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The Determinants of Technical Efficiency of Hazelnut Production in Azerbaijan: An Analysis of the Role of NGOs

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Abstract: The role of non-government organizations (NGOs) has been commendable in promoting sustainable farming. Through mobilization of existing resources and provision of training to farmers on various agriculture subjects, NGOs could trigger increased productivity and agricultural sustainability. However, empirical evidence on this claim is limited and no study recognizes the supporting conditions required for NGO intervention to improve productivity. Cross-sectional data from hazelnut farmers in Azerbaijan are used to evaluate the role of NGO intervention in improving farmers' technical efficiency. To this end, stochastic frontier analysis (SFA) is applied to study hazelnut farmers' production efficiency. Three different measures are employed to estimate NGO intervention: Training, subsidy and, a combination of training and subsidy. The results indicate that NGO intervention is not significant in influencing technical efficiency. This is attributable to the absence of good organization, innovation orientation, accountability and stakeholder involvement and support which are the necessary supporting conditions facilitating an enabling environment for NGO intervention to improve farmers' technical efficiency. Therefore, we recommend policy directed at addressing these issues in order to simultaneously enhance farmers' productivity and improve the functioning of the NGOs. Beyond NGO intervention, encouraging farmers to specialize in hazelnut production and allocating more suitable land for hazelnut production will also improve farmers' technical efficiency significantly.

Keywords: technical efficiency; hazelnut production; stochastic frontier analysis; NGO intervention; Azerbaijan

1. Introduction

Agriculture plays a vital role for humanity considering that human welfare heavily depends on the stability and amount of agricultural production [1,2]. For the most part, the sector plays an essential role in the development process by supplying industrial inputs, food items, generating foreign exchange, contributing to gross domestic product (GDP), creating employment opportunities and expanding markets for industrial outputs. Particularly for developing countries, agriculture is the major source of income contributing approximately 32% in GDP [3] and employs about 70% of the world's rural poor societies. With such statistics, agriculture is globally held as a critical strategy for world economic growth, poverty reduction and environmental sustainability [4].

Consistent with the aforementioned, agriculture is also among the most important activity in Azerbaijan, as the majority of the population is engaged and associated with agriculture [5,6]. Of interest to this study is the cultivation of hazelnut which has attracted many non-governmental organizations (NGOs) and this could be attributed to the fact that the country is the world's third-largest hazelnut producer [7] (Figure 1), corroborating the fact that hazelnut production is a good source of revenue for the country [8,9]. For instance, in 2017 approximately 50,000 tons and $150 million of hazelnuts were produced and exported respectively [10,11]. With about 200 hazelnut trees in one hectare of orchard, a revenue of 6000–7000 Manats [$3000 to $3800] is derived. Following the increased exports (about 90% of production) [12], the Azerbaijan Hazelnut Exporters Consortium provides information, advisory support and assists with legal and tax legislation to its farmer members. In addition, the consortium offers educational training and workshop in a quest to increase the efficiency and quality of their products [13].

Currently, NGOs such as Ganja Agribusiness Association (GABA) are in operation with the goal to improve the productivity of the agricultural products and sustainability of hazelnut production. Their activities with farmers involve human potential development and knowledge, and resource transfer through training on various subjects related to agriculture [14]. Besides, NGOs also provide agricultural inputs and various grants [6,15]. It is anticipated that such interventions would lead to increased productivity and agricultural sustainability as farmers are equipped with knowledge on current production technologies and empowered with subsidized production inputs. The hypothesis is that farmers will no longer make their farming decisions blindly and this will facilitate the efficient allocation of resources. Eventually, this has implications for sustainability considering that the term sustainability indicates initiatives, programs and actions targeted at the preservation of a particular resource, which is hazelnut in this case. Thus, as NGOs perform the highlighted critical roles, this could foster human, social, economic and environmental sustainability [16–19]. However, some farmers still face restrictions relating to information asymmetry, trust issues regarding which organizations are authentic and the process on how to obtain subsidies from NGOs [20].

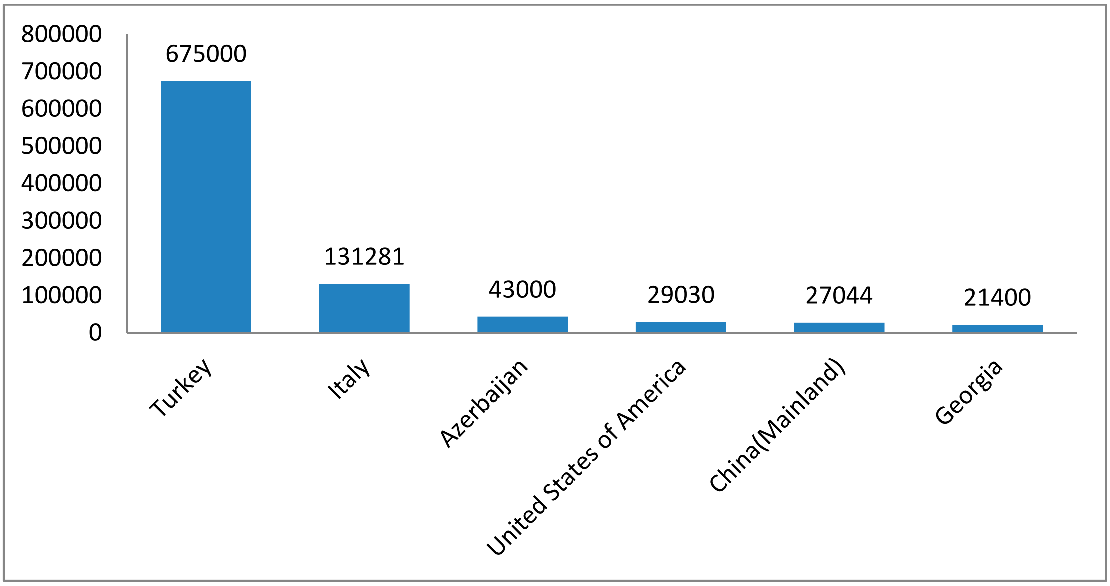

Figure 1. Top six hazelnut producers (with shell) in the world (tonnes). Source: FAOSTAT [21].

