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DEVELOPMENT AND POTENTIAL OF SOYBEAN *(Glycine max (*L.) Merrill) IN BANJARNEGARA REGENCY

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ABSTRACT

Soybean (*Glycine max* (L.) Merrill) is a highly nutritious legume that is rich in protein, iron, and calcium. Soybeans are an excellent source of vegetable nutrition for the human body and contain nutrients such as carbohydrates (20–30%), lipids (19%), essential fatty acids, phosphorus, iron, calcium, zinc, thiamine, riboflavin, vitamin E (tocopherol), dietary fiber (16%), and sugar. The potential for developing agricultural products has the potential to increase, marked by increased consumer demand which is soybean that has the potential to be developed due to production development in Banjarnegara Regency increasing annually. The research aims to determine the potential for developing soybeans in Banjarnegara Regency through historical data on plant cultivation. This research was carried out in September–October 2023. The research method used was qualitative research. This research data is secondary data obtained through the Central Statistics Agency (BPS) website and the Food and Agriculture Organization Corporate Statistical Database (FAOSTAT). The data obtained were analyzed using Pearson's correlation analysis and simple regression at the 95% level. Furthermore, data forecasting analysis (forecasting) was also carried out to determine soybean productivity in 2023. The data was analyzed and displayed in graphical form using the Minitab v.21.4 application, while the data was displayed in tabular form using Microsoft Excel 2019. The conclusion is the development of soybean plants in the Regency Banjarnegara can be stable and increase every year, this needs to be maintained through local government policies, agricultural services, and researchers at institutions/universities to maintain the stability of soybean production and food security in the present and future.

Keywords: Agricultural Ecology; Food Safety; Food Security; Soybeans; Sustainable Agriculture

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is a highly nutritious legume that contains protein, iron, and calcium (Nair et al., 2023). Soybean was also known as 'Edamame' (Japan), 'Mao Dou' (China), and 'Poot Kong' (South Korea). The seed size is large (>60–75 g/fresh weight of 100 seeds) and the taste is sweeter (Nair et al., 2023). Apart from being a food source, soybeans have various by-products related to their production, such as glycerin, lecithin, carboxylic acids and their derivatives, lubricants, and biodiesel (Maciel et al., 2015).

Soybean is an excellent source of vegetable nutrition for the human body and contain nutrients such as carbohydrates (20–30%), lipids (19%), essential fatty acids, phosphorus, iron, calcium, zinc, thiamine, riboflavin, vitamin E (tocopherol), dietary fiber (16%), and sugar (Rigo et al., 2015; Lovabyta et al., 2020). Soybean contains natural isoflavones (48.95 mg/100 g) which can reduce the risk of cancer (Huang et al., 2014), cardiovascular disease, and osteoporosis. Isoflavones in soybean are in the form of glycosides: genistin (β-glucoside), daidzin (acetyl-β-glucoside), glycitein (malonyl-β-glucoside) (Nair et al., 2023), and aglucone (Rigo et al., 2015).

The development of agricultural products in Banjarnegara Regency increases annually (BPS, 2023). The potential for developing agricultural products has the potential to expand, marked by enlarged consumer demand. Banjarnegara Regency is one of the districts in Central Java Province. This area has topography, the majority of which (>65%) is at an altitude of between 100-1000 meters above sea level. This area has the potential to develop various types of plants because of the abundant water availability and supportive tropical climate, the plant that has the potential to be developed is soybean. The research aims to determine the potential for developing soybean plants in the Sumbawa Regency through historical data on plant cultivation.

The need for soybeans in Banjarnegara Regency is starting to be considered in the future due to the strong production and market trends of snake fruit. Salak production in Banjarnegara is able to contribute >10% of needs in Indonesia, and this greatly narrows market opportunities and increases soybean production. Soybean production in Banjarnegara needs to be observed from historical data trends and future data trends to maintain production.

