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Assessment of the effectiveness of high-tech agricultural development policies on the Co Ho ethnic group in Lac Duong District, Lam Dong Province

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Abstract

High-tech agricultural development has become a key strategy to enhance productivity and sustainability in rural areas, particularly among ethnic minority communities with limited access to modern technologies. This study examined the effectiveness of policies promoting high-tech agriculture among the Co Ho ethnic group in Lac Duong District, Lam Dong Province, Vietnam. A mixed-methods approach was applied, including structured surveys of 364 households, in-depth interviews, and focus group discussions with local stakeholders. Quantitative data were statistically analyzed, while qualitative data provided contextual insights. The findings indicated high awareness and initial adoption of accessible technologies such as improved crop varieties, drip irrigation, and smart fertilizers; however, only a small proportion of households fully understood policy content and procedures. Significant barriers included financial constraints, inadequate infrastructure, and traditional cultural practices. Although market connectivity and labor efficiency improved, productivity and income increased moderately. The study concluded that while current policies facilitated early technology adoption, knowledge gaps, financial limitations, and socio-cultural factors hindered sustained economic benefits. To improve policy effectiveness, integrated interventions addressing financial accessibility, advanced technical training, infrastructure development, and culturally sensitive communication were recommended to support equitable and sustainable agricultural modernization among ethnic minority farmers.

Keywords: Co Ho community, ethnic minorities, high-tech agriculture, policy effectiveness, rural livelihoods, sustainable agricultural development, technology adoption, Vietnam's Central Highlands.

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1. Introduction

Agricultural modernization through the application of high technology has become an essential strategy worldwide to enhance productivity, improve resource efficiency, and ensure sustainable food production amid climate change and population growth. In Vietnam, the government has prioritized the development of high-tech agriculture through a series of national policies and programs designed to modernize the agricultural sector, increase product quality, and enhance competitiveness in domestic and international markets [1, 2]. These initiatives include financial incentives, technical training, infrastructure investment, and market support to accelerate the transition from traditional to high-tech agricultural production models.

The Central Highlands region, especially Lam Dong Province, possesses considerable agricultural potential due to its favorable agro-climatic conditions. However, this region is also home to various ethnic minority groups, including the Co Ho community in Lac Duong District. Unlike the mainstream agricultural sector, these communities predominantly engage in traditional, labor-intensive farming systems that are vulnerable to environmental uncertainties and poorly integrated into commercial value chains. Despite government efforts, the adoption of high-tech agriculture among ethnic minorities remains limited, which raises concerns about the inclusiveness and equity of agricultural development policies.

The problem addressed by this study lies in the apparent gap between policy formulation and the effective adoption of high-tech agriculture among ethnic minority households. Key challenges include limited awareness and understanding of policies, inadequate access to financial and technical support, cultural and social barriers, and infrastructural deficits. These factors collectively hinder ethnic minorities' ability to benefit fully from high-tech agricultural initiatives, risking the exacerbation of existing socio-economic disparities.

Although prior studies have investigated high-tech agricultural adoption in Vietnam, there is a distinct lack of focused research on how high-tech agricultural policies impact ethnic minority groups in mountainous and remote areas. Existing evaluations often emphasize macro-level outcomes or economically advantaged farming communities, insufficiently accounting for the complex socio-cultural, geographic, and economic realities that shape technology uptake among minorities such as the Co Ho. This research gap underscores the need for empirical, context-specific studies that examine policy effectiveness, barriers, and enablers within ethnic minority contexts.

This study aims to evaluate the effectiveness of public policies promoting high-tech agricultural development for the Co Ho community in Lac Duong District and to identify the factors influencing their access to and adoption of high-tech agriculture. Three main research questions guide this study:

- What high-tech agricultural policies and programs have been implemented in Lac Duong District to support the Co Ho community?
- To what extent are these policies known, accessed, and perceived as effective by Co Ho households?
- What socio-economic, cultural, and infrastructural factors facilitate or hinder the Co Ho community's transition to high-tech agricultural production?

A mixed-methods research design was employed to address these questions. Quantitative data were collected through structured surveys administered to a representative sample of Co Ho households to measure awareness, access, and benefits of high-tech agricultural policies. Qualitative data were gathered via in-depth interviews with local government officials, agricultural extension agents, community representatives, and focus group discussions to provide a detailed contextual understanding of the challenges and perceptions surrounding high-tech agrarian adoption. Integrating quantitative and qualitative approaches enables a comprehensive assessment of policy impact and informs tailored recommendations to enhance the inclusivity and sustainability of high-tech agricultural development among ethnic minority populations.

2. Literature Review

2.1. Development of High-Tech Agriculture and Policy Landscape in Vietnam

High-tech agriculture is increasingly recognized as a vital mechanism to enhance agricultural productivity, resource efficiency, and environmental sustainability by integrating advanced technologies such as precision farming, automation, biotechnology, and digital platforms [3, 4]. Globally, high-tech agriculture addresses pressing challenges, including climate change adaptation and sustainable food production [5]. In Vietnam, the government has actively promoted high-tech agriculture through strategic policies, notably the Government of Vietnam [1] and the Government of Vietnam [2], which offer financial incentives, technical training, infrastructure development, and market facilitation to modernize agriculture and improve competitiveness [6-8].

