human resource development is still an ongoing effort. This is because the performance of the agricultural sector is thought to have not been able to achieve production targets that can guarantee sustainability. The fact is that the contribution of the food crop sub-sector to national GDP from 2019 to 2023 shows a decline. Ministry of Agriculture of the Republic of Indonesia, Center for Agricultural Data and Information System (2023) recorded that the GDP of the food crops sub-sector in 2019 was IDR 446.5 trillion, in 2021 it was IDR 441.4 trillion, and in 2023 to IDR 271.4 trillion. This has consequences for growth, where in 2019 it grew at 3.31%, in 2021 it only grew at 1.12%, and in 2023 it only grew at 0.33%. This is different from the contribution of the mining sector, which from 2019 to 2023 shows an increase. Data from the Central Statistics Agency (Taufikurahman *et al.*, 2023) states that the contribution of the mining sector in 2019 was 7.26%. In 2021 it will increase to 8.97% and in 2023 around 12%.

Summarized from several studies, the agricultural sector in the future will experience a decline along with pressure on land resources due to various reasons, such as land conversion, limited irrigation, and reduced labor absorption in the agricultural sector (Djelantik and Dewi, 2022; Puteri *et al.*, 2022; Hermansyah *et al.*, 2017; and Greenwell *et al.*, 2014).

Empirical facts as reported by researchers such as Tanjung *et al.*, (2021); Anggraini (2020); Inayah *et al.* (2022); and Khairiyakh *et al.* (2015) stated that the contribution of the agricultural sector to GRDP in several regions in Indonesia shows a decreasing trend. Behind that, several regions have a fairly good contribution to GRDP which is marked by an increase every year, their consistent role as a base and superior (Sutrino, 2024; Darmanto *et al.*, 2022; Rosid and Amin, 2022; Saputro and Sunaryono, 2020; Ramli and Hiola, 2019; and Putri and Mustafa, 2018).

Seeing the trend of decreasing contribution from the agricultural sector, it is natural that experts are worried about food sufficiency, amidst population growth and conversion of agricultural land due to the mining industry. Researchers such as Hariono *et al.* (2024); Suprianto *et al.* (2024); Fahriza (2024); Anggraeni *et al.*, (2023); Pauzia *et al.* (2023); Silamat *et al.* (2023); Pratama *et al.* (2023); Purba *et al.* (2023); and Tanjung (2023) have examined these concerns to uncover facts about the future of food and agriculture.

One of the regions in Indonesia as a target for developing the nickel mining industry is Konawe Regency, Southeast Sulawesi Province. In this region, there are two national mineral mining industrial areas, namely the Morosi Mining Industry and the Routa Mining Industry. During 2019-2023, the mining sector's contribution to GRDP grew around 6.52% in 2019, then to 8.96% in 2023. Meanwhile, the contribution of the agricultural sector showed a different pattern, where in 2019 it grew around 6.76% and in 2023 will only grow 6.00% (Konawe Regency Central Statistics Agency, 2023).

To answer the problems described above, there needs to be an initial step in analyzing these problems in research. The hope is to provide a database and information that is useful for the government in terms of repositioning agricultural development policies, specifically in the food crop sub-sector to ensure food availability and sufficiency, especially in light of world concerns in 2050.

The research position also updates previous studies as suggested by Dijk *et al.* (2021); O'Neill *et al.* (2017); Vuuren *et al.* (2017 and 2014); and Maulita *et al.* (2018) that one of the topics that has not been discussed about food security is the assumption of key driving factors for the dynamics (decrease) in the contribution of the food crop sub-sector. The next research position is that there have been no previous studies that have taken cases in the mineral (nickel) mining industry.

This study has two objectives, First to determine and analyze the development of the role of the food crop subsector during



Table 1. Konawe Regency Food Crop Commodity Production 2014-2022 (Tons).

No	Commodity	Year									
		2014	2015	2016	2017	2018	2019	2020	2021	2022	
1.	Rice	253,131	234,169	230,334	233,876	216,476	220,451	198,280	176,534	132,209	
2.	Corn	1,807	1,158	2,533	16,809	11,677	7,719	11,550	15,787	7,860	
3.	Soybeans	1,022	1,719	1,741	278	986	560	343	647	1,046	
4.	Peanuts	95	213	111	100	122	172	107	146	63	
5.	Mung Beans	70	100	68	79	55	92	59	34	37	
6.	Cassava	5,471	7,582	7,132	6,444	6,184	5,270	4,415	8,040	7,690	
7.	Sweet Potato	1,059	2,451	1,979	2,251	2,474	2,047	1,184	1,368	2,358	
Total		262,655	245,675	243,898	259,837	237,974	236,311	215,938	202,556	151,263	