RESEARCH METHODS

This research was carried out in September–October 2023. The research method used was qualitative research. This research data is secondary data obtained through the Central Statistics Agency (BPS) website and the Food and Agriculture Organization Corporate Statistical Database (FAOSTAT). The data obtained were analyzed using Pearson's correlation analysis and simple regression at the 95% level. Correlation analysis is carried out to find out how strong the relationship is between two variables. Correlation analysis shows the direction of the relationship between two or more variables. The relationship in correlation analysis is shown in the direction of a negative relationship and the direction of a positive relationship. Pearson's correlation coefficient scale includes 0.00–0.19 = very low, 0.20–0.39 = low, 0.40–0.59 = medium, 0.60–0.79 = high, and 0.80–1.00 = very high (Selvanathan et al., 2020). Regression is used to determine the relationship between the influence of the dependent variable and the independent variable. The dependent variable is usually denoted with the Y axis, while the independent variable is denoted with there, determining what adjustments need to be made, and what new offerings will spark interest. The data was analyzed and displayed in graphical form using the Minitab v.21.4.2 application, while the data displayed in tabular form was prepared using Microsoft Excel 2019.

RESULTS AND DISCUSSION

The soybean is a species of legume and in Indonesia is widely used as a basic ingredient for making tofu, tempeh, soy milk, and soy sauce (Chen et al., 2012). This plant is an important source of vegetable protein and oil and is a key component in various community food products (Dilawari et al., 2022) and animal feed (Krishnan, 2008; Soni et al., 2023).

Table 1. Productivity (tons/ha) of various agricultural commodities in Banjarnegara Regency

Commodities	Years		Notes
	1991	2022	
Soybean (*Glycine max* (L.) Merrill)	1.13	1.24	↑ 9.73
Paddy (*Oryza sativa* L.)	5.75	6.85	↑ 19.13
Maize (*Zea mays* L.)	2.90	6.57	↑ 126.55
Cassava (*Manihot esculenta* L.)	3.02	29.74	↑ 884.77
Sweet Potato (*Ipomoea batatas* [L.] Lam)	11.03	28.08	↑ 154.58
Mung Bean (*Vigna radiata* [L.] Wilczek)	1.41	1.10	↓ 28.18
Peanut (*Arachis hypogaea* L.)	1.03	2.61	↑ 153.40
Coffee (*Coffea sp.*)	0.28	0.71	↑153.57
Tea (*Camellia sinensis* L.)	3.67	1.58	↓ 132.28

Note: Data obtained from the Central Statistics Agency for 1991 and 2023; ↑ = increase; ↓ = decrease

Based on Table 1, it shows that soybean productivity increased by 9.73% from 1991–2022. Several types of annual crops, apart from soybeans, have experienced increases in productivity, including rice, corn, cassava, sweet potatoes, and peanuts. Meanwhile, green beans experienced a decrease of 28.18%. Annual crops also experienced an increase in productivity, namely coffee and tea. The history of plant cultivation in Banjarnegara Regency which has been recorded in the Central Statistics Agency shows that there has been a conversion and trend in planting carried out by farmers, one of which in the 1990s was dominated by annual crops and several food/horticultural/biopharmaceutical/ornamental plants. This is because farmers are adapting to sustainable agriculture where their agricultural land is adjacent to forests with dense vegetation. In recent years, some of the forests that have begun to be eroded due to trees have begun to be replaced with annual crops that harvest more quickly and produce sales that are easier to obtain. Banjarnegara Regency still prioritizes snake fruit cultivation and it can be said that this district contributes 32.05% of production and 16.70% of national production of snake fruit. This means that this commodity is still superior to soybeans, but the demand for soybeans is increasing. The increase in food ingredients from soybeans causes increased consumption and higher production (Pagano & Miransari, 2016). Based on research by Ningrum et al. (2018) consumption levels have a positive effect on import factors in Indonesia, while production has a negative effect. Therefore, it is necessary to increase soybean production to meet the demand for soybeans in Indonesia for 20 years by increasing land expansion by at least 70% per year, using seeds with a minimum production level of 2.4 tons/ha or short-lived seeds (Hasan et al., 2018). Therefore, the encouragement of the use of innovative technology on a large scale to encourage increased soybean production (Leguizamón, 2017; Mahama et al., 2020).