Agricultural efficiency evaluation is pivotal, especially when considering the supportive role other agricultural stakeholders play in the evolvement and advancement of the agricultural sector [22]. By definition, technical efficiency is the ratio of the actual output to maximum output obtainable under the available production technology [23]. Since hazelnut production demands inputs such as labor, organic fertilizer, seeds and working capital, any assistance from NGO in this line is likely to have productivity implication. Also, mindful of the postulation by Latruffe, et al. [24] that production is a function of inputs as well as efficiency, it is vital to comprehend how support from NGOs influence farmers' efficiency, especially when farmers encounter several barriers in production that may actually diminish the positive impact of an NGO intervention. In support, Balew, et al. [25] contends that certain prevailing conditions need to be satisfied to attain positive results from external aid meant to boost productivity. However, up until now, the technical efficiency of hazelnut farmers has hardly been assessed with the focus of NGO intervention [26–29].

Therefore, the motive for initiating this study is that, while previous studies have found that NGOs play an important role in the improvement of productivity, no study recognizes the supporting conditions required for the attainment of improved technical efficiency and the implication for sustainability. This has prompted policymakers and development partners to search for possible underlying mechanisms and empirical evidence regarding the creation of an enabling environment for positive results. The fact is such information is limited and this has thwarted the development and formulation of policy aimed at boosting the country's hazelnut production capacity.

Hazelnut is one of the popular and favored nuts across the world but its productivity is somehow inadequate owing to failure to address determinants of technical efficiency [14]. Even with active NGO intervention in Azerbaijan, the productivity has been contrary to the reports elsewhere. Intuitively, this could be an indication of a violation of the essential requirements necessary for improved productivity. As Harsh, et al. [30] points out, poor organization or lack of trust from farmers would frustrate any developmental scheme in agriculture. The current situation questions the role of NGOs and also demands an establishment as to whether the existing environment guarantees increased productivity on account of NGO intervention.

Azerbaijan has the potential to be the world-leading hazelnut producer [8,12,15]. Its hazelnuts are considered to be of the highest quality (high in oil content) attributable to organic production (without the use of pesticides and other chemicals) and optimal weather conditions, particularly in the Shaka-Zaqalata region [10]. As a hazelnut producer, Azerbaijan generates a substantial income for the farmers. However, with the experienced decline in production, the situation may lead to unpleasant trade and ultimately, poor farmers' welfare. Although hazelnut production remains an essential contributor to Azerbaijan's economy, its performance has been unsatisfactory and unable to sustain the growing demand stirred by the population growth [7]. At the same time, the role of NGOs has been commendable in promoting sustainable farming but empirical evidence is limited and incomplete. While NGOs help farmers with inputs and information, it is still unclear whether this translates to the adoption of useful agricultural technology or efficient resource use [6]. This poses a real cost to society in terms of untapped potential to production output and economic growth.

While a few researchers have conceptually scrutinized how NGO intervention could impact welfare dimensions such as productivity, empirical evidence on technical efficiency is not cogent to warrant focused policy action. For instance, in a recent article by Candemir, Özcan, Güneş and Deliktaş [14], technical efficiency estimations are conducted without addressing endogeneity and other biases stemming from unobserved variables. This according to Bravo-Ureta, et al. [31] does not give robust estimates, as estimates could be exaggerated as found by Mwalupaso, et al. [32]. In another study, Guney [9] presents a discourse on hazelnut production without indicating the productivity levels. Based on the disclosure by Fideghelli and De Salvador [7], the demand for hazelnut has increased due to the burgeoning population and thus authors advocate for more research on productivity rather than production alone. To begin to fill this gap, the primary aim of the present study is to investigate whether NGO intervention improves the farmers' technical efficiency in hazelnut production. Specifically, it is to estimate the determinants of technical efficiency with a focus on the impact of NGO intervention and to establish the supporting conditions necessary for NGO intervention to have a positive and significant impact on the Shaki-Zagatala area of Azerbaijan. Understanding the levels of efficiency can assist in addressing productivity gains if there are significant opportunities to improve management practices as well as socio-economic characteristics. Also, given the situation that developing nations have scarce resources to command new investments in modern practices, improving the technical efficiency of the farmers is indispensable. Most importantly, undertaking empirical studies on farm level technical efficiency is essential in offering valuable information to policymakers that might be useful in enhancing hazelnut productivity.

Consequently, our study contributes to the literature in three aspects. First, we use an empirical strategy that accounts for biases by using the Hausman test in the stochastic frontier analysis (SFA) and the principal component analysis (PCA). Second, we attempt to link NGO intervention with technical efficiency. This is very important especially against the background of the growing population and rising income which is expected to increase demand. Lastly, to the best of the authors' knowledge, there is a research gap on the subject and this has inhibited policy formulation with respect to the role of NGO in agriculture. Therefore, our study provides substantial empirical evidence to inform policy on the necessary conditions required for NGO intervention to produce the intended results.