Despite these comprehensive efforts, high-tech agricultural adoption and impact remain uneven across regions and social groups. The Central Highlands, particularly Lam Dong Province's favorable agro-climatic conditions, are a focal point for agricultural development. However, ethnic minority communities such as the Co Ho often remain on the margins of modernization due to socio-economic and cultural factors [7, 8]. This divergence highlights a critical policy challenge: ensuring that the benefits of high-tech agriculture are equitably distributed and effectively reach marginalized populations.

A significant research gap exists regarding how high-tech agricultural policies have been accessible and practical for ethnic minority groups in remote, mountainous areas. Existing evaluations tend to focus on regional or national averages or more economically advantaged regions, insufficiently addressing the unique constraints faced by ethnic minorities. This gap limits the capacity to design targeted policies that address their needs and barriers.

2.2. Barriers and Enablers Affecting High-tech Agricultural Adoption among Ethnic Minorities

The adoption of high-tech agricultural technologies by ethnic minority farmers was influenced by a complex interplay of financial, infrastructural, socio-cultural, and institutional factors. Financial constraints, including limited access to credit, high initial capital requirements, and small landholdings, posed substantial barriers to technology adoption [8, 9]. Additionally, infrastructural deficits such as inadequate transport, poor digital connectivity, and limited extension services restricted farmers' access to markets, information, and technical support [10, 11].

Cultural and educational dimensions were equally critical. Low formal education and technical literacy among ethnic minority farmers limited their ability to effectively comprehend and apply advanced technologies [8, 12]. Furthermore, strong adherence to traditional farming practices often resulted in hesitance or resistance toward adopting high-tech agriculture [13, 14]. Integrating indigenous knowledge systems with modern agricultural technologies was proposed as a promising approach to increase acceptability and sustainability [15], but practical models and evidence remained limited.

Institutional support mechanisms enabled high-tech agricultural adoption, including policy design, effective training programs, financial subsidies, and market facilitation [16, 17]. Social capital and local governance structures also influenced farmers' access to resources and knowledge networks [18]. However, key research gaps persisted. There was a lack of comprehensive studies analyzing how these multiple factors interacted within ethnic minority contexts to influence technology uptake. Longitudinal data on the sustainability and socio-economic impacts of high-tech agricultural adoption among ethnic minorities were scarce. Furthermore, research on culturally adapted, participatory policy and extension models remained limited. The role of digital inclusion in bridging technology access and adoption gaps in these communities also required further investigation.

This synthesis of existing research revealed significant opportunities for future studies to generate context-sensitive evidence that could inform equitable and effective high-tech agricultural policies and interventions tailored to ethnic minority farmers. Addressing these gaps is essential for achieving inclusive agricultural modernization and sustainable rural development in Vietnam's diverse socio-cultural landscapes.

3. Materials and Methods

This study collected primary data through semi-structured interviews with households of the Co Ho ethnic community in Lac Duong District, Lam Dong Province. The interviews aimed to gather detailed information on respondents' awareness, access, and perceptions of high-tech agricultural policies, as well as the socio-economic and cultural factors influencing technology adoption.

3.1. Study Area and Population

Lac Duong District was selected as the study site due to its significant Co Ho population and ongoing initiatives to implement high-tech agricultural models. The Co Ho ethnic group, with distinct cultural and agricultural practices, provides a relevant context to evaluate the socio-technical dynamics of policy interventions.

3.2. Data Collection

Quantitative Data: A structured questionnaire survey was administered to a representative sample of 364 Co Ho households. The sample size was determined based on the total Co Ho population in the district and standard sampling formulas to ensure statistical reliability [19]. The questionnaire covered demographic characteristics, awareness and understanding of policies, technology adoption, access to support services, and perceived policy impacts. Data collection was conducted from January to March 2025.

Qualitative Data: To complement and deepen quantitative insights, semi-structured in-depth interviews, including Co Ho household representatives, local government officials, and agricultural extension agents. Additionally, two focus group discussions (FGDs) were held with community members to explore social, cultural, and behavioral factors influencing technology adoption and policy perceptions [20, 21]. Interview and FGD guides were developed based on the conceptual framework of technology adoption in ethnic minority contexts. All sessions were audio-recorded with consent and transcribed verbatim for thematic analysis.

3.3. Data Analysis

The quantitative data obtained from the interviews were analyzed using SPSS v21. SPSS is a widely used software tool for statistical analysis, which allows efficient data management, descriptive statistics, correlation, and inferential testing. It enabled the identification of significant relationships and patterns within complex social data.

Unlike previous studies that primarily relied on descriptive or qualitative analyses, this study employed advanced statistical methods using SPSS to provide a more rigorous and objective evaluation of factors affecting policy access and high-tech agriculture adoption among the Co Ho community. This approach facilitated hypothesis testing and multivariate analyses, which controlled for confounding variables and yielded deeper insights into the relative importance of different determinants. Furthermore, integrating qualitative interview data with quantitative SPSS analysis enhanced the validity and comprehensiveness of the findings.

Model fit, and multicollinearity diagnostics were conducted to ensure the robustness of results. Significance was assessed at the 5% level.