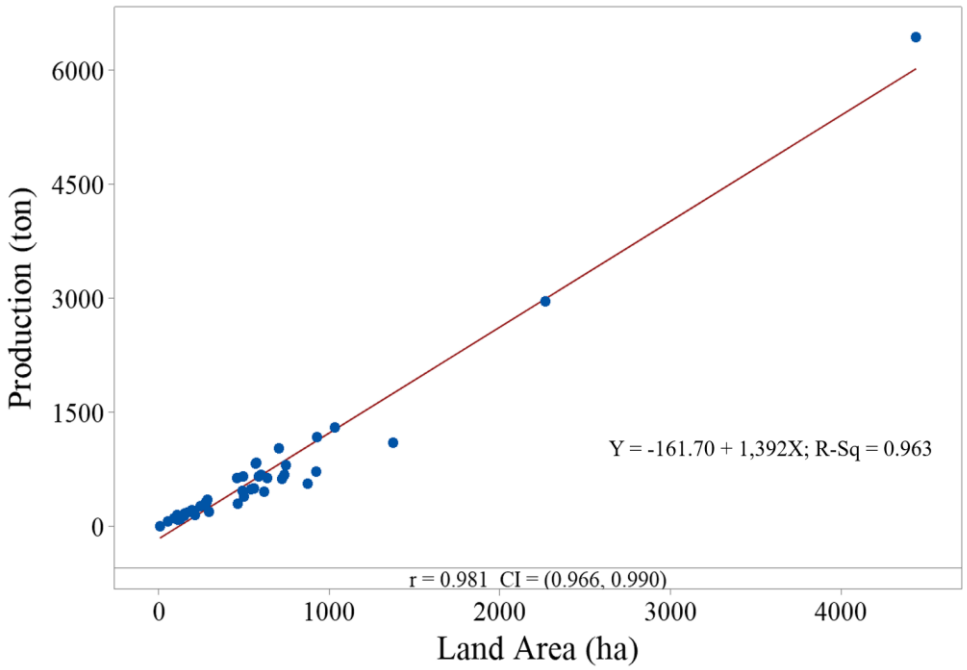

Figure 1. Pearson's Correlation between production and soybean land area in Banjarnegara Regency

Figure 1 shows that the correlation between production and soybean area in 1981–2022 has a very strong relationship according to Selvanathan et al. (2020). This is in line with consumer needs for high production which is characterized by land clearing/expansion of agricultural land specifically for soybean cultivation. Increasing soybean productivity cannot be separated from the cultivation aspect (Egli & Hatfield, 2014) which plays a big role in providing plant nutrition. The balance of nutrients in plants must be taken into account so that the effectiveness of fertilization is optimal. Organic and inorganic fertilizers must be balanced, to maintain the availability of nutrients in the soil (Khairi et al., 2023). This balance also has a positive correlation with soil microbial activity that supports plant growth. Apart from that, soybean cultivation cannot be separated from pest attacks, techniques for detecting pests in post-harvest soybeans are needed (Purnamasari & Haryanto, 2023) as well as bioacoustics control of pests that attack soybean plants (Purnamasari et al., 2022) so that integrated plant control can be achieved implemented holistically (Bueno et al., 2021).

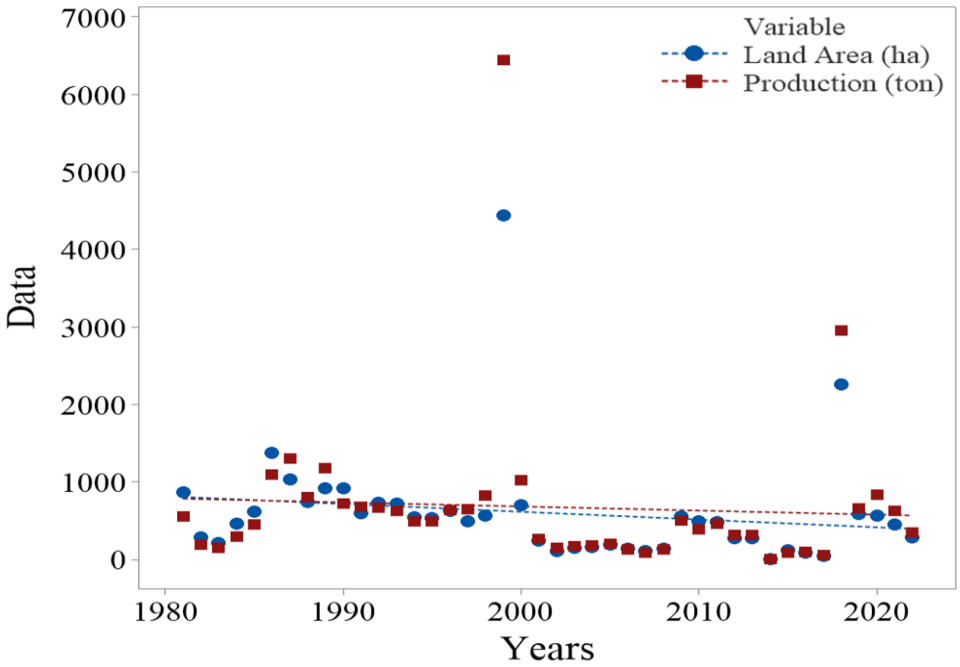

Figure 2. Comparison of Production with Soybean Land Area in Banjarnegara Regency

Figure 2 shows that the relationship between land area and year is 0.280, which means the relationship is low, while production and year is 0.400, which means the relationship is low.

