TẠP CHÍ KHOA HỌC ĐẠI HỌC TÂN TRÀO

ISSN: 2354 - 1431

http://tckh.daihoctantrao.edu.vn/

ASSESSMENT OF LAND USE EFFICIENCY FOR SELECTED KEY CROPS IN BAC SON SƠN DISTRICT, LANG SON PROVINCE

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https://doi.org/10.51453/2354-1431/2024/1224

Article info

Received:12/6/2024

Revised: 17/7/2024

Accepted: 25/8/2024

Keywords:

Bac Son, land use efficiency assessment, key crops, Lang Son

Abstract:

Bac Son is a mountainous district in Lang Son province, where agricultural land occupies 79.24% of the natural land area. Based on 2 factors, the district has identified three key crops: golden tangerine (quýt vàng), tobacco, and red peanut. The assessment reveals that tobacco cultivation yields moderate economic efficiency (6 points), while golden tangerine and red peanut land use show high economic efficiency, with 9 and 8 points, respectively. All three main crops exhibit high social benefits, with golden tangerine identified as especially promising, due to its economic potential and widespread acceptance among local farmers. Among these three main crops, golden tangerine provides the highest environmental benefits, offering complete soil coverage (100%) and compliance with recommended pesticide and fertilizer use. The other two crops require better management of fertilizer and pesticide application. Moving forward, a increasing investments in agricultural inputs and advancing cultivation techniques are recommended to ensure these crops continue to contribute to the economic well-being of Bac Son's residents.

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ĐÁNH GIÁ HIỆU QUẢ SỬ DỤNG ĐẤT CỦA MỘT SỐ CÂY TRỒNG CHỦ LỰC TRÊN ĐỊA BÀN HUYỆN BẮC SƠN, TỈNH LẠNG SƠN

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https://doi.org/10.51453/2354-1431/2024/1224

Thông tin bài viết

Ngày nhận bài: 12/6/2024

Ngày sửa bài: 17/7/2024

Ngày duyệt đăng: 25/8/2024

Từ khóa:

Bắc Sơn, đánh giá hiệu quả sử dụng đất, cây trồng chủ lực, Lạng Sơn

Tóm tắt

Bắc Sơn là huyện miền núi của tỉnh Lạng Sơn, có diện tích đất nông nghiệp chiếm 79,24 diện tích đất tự nhiên. Từ các yếu tố về đã xác định ba cây trồng chủ lực của Huyện là: cây Quýt vàng, Thuốc lá và Lạc đỏ. Đánh giá hiệu quả sử dụng đất cho thấy kiểu sử dụng đất cây Thuốc lá cho hiệu quả kinh tế trung bình (6 điểm) trong khi đó kiểu sử dụng đất cây Quýt vàng và Lạc đỏ cho hiệu quả kinh tế cao (lần lượt là 9 và 8 điểm). Cả 3 cây trồng chủ lực của huyện đều cho hiệu quả xã hội ở mức cao là những cây trồng tiềm năng kinh tế và xã hội lớn, đặc biệt là cây quýt vàng. Trong 3 loại cây trồng chủ lực thì quýt vàng có hiệu quả môi trường cao nhất do khả năng che phủ đất tốt (100%) và sử dụng thuốc bảo vệ thực vật và phân bón đúng khuyến cáo. Hai loại cây trồng còn lại cần phải kiểm soát tốt việc sử dụng phân bón và thuốc bảo vệ thực vật. Trong những năm tới bên cạnh việc chú trọng nâng cao hiệu quả kinh tế cần phải nâng cao kỹ thuật canh tác và hỗ trợ đầu tư về phân bón, thuốc BVTV hiệu quả để các cây trồng tiếp tục trở thành cây chủ lực của Huyện mang lại giá trị cao cho người dân.

1. Introduction

Bac Son, a mountainous district in Lang Son Province, holds significant potential for agricultural development oriented towards commercialization, linked with community-based and agro-ecotourism activities. In recent years, Bac Son has prioritized fostering key crops such as the golden-skinned Bac Son orange, tobacco, and red peanuts. These key agricultural products have contributed to the economic development of the locality. However, the production scale of these key crops remains fragmented, necessitating a comprehensive evaluation and strategic land-use planning to allocate suitable land for these crops. This would increase commodity production and enhance efficient land use. Thus, assessing the land-use efficiency of certain key crops in Bac

Son District, Lang Son Province, is a critical task at present.