4. Results

4.1. Awareness, Understanding, and Access to High-Tech Agricultural Policies among the Co Ho Community

Over historical periods, the local government of Lam Dong Province has implemented policies tailored to the evolving regional context, aiming to improve both the material and spiritual well-being of residents, including the Co Ho community. In 2004, Lam Dong introduced a high-tech agricultural development policy for the 2004–2010 period, explicitly targeting the application of high-tech processes in vegetable, flower, ornamental plant, and strawberry production, as well as high-tech seed production for tea and the development of high-quality beef and dairy cattle breeds [22].

By 2011, the provincial government advanced a policy to promote high-tech agriculture 2011–2015 with an orientation toward 2030, outlining specific objectives across sectors such as crop production and livestock, particularly dairy and beef cattle. In 2016, Lam Dong continued with a comprehensive, sustainable, and modern agricultural development policy for 2016–2020 with a vision to 2025, aiming to maintain agrarian growth rates, stabilize cultivation areas, attract enterprise investment in agriculture, further develop cold-water fish farming, and build new rural areas [23].

In alignment with provincial policies, the Lac Duong District government, in 2005, adopted a policy promoting economic restructuring toward tourism services and high-tech agriculture. This policy linked economic growth with social progress and equity, gradually reducing living standard disparities across social strata and ethnic communities. Subsequently, in 2014, Lac Duong issued plans for ethnic affairs and human resource development for ethnic minorities in the district for the 2016–2020 period.

Overall, the Vietnamese government's implementation of national target programs, alongside Lam Dong's socio-economic development plans, has led the Lac Duong local authorities to invest in infrastructure such as irrigation systems and rural roads. These efforts have improved poor communes and ethnic minority areas, contributing to gradual rural transformation.

Since 2004, numerous Co Ho households have transitioned to high-tech agricultural models cultivating vegetables, flowers, mushrooms, tomatoes, bell peppers, Palermo chili, and artichokes, among others. This shift has fundamentally transformed the Co Ho economic activities in Lac Duong, accelerating the transition from subsistence, self-sufficient food production to commercial agriculture serving export markets. This transformation has driven significant changes in cropping cycles, cultivation techniques, the production-consumption relationship, and other livelihood activities. Traditional economic forms such as swidden cultivation, natural resource extraction, and handicrafts have gradually diminished in scale and importance. These economic changes have positively impacted many aspects of local life, including a sharp reduction in poverty rates, improved material and spiritual living standards, and visible rural development.

Survey results indicate that 93.1% of Co Ho households are aware of government programs and policies related to high-tech agriculture, while only 6.9% reported no awareness or vague knowledge of their content. However, awareness levels vary across policy types: 68.7% know about credit support policies, 60.4% are aware of technical training programs, whereas only 49.5% and 44.0% are familiar with infrastructure support and investment incentive policies, respectively (Figure 1).

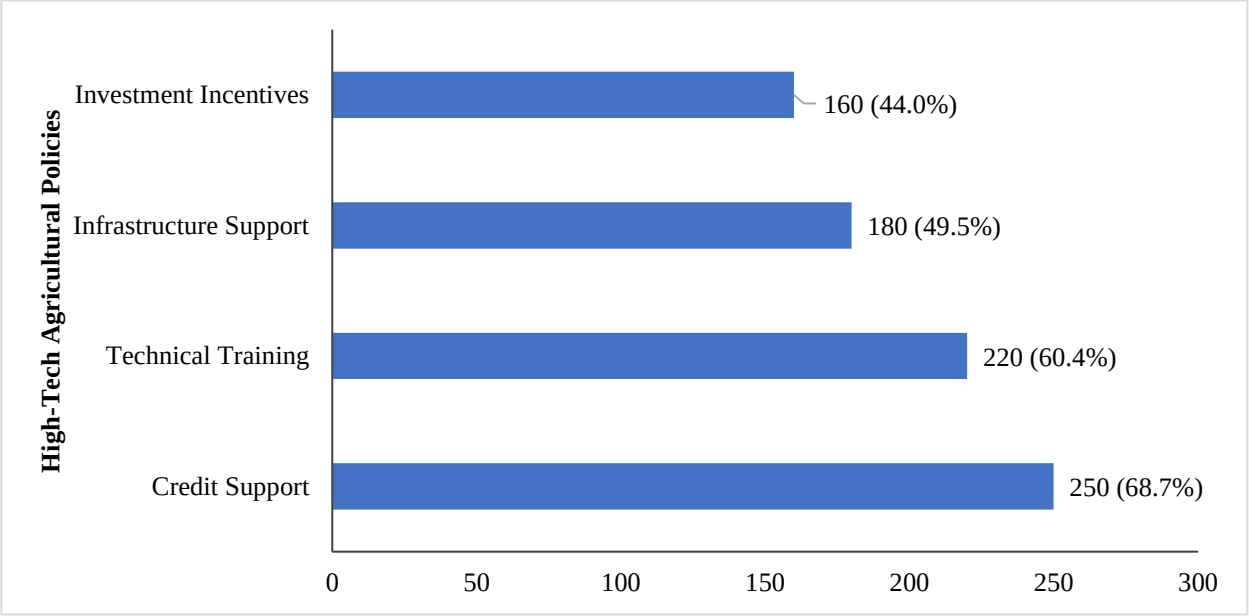

Figure 1.
Awareness Levels of High-Tech Agricultural Policies among the Co Ho Community in Lac Duong District, Lam Dong Province.