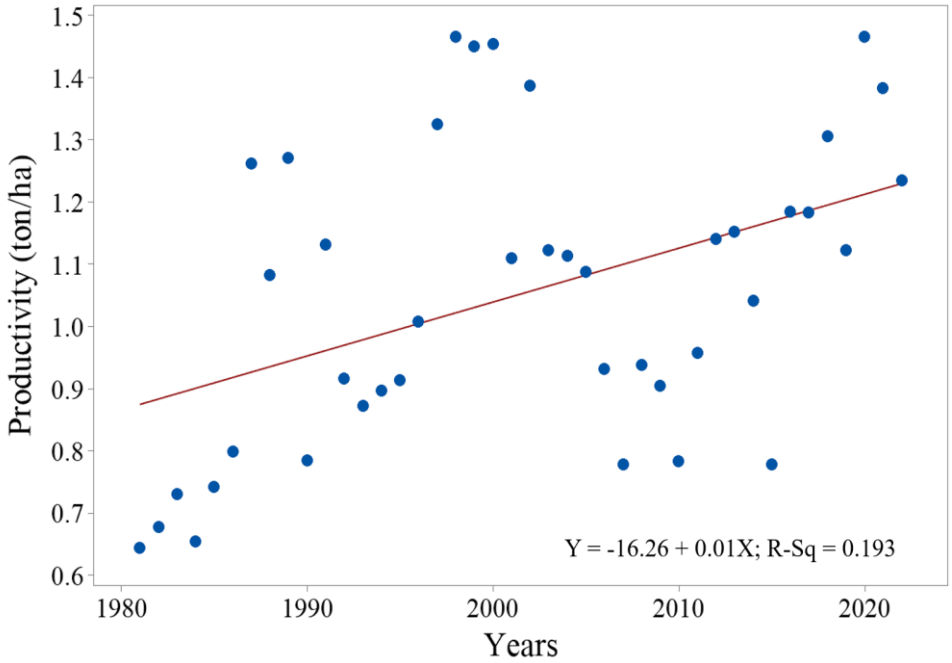

Figure 3. Soybean Productivity 1981-2022 in Banjarnegara Regency.

Figure 3 shows that the relationship between productivity and year is very low. Data are shown from 1981–2022 in Banjarnegara Regency for soybean crops.