2. Literature Review

Land evaluation and classification serve as the foundation for effective land-use planning. Recognizing the importance of this task, the Food and Agriculture Organization (FAO) convened soil scientists and leading agricultural experts to compile research findings and practical experiences in land evaluation from various countries. This effort aimed to establish unified principles and global standards for land evaluation. As a result, the International Committee for Land Evaluation Research was established under the FAO in Rome, Italy. The committee developed a series of guidelines on land evaluation to support agricultural and rural development. These guidelines, published between 1983 and 1993 (FAO, 1983, 1985, 1986, 1988, 1989, 1990, 1993), have provided a theoretical and practical foundation for global land-use planning initiatives. The process of studying and analyzing land potential involves examining the characteristics and properties of each soil type, as well as assessing the suitability of different land-use types, identifying the advantages and challenges associated with their application. This serves as a basis for proposing land-use strategies aimed at achieving high efficiency and sustainability, which is the essence of land evaluation. (Nguyen Ngoc Nong et al., 2020).

Land potential evaluation includes the following objectives:

- Assessing suitability for various uses: Based on human purposes and needs, it is essential to evaluate the suitability of land areas for different intended uses.

- Determining suitability levels and efficiency: Understanding the degree of suitability and the efficiency of land use for selected purposes.

- Identifying limiting factors and criteria: For chosen land-use purposes, it is crucial to identify the limiting factors and criteria that may affect land use efficiency (Bui Văn Sy, 2012).

Suitability determination process: The process of determining the suitability level of various land-use types for a specific land unit and synthesizing the results for the entire area involves comparing the requirements of land-use types with the characteristics of land units. This process forms the foundation of land suitability evaluation. If potential land areas are reasonably planned and concentrated, they can greatly benefit commodity production and the application of scientific and technological advancements to enhance productivity, output, and competitiveness in production (Nguyen Xuan Thanh, 2021).

Efficiency refers to the value obtained relative to the resources invested, measured either in absolute or relative terms. In contemporary evaluations, efficiency must consider three key dimensions: economic, social, and environmental efficiency.

- Economic Efficiency: In agriculture and forestry production, economic efficiency is the output or value of products generated per unit area within a specific production cycle (e.g., one crop season or one year).

- Social Efficiency: Social effectiveness is analyzed through indicators such as labor attraction levels, labor utilization rates, job creation, and income enhancement (Nguyen Duy Tinh, 1995).

- Environmental Efficiency: Ensures that the environment is not degraded or polluted. This includes enhancing vegetation cover, increasing soil nutrient content and moisture levels, and reducing soil degradation during agricultural land use (Đỗ Kim Chung et al., 1997). The minimum canopy cover must reach the ecological safety threshold (> 35%), with biodiversity reflected through species composition. (Nguyen Văn Bo & Bui Huy Hien, 2001).

- Developing agricultural production in a commodity-oriented manner to achieve greater

economic value, ensure food security, social welfare, and mitigate environmental pollution is an urgent issue for all nations, including Vietnam. On this basis, many localities across the country have identified key provincial agricultural products based on their specific conditions. Today, with a global population exceeding 7 billion, commercial agricultural production plays a vital role in meeting the basic needs of humanity for survival and development.

3. Methods

3.1. Method for collecting secondary data

The collection of secondary data involves gathering and compiling relevant published materials and newly acquired data from the research area. This includes: Information on natural, economic, and social conditions sourced from the Land Use Planning Reports of Bac Son District. Updated data from the socio-economic development reports of the district. Statistical data on the yield and output of major crops in the district, obtained from the statistical yearbooks for the years 2019–2023.

3.2. Method for collecting primary data

Primary data collection was conducted using land-use survey questionnaires designed with the Participatory Rural Appraisal (PRA) approach, ensuring the involvement of local residents. Representative research sites were selected to reflect the ecological and agricultural economic regions of the district. The selected communes were chosen based on their land characteristics, topography, farming practices, and cropping systems advantageous for agricultural production, with significant areas dedicated to key crops. These communes include: Tân Hương and Chiến Thắng: Specializing in golden-skinned oranges, Tân Chi: Known for red peanuts, Vũ Lăng and Chấn Yên: Focusing on tobacco cultivation. A survey was conducted, involving interviews with 258 households, determined using Slovin's formula. These households were selected based on their involvement in cultivating the district's key crops. The questionnaire was designed to assess production efficiency.