Regarding the level of understanding of policy content and access procedures, data from Figure 2 indicated that only 24.7% of households reported fully understanding the content, conditions, and benefits of high-tech policies. Most households (46.7%) had only partial understanding, mainly through informal word-of-mouth or limited information. Notably, 28.6% of households did not possess any specific knowledge about support programs, highlighting a significant gap between being "aware of" and "fully understanding" the policies.

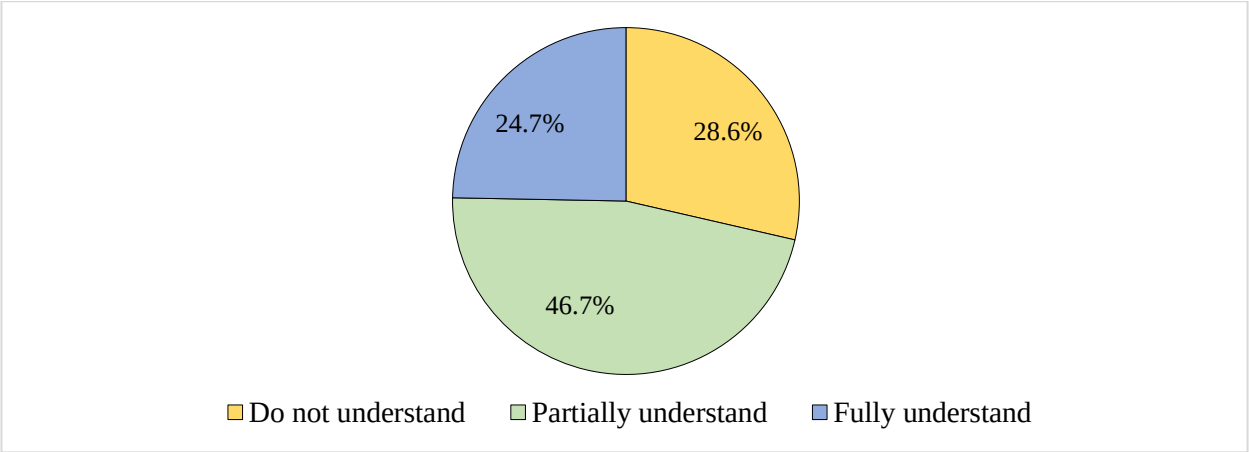

Figure 2.
Level of understanding of high-tech agricultural policies among the Co Ho community in Lac Duong District, Lam Dong Province.

Regarding the level of access to and actual benefits from policies among Co Ho households, data in Figure 3 showed a clear differentiation in participation across policy types. Programs related to technical training and equipment provision recorded very high participation rates, with 92.1% of households attending high-tech technical training courses and 90.2% receiving support for equipment and technological products. Production planning training activities also attracted 85.2% of households, indicating a strong demand for enhancing production capacity among Co Ho households.

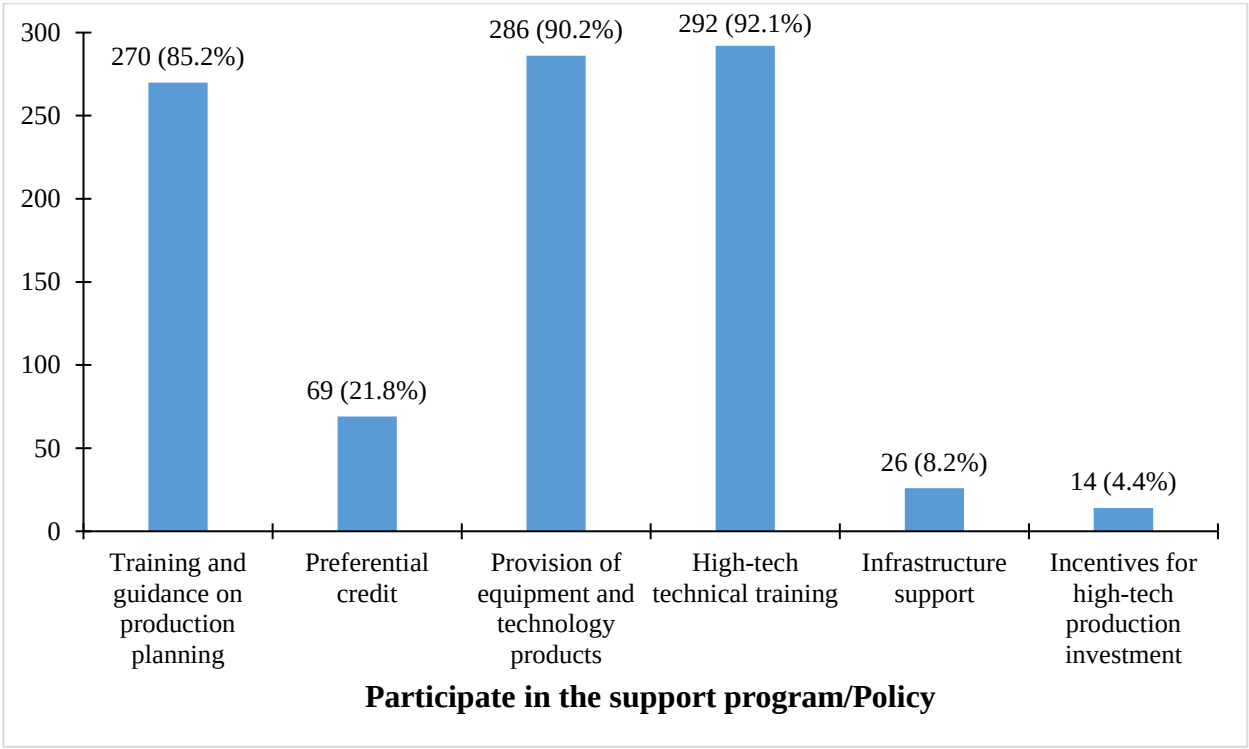

Figure 3.
Access to and benefits from policies among Co Ho households.

