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Integration of Geographic Information Systems in the Economic Valuation Analysis of Food Crops in Bleberan Village

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ABSTRACT

The agricultural sector is a mainstay of the Indonesian economy, yet it faces serious challenges in the form of a nationwide decline in cultivated land area. This study aims to examine the state of food crop agriculture, identify the benefits derived by the community, and analyze the Total Economic Value (TEV) of agricultural activities in Bleberan Village, Playen Subdistrict, Gunungkidul Regency. The research method used is quantitative descriptive with an economic valuation approach. Data collection was conducted through observation, documentation, and interviews with 100 farmer respondents selected using the Slovin formula. Data analysis includes the calculation of direct utility value, indirect utility value, option value, and existence value. The results of the study indicate that agricultural activities in Bleberan Village are divided into three main phases: pre-planting, planting, and post-harvest, with corn as the flagship commodity due to its adaptation to dry land. The Total Economic Value (TEV) of food crop agricultural activities in Bleberan Village reached Rp 2,584,508,776. This value consists of direct benefits of Rp 1,493,057,500, indirect benefits of Rp 1,089,829,596 (including oxygen-producing and carbon-absorbing functions), choice value of Rp 468,840, and existence value of Rp 1,152,840. These findings confirm that the economic benefits of agriculture extend far beyond the mere market value of commodities, encompassing ecosystem services and existential values that are crucial to the sustainability of the region.

A. INTRODUCTION

Food crop land is a strategic asset of fundamental economic value for the sustainability of food security and agricultural development at both the national and local levels (Chaudhary et al., 2025). However, the assessment of the economic value of food crop land still faces significant methodological challenges, particularly in accurately and efficiently integrating biophysical productivity dimensions with economic valuation (Yuan et al., 2025). Traditional land valuation approaches often focus on market-based methods without comprehensively considering the natural attributes that form the foundation of a land's productive capacity. This results in valuations that do not fully reflect the actual productive value of agricultural land (Achmad et al., 2025).

Geographical Conditions of Gunungkidul Regency, which covers nearly 46.63% of the DIY region, is one of the largest producers of food crops in the province. Characterized by

a karst landscape (Gunung Sewu), this region faces limited water availability and dry soil conditions (Khalimi & Kusuma, 2018). Playen Subdistrict, particularly Bleberan Village, is a significant center for corn production with a potential land area of 748 ha (Agency, 2022). The majority of the population in Bleberan Village (approximately 90%) relies on the agricultural sector for their livelihood, primarily on forest land and rain-fed rice fields (Abisono et al., 2020).

As global food demand rises and pressure on agricultural land conversion increases, accurate information on the productivity and economic value of food crop land is becoming increasingly crucial (Raza et al., 2025). In a local context, Bleberan Village an agricultural area with high bio physical heterogeneity requires a land assessment system capable of capturing the spatial variability of productivity at a micro resolution (Zakaria et al., 2026)(Budiman et al., 2022). Conventional approaches based on field surveys and manual sampling are not only costly but also have limitations in spatial coverage and data consistency, particularly for areas with complex land fragmentation (Lykhovyd et al., 2024).

Remote sensing technology has opened up new opportunities to address these limitations. The Normalized Difference Vegetation Index (NDVI), a vegetation index derived from satellite spectral data, has been shown to have a strong correlation with indicators of land productivity, including plant biomass, canopy cover, and crop yield (Yan et al., 2025). The advantage of NDVI lies in its ability to measure vegetation health and density over a wide area, with temporal consistency, and at a relatively affordable cost compared to traditional assessment methods (Rafsanjani & Papilaya, 2024). NDVI quantifies the difference between the reflectance of near infrared (NIR) light and visible red light, reflecting the presence of chlorophyll and plant photosynthetic activity direct indicators of vegetation vigor and production capacity (Andresi et al., 2024).