3.3. Method for Evaluating Economic, Social, and Environmental Efficiency

** Economic Efficiency Evaluation Indicators*

- Gross Output (GO): The total monetary value (VND) of products obtained per hectare per year. GO= Product Output × Selling Price

- Intermediate Costs (IC): The total production costs, including material costs, hired labor costs, and other expenses, expressed in million VND/ha. IC = Material Costs (million VND/ha) + Hired Labor Costs (million VND/ha) + Other Costs (million VND/ha)

- Net Value Adde (NVA): Represents the income remaining after subtracting intermediate costs from the gross output value. NVA = GOV - IC

- Capital Efficiency (CE): Measures the return on investment for production over one year or production cycle. CE = NVA / IC ((Hội Khoa học đất Việt Nam 2015)

Table 1. Criteria for Classifying Economic Efficiency Evaluation

Evaluation Level	Scale	GO (Million)	NVA (Million)	CE (time)
High	3	> 110	> 70	>=2,4
Medium	2	50-110	50-70	1,2-2,4
Low	1	<50	<50	<1,

(Note: The classification table above was developed based on the following sources: consultations with staff from the Department of Agriculture regarding the general economic efficiency levels of key crops in the area, the prevailing agricultural labor wage rates, and results from field surveys.)

- High economic efficiency (H): Scores range from 8 to 9 points.

- Medium economic efficiency (M): Scores range from 6 to 7 points.

- Low economic efficiency (L): Scores total ≤ 5 points.

** Evaluation of Social Efficiency*

- Labor absorption capacity: measured by the number of labor days required for the production process

- Ability to sustain livelihoods: assessed through the value of labor per workday. - labor day value (LDV) = Net Value Adde (NVA)/ Number of Labor Days (LD)

- Post-harvest product marketability: Evaluated based on the ease and capacity of local farmers to sell their harvested products.

- Level of community acceptance: Reflects how well the crop production system is accepted and supported by local residents

Table 2. Criteria for Social Efficiency Evaluation Classification (per 1 hectare)

Evaluation Level	Scale	Labor attraction capacity (person-days)	Daily Wage Value (1,000 VND/person-day)	Product Consumption Capability (%)	Public Acceptance Rate (%)
High	3	>150	>540	>75	>75
Medium	2	80-150	270-540	50-75	>50-75
Low	1	<80	<270	<50	<= 50

- High social efficiency (H): achieves a score of 8–9 points.

- Medium social efficiency (M): achieves a score of 6–7 points.

- Low social efficiency (L): land-use type with a total score ≤ 5 points.

** Evaluation of Environmental Efficiency*

Assessment of the impact of fertilizer and pesticide use on soil through comparison of actual usage with recommendations from the Bac Son District Agricultural Extension Center. Evaluation includes: Ground cover rate (%), Fertilizer usage level, Pesticide usage level (Source: Vietnam Soil Science Society, 2015)

Table 3. Criteria for environtmental efficiency evaluation classification (1 hectare)

No.	Criteria	Assessment Score/Rate		
		3	*2*	*1*
1	Ground cover rate to prevent erosion (%)	> 75	> 50 - 75	< 50
2	Ground cover rate to prevent erosion (%)	Use or less than recommended; mainly biological pesticides	Matches recommendations, mainly using chemical pesticides	Not in accordance with recommendations
3	Ground cover rate to prevent erosion (%)	Matches recommendations	Fertilizer application deviation from recommendations ≤10%	Fertilizer application deviation from recommendations >10%

- High environmental efficiency (H): Achieves 8–9 points;

- Moderate environmental efficiency (M): Achieves 6–7 points;

- Low environmental efficiency (L): Land use type with a total score of ≤5.

- Overall evaluation of land use efficiency: Uses the same scoring method as the evaluation of the three above-mentioned efficiencies.

3.4. SWOT analysis method

The SWOT analysis model (Strengths, Weaknesses, Opportunities, and Threats) is presented in the form of a 2x2 matrix divided into four sections, each corresponding to strengths, weaknesses, opportunities, and threats. The purpose of SWOT analysis is to identify the strengths we possess as well as the limitations that need to be addressed (Bùi Nữ Hoàng Anh, 2013). In this study, SWOT is used to analyze the strengths, weaknesses, opportunities, and challenges related to the land use efficiency of some key crops in the Bac Son district.