2. Materials and Methods

2.1. Study Area

The study was conducted in the Shaki-Zaqatala region of Azerbaijan which was declared a national reserve in 1926. Most of the hazelnuts grown in this area are for exports [33]. It is located in the north of Azerbaijan (Figure 2) and is considered an economic region due to its massive hazelnut production, especially when considering that the hazelnut farmers are the largest group of producers in the region. The country exports most of its hazelnuts to western Europe and Russia.

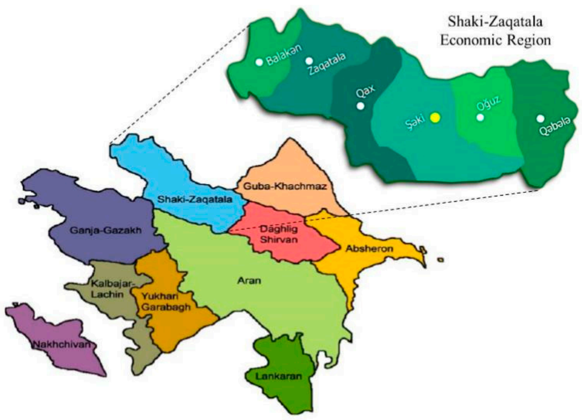

Figure 2. The map describing the study region Shaki-Zaqatala Economic Region of Azerbaijan. Source: Telesca, Kadirov, Yetirmishli, Safarov, Babayev and Ismaylova [33].

The hazelnut harvesting period is usually between August and October while planting is done during winters and spring seasons. The annual hazelnut tree yield ranges between 10–15 kg. The goal of production for farmers is to derive as much output as possible. Thus, in view of the fact that hazelnut production takes some time for the tree to grow before harvesting, a significant amount of capital is injected into the production. As for land, a substantial area has been used and good hazelnut yields could be attained especially that 3 tonnes can be derived from one hectare [34]. In the end, after harvest, the nut is sorted by size and dried, before either selling in shells or after kernel factory processing.

Generally, Azerbaijan has an interesting geographical location and suitable climate for agriculture [35]. The total area of agricultural crops is 201,811 hectares and apart from hazelnut production, vegetables, tobacco, cherry and almond are produced.

2.2. The Role of NGOs in Hazelnut Production

The main support given to hazelnut farmers is from NGOs and the government through the Ministry of Agriculture. Considering the limitation of resources from the government as it is with most developing countries, few farmers are on a government scheme as compared to NGOs. Both offer input subsidies but NGOs have a wider and larger catchment area in hazelnut production. However, little is known whether the prevailing circumstances in Azerbaijan facilitate ideal supporting conditions for NGO interventions to have a positive impact or not.

Interviews with key informants, NGOs and farmer associations informed the study that NGOs indeed train farmers on a wide range of topics such as environmental friendly hazelnut production, international standards adherence, production techniques, climate-smart agriculture and the efficient use of resources/production inputs. At present, records reveal that over 1000 farmers have been trained in the aforementioned subjects [28]. Evidence from farmers' list verified by the beneficiary farmers was also presented to validate that subsidies to farmers are given although not regularly. The subsidies are in the form of inputs to production comprising of fertilizer, seeds and hire of land. The registration of farmers to insurance institutions is also done by NGOs. While the quantities of inputs given are unknown, it is on record that over 40% of farmers in the study area have benefited from the subsidy program.

Table 1 displays the names of NGOs and their activities in assisting hazelnut farmers. Tentatively, training and input subsidies are the most prevalent form of aid. However, the approach used by each respective NGO is different as detailed in the table below.

Table 1. List of NGOs in Shaki-Zaqatala.

Name	Task Description	Activities	Supports in Detail
Ganja Agribusiness Association (GABA)	Training farmers on hazelnut production and machinery control	Training	Hazelnut Village Programme for farmers on the maintenance of hazelnut warehouse
		Subsidy	
Azerbaijan Hazelnut Exporters Consortium (AHEC)	Training on hazelnut production and harvesting technology for a group of 500 to 650 farmers	Training	At the time of harvesting hazelnut crop: Training on hazelnut production technique, isolation distance of trees, sowing practices and other agronomic practices
		Subsidy	500 young trees per hectare; $0.6 aid per young tress
Global Forum for Rural Advisory Services (GFRAS)	Training on hazelnut tree protection measures to groups of 40 farmers and provide favorable financial subsidies	Training	Environmental protection and sustainable intensification practices
		Subsidy	A five-year bank credit to the farmers without bank commission
AZERSTAR	Training on Repair, Maintenance, Operation and selection of various Hazelnut Machinery & Equipment and Post-Harvest Management	Training	Agricultural machine use
		Subsidy	$5 fertilizer subsidy per hectare

2.3. Sampling Technique and Data Collection

Multistage sampling procedure was used to facilitate unbiased data collection. Firstly, Shaki-Zaqatala region was purposely selected. Secondly, 10 villages from this region were randomly selected. Thirdly, 300 farmers were carefully chosen using a stratified random sampling method with the following three land categories: 0.1–2.5 hectares, 2.5–5 hectare, and more than 5 hectares. Then, 100 farmers were randomly selected from each stratum using the farmers' list from the Ministry of Agriculture in the region. All participating farmers consented to participate in the study and were witnessed by an officer from the Ministry. In accordance with human rights and ethical procedures when dealing with humans, the research received approval from the Ethics Committee of the School of Economics and Management, Nanjing Agricultural University, which bases its foundations on the 1964 Helsinki declaration and also from the local government in the region.