Several previous studies have demonstrated the effectiveness of NDVI for various agricultural applications. In a study conducted in an irrigated area, NDVI showed 92% accuracy in distinguishing between irrigated and rain fed farmland (Lykhovyd, 2023). Another study reported a significant positive correlation between NDVI values at various stages of crop growth and crop yield, with an R^2 value reaching up to 0.95 during the grain filling phase (Sultana et al., 2014). For more specific estimates of land productivity, a recent study integrated a comprehensive land quality index with a potential productivity model based on natural attributes, resulting in an assessment of land's economic value with high spatial precision (Zhang et al., 2022).

Nevertheless, the integration of NDVI for the economic valuation of food crop land particularly in the context of local biophysical heterogeneity and smallholder farming systems remains a relatively under explored area of research (Agriculture, 2025). Most previous studies have focused on estimating crop yields or assessing plant health qualitatively, while research that explicitly converts NDVI data into measurable and operational economic valuations remains scarce (Tenkorang & Lowenberg-doboer, 2008). Furthermore, in the context of agricultural villages in Indonesia, where farming systems are characterized by small landholdings, high fragmentation, and complex agroecological heterogeneity, adapting NDVI based methodologies for economic land

valuation requires an approach sensitive to local characteristics (Siankwilimba et al., 2025).

The Importance of Economic Valuation in Agricultural Geography allows for the study of the spatial variations of agricultural phenomena through ecological and regional approaches. In this context, economic valuation is necessary to assign quantitative values to the goods and services produced by natural resources, whether they have market or non market value (Lyle et al., 2015). Until now, public perception has often been limited to agriculture's role as a producer of physical products (rice, corn, etc.), while its functions as a provider of environmental services such as oxygen production, carbon sequestration, and cultural preservation tend to be overlooked (Arysandi, 2025).

The lack of appreciation for the non-market functions of agriculture often results in land management policies that do not prioritize the preservation of ecological functions. Therefore, this study was conducted to provide a quantitative comparison of the total economic value of agricultural land in Bleberan Village so that the government and farmers can make informed decisions regarding sustainable agriculture. This study differs from previous studies in its use of a spatial approach to enhance the analysis of the total economic valuation of food crop farming in dryland areas, this study has the first objective of calculating the total economic valuation of food crop farming activities and mapping the vegetation conditions in Bleberan Village.

B. METHODS

Research Design and Location This study employs a descriptive quantitative method, presenting results in the form of numerical data accompanied by systematic explanations. The research was conducted in Bleberan Village, Playen Subdistrict, Gunungkidul Regency, an area dominated by dryland agriculture.

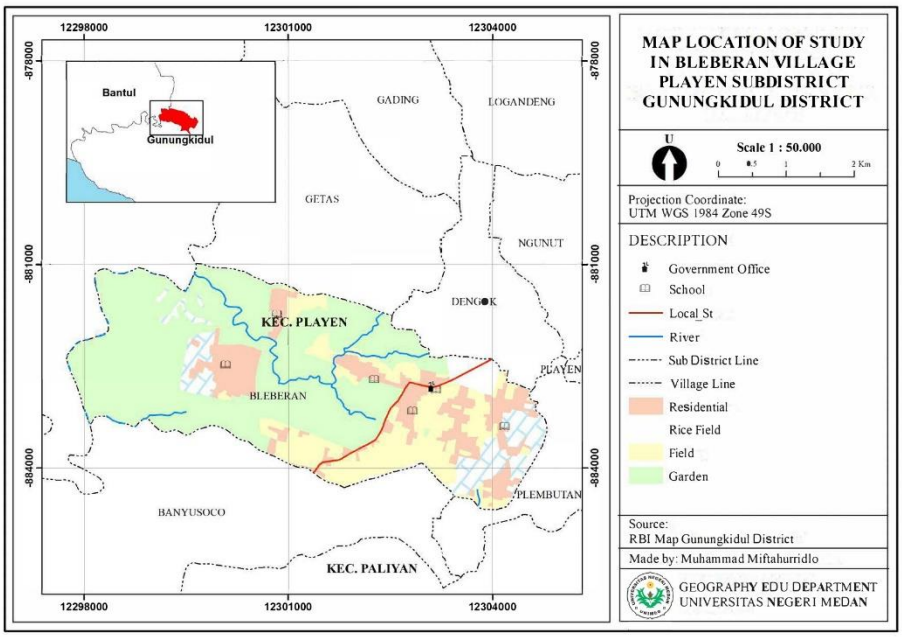

Figure 1. Map Location of Study

Population and Sample The study population consisted of all farmers in Bleberan Village, totaling 2,074 people. Using the Slovin formula with a 10% margin of error, a

minimum sample size of 96 respondents was calculated, which was then rounded up to 100 respondents to improve data accuracy. The sampling technique employed Proportional Random Sampling from 11 hamlets.