In contrast, financial and infrastructure support programs recorded very low access rates. Only 21.8% of households accessed preferential credit, 8.2% benefited from infrastructure support policies, and 4.4% participated in high-tech production investment incentive programs. This reflected the reality that policies requiring substantial counterpart resources or complex procedures had not effectively reached small-scale producers and ethnic minority households, groups particularly vulnerable during the production model transition. This disparity indicated that although technical training and equipment support policies successfully disseminated knowledge and high-tech production technologies, critical long-term success factors such as access to capital, infrastructure investment, and market linkage development remained bottlenecks. This underscored the urgent need to redesign support programs to reduce financial access barriers, simplify procedural requirements, and enhance infrastructure investment, thereby promoting a comprehensive and sustainable transition to high-tech agriculture in the region.

Survey results showed relatively high satisfaction levels among Co Ho households regarding the perceived effectiveness of high-tech agricultural support policies received by households. As many as 79.0% of respondents reported being satisfied, and 3.1% were delighted with the support received. The combined positive satisfaction rate (satisfied and very satisfied)

reached 82.1%, reflecting strong acceptance of current policies and intervention programs. Conversely, the rates of very dissatisfied and dissatisfied households were very low, at only 0.6% each, indicating negligible opposition to the policies within the surveyed community. However, approximately 16.6% rated their satisfaction as moderate, suggesting a significant portion of the population has yet to perceive clear changes or real benefits from the support programs.

In summary, the data showed that although some Co Ho households were aware of and proactively accessed high-tech agricultural policies, the deep understanding and actual benefit rates remained low. This highlighted the need to strengthen policy communication, simplify access procedures, and provide support tailored to the practical capacities of ethnic minority households.

4.2. Impact of High-Tech Agricultural Policies on Production Model Transition among Co Ho Households and Factors Influencing the Decision to Adopt High-Tech Production Models

Survey results showed that the application of high-tech agriculture has become widespread among Co Ho households in Lac Duong. Among the 364 surveyed households, 337 (93.1%) confirmed that they had adopted at least one form of high-tech technology in their production processes, while only 6.9% had not applied any technology. This reflects a strong diffusion of high-tech solutions in local agricultural production practices.

By technology type (Figure 4), new crop varieties were the most common, with 97.0% of households adopting them, indicating that improved crop varieties were easily accessible and suited to local cultivation conditions. Drip irrigation technology (87.2%) and innovative fertilizer technology (86.3%) also recorded high adoption rates, reflecting farmers' practical needs to conserve resources and enhance input efficiency. More advanced technologies, such as automated pest management systems (80.3%) and sensor-control devices (73.1%), were gradually adopted, though their application rates remained lower than basic technologies. This suggested that although the level of high-tech application had made considerable progress, further consolidation was needed, especially for technologies requiring higher operational skills. Other technologies outside the common categories accounted for only 0.9%, indicating limited access or low demand for specialized technologies.

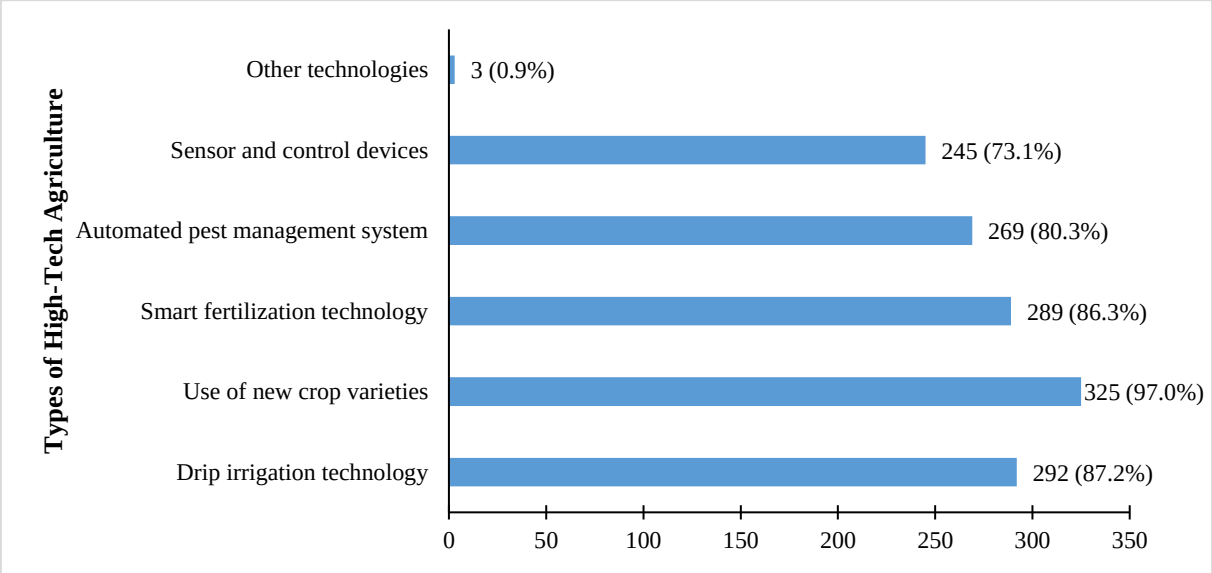

Figure 4.
Types of high-tech agriculture adopted by Co Ho households.