Both qualitative and quantitative approaches were implemented in collecting the cross-sectional data. A questionnaire was the sole instrument administered to respondents and the data collection period was from March to September 2018. It was rich in content and captured information on the classical agricultural inputs used. Also, socioeconomic characteristics such as education, age, specialization and membership to a cooperative were also captured.

To ensure accurate data were collected, the instrument was pretested and well-trained. Officers from the Ministry of Agriculture were engaged as enumerators for data collection as well as assisting in identifying the randomly selected farmers. In view of the primary aim of the study which is to evaluate the effect of NGO intervention on the technical efficiency of hazelnut farmers, the authors explicitly investigated NGO intervention by capturing the variable in three aspects: (i) Subsidies only, (ii) training only and (iii) both training and subsidy. The reasoning is that such an approach facilitates the derivation of more realistic and specific policy implications.

Questionnaire Design

The questionnaire was divided into 4 sections (Table 2), Section one contained the farmers' demographic information such as; gender, marital age, educational background and employment. The demographic information in this section establishes a comparison between households. Section two focused on land characteristics, use of labor, production expenses, annual hazelnut yield, employee wages, machines that the respondents use, working capital, active capital, the cost of renting of equipment and rate of irrigation. Also, respondents were asked whether they use fertilizers or pesticides, the type, cost and amount of pesticide and fertilizers they use per hectare. These formed the classical inputs for productivity analysis. Section three focused on factors that promote hazelnut growth and technical efficiency such as specialization. The last section mainly concentrated on any external help farmers received such as the agricultural loans, subsidies in various units, subsidy on chemical or organic compounds and insurance. The focus was on NGO interventions.

Table 2. Questionnaire design.

Section No.	Section Name	Number of Questions
One	Demographic information: Age, gender, education, family size and farming experience	5
Two	Land characteristics farm size, fertility, the specific size used for hazelnut production and how it is acquired	17
Three	Factors that promote hazelnut growth: Quantities of the classical inputs used i.e., labor, capital and land	10
Four	NGO intervention: How NGO administer their support to farmers and how many farmers are on their scheme	9

By cautiously constructing the questionnaire using common layouts for productivity studies [36], we tried to minimize measurement error as follows: training the team of enumerators and pre-testing the instrument in the local setting. Particularly, the interrogations pertainingto technical efficiency were easy for farmers to respond to. Thus, we do not expect methodical discrepancies in the precision of the answers among beneficiaries or non-beneficiaries, so that measurement error should not culminate in biased estimation.

2.4. The Empirical Model Specification

The stochastic production frontier model developed by Meeusen and van Den Broeck [37] and Aigner, et al. [38] was applied to estimate the technical efficiency of hazelnut farmers. The basic specification is as follows:

$$Y_i = f\ (x_i,\ \beta)\ exp\ (v_i)\ exp\ (-u_i) \tag{1}$$

where Y_i is the output, x_i is a vector of inputs, β is a vector of parameters to be estimated, and v_i and u_i are the random error and the inefficiency term, respectively. The factors influencing technical inefficiency is modeled as follows:

$$TE_i = \exp(-u_i). \tag{2}$$

The empirical model advanced by Battese and Coelli [39] was applied to estimate the Cobb–Douglas function specified as follows:

$$lnY_i = \beta_0 + \beta_1 lnL_i + \beta_2 lnC_i + \beta_3 lnW_i + v_i - u_i \tag{3}$$

$$u_i = \alpha_0 + \alpha_1 NGO_i + \sum \alpha_i G_i + z_i, \tag{4}$$

where Y_i is the output of hazelnut, land (L_i), capital (C_i), and labor (W_i) are the three classical inputs, β_0, α_0, α_1, α_i and β_i are parameters to be estimated, G_i is a vector of other determinants of technical inefficiency other than NGO intervention, u_i is a non-negative inefficiency component that follows a truncated-normal distribution and v_i is a random error following a normal distribution for the production function while z_i is a random error for the inefficiency model. Following the guidance of Belotti, et al. [40], truncated normal distribution is the most appropriate for a one-step technical efficiency analysis.

NGO intervention is a choice variable, especially where training is concerned and as such might be correlated with the error term in Equation (3). The Durbin–Wu–Hausman (DWH) test [41] was employed to address endogeneity in the model [42]. The null hypothesis is that error terms are uncorrelated with the regressors and in cases where they are, the instrumental variable approach is used [43,44].

According to Mwalupaso, Korotoumou, Eshetie, Alavo and Xu [36] proper analysis of data aids in the presentation of appropriate and exact results and also in making evidence-based conclusions [45–47]. Therefore, to ascertain the robustness of the results, an extensively used flexible form for representation of the production technology in SFA (translog production function), which can be taken as the second-order approximation of any unknown function [39,48] was employed as a robust check. The specification is as follows;

$$\text{In}Y_i = \beta_0 + \sum_{j=1}^{3} \beta_j InX_{ij} + \frac{1}{2} \sum_{j=1}^{3} \sum_{k=1}^{3} \beta_{jk} InX_{ij} InX_{ik} + \varepsilon_i \tag{5}$$

where $j \leq \beta_{ik}$, $\varepsilon_i = v_i - u_i$ and u_i is a non-negative inefficiency component that follows a truncated-normal distribution while v_i is a random error following a normal distribution. Y_i is the hazelnut output, X_{ij} is a vector of three inputs (land, labor and capital) while, β_0, β_j and β_{jk} are parameters to be estimated.