Data Collection Methods;

1. Observation: Direct observation of land conditions and farming activities.
2. Interviews: Using structured questionnaires to collect primary data on production costs, income, and willingness to pay (WTP).
3. Documentation: Collection of secondary data from government publications regarding land area and village monographs.
4. Remote Sensing Analysis: Using the Normalized Difference Vegetation Index (NDVI) algorithm to monitor changes in vegetation cover across different growing seasons. The satellite imagery data used for NDVI analysis is from Sentinel-2.

Data Analysis:

NDVI is calculated using the following equation (Lykhovyd, 2023):

NDVI = (NIR - Red) / (NIR + Red)

Notes:

NDVI = Normalized Difference Vegetation Index
NIR = Near Infra-Red

Total Economic Value (TEV) Total Economic Value is calculated using the following formula (Harini et al., 2022):

TEV = UV + NUV
UV = DUV + IUV + OV
NUV = EV

Notes:

DUV (Direct Use Value) = Calculated using the Market Price Method
IUV (Indirect Use Value) = Includes estimates of oxygen production, CO2 absorption, and waste utilization
OV (Option Value) = Uses the Contingent Valuation Method (CVM) to estimate the public's WTP for maintaining ecological functions.
EV (Existence Value) = Uses CVM to assess social, cultural, and aesthetic benefits

The measurement of direct benefits based on market prices can be formulated as follows (Anwar et al., 2023).

MLi = (Hpi × Pi)

Notes:

MLi = Direct benefit of commodity i (Rp/kg)
Hpi = Market price of commodity i (Rp/kg)
Pi = Production of commodity i (kg)
I = Type of commodity (e.g., rice, horticultural crops, etc.)

CO_2 absorption is calculated using the formula as follows (Anwar et al., 2023).

$CO_2 = C_n \times 3{,}67$

Notes:

CO_2 = carbon dioxide absorption (Ton/ha)
C_n = carbon content per unit area
3,67 = equivalent number

O_2 producer is calculated using the formula as follows (Anwar et al., 2023).

O_2 = CO_{2n} x 0,73

Notes:

O_2 = oxygen absorption (Ton/ha)

CO_{2n} = CO_2 absorption per unit area

0,73 = equivalent number

This study employs the Contingent Valuation Method (CVM) to measure the economic value associated with food agriculture activities as a cultural benefit perceived by the community of Bleberan Village, Playen Subdistrict. Through the CVM, the researchers obtained data on the extent to which the village community values and recognizes the contribution of food agriculture activities to their cultural identity. Questions regarding willingness to pay (WTP) were used to collect data on the economic value assigned by the community to maintaining and supporting food agriculture activities as a cultural benefit.

C. RESULT AND DISCUSSION

1. The State of Food Crop Farming in Bleberan Village

Agricultural activities in Bleberan Village are heavily influenced by the monsoon rainfall pattern. Farming is carried out in three phases: pre-planting, which involves land preparation using hoes or tractors; the planting season, which involves the planting of five major crops; and post-harvest. Planting activities in Bleberan Village are carried out once all the land is ready for planting food crops. In this study, there are five types of food crops planted by farmers, including rice, corn, cassava, peanuts, and soybeans. Each crop has a different planting method.

Changes in the agricultural conditions of food crops in Bleberan Village can be observed from planting season 1 through planting season 3. Weather conditions, which change monthly, cause agricultural activities to adjust accordingly. Changes in land cover can indicate differences in agricultural conditions during planting season 1 (November to March), planting season 2 (April to July), and planting season 3 (August to October). Analysis using the NDVI (Normalized Difference Vegetation Index) can reveal differences in vegetation density across each planting season.