3.5. Data synthesis and processing method

Based on field surveys, data is aggregated according to each subject, each type of land use transfer, and each year to create a database using Excel software.

4. Results (Kết quả)

4.1. Current status and changes in agricultural land use in Bac Son District, Lang Son Province

Table 4: Changes in agricultural land use during the 2022–2023 period

No.	Land Use Indicators	Code	2023		Compare to 2022	
			Area (ha)	*(%)*	*2022 Area (ha)*	*Change 2023/2022*
I	Type of Land		69.941,36	100,00	69.941,36	0,
1	Agricultural land	NNP	55.419,20	79,24	55.479,40	-60,20
	Including:			-		
1.1	Rice-growing land	LUA	4.466,05	6,39	4.484,48	-18,43
	Paddy fields	LUC	845,66	1,21	849,74	-4,09
1.2	Land for other annual crops	HNK	5.570,36	7,96	5.703,19	-132,83
1.3	Land for perennial crops	CLN	1.893,09	2,71	1.922,49	-29,40
1.4	Protective forest land	RPH	10.089,56	14,43	10.094,03	-4,47
1.5	Special-use forest land	RDD	955,12	1,37	955,12	0,00
1.6	Production forest land	RSX	32.108,55	45,91	32.161,18	-52,63
	Forests with natural production	RSN	18.764,14	26,83	18.776,18	-12,04
1.7	Aquaculture land	NTS	157,35	0,22	157,74	-0,39
1.8	Salt-making land	LMU	-	-	0,00	0,00
1.9	Miscellaneous agricultural land	NKH	179,12	0,26	1,17	177,95

(Source: People's Committee of Bac Son District.)

According to 2023 statistics, the total land area of the district is 69,941.36 hectares, unchanged from 2022. Compared to 2022, the agricultural land area decreased by 60.20 hectares. While the total land area remains stable, there is a slight decline in agricultural land, particularly in land for other annual crops and production forests.

4.2. Evaluation of land use efficiency for key crops in Bac Son District

4.2.1. Criteria for selecting key crops

* Based on the proportion of goods and market development potential.

Table 5: Consumption methods of key agricultural products and market sales proportions

No.	Product name	Ratio (%)		Ease of Consumption	Buyer type
		For use	*For sale*		
1	Spring Rice	80	20	Easy	Middlemen
2	Summer Rice	40	60	Easy	Middlemen
3	Maize (Corn)	50	50	Easy	Middlemen
4	Sweet potatop	90	10	Easy	Middlemen, Direct Sales
5	Potato	90	10	Average	Middlemen, Direct Sales
6	Vegetables	50	50	Average	Middlemen, Direct Sales
7	Beans	50	50	Average	Middlemen
8	Red peanut	20	80	Easy	Middlemen
9	Golden tangerine	10	90	Easy	Middlemen
10	Tobaco	10	90	Easy	Middlemen, Direct Sales

(Source: Survey data)

Datas in Table 5 shows that most of Bac Son District's main agricultural products are marketable. Notably, some products, such as tobacco and golden tangerine, are entirely purchased by traders directly at the production site. Thus, based on this criterion, the crops that can be considered key agricultural commodities of the district include golden tangerine, red peanuts, and tobacco.

* Based on yield and cultivation area criteria.

Table 6: Cultivated area and production of major crops during the 2019–2023 period

No.	Crop	Area (ha)					Area 2019/2023 (ha)	Yield 2023 (tons)
		2019	*2020*	*2021*	*2022*	*2023*		
1	Spring Rice	810,30	780,00	833,9	800	912,10	1,8	4.797,37
2	Summer Rice	3.722,91	3.500,00	3.596,03	3.500,00	3.675,67	-47,24	16.107,30
3	Maize (Corn)	4.149,25	3.720,39	3.909,36	4.271,42	4.291,36	142,11	19.783,27
4	Sweet potatop	108,42	99,13	92,47	110,00	97,58	-10,84	432,8
5	Potato	12,68	4,46	4,54	3,72	3,72	-8,96	36,56
6	Vegetables	536,73	460,0	563,30	480,00	548,96	12,23	4.969
7	Beans	111,40	129,11	115,12	110,00	106,17	-5,23	140,95
8	Red peanut	1.076,27	1.159,03	1.126,23	1.125,53	1.122,13	45,86	1.222,28
9	Golden tangerine	450,34	510,23	520,43	447,57	490,00	39,66	1.350,00
10	Tobaco	1.140,68	1.073,58	1.215,82	1.328,17	1.516,16	375,48	3.416,63