For all the models presented in this section, Stata version 14 (Stata Corporation, College Station, TX, USA) was used to analyze the data after coding and data cleaning. The analyses included preparing descriptive statistics such as standard deviations and means, standard errors, significance level and principal component analysis. Stochastic frontier analysis was estimated using Maximum Likelihood Estimator (MLE) as guided by Wang and Schmidt [49] (Appendix A).

3. Results and Discussion

3.1. Descriptive Statistics

Table 3 present the description and summary of the variables used in the estimation. The value of the hazelnut produced is significantly greater than the sum of the value of the inputs. This is important especially against the purpose of a production system as presented by Rahman and Rahman [50]—output of any agricultural production process must outweigh the cost of inputs used. On production input costs, we find that labor costs are fairly high due to the inevitable demand especially during the early stages of production. Labor in hazelnut production is critical just as it is for most orchard-based production [51].

Table 3. Summary statistics and variable definitions.

Variable Category	Unit	Definition	Mean	SD
Dependent Variable				
Hazelnut Production (Y_i)	AZN	Hazelnut production value in manat, the currency of Azerbaijan	31.2	14.0
Independent Variables (x_i)				
Land (L_i)	Ha	Area of the land cultivated	3.2	1.3
Capital (C_i)	AZN	Value of fertilizer, seeds and machinery in manat	11.4	51.7
Labor (W_i)	AZN	Value of hired and family labor in manat	2.2	6.8
Age (G_1)	years	Age of household head	34.5	14.1
Education (G_2)	years	Number of years of formal education for household head (can read and write)	7.2	4.1
Specialization (G_3)	%	total income corresponding to income from hazelnut	62.1	32.0
Membership (G_4)	%	Dummy where 1= farmer is a member of an association and 0 otherwise	52.4	50.0
Farm Size (G_5)	Ha	Total land owned	3.5	1.2
NGO Intervention				
Subsidy (NGO_1)	AZN	Value of subsidies received	1.2	0.9
Training (NGO_2)	%	Dummy where 1= farmers who received training	56.6	49.7
Training + Subsidy (NGO_3)	%	Dummy where 1= farmers who received training and subsidy	82.6	37.9

Notes: AZN is the international form to quote manat, the currency from Azerbaijan. The notation in parenthesis is based on the presentation in the empirical model section.

Regarding other explanatory variables, most farmers have lived for more than five decades and are members of farmers' associations. Age is an important element in hazelnut production because this is a perennial crop and so there is a longer period of waiting before harvesting can begin. Likewise, membership in cooperatives is also important in providing information on new production technologies and market access [52]. Education levels in the study area are low as a majority have a formal education of about seven years. However, for rural households, this may be good enough but may not be ideal in this case considering that hazelnut in Azerbaijan is mostly for exports (dealing with an international market). This entails that farmers need a good education to understand production economics. We also find that over half of the farmers are specialized in hazelnut production, which is good as this suggests skill development and quality in production [53].

The hazelnut farm sizes are larger than most farms (for other agricultural produce) in the country and thus, provide a good space for production. Generally, orchards need a big area if production is to be excellent [54]. For NGO intervention, three variables are used to measure its impact as already mentioned—subsidy, training and the two combined. This is because some farmers receive training but do not receive subsidies and vice versa. For another group of farms, both interventions are administered. Therefore, it is important to consider these differences so that an accurate conclusion can be made. There are more farmers who receive a combined package than those who are only trained. Also, the subsidy provided is considered high enough to elicit significant changes in production. These discussed variables are very important in robustly estimating the impact of NGO intervention because they satisfy management and social factors which are very essential for productivity and technical efficiency analysis [55].

3.2. Impact of NGO Intervention on Technical Efficiency

The results of the impact of NGO intervention on technical efficiency of hazelnut farmers are reported in Table 4. We begin by presenting the characteristics depicting the quality of the estimation that is included in the bottom part of the table. The DWH test reveals that endogeneity is not a problem in our estimation and assures the reliability of the finding. Also, based on the finding that sigma, a pointer of the influence of technical efficiency on observed output, is not equal to zero (a value above zero is a prerequisite for validation of technical efficiency analysis), estimation of our stochastic model is more consistent than using OLS. Similarly, gamma (widely used as an indicator to measure the influence of the inefficiency component) is significant, implying that technical efficiency also explains the variation in hazelnut output.

Table 4. Results of stochastic frontier estimation.