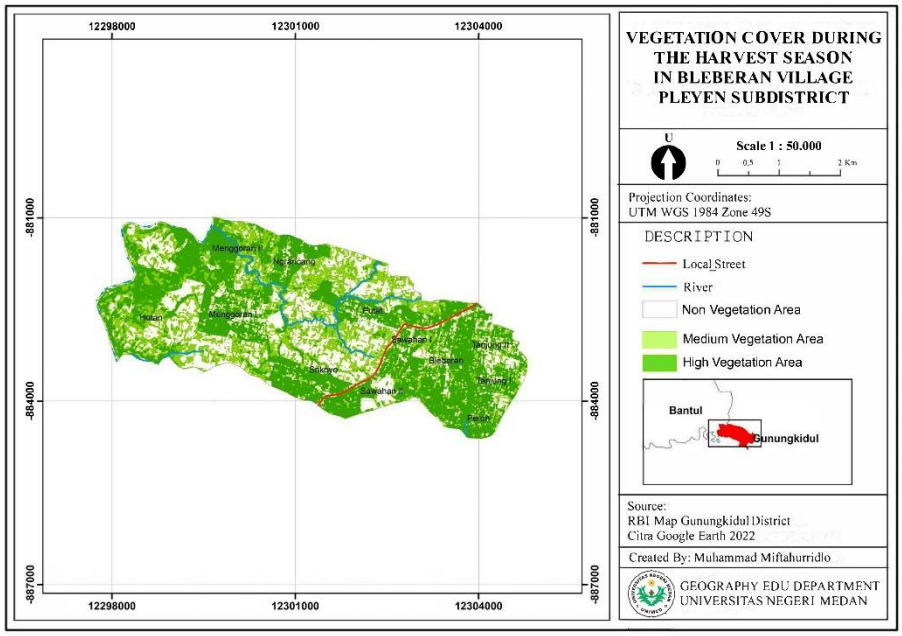

Figure 2. Vegetation Cover During the Harvest Season in Bleberan Village

The state of agriculture in Bleberan Village can be assessed by the density of vegetation covering the village area. In this study, vegetation cover was analyzed using NDVI to identify which areas were covered by vegetation. Based on land cover during the harvest season, high vegetation cover spans 633 ha, while moderate vegetation covers 472 ha. Areas with low to no vegetation cover span 354 ha. During the harvest season, the condition of crops in Bleberan Village is generally lush, as farmers are now ready to reap the rewards of the agricultural activities they undertook several months ago.