Source: Konawe Regency Central Statistics Agency (2023; 2019; and 2015)

Analyzing the performance (LQ) of each food crop commodity is:

$$LQ = (pi/pt) / (Pi/Pt)$$

Where:

- pi : Production of commodity type *i* at regency level (tons)
- pt : Production of all commodities at regency level (tons)
- Pi : Production of commodity type *i* at the provincial level (tons)
- Pt : Food crop production of all commodities at the provincial level (tons)

The results of LQ calculations can be categorized into the following three provisions (Tarigan, 2005):

1. If $LQ > 1$, it is base/prime, which means that the business field and/or food crop sub-sector in the area can provide for the entire population and the remainder is exported to other areas, so the sector is called a base sector area, or can also be considered a sector superior.
2. If $LQ \leq 1$ which means that business fields and/or food crop subsectors in a region are unable to meet the needs of the entire population so they have to import from other regions.
3. If $LQ = 1$, it is also categorized as non-based because the business field and/or food crop sub-sector can provide for the entire population, but the area cannot be transferred to other regions, because the production of the food crop sub-sector is limited.

RESULTS

Development of Production and Contribution of the Food Crops Sub-Sector: The existing types of food crop commodities cultivated by farmers in Konawe Regency during the 2014-2022 period are seven types as presented in Figure 3 and Table 1. As can be seen in Figure 1, the production value of all food crop commodities each year is considered not good, because shows a fairly consistent decreasing curve. The highest production occurred in 2014, around 262,655 tons, slowly decreasing until 2022 to 151,263 tons. This means that between 2014-2022 there will be a decline in production of around 12,377 each year.

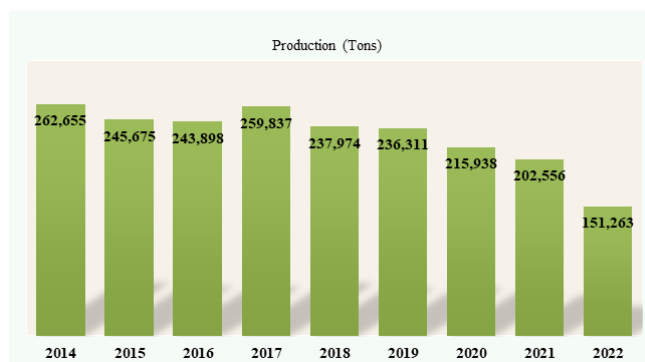


Figure 3. Development of Food Crop Commodity Production in Konawe Regency 2014-2022.

Data from Table 1 shows that Rice is the community's staple food and is widely cultivated by farmers, with the largest production value. The average rice production of total food crop production during 2014-2022 is around 91.86%. It's just that the trend shows a decline, in 2014 it was 253,131 tons, then in 2018 it was 216,476 tons and in 2022 it was 132,209 tons.

The second place is occupied by Corn with an average production contribution of around 3.91%. Corn is widely used as an alternative food ingredient to replace paddy (rice) and partly for feed production, including vegetables. The development of corn production during 2014-2022 is considered good because there is a tendency to increase production. In 2014 it was 1,807 tons, increased significantly in 2017 to 16,809 tons but then decreased until 2022 to 7,860 tons.

The third largest commodity is Cassava with an average production contribution during 2014-2022 of around 2.94% which is widely used as an alternative food ingredient in various processed forms. The production trend is considered good because it shows a decline from 1,059 tonnes to 2,358 tonnes in 2022. There was a decline in 2016, 2020, and 2021, but it was still higher than in 2014.

The fourth highest production is Sweet Potatoes with an average production contribution during 2014-2022 of around



0.86%. The development of production values between 2014 and 2022 shows an increase, with a fluctuating pattern between 2017-2020. Next is the type of Soybeans with an average production contribution to total production of around 0.41%, then Peanuts contribute around 0.05 and Green Beans only 0.03%.

Judging from the data in Table 1, the six commodities experienced fluctuations, while the Rice commodity experienced a significant decline as seen in Figure 4.