Variables	Coef. (Std. Err.)
Constant	4.609 (0.989) ***
Land	0.260 (0.086) ***
Capital	0.626 (0.076) ***
Labor	0.116 (0.027) ***
Inefficiency Model	
Constant	0.159 (0.771)
Age	0.019 (0.010) **
Education	0.013 (0.026)
Specialization	−0.010 (0.003) ***
Membership	0.266 (0.197) *
Farm Size	−0.003 (0.001) ***
Training	−0.202 (0.301)
Subsidy	−0.230 (0.005)
Training and Subsidy	−0.605 (0.055)
Estimation Characteristics	
Returns to Scale	1.002
MLF	−211.51
Sigma^2	0.449 (0.073) ***
Gamma	0.518 (0.114) ***
Average TE	0.66
Endogeneity (F-value)	0.987

Notes: Figures in parenthesis are standard errors of the coefficients while *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

All the classical inputs are positive and statistically significant and capital is the major factor in production based on the coefficients estimated (around 0.6). Our finding is similar to that of Solís, et al. [56], and Shavgulidze and Zvyagintsev [57] who also found that capital was an important factor in production. The sum of 1 (rounding off to the nearest number) of the classical inputs' coefficients indicates constant returns to scale for the models under investigation. Such a finding is similar to that of Reddy and Bantilan [58], Sarıca and Or [59], Gul, et al. [60] and Sotnikov [61].

Concerning the factors in the inefficiency model, Gorton and Davidova [62] divide them into structural and agency factors. The former denotes farmers' capacity to act independently (i.e., age, education, specialization and membership) while the latter influences farmers' decisions such as farm size and NGO intervention.

We find that age, specialization, membership to an association and farm size are significant factors influencing technical efficiency. Particularly, younger farmers are more efficient than older farmers. This could be due to that fact that older farmers are not willing to switch to new hazelnut production technologies and this hampers their efficiency. Other studies also reveal that farmers' age is associated with technical efficiency. Similar results were found in these studies [63–65] while Jaime and Salazar [66], Bozoğlu and Ceyhan [67] and Mariano, et al. [68] found contrary results, indicating that an increase in farmers age improves technical efficiency.

Consistent with common sense, farmers who specialize in hazelnut production are more efficient. This sits well with the revelation by Karagiannias, et al. [69] that technical efficiency is dependent upon specialization. Our finding is consistent with Guesmi, et al. [70], who also found a positive relationship between specialization and technical efficiency.

Regarding the variable membership to farmers' associations, we found a result different from Dios Palomares, et al. [71], Jaime and Salazar [66] and Binam, et al. [72] that found that farmers who are association members have higher technical efficiency than those that do not. For hazelnut farmers, the result in our study is attributable to the time factor, in that membership entails attending various long meetings at the expense of production. Also, unlike their counterparts, participating members make use of the traditional production approach which affects their productivity.

Last among the significant factors is farm size which positively impacts on technical efficiency. This is consistent with the notion that, on account of resulting economies of scale, farmers with large farms are more technically efficient [58,64,66,73]. Hazelnut production requires a large production space for the tree to adequately gain the required nutrients. Also, a large space facilitates the adoption of various production technologies [74,75]. Therefore, more cultivation area would lead to higher technical efficiency.

Contrary to our expectation, education and NGO intervention were not statistically significant. According to the literature [56,63–65,72], education impacts positively on technical efficiency because it facilitates learning, improves information access and smooth adoption of new technologies in production. Our finding disagrees with this assertion. This could be because specialization is more important than education in hazelnut production. Considering that hazelnut production takes place in an orchard environment, farmers' understanding of how to produce is more important than attainment of general education [54]. An insignificant and positive sign on education was also found by Mwalupaso, Wang, Rahman, Alavo and Tian [32] and Bozoğlu and Ceyhan [67]. Regarding NGO intervention being insignificant, the translog production function (another specification applied as a robust check) discloses consistent results to those in Table 4, implying that no bias is introduced on account of the interaction of the classical inputs.

To provide an accurate distribution of the technical efficiency scores, the kernel density distribution in Figure 3 has been provided. The average mean is about 66%, implying that there is still potential to increase output by 34% without changing the level of inputs. This result is similar to that of Bozoğlu and Ceyhan [67] who found a 65% mean technical efficiency but differs from Shavgulidze and Zvyagintsev [57] and Sotnikov [61] who found 56% and 77% mean score respectively.

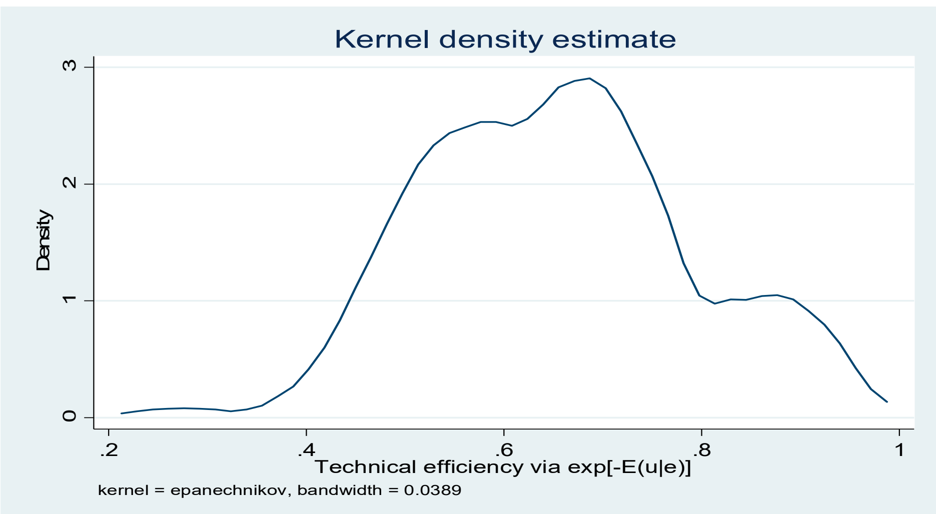

Figure 3. Kernel density.