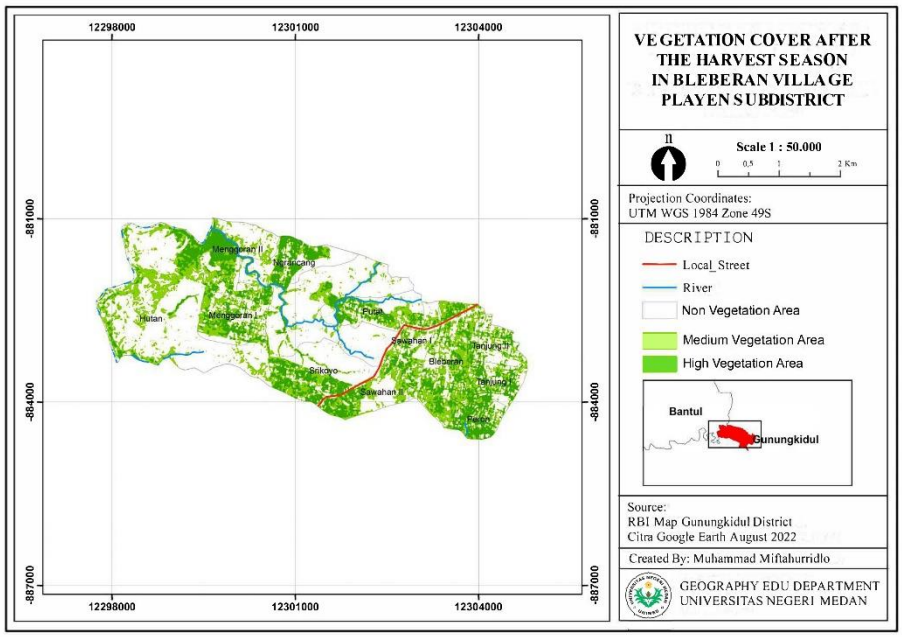

Figure 3. Vegetation Cover After the Harvest Season in Bleberan Village

The post-harvest agricultural landscape shows that the green areas have begun to fade, and white areas now dominate the village. Based on vegetation cover analysis using NDVI, it was found that areas with high vegetation cover span 265 hectares, while areas with moderate vegetation cover span 390 hectares. Meanwhile, areas dominated entirely by low vegetation or no vegetation at all cover a total of 800 hectares.

According to research (Harini et al., 2022), total economic valuation was conducted solely to calculate the total value of agricultural activities without mapping the areas involved; however, this study incorporates a spatial analysis of vegetation to identify which areas need to be protected from the threat of land-use conversion that could affect community agricultural production.

2. Issues in Food Crop Farming in Bleberan Village

Agricultural activities carried out by the residents of Bleberan Village do not always go smoothly; rather, they face various problems, both natural and man made (Pewista & Harini, 2013). The agricultural challenges faced by farmers can have a negative impact on crop yields, such as damage to food crops, reduced harvests, and even crop failures. Some of the agricultural challenges faced by the residents of Bleberan Village are as follows:

1. Inadequate Equipment

   As the population of rural communities grows over time, the demand for food increases, requiring farmers to produce higher yields of food crops as time goes on. Agricultural tools are one of the factors that can boost the productivity of food crop farming. This is especially true for modern equipment that can make farmers' work easier, such as tractors for plowing fields and harvesting tools to facilitate

the harvesting process. Farmers need various planting tools to ensure that their farming activities run smoothly.

2. Unfavourable Weather Conditions
   Gunungkidul is located in the Gunung Sewu mountain range, an area characterized by limestone geology. Areas with limestone are typically associated with dry soil conditions and limited water availability. Agricultural activities are inherently dependent on water availability; without water, food crops cannot thrive, leading to crop failure. The village of Bleberan, which lacks natural springs, relies on rainwater during the rainy season. Consequently, farmers must fully capitalize on the rainy season to maximize their agricultural activities.
3. Destructive Plant Pests
   Food crops thrive when they have an adequate water supply and sufficient nutrients. Once the crops begin to flourish, farmers face the challenge of protecting them from attacks by planthoppers, birds, and rats. In 2021, rats became a major threat to farmers in Bleberan Village because they damaged the rice and corn crops, which are the village's primary food crops. Pest infestations have become a particular concern for farmers, leading them to implement various measures to combat planthoppers and rats, such as applying insecticide sprays and erecting scarecrows in the fields.

3. The Benefits of Food Crop Farming in Bleberan Village

Direct Benefits

The assessment of direct benefits is based on five key food crops cultivated by farmers in Bleberan Village, including rice, corn, peanuts, cassava, and soybeans. The total agricultural yield at the end of the harvest season will be calculated based on prevailing market prices for these commodities. Thus, this figure will reveal the direct benefits derived from food crop farming in Bleberan (Harini et al., 2025).

Table 1. Direct Benefits of Agricultural Activities in Bleberan Village

No	Type of Commodity	Direct Benefits (Rp/Year)	Percentage (%)
1	Rice	454.820.000	30,46
2	Corn	824.877.500	55,25
3	Peanuts	21.780.000	1,46
4	Cassava	68.150.000	4,56
5	Soybeans	130.710.000	8,27
	Total	**1.493.057.500**	**100,00**

Based on the data presented in Table 1, it can be observed that rice (30.46%) and corn (55.25%) are the primary food crops that contribute most significantly to direct benefits. This analysis is consistent with the important role of rice and corn as primary food crops in many villages in Indonesia. Furthermore, peanuts (1.46%), cassava (4.56%), and soybeans (8.27%) also make positive contributions to supporting the economy in Bleberan Village, Playen District, although their proportions are smaller compared to rice and corn. Further analysis will elucidate the role of each commodity and its implications for decision-making and policy development in the agricultural sector.