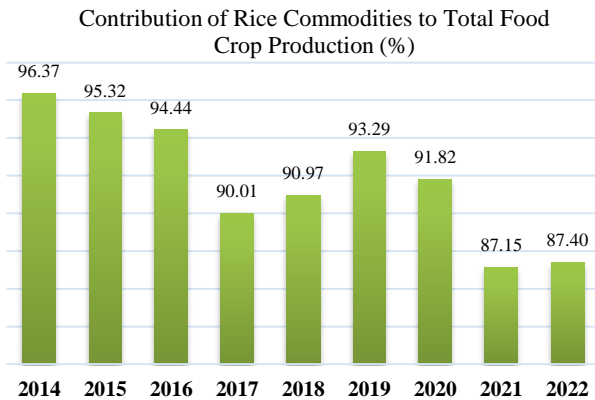


Figure 4. Development of Rice Commodity Contribution to Total Food Crop Production in Konawe Regency 2014-2022.

Furthermore, in Figure 5, the food crop commodities between 2014 and 2022 that experienced an increase in production and an increase in contribution to total production were corn, from 0.60% to 5.20%; Soybeans from 0.39% to 0.69%; Cassava from 2.08% to 5.08%, and sweet potato from 0.40% to 1.56%. Meanwhile, the three commodities, namely Rice, Peanuts, and Mung Beans, experienced a decline in both production and their contribution to total food production.

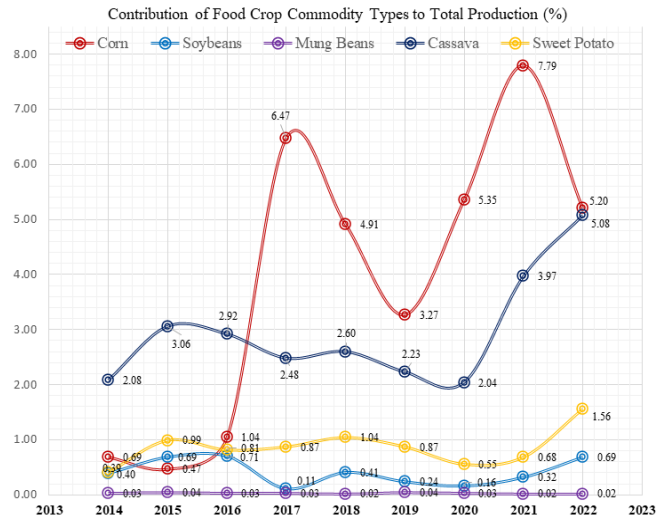


Figure 5. Development of Commodity Contribution to Total Food Crop Production According to Commodity Type Konawe Regency 2014-2022.

The Role of Each Food Crop Commodity in the Agricultural Sector in the Economy (Basic/Leading): The role of each food crop commodity in the agricultural sector is calculated based on the production value of each commodity in the Konawe Regency against the total production at the Southeast Sulawesi Province level. The production value of food crop commodities for Southeast Sulawesi Province in 2014-2022 is presented in Table 2.

The food crop production data for Southeast Sulawesi Province in Table 2 has a development pattern that is almost the same as what happened in the Konawe Regency. For example, there is a decrease in the amount of Rice and Soybean production, as well as commodities that experience an increase, such as Corn.

When aggregated, the amount of food crop production in Konawe Regency is large enough to support production at the Southeast Sulawesi Province level. Total Rice production during 2014-2022, the average contribution is around

Table 2. Total Food Crop Commodity Production in Southeast Sulawesi Province 2014-2022 (Tons).

No	Commodity	Year								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
1.	Rice	657,616	660,720	696,954	711,401	709,516	519,707	532,773	530,029	478,958
2.	Corn	60,600	68,141	90,007	172,078	221,498	279,170	179,906	144,538	165,391
3.	Soybeans	5,691	12,799	16,136	4,055	9,853	1,540	629	859	1,831
4.	Peanuts	4,652	3,471	3,022	2,617	2,054	3,221	3,046	3,070	2,911
5.	Mung Beans	1,192	1,036	1,003	681	510	449	804	296	459
6.	Cassava	175,086	175,096	161,492	242,901	210,387	144,752	167,769	134,038	155,216
7.	Sweet Potato	24,914	25,740	23,960	24,753	20,291	17,682	17,707	16,682	16,339
Total		929,751	947,003	992,574	1,158,486	1,174,109	966,521	902,634	829,512	821,105

Source: Southeast Sulawesi Provincial Central Statistics Agency (2023; 2019; and 2015); and Department of Food Crops and Livestock, Southeast Sulawesi Province, (2022)



Table 3. LQ Value of Food Crop Commodities on the Konawe Regency Regional Economy 2014-2022.