3.3. Potential Explanations for the Insignificant NGO Intervention

The question that could inform policy is, what could be the possible reasons behind the insignificant result? To gain insight into the obtaining situation regarding the elements that farmers consider as very essential conditions in relation to NGO interventions, we explicitly asked them to rank using a five-point Likert scale (1 = not critical, 2 = less critical, 3 = neutral, 4 = critical and 5 = very critical). The ranking reveals a measure of the importance of these elements. Table 5 displays the summary of the ranked critical elements that are absent or inappropriate for NGO intervention to have a smooth positive impact.

Table 5. Mean scores of factors affecting NGO intervention.

Missing Elements in Ensuring Ideal Supporting Conditions	Mean	SD
Late delivery of subsidies	4.85	1.20
Lack of sustainable knowledge development and training activities	4.80	0.15
Poor record-keeping	4.63	0.90
Changes in training schedule	4.54	0.35
Wrong/erroneous farmer registration list	4.20	1.38
Lack of knowledge development motivation	4.05	1.41
Lack of collaboration with the Ministry of Agriculture	3.95	1.40
Programs and activities without farmers' association	3.90	1.72
Unknown organization structure/contact person	3.73	1.50
Lack of technological adoption options	3.68	1.60
Lack of formal reporting or system for checks and balances	3.55	1.03
Irregular and inconsistent communication	3.05	1.35
Other key players not consulted	3.0	1.09

Results reveal that mean scores range from 4.83 to 3.0. Eleven out of thirteen elements are found to be critical based on the measure (above three depicting critical and very critical scores) and this is quite substantial for any meaningful project to have no impact at all. The highest is late delivery of subsidies (mean = 4.85) which, when rounded off gives a value of 5 (very critical) according to the Likert scale. Chiona, et al. [76] contend that late delivery of inputs to farmers has the potential to disrupt the functioning of agriculture because production has strict scheduled time for the application of the inputs. More than that, farmers' trust is lost when such events occur and thus would lead to no impact of the intervention on productivity. The second in rank according to farmers is the lack of sustainable knowledge development and training activities, while the last in line is no consultancy of other key players. All these elements are essential in discussing the supporting conditions required for NGO intervention to have a positive and significant impact. Intuitively, this may suffice to explain why NGO intervention is not a determinant of technical efficiency in the study area. However, there is a need to come up with meaningful categories out of the ranked critical factors.

To accurately do so and correctly present the findings, principal component analysis (PCA) was used to reduce and group the variables into meaningful components. Table 6 displays the derived groups from the critical missing elements. As guided by Goswami, et al. [77] and Chatterjee, et al. [78], the orthogonal rotation was implemented on principal components, which resulted in four principal components with an eigenvalue greater than 1 and explaining 60.2% of the total variance. Also, according to Kaiser [79], a mean communality above 0.60 is the lowest standard for PCA analysis. Therefore, our PCA estimation is a good fit as this requirement was met (60.2).

Table 6. Results of the Principal Component Analysis.

Items	Grouping for Restrictions			
	Comp 1	Comp 2	Comp 3	Comp 4
Poor NGO organization				
Late delivery of subsidies	0.866			
Changes in training schedule	0.764			
Wrong/erroneous farmer registration list	0.726			
Irregular and inconsistent communication	0.691			
Unknown organization structure/contact person	0.649			
Innovation orientation restrictions				
Lack of sustainable knowledge development and training activities		0.711		
Lack of knowledge development motivation		0.691		
Lack of technological adoption options		0.646		
Stakeholders' involvement and support				
Lack of collaboration with the Ministry of Agriculture			0.838	
Programs and activities without farmers' association			0.609	
Other key players not consulted			0.530	
Accountability				
Poor record-keeping				0.760
Lack of formal reporting or system for checks and balances				0.635
Eigenvalue	8.546	2.323	1.625	1.547
Variance (%)	32.869	15.136	6.250	5.950
Cumulative variance (%)	32.869	48.005	54.255	60.205

Poor NGO organization is the first component, explaining 32.87% of the variance. The remaining components (2–4) cumulatively account for only 27.34% of the variance and these components are innovation orientation restrictions, stakeholders' involvement and support and accountability respectively.

Poor NGO organization captures late delivery of subsidies, changes in the training schedule, wrong/erroneous farmer registration list, irregular and inconsistent communication and unknown organization structure/contact person. Farmers disclose that rampant changes in training schedules are prevalent which disturbs farmers in the hazelnut production. Poor organization of NGOs has been cited as a bad element to productivity improvement [30,80]. In our case, this has provoked a perception that NGOs lack seriousness of purpose and are labeled as time wasters. Such a scenario explains why NGO intervention is insignificant. The elements under this component are vital supporting conditions that must be met if the impact is to be significant and positive [81]. Our discourse on this aspect is consistent with that of Jaime and Salazar [66] who found that poor organization affects productivity.

Innovation orientation restriction is made up of a lack of sustainable knowledge development and training activities, knowledge development motivation and technological adoption options. Farmers require information and motivation to adopt useful technologies because hazelnut production faces different changing circumstances such as weather, soil quality and insufficient income for the required inputs [82–84]. General training of farmers has very little to offer to farmers because skill development is very pivotal in hazelnut production. It is thus non-beneficial for farmers to attend training when in fact the trainer has no experience in hazelnut production or skill in some of the useful technologies that farmers can adopt in changing times. As Hussain, et al. [85] puts it, training in agriculture needs to offer cogent encouragements for farmers to adopt excellent technologies and also create an environment for knowledge development. We find that NGOs are not innovation-oriented and this has culminated in no impact at all on technical efficiency.