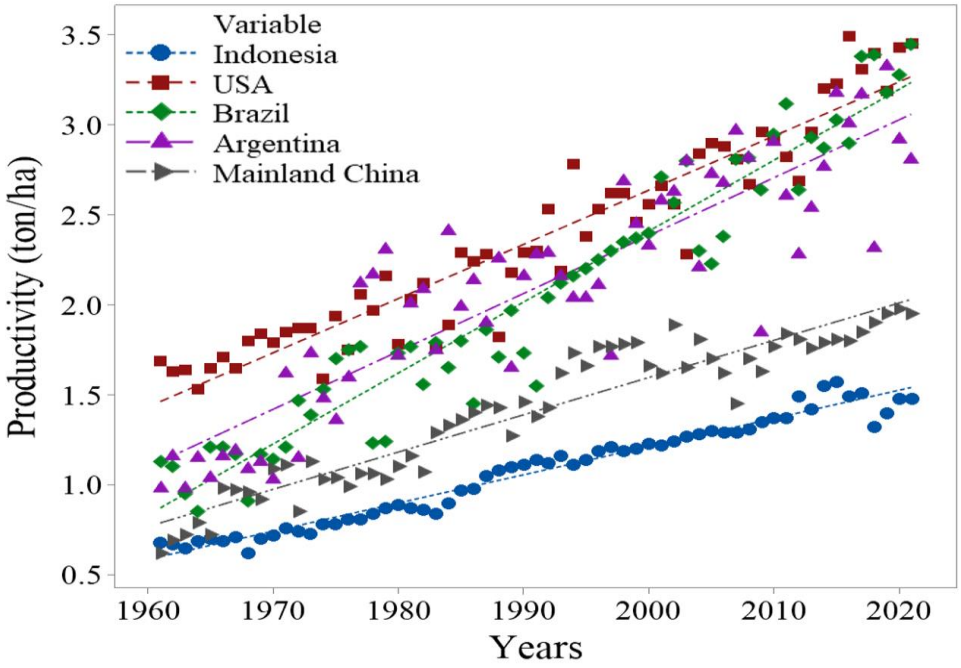

Figure 4. Comparison of soybean productivity 1961-2021 in various countries

Figure 4 shows that Indonesia's soybean productivity is compared with several countries which are the four largest soybean contributors in the world. These countries include China, Brazil, the United States, and Argentina. This comparison of soybean productivity is to measure the comparison with Indonesia, whose data samples were taken from 1961–2021. As a result, the United States (R–Sq = 0.907) is in the first place as a contributor to soybean productivity in the world, followed by Brazil (R–Sq = 0.929), Argentina (R–Sq = 0.793), and China (R–Sq = 0.899). The linear regression graphic pattern presents China's productivity as quite far from Brazil, the United States, and Argentina, but it is close to Indonesia. It was possible that in the future soybean productivity in Indonesia (R–Sq = 0.929) surpassed China.

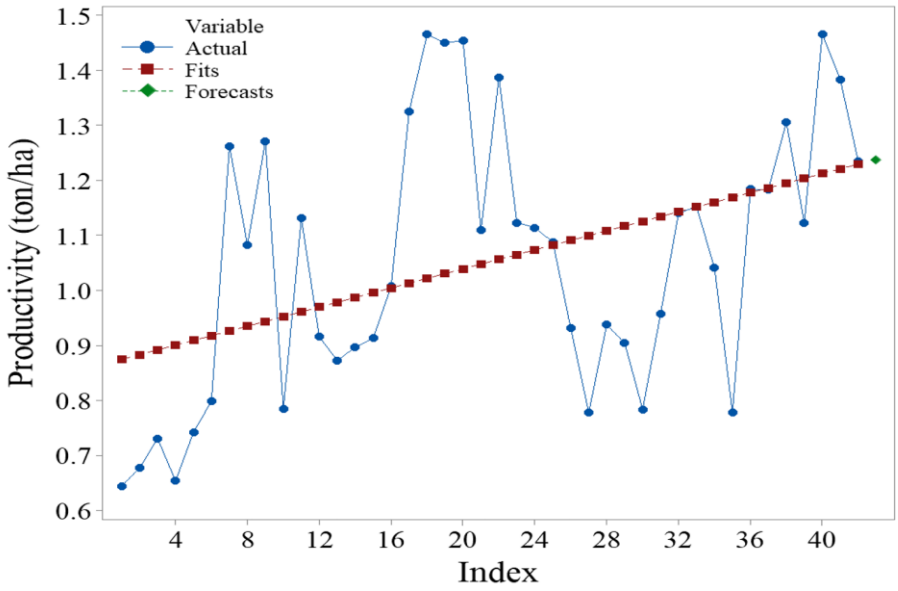

Figure 5. Soybean productivity forecasting 1981-2022 in Banjarnegara Regency

Figure 5 shows that the forecasting results for soybean productivity in 2023 using sample data from 1981–2022 in Banjarnegara Regency are 1.3 tonnes/ha. Apart from that, the Mean Absolute Percentage Error (MAPE) = 17.19, Mean Absolute Deviation (MAD) = 0.17, and Mean Square Deviation (MSD) = 0.05 were also obtained.