No.	Commodity	Location Quotient (LQ)								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
1.	Rice	1.36	1.36	1.34	1.47	1.51	1.73	1.56	1.35	1.50
2.	Corn	0.11	0.07	0.11	0.44	0.26	0.11	0.27	0.44	0.26
3.	Soybeans	0.64	0.51	0.44	0.31	0.49	1.49	2.28	3.05	3.10
4.	Peanuts	0.07	0.23	0.15	0.17	0.29	0.22	0.15	0.19	0.12
5.	Mung Beans	0.21	0.37	0.28	0.52	0.53	0.84	0.31	0.47	0.44
6.	Cassava	0.11	0.17	0.18	0.12	0.15	0.15	0.11	0.24	0.27
7.	Sweet Potato	0.15	0.36	0.34	0.41	0.60	0.47	0.28	0.33	0.78

34.55%. This means that almost half of the rice production in Southeast Sulawesi Province comes from Konawe Regency. Next, Soybean production in Konawe Regency during 2014-2022 contributed an average of around 29.89% to the province, and Mung Beans contributed around 10.23%. Meanwhile, other commodities contribute between 3-9%. The complete contribution data can be seen in Figure 6.

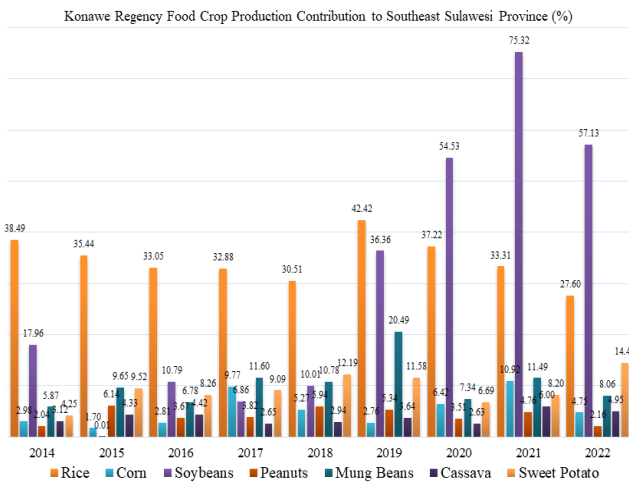


Figure 6. Contribution of Konawe Regency Food Crop Production to Southeast Sulawesi Province 2014-2022.

The data in Table 1 and Table 2 as well as the results of the local quotient (LQ) analysis show the role of each food crop commodity in the regional economy as presented in Table 3. Rice production in Konawe Regency during 2014-2022 is classified as basic with the resulting LQ value being $LQ > 1$. This means that rice has become a business field and/or can meet all the needs of the population of Konawe Regency during the observation period, and is even able to meet the needs of other districts/cities in Southeast Sulawesi Province. In other words, rice is a superior commodity that has an important role in meeting regional food and economic needs, especially in the agricultural sector.

The main destination area for Rice distribution in Konawe Regency is Kendari City. As an urban area and the government center of Southeast Sulawesi Province, Kendari

City's economy is mostly generated from services, and there is very little agricultural land, so Rice production in Konawe Regency is very vital for providing food for the residents of Kendari City.

The second base commodity is Soybeans ($LQ > 1$). However, its role as a basis occurs from 2019 to 2022. This means that Soybean production can contribute significantly to the economy during the period in question. Judging from the development of production (Table 2), there has indeed been a significant increase since 2010 (343 tons) to 1,046 tons in 2022. Likewise, the amount of production at the Southeast Sulawesi provincial level shows the same thing, so the increase in production is an effect of the increase in Konawe Regency.

Direction of Human Resource Development in Agriculture: Farmers as human resources in the agricultural sector are very important in agricultural activities. Data from the Central Statistics Agency shows that in terms of quantity, the number of farmers tends to decrease. In 2018, the number of farmers in Konawe Regency was 40,559 people, consisting of 34,741 men and 5,818 women (Konawe Regency Central Statistics Agency, 2018). This means that 14% of farmers in Konawe Regency are worked by women. In 2023, the number of farmers in Konawe Regency will be 32,611 people, or a decrease of around 6% from 2018 (Konawe Regency Central Statistics Agency, 2024). The Central Statistics Agency also noted that the number of farming households between 2013 and 2023 decreased by around 9.92%.

Since 2020, agricultural businesses have begun to be of interest to millennials. They are engaged in household-scale farming and some urban farming. The Central Statistics Agency noted that during 2023, millennial farmers in Konawe Regency were around 4,343 people. This figure has increased by 1.2% since 2020 (Konawe Regency Central Statistics Agency, 2024).