(Source: Survey data)

From 2019 to 2023, Bac Son District had five crop groups with large cultivation areas and yields: rice, corn, red peanuts, tobacco, and golden tangerine. Among these, the cultivation area and yield of golden tangerine and Bac Son red peanuts are currently OCOP products representing the district's agricultural brand. In 2021, peanut oil was recognized as an outstanding provincial rural industrial product, and in 2022, it received a 3-star OCOP certification at the provincial level. Many tangerine orchards have been cultivated and managed according to good agricultural practices, clean and environmentally friendly standards (VietGAP, GlobalGAP).

Thus, based on these criteria, the crops that can be considered key agricultural commodities of the district include golden tangerine, red peanuts, tobacco, seasonal rice, and corn.

Based on the two criteria above, rice and corn are primarily produced by local farmers for subsistence, with market sales mainly limited to the Bac Son "Nếp cái hoa vàng" rice variety, which has an unstable market. However, these crops are of special interest to Lang Son Province and Bac Son District and are planned to be key crops in the future.

Therefore, the crops selected for study as the district's key crops are tobacco, golden tangerine, and red peanuts.

4.2.2. Economic Efficiency of land use

Table 7: Economic efficiency of key crops in Bac Son District

No	Crop	G0	IC	NVA	CE (Time)	Total score	Classification
		(Million/ha)					
1	Tobacco	145,10	75,65	69,45	0,92	6	M
2	Golden tangerine	428,56	109,90	318,66	2,90	9	H
3	Red peanut	140,54	51,00	89,54	1,76	8	H

(Source: Survey data)

Based on the production value per hectare of major crops, the following observations can be made: Tobacco has relatively low production value and mixed income compared to other crops. Its capital efficiency (0.92 times) is low, indicating that investment costs are nearly equal to the profits earned, classifying tobacco's economic efficiency as moderate. Red peanuts have high capital efficiency (1.76 times), meaning the profit is nearly twice the investment cost. With high mixed income and low intermediate costs, red peanuts are a crop with very high economic efficiency. Golden tangerine have the highest production value and mixed income among all crops. Their capital efficiency reaches 2.90 times, showing that investment in golden tangerine yields profits nearly three times the investment cost, making it a highly profitable crop.

4.2.3. Social efficiency of land use

Table 8. Social efficiency of key crops

No	Crop	Labor Attraction Capacity (person-days)	Daily Wage Value (1,000 VND/person-day	Ability to sustain livelihoods (%)	Product consumption capability	Total score	Classification
1	Tobacco	150	623,73	92	95	11	H
2	Golden tangerine	350	910,46	93	95	12	H
3	Red peanut	150	596,93	90	90	11	H

(Source: Survey data)

Golden tangerine have the highest agricultural value (910 thousand VND) and the highest labor demand. At the same time, they are highly accepted by farmers and have good marketability, indicating significant economic and social potential. Tobacco and red peanuts require a similar labor input of 150 workdays each. Although their agricultural value is lower than that of golden tangerine, they still maintain high levels of acceptance and marketability. These crops demonstrate considerable social efficiency and may be suitable for households that prefer to invest less labor compared to golden tangerine.

4.2.4. Environmental efficiency of land use

Table 9. Environmental efficiency of key crops

No	Crop	Level of fertilizer usage	Level of pesticide usage	Soil Coverage Potential	Total score	Classification
1	Tobacco	2	3	1	6	M
2	Golden tangerine	3	3	3	9	H
3	Red peanut	2	2	2	6	M

(Source: Survey data)

Golden tangerine have the highest environmental efficiency among the crops due to their excellent soil coverage and adherence to recommended fertilizer usage, making them suitable for protecting and improving soil quality. Tobacco and red peanuts both exhibit moderate environmental efficiency. Tobacco has limitations in terms of low soil coverage and non-compliant pesticide use. Red peanuts, on the other hand, have lower pesticide usage and moderate soil coverage.