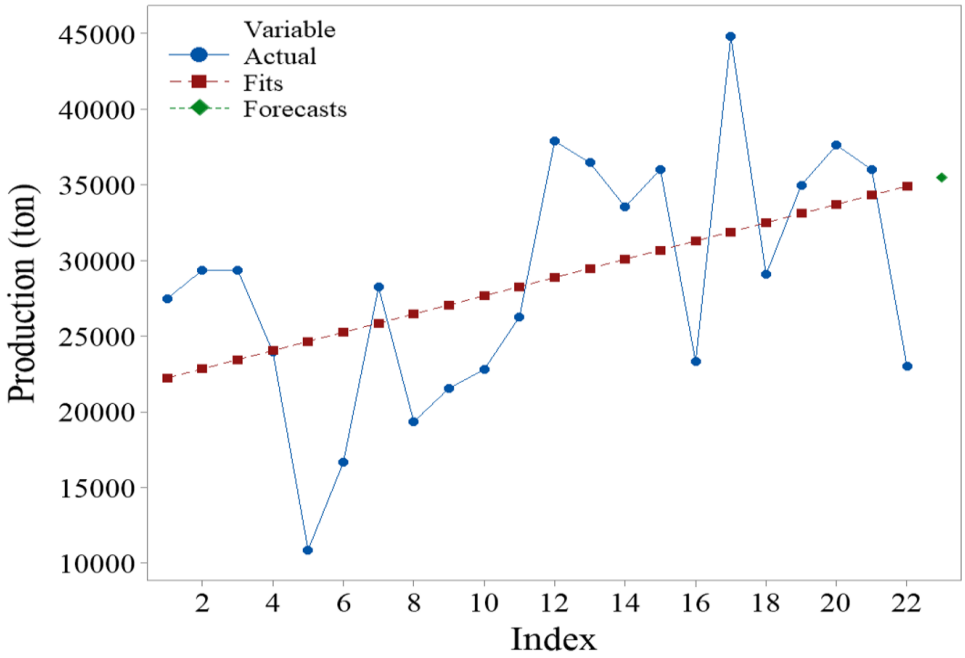

Figure 6. Forecasting Salak Production for 2001-2022 in Banjarnegara Regency.

Figure 6 shows that the forecasting results for snake fruit production in 2023 using the 2001–2022 data sample in Banjarnegara Regency amounted to 35,532.80 tons. Apart from that, the values also obtained were MAPE = 25, MAD = 5930, and MSD = 48,082,343.

The United States is a country that applies biotechnology in the agricultural sector. In the application of agricultural biotechnology, soybean plants can produce many and large seeds. One of them is Genetically Modified Organisms (GMOs) (Bonny, 2008). GMOs in plants are plants whose genes have been changed using genetic engineering techniques, or what is usually called genetic editing. Several different cases have also been applied to one type of tomato plant. The tomatoes studied by Khairi et al. (2022) experienced gene mutations and the ripening of tomatoes could be slowed down without the addition of certain compounds. Khairi et al. (2023) reported that Non-Ripening (NOR) tomato fruit produces limited ethylene production and fruit respiration, so the fruit takes longer to mature.

Brazil ranked second after the United States in 2015 in terms of land area for transgenic crops with an area of 44.2 million ha (up from 42.2 million ha in 2014). The increase in 2015 was 2 million ha or equivalent to a growth rate of 5%. Brazil commercially planted soybeans with insect resistance and herbicide tolerance on 11.9 million ha in the third year, increasing from 2.3 million ha in 2013 to 5.2 million ha in 2014 (a five-fold increase) (Martins-Salles et al., 2017). Therefore, increases in planted area, productivity, output, and demand for inputs are all related to the soybean commodity's potential economic benefits in Brazil (Toloi et al., 2021).

China currently ranks as the 4th largest soybean producer, but still imports 100.33 million tonnes of soybeans (constituting 85.7% of soybean consumption), with domestic

soybean production ranging around 19 million tonnes (Wu et al., 2023). This country has become one of the largest importers of soybeans globally, especially from Brazil and the United States (Wu et al., 2023). Soybean yield is determined by cultivar characteristics and the environment (climate, soil, and management). Yield potential is defined as the result of a cultivar that adapts when planted with optimal water and nutrient management and without loss of yield due to biotic and abiotic stress (Fischer, 2015).

Agricultural products produced through genetic manipulation of plants commonly called transgenic plants such as soybeans, cotton, tomatoes, potatoes, canola, and corn have been approved for marketing (Ghimire et al., 2023). GMOs have great potential to overcome global population poverty, increase the nutritional value of crops, reduce environmental pollution, increase medicinal value, and contribute to agricultural sustainability (Brookes & Barfoot, 2018).

CONCLUSION

Soybean cultivation in Banjarnegara Regency can develop in the future because consumer needs are increasing every year. Soybean development needs to be carried out through local government policies, agricultural services, and researchers at research institutions/universities to maintain the stability of soybean production and food security now and in the future.

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