Survey data from Figure 5 showed that high-tech agricultural support policies produced positive but uneven results for Co Ho households. The most notable outcomes involved improved market connectivity and reduced labor burdens. Specifically, 65.3% of households reported that applying high-tech solutions helped them better connect with agricultural product markets, indicating that policies had partially enhanced farmers' commercialization capacity. Additionally, 59.9% of households acknowledged reduced labor efforts due to adopting automation and mechanization technologies. This was particularly significant given the decline of rural labor caused by urbanization and labor migration. A considerable proportion of households (56.1%) also reported reduced production risks, reflecting high-tech agriculture's role in stabilizing production through better control of cultivation conditions and pest management. However, results directly related to productivity and income fell short of expectations. Only 49.9% of households noted increased productivity, and 44.8% reported improved income. This indicated that although high-tech technologies improved production techniques and market access, their translation into actual economic value remained highly dependent on market prices, investment costs, and production management skills. Notably, only 23.1% of households reported reduced input production costs, suggesting that initial investment costs in high-tech agriculture continued to burden many farmers. The proportion selecting "other reasons" accounted for just 1.2%, confirming that the primary factors were well captured within the survey options.

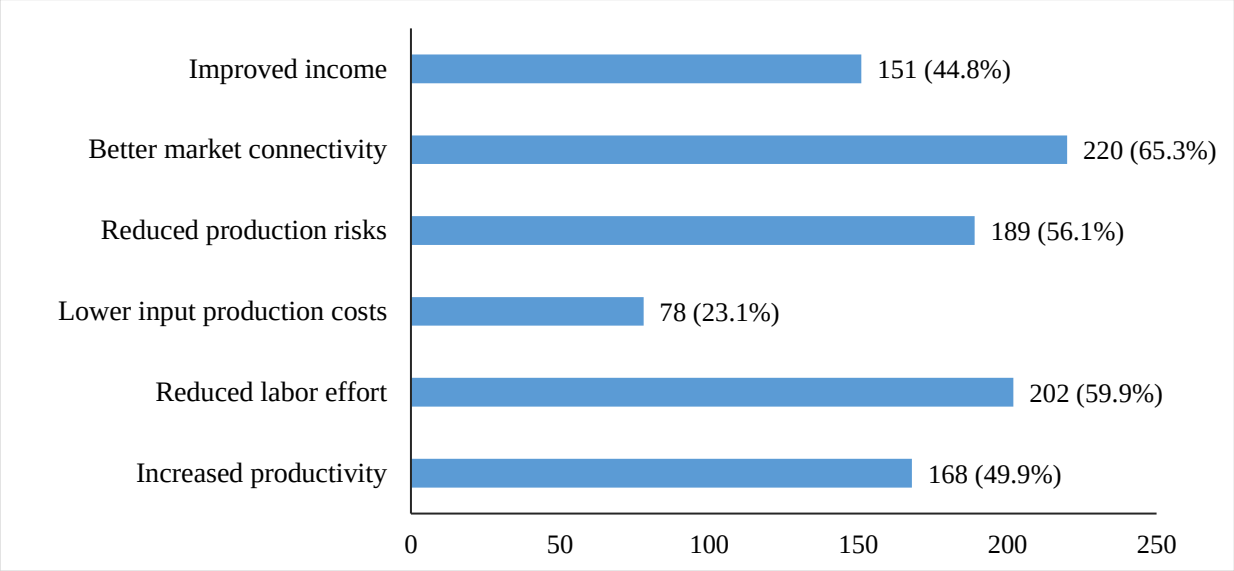

Figure 5.
Effectiveness of high-tech development support policies for Co Ho Households in Lac Duong District, Lam Dong Province.

In interviews conducted by the research team on February 20, 2025, Mr. Păng Ting Sin (Co Ho ethnicity), born in 1965 in Lat Commune, Lac Duong District, stated: "*Thanks to government support and guidance, my family boldly invested in high-tech crop production. Farming is much easier now; product quality and market access are no longer difficult issues. The only challenges that remain are the high initial investment costs and the limited technical skills of the people*."

Additionally, on March 28, 2025, the research team interviewed Ms. Cil K Ji (Co Ho ethnicity), born in 1980 in Da Chais Commune, Lac Duong District: "*Thanks to support policies from the government and local authorities, my family was able to access greenhouse vegetable cultivation. Previously, the whole family manually prepared the soil and watered the vegetables by hand, which was labor-intensive. With drip irrigation and machinery, we only need to turn on a switch to water the entire garden. Our working hours have been reduced to about 3–4 hours per day instead of the whole day, allowing more time to care for children and weave traditional textiles to sell. Previously, we only cultivated outdoors with low yields; heavy rain or hail would destroy the crops. Production has become more stable since receiving technical training and partial funding support for greenhouse construction, and income has increased*."