Indirect Benefits

The indirect benefits to be analyzed from agricultural activities in Bleberan Village, Playen District, include the indirect benefits of land as a source of oxygen (O2), land as a

carbon dioxide (CO2) sink, the utilization of agricultural byproducts, and employment in the agricultural sector (Harini et al., 2021).

Table 2. Results of Oxygen and Carbon Dioxide Emission Calculations

Land Type	Land Area (Ha)	Land Total (Ha)	Emisi CO2 (Ton/Ha)	Emisi O2 (Ton/Ha)	CO2 (Ton)	O2 (Ton)
Rice Field	13,765					
Farmland	56,762	70,527	18,35	13,40	1294,17	945,06

Table 2 shows the estimated total absorption of carbon dioxide (CO2) and production of oxygen (O2) on the land of Bleberan Village, Playen District, over a one-year period. Agricultural activities also generate waste, which farmers then utilize as fertilizer. The fertilizer produced from agricultural waste is subsequently sold commercially, with estimated sales reaching up to Rp 5,600,000. In practice, agricultural activities in Bleberan Village also drive the local economy through the creation of new jobs. Generally, people who do not own land for farming become day laborers working for someone who owns large tracts of land but lacks labor. Agricultural activities can absorb labor over the course of a year valued at Rp 118,608,000.

Option Benefits

In the value-based approach, calculations were performed by asking respondents about their willingness to pay fees to preserve existing ecological functions and biodiversity in agricultural areas. Based on data from respondents, shows that 72% of respondents or 72 people are willing to pay because they recognize the potential of agricultural land to maintain its ecological and biodiversity functions. Meanwhile, the remaining 28% or 28 people are unwilling to pay because they do not yet consider agricultural land to have significant potential for maintaining its ecological and biodiversity functions. Based on the interview data, a range of WTP values was also obtained from respondents for preserving agricultural land for ecological functions and biodiversity. The WTP values ranged from Rp. 5,000 to Rp. 100,000. Within this range, one respondent reported the highest WTP value. Meanwhile, there was 1 respondent who reported the lowest WTP value. The rest reported WTP values between Rp. 5,000 and Rp. 100,000. The average WTP value reported was Rp. 39,070 per month; to calculate the annual WTP amount, the average monthly WTP value is multiplied by 12 months. The annual WTP value paid by farmers is Rp. 468,840.

Existence Benefits

The value of existence in food crop agriculture refers to the intrinsic or existential benefits derived from the existence and sustainability of agriculture. This value is not related to the direct use or consumption of agricultural products, but rather to the recognition of the importance of agriculture in maintaining the balance of ecosystems, biodiversity, and human life. The value of existence takes the form of social, cultural, and aesthetic benefits.

Based on data from respondents, show that the average WTP value among farmers is Rp. 33,370 per month. This indicates that, on average, respondents are willing to pay this amount as their contribution to the existence of food agriculture activities as a social benefit. Based on the WTP distribution data, there is variation in the WTP amounts stated by each respondent, ranging from Rp. 5,000 to Rp. 100,000 per year. Seventy-eight percent (78%) or 78 people stated they agree and are willing to pay to maintain the

functions of food agricultural activities that provide social benefits so they can be utilized by future generations. In contrast, 22% or 22 people stated they were unwilling to pay to maintain the functions of food agricultural activities that provide social benefits. It can be concluded that the economic potential of agricultural activities in Bleberan Village, Playen Subdistrict, has a social benefit value of Rp. 400,440.

Base survey data of 100 respondents, indicating that the average WTP value is Rp. 15,100 per month. These results indicate that, on average, the village community is willing to pay this amount as a contribution to the existence of food agriculture activities as a cultural benefit. The WTP distribution shows variation in the amounts stated by each respondent, ranging from Rp. 5,000 to Rp. 100,000 per year. Seventy five percent (75%) of respondents or 75 people expressed agreement and willingness to pay to preserve the functions of food agriculture activities that provide cultural benefits so they can be utilized by future generations. On the other hand, 25% or 25 people stated they were unwilling to pay to maintain the functions of food agricultural activities that provide cultural benefits. It can be concluded that the economic potential of agricultural activities in Bleberan Village, Playen Subdistrict, has a value of cultural benefits amounting to Rp. 181,200.