DISCUSSION

Agricultural development, especially food crops in mining (industrial) areas such as Konawe Regency for almost the last decade has been considered poor, because total production of all commodities shows a decline of up to 40% or 5% every



year. Ironically, rice, the people's main food, continues to decline. Even types of nuts that balance nutrition and maintain health have also decreased. This fact is in line with global concerns, that food availability will indeed be a problem in the future, therefore it is necessary to increase production between 35% - 56% (Dijk *et al.*, 2021).

There is no choice but to improve the performance of food crop development. By maximizing rice and soybean commodities as the basis of the economy, it is an opportunity for local governments to focus on development targets. The private sector also needs to be involved in answering this problem, investment in food crops has the potential to maximize economic value from upstream to downstream. It would be very good if there was collaboration with mining companies so that there were two profitable directions, the green transition would be accelerated with the choice of approach to becoming a *green industrial park*.

If this is not done as soon as possible, a potential food crisis of famine will await, not only in Konawe Regency, but more broadly on a regional and national scale. It is very logical, because the same concern was reported by Elsi *et al.* (2020) that around 42% of the Indonesian population still has low food security, this area includes Sulawesi, as well as several other areas such as West Sumatra, Riau, Bangka Belitung Islands, Riau Islands, DKI Jakarta, West Java, Banten, Bali, Central Kalimantan, South Kalimantan, East Kalimantan, West Papua and Papua. Even (Dijk *et al.*, 2021; Huppmann *et al.*, 2018; Baldos and Hertel, 2016; Hasegawa *et al.*, 2015; Godfray and Robinson, 2015; Ishida *et al.*, 2014; and Dijk and Meijerink, 2014) have warned, if the concentration of agricultural development does not lead to food availability, there is the potential for starvation, even at the global level the threat of starvation for 30%-60% of the global population.

The key factor in maintaining a balance between food availability and mining as an energy provider is that a green transition is absolutely necessary to change the economic model from extractive mining exploitation of natural resources to a *green industrial park* based on climate mitigation and helping food security. program. This approach is important, considering that agricultural commodities are highly dependent on the climate, while the mining industry contributes to climate change.

A practical approach to the green transition with *green industrial park* is to direct Corporate Social Responsibility (CSR) programs to farmers with the help of agricultural innovation and technology for resilience to climate change. This can also be done by referring to management techniques from planting to post-harvest so that there is added value by producing derivative products with economic value.

Direction of Human Resource Development in Agriculture: In terms of agricultural human resources, two focuses are the direction of development for agricultural sustainability in mining areas. The first is aimed at female farmers entrepreneurs, and millennial farmers. For female farmers and

agricultural entrepreneurs, by maximizing the Company's CSR, it is necessary to strengthen social protection programs for women, followed by empowerment and business competence, through agricultural training programs and self-reliant villages.

For millennial farmers who are mostly in urban areas, then the service of access to information technology (digital farming), and capital becomes the way to bring the spirit and interest of millennials to try farming. The potential for developing millennial agricultural resources in the future is a key factor because, in the future, this brand will be the successor to the baton of agricultural development. If not done early, it will certainly give birth to many detrimental consequences.

Conclusion: In theory, every activity that changes the landscape will have an impact on everything above it. Likewise, changes in the forest landscape and productive land for agriculture have an impact on agricultural production, including agricultural land for food crops.

Agriculture in Indonesia includes the Konawe Regency as a key factor in the economic structure (GRDP). Based on the results of the analysis, economic development so far has tended to use an extractive pattern, it is proven that the mining sector's contribution to the economy has shown an increase, while the contribution of the agricultural sector, especially food crops, has decreased.

The logical (theoretical) implication that leads to the choice taken to overcome the gap is to try to bridge sustainable mining and agricultural activities (industry), as is often suggested, namely a green transition with a *green industrial park*. At the same time, human resource development must be carried out with a focus on women and millennials.

The practical and policy implications are that the government and private sector (investors) must sit together to create a technical format to avoid extractive patterns towards a green transition (*green industrial park*). The hope is that farmers' efforts to provide food will be adaptive to climate change.

Limitations: Research has not been able to reveal a direct causal correlation between mining development achievements and food crops. Then it has not revealed problems at the farmer level regarding the decline in food crop productivity.

Suggestions: To cover these limitations, further research is needed on two things. First, analyze the direct causal correlation between mining development achievements and food crops. Second, analysis of problems at the farmer level regarding the decline in food crop productivity. This is quite urgent to get a real picture of the problems at the farmer level, to then help explain the cause and effect relationship as referred to in the first point.

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Fariki, L., Asrul., and Ishak, A assisted the first author in following up on the concept, data processing, and manuscript drafting.

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SDG's Addressed: Zero Hunger, Responsible Consumption and Production, Climate Action, Life on Land.

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