Survey results from Table 1 showed that multiple factors simultaneously influenced Co Ho households' decisions to transition to high-tech agricultural production models. Among these, technical training and support, market conditions, and financial factors played prominent roles.

Table 1.
Major Factors influencing the decision of Co Ho households to transition to high-tech agricultural production models.

Influencing Factors	Frequency	Percentage (%)
Investment costs in high-tech agriculture	263	78.1
Expected profits from high-tech adoption	261	77.5
Stability and pricing of product markets	286	84.9
Access to financial resources and credit	133	39.1
Availability of technology locally	285	84.6
Adequate technical training and support	299	87.9
Capacity to maintain and repair high-tech equipment	278	82.5
Compatibility of high-tech agriculture with current production methods	137	40.8
Convenience in accessing preferential loans for high-tech agriculture	140	41.5

Firstly, training and technical assistance were identified as the most influential factors, with 87.9% of households rating them as decisive. This aligned with earlier analyses highlighting the role of high-tech training programs, demonstrating that knowledge and practical skills directly affected the capacity to adopt and implement high-tech models effectively. Market stability and local technology availability also recorded high influence rates, at 84.9% and 84.6%, respectively. Stable product outlets and access to technological equipment were prerequisites enabling households to minimize risks while investing in and operating high-tech technologies. Additionally, 82.5% of households considered equipment maintenance and repair capabilities necessary, reflecting the practical concern of sustaining device functionality under local conditions.

Economically, investment costs and expected profits from technology adoption strongly affected transition decisions at 78.1% and 77.5%, respectively. This indicates that farmers' adoption of high-tech agriculture is primarily based on cost-benefit considerations, heavily influenced by initial financial feasibility.

Other financial factors, such as access to credit (39.1%) and ease of obtaining preferential loans (41.5%), showed moderate influence. Meanwhile, technology compatibility with current farming practices was valued by only 40.8% of households, suggesting that traditional production habits, while relevant, were not significant barriers to transition decisions.

These results demonstrated that Co Ho households' decisions to adopt high-tech agriculture were concurrently influenced by three main groups of factors: (i) training and technical support, (ii) market stability and equipment availability, and (iii) investment costs and profit expectations. However, financial barriers persisted, highlighting the need to design more appropriate financial support programs while continuing to enhance technical capacity and improve local technological infrastructure to promote a comprehensive and sustainable high-tech agricultural transition.

5. Discussion

5.1. Discussion

The findings reveal that although 93.1% of Co Ho households were aware of high-tech agricultural support policies, only 24.7% fully understood the content and procedures for accessing these policies. This gap between awareness and comprehension reflects common challenges in marginalized ethnic communities where education levels and information accessibility are limited [7]. Ineffective communication and a lack of detailed guidance have prevented many households from fully benefiting from available policies, resulting in suboptimal policy outcomes. This aligns with Bui and Truong's [16] findings, emphasizing that information and knowledge barriers significantly hinder the adoption of high-tech agriculture in Vietnam.

The relatively high adoption rates of widely accessible technologies such as improved crop varieties, drip irrigation, and smart fertilizers demonstrate alignment between technology features and local agronomic conditions and needs [7]. However, adopting more complex technologies like automated pest management and sensor devices remains limited, highlighting persistent technical capacity and infrastructure constraints. These findings correspond with Nguyen [24], who noted variations in technology adoption based on farm size, education level, and support through training programs.

Nevertheless, recent studies showed that technical capacity and infrastructure were not always the primary barriers to technology adoption in rural and minority farming communities. Hu et al. [13] found that cultural and psychological barriers often played a more decisive role in rural China than infrastructural limitations. They reported that formal agricultural extension services are disconnected from farmers' practical needs due to social and administrative factors, limiting the effectiveness of technology adoption. Similarly, Tahmasebi [25] emphasized that although infrastructure and economic challenges existed, educational gaps and the digital divide critically constrained technology utilization, demonstrating that infrastructure improvements alone were insufficient without concurrent community engagement and education. In parallel, Guynn et al. [26] studied minority farmers in South Carolina and revealed that despite improved technical infrastructure, distrust in institutional programs and unclear communication hindered the adoption of climate-smart agricultural practices. Their work highlighted the importance of trust-building, program transparency, and sustained support in promoting technology uptake among underserved populations. The OECD [27] also reported that expanding rural broadband and infrastructure in the United States was necessary but not sufficient to foster innovation; policies needed to integrate social, economic, and cultural factors tailored to local community contexts to maximize impact. These findings collectively reinforce the need for culturally sensitive communication, comprehensive training, and community-based approaches alongside technical support to overcome adoption barriers in ethnic minority and marginalized farming communities like the Co Ho.

Positive policy impacts were evident in enhanced market connectivity and reduced labor demands, consistent with reports on the economic benefits of high-tech agricultural adoption [28]. Nevertheless, limited improvements in productivity and income suggest that technology alone is insufficient; broader economic factors such as market prices, input costs, and farm management skills play critical roles. This concern echoes [16] observations regarding the gap between technological adoption and economic gains.