Base data of respondents, shows the results of a survey of 100 respondents, indicating that the average WTP value is Rp. 47,600 per month. These results indicate that, on average, rural residents are willing to pay this amount as a contribution to the existence of food agriculture activities for their aesthetic benefits. The WTP distribution shows variation in the amounts stated by each respondent, ranging from Rp. 5,000 to Rp. 100,000 per year. Sixty-nine percent (69 people) agreed and were willing to pay to preserve the function of food agriculture activities that provide aesthetic benefits so they can be passed on to future generations. On the other hand, 31% or 31 people stated they were unwilling to pay to maintain the function of food agricultural activities that provide aesthetic benefits. It can be concluded that the economic potential of agricultural activities in Bleberan Village, Playen Subdistrict, has a value of aesthetic benefits amounting to Rp. 571,200.

Total Economic Valuation of Food Crop Agriculture in Bleberan Village

In this study, the economic valuation of food crop farming activities in Bleberan Village, Playen District, was analyzed and examined using the Total Economic Value (TEV) approach. TEV is a concept used to describe the total economic value associated with an activity or resource as a whole. According to Groombridge (1992) as cited in the study by Santoso et al. (2019), TEV encompasses various aspects, including direct benefits, indirect benefits, option benefits, and existence benefits. This analysis aims to provide a deeper understanding of the significant economic contribution of the food crop sector in Beberan Village, Playen Subdistrict, as well as the importance of considering various benefit values in decision making regarding the development and sustainability of this sector.

From this cost benefit analysis, it can be concluded that food crop farming practices in Bleberan Village, Playen District, contribute significantly to the economy, promote environmental sustainability, uphold social, cultural, and aesthetic values, and strengthen community bonds. Based on the analysis of this data, the total economic value derived from agriculture can be calculated by summing all previously identified benefits, amounting to Rp 2,584,508,776. The total economic value of food crop farming activities in Bleberan Village, Playen Subdistrict, is presented in detail in the following table.

Table 3. Total Economic Value (TEV) of food crop farming activities in Bleberan Village

No	Economic Values	Total (Rp)	Persentage (%)
1	Agricultural Commodities	1.493.057.500	57,77%
2	As a O^2 Producer	876.072.288	33,90%
3	As a CO^2 Absorption	89.549.308	3,46%
4	Utilization of Commodity Waste	5.600.000	0,22%
5	Labor Absorption	118.608.000	4,59%
6	Ecological Function	468.840	0,02
7	Social Benefits	400.440	0,02
8	Culture Benefits	181.200	0,01
9	Aesthetic Benefits	571.200	0,02%
	TOTAL	**2.584.508.776**	**100,00%**

In addition to the benefits explained above, this study reveals that the economic assessment of food crop farming in Bleberan, Playen District, encompasses not only financial aspects but also social, cultural, and environmental factors that provide added value to the people of Bleberan Village, Playen District. To ensure sustainable agriculture, it is crucial for the government and stakeholders to recognize and support these values in the decision-making and policy development processes.

D. CONCLUSION AND SUGGESTIONS

Agricultural activities in Bleberan Village are dominated by corn cultivation that adapts to dry karst land conditions through three main activity phases, where ecologically the vegetation cover reaches its peak at harvest time according to the results of the NDVI analysis. This study successfully identified the benefits of agriculture that include the direct economic aspects of the five main commodities, environmental aspects through oxygen-producing and carbon-absorbing services, and socio-cultural aspects reflected in the community's willingness to maintain the existence of the land. The Total Economic Value (NET) analysis shows that the total valuation of food crop farming activities in Bleberan Village reached IDR 2,584,508,776, which proves that this sector has a crucial role not only in the economic resilience of farmers, but also in providing invaluable public services in the market so that land protection policies are needed from non-agricultural conversion for the sake of regional sustainability.

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