Table 10. Classification results of the effectiveness of land use types for key crops

No	Crop	Economic efficiency	Social efficiency	Environmental efficiency	Classification
1	Tobacco	M	H	M	M
2	Golden tangerine	H	H	H	H
3	Red peanut	H	H	M	H

(Source: Survey data)

Based on the above analysis, it can be concluded that among the key crops of Bac Son district, Quyt Vang (Golden Tangerine) and Lac Do (Red Peanut) are the two crops that yield the highest overall effectiveness across economic, social, and environmental dimensions. Meanwhile, Tobacco requires measures to improve its environmental efficiency.

4.3. Strategic orientation for the development of key crops

Table 11. SWOT analysis for the development of key crops

SWOT	Tobacco	Golden Tangerine	Red Peanut
Strengths	- Widely accepted by local farmers. - Strong market demand and stable outlets. Short harvesting period allows for quick capital turnover.	- High economic value among key crops. - Excellent soil coverage and environmental benefits, contributing to land conservation. - Popular and well-received by consumers, with strong market demand.	- Low input costs, making it economically viable. - Minimal use of chemical pesticides and fertilizers, reducing environmental impact. - Short growth cycle, allowing for flexible seasonal planning.

Weaknesses	- High reliance on chemical pesticides, negatively impacting the environment. - Poor soil coverage, increasing the risk of soil erosion	- High labor requirements for cultivation. - Heavy use of fertilizers and chemical pesticides leads to high production costs.	- Low economic value compared to other crops. - Moderate soil coverage capacity, offering less environmental protection.
Opportunities	Stable local and regional markets provide consistent demand.	-Strong export potential, especially if quality standards are improved. - Opportunities to develop sustainable cultivation practices in harmony with land conservation goals.	- Well-suited for sandy or light soils, allowing for geographic flexibility in cultivation. - Stable local demand and potential to expand into regions with popular legume-based crop systems.
Threats	- Price volatility can affect profitability. - Pressure to reduce chemical pesticide usage due to increasing focus on green and sustainable production.	- High initial investment costs and market dependency expose farmers to risks during price fluctuations. - Skilled labor shortages may limit production capacity.	- Low economic returns might lead to shifts toward more profitable crops. - Competition with Golden Tangerine, which has stronger market appeal, may limit expansion.

The SWOT analysis will enable Bac Son District to clearly identify the strengths and challenges associated with each crop, thereby formulating development strategies that align with local conditions and market demands. Based on the analysis, the following recommendations are proposed:

For tobacco, the focus should be on reducing the use of chemical pesticides, gradually transitioning to sustainable cultivation practices, and maintaining stable market outlets to ensure farmers' confidence in production.

For Golden Tangerine, efforts should be intensified to develop it into a key economic crop with high economic value. Production should aim to meet high-quality standards for export. Additionally, it is essential to enhance cultivation techniques and provide investment support for the effective use of fertilizers and pesticides to maximize productivity and profitability.

For Red Peanut, cultivation should be encouraged in areas with suitable soil conditions, leveraging its low production costs to ensure stable income for farmers. Technical support should be provided to improve the economic value and enhance product quality, creating potential for value-added or processed products.

5. Conclusion and Discussion

1. Bac Son District, located in Lang Son Province, possesses a relatively favorable geographical position and infrastructure, which facilitates the development and trade of its key crops. Based on two main criteria, the study identified Tobacco, Red Peanut, and Golden Tangerine as the district's three primary crops.

2. Through an evaluation of economic, social, and environmental factors, it is evident that each crop has distinct advantages and limitations, which influence land-use strategies and sustainable agricultural development in the region. Golden Tangerine stands out with the highest economic value, strong local acceptance, and excellent soil coverage capacity, contributing to land conservation and erosion prevention. Tobacco offers the advantage of a stable market demand

and a short growth cycle, enabling quick capital turnover. Red Peanut demonstrates high cost-efficiency, minimal use of chemical pesticides, and suitability for sandy and loose soils, coupled with a short growing period.

3. The research results also emphasize the need to formulate a long-term strategy, focusing on solutions to protect soil resources and enhance product quality. This approach will enable Bac Son District to maximize its land-use potential, meet market demands, and drive local economic development sustainably.

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