Furthermore, cultural factors and traditional farming practices remain substantial barriers to transitioning to high-tech production among the Co Ho. Risk aversion and strong ties to customary farming methods create cautious attitudes, slowing technology acceptance. This is reinforced by Tu and Hai [7] and Bui and Truong [16], who highlight the importance of culturally sensitive communication and training programs tailored to local contexts to facilitate behavioral and perceptual changes.

In summary, while high-tech agricultural policies have facilitated initial technology adoption among the Co Ho, enhancing policy effectiveness and sustainability requires coordinated efforts in communication, advanced training, flexible financial support, and appropriate infrastructure development. Addressing knowledge, technical, and cultural barriers will be key to successful technological transformation within ethnic minority communities and contribute to sustainable socio-economic development in the Central Highlands.

5.2. Policy Implications

Overall, enhancing the effectiveness of high-tech development policies for the Co Ho community requires comprehensive adjustments in both policy design (focusing on capital support and market access) and advanced training and implementation methods (emphasizing long-term accompaniment and reducing access barriers). Only through these measures can high-tech agriculture become a genuine driver of sustainable livelihoods for ethnic minorities in the Central Highlands.
Specific policy directions include:

- Enhancing appropriate financial support: Designing flexible preferential credit packages with extended loan terms and low interest rates to assist initial investment costs for small-scale producers and ethnic minority communities with limited financial resources.
- Developing sustainable market linkages: Building and strengthening high-tech agricultural value chains, establishing close connections among farmers, enterprises, and distribution systems to ensure stable market outlets and increase product value.

- Promoting intensive technical training: Shifting focus from short-term workshops to long-term technical support programs, including training on equipment operation, maintenance, and household economic management, enabling farmers to improve skills in effectively utilizing and maintaining high-tech systems.
- Improving rural technological and logistics infrastructure: Investing in upgrading irrigation systems, rural transportation, storage facilities, and on-site equipment repair services to establish a solid infrastructure foundation for high-tech applications and expansion.
- Designing culturally appropriate programs: Developing communication and training programs based on an understanding of traditional production practices, supporting gradual shifts in local awareness and production behaviors to minimize cultural resistance.

The synchronized adjustment of these solution groups will promote a more effective and sustainable adoption of high-tech agriculture, positively contributing to the socio-economic development goals for ethnic minority communities in the Central Highlands.

Although this study provided a comprehensive overview of the access and effectiveness of high-tech agricultural support policies for Co Ho households, several limitations should be noted:

- First, the study mainly relied on quantitative survey data, while the in-depth exploration of qualitative factors such as individual motivation, risk perception, and the influence of social networks on technology adoption decisions was limited. The number of supplementary in-depth interviews was small, thus not fully reflecting the diversity of perspectives and practical experiences among households.
- Second, the research scope was confined to Lac Duong District and the Co Ho community, limiting generalizability to other ethnic minority groups in the Central Highlands. Socio-economic characteristics, cultural practices, and production levels of other ethnic groups may differ significantly, leading to different results and policy implications.
- Third, the study focused on measuring the short-term impacts of policy access. Long-term effects on sustainable production capacity, household income, and changes in agricultural production organization were not thoroughly analyzed due to time constraints and lack of longitudinal data.

Based on these limitations, future research directions should expand in several aspects: (1) Deepen qualitative research methods such as in-depth interviews and focus group discussions to explore psychosocial factors affecting households' technology adoption behavior; (2) Broaden comparative studies among different ethnic minority groups and across areas with diverse socio-economic conditions to assess the homogeneity or variability of barriers and drivers of high-tech adoption; (3) Conduct longitudinal studies to monitor changes in productivity, income, and household livelihoods over time, enabling evaluation of the long-term impacts and sustainability of high-tech agricultural support policies.

Addressing these limitations and expanding research directions will enhance the scientific evidence base, better supporting the formulation and adjustment of high-tech agricultural development policies that are suited to the real conditions of ethnic minority communities in Vietnam.

6. Conclusion

Implications: This study demonstrated that high-tech agricultural support policies positively influenced production techniques and market access among Co Ho households in Lac Duong District. However, technological advances did not fully translate into sustained productivity and income growth due to limited policy understanding, restricted financial access, and infrastructural constraints. Traditional cultural practices and risk aversion further complicate the adoption of technology. To enhance policy effectiveness, integrated approaches addressing economic, social, and cultural factors alongside technical support are essential. Emphasis on capital support, market development, advanced training, and culturally sensitive communication is necessary to facilitate sustainable agricultural modernization for ethnic minorities.

Limitations: The research primarily relied on quantitative survey data with limited qualitative interviews, which restricted an in-depth understanding of psychosocial and motivational factors influencing adoption. The study was geographically confined to the Co Ho community in Lac Duong District, limiting the generalizability of findings to other ethnic minority groups and regions. Moreover, the analysis focused on short-term policy impacts without longitudinal data to assess sustainability and long-term socio-economic outcomes.

Future Research Suggestions: Future studies should expand qualitative research to explore deeper psychosocial dynamics and social network influences on technology adoption. Comparative analyses across diverse ethnic minorities and geographic areas would clarify the variability of barriers and facilitators. Longitudinal research would be necessary to evaluate the lasting impacts of high-tech agricultural policies on productivity, income, and livelihood sustainability, thereby informing more effective, context-specific policy design.

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