Stakeholders' involvement and support are missing among the factors facilitating an enabling environment for NGO intervention. From the farmers' perspective, it seems that NGOs are functioning without the guidance of key players in hazelnut production and also without the experts from the government. Collaboration between NGOs and the Ministry of Agriculture is absent and this has affected the attractiveness of the interventions especially where training is concerned. Agbamu [86], Anderson and Feder [87] assert that extension officers are well trained to effectively organize farming communities and produce outstanding results in awareness programs. Therefore, the absence of such key personnel creates a gap in the implementation of developmental programs. The extension officers are also well acquainted with the farmers and understand farmers' needs relatively well. To have a significant impact, farmers' needs have to be met rather than offering any form of aid. This approach demands farmers' attention and increases productivity. Babu et al. [88] also found that meeting farmers' requirements in development schemes produce positive outcomes. Apart from extension officers, other key players are not included and the activities of NGOs do not have the blessing of farmer associations. This has created an inappropriate environment warranting failure to meet the set objectives. Many researchers have highlighted the importance of engagement of farmer organizations in affairs that pertain to farmer welfare or agricultural productivity [2,66,89]. This factor is critical in facilitating the supporting conditions for positive NGO intervention.

Finally, response to NGO intervention is voluntary on the part of the farmer. This makes accountability very complicated because expectations are not well set [30]. Farmers in most cases do not take training seriously but are rather interested in the incentive given after the training. Also, poverty causes farmers on NGO schemes to sell inputs given so that they could have some income to sustain their family. With the absence of a system offering checks and balances, resource mismanagement is likely to become the order of the day. While NGOs are interested in boosting the hazelnut productivity and its sustainability, farmers' commitment is left unchecked. Intervention to be sustainable and effective requires convincing analysis depicting current spending and how it is contributing to the achievement of that purpose [90,91]. Unfortunately, ever since NGOs took interest in hazelnut production, evidence of the effect of their intervention is missing and unclear (poor record-keeping). In view of this, it is plausible that the effect of NGO intervention on technical efficiency is insignificant.

3.4. Implication for Sustainability

The results of the study provide insight into one cardinal scholarly and sustainability-related question. How essential is NGO intervention in improving technical efficiency and sustainability of hazelnut production? Empirical evidence answering this question is very crucial for policymakers too. Azerbaijan provides a suitable case study because of its track record in hazelnut production as well as unprecedented NGO involvement.

Our results robustly suggest that NGO intervention is, at present, not associated with improvement in technical efficiency due to some missing elements that are necessary for creating an ideal environment for meaningful impact. Based on the roles played by NGOs in the study area, there is the potential to contribute to the four pillars of sustainability—human, social, economic and environmental. Considering the extent of farmer training by NGOs, this has the likelihood to culminate in human sustainability which aims to maintain and improve human capital in society [92]. The fact is, access to knowledge and skills are all programs under the umbrella of human sustainability [18]. Therefore, it is important for policy to be directed at enhancing the work of NGOs because it could lead to the development of skills and human capacity to support hazelnut production and productivity as well as promoting the welfare of the region.

Bearing in mind that social sustainability focuses on maintaining and improving social quality with concepts such as cohesion and the importance of relationships amongst people [17,93], NGO intervention in the hazelnut producing region is likely to achieve this, especially because it involves working with different individuals and stakeholders. Eventually, this is what leads to sustainable development as pointed out by Dempsey, et al. [94].

Economic sustainability is another area likely to be realized through NGO intervention as the goal is to improve the standard of living [16,18]. By providing subsidies, the capital of hazelnut farmers is kept intact and, in the case that it leads to increased productivity, it would augment farmers' income and also provide more food for the rural communities.

Lastly, though indirectly, NGO training and subsidies may promote environmental sustainability. By giving information on how to protect the environment and providing subsidies that are environmentally friendly, improvement in human welfare through the protection of natural capital would be realized [19,95]. This would ensure that the needs of the population in hazelnut production are met without compromising those of the future generation [96]. This is achievable with ease considering that farmers in Azerbaijan have been quick to comprehend the significance of environmental protection for their livelihoods [97,98].

4. Conclusion and Policy Recommendation

Azerbaijan is among the top five hazelnut producers in the world as it has favorable climatic conditions for hazelnut cultivation. Thus, due to the experienced high global hazelnut demand, NGOs have taken a key role in attempting to improve productivity as well as the sustainability of hazelnut production. However, the impact of their interventions remains unclear. Therefore, the present study was conducted to investigate the role played by NGOs and also evaluate the effect of NGO intervention on hazelnut farmers' technical efficiency in Azerbaijan. To this end, three groups of farmers are categorized based on NGO intervention: (i) Those who only receive subsidies, (ii) those who only receive training and (iii) those that receive both training and subsidies.

The results reveal that the current NGO intervention is not significant in improving farmers' technical efficiency. We find substantial empirical evidence indicating that the supporting conditions necessary for NGO intervention to have a positive impact are missing. Precisely, the absence of a system of accountability, good organization, innovation orientation, and involvement of key stakeholders are established as barriers to the positive impact of NGO intervention on technical efficiency. While the current NGO interventions have the potential to drive productivity and sustainability of hazelnut production, these missing elements stand as critical obstructions in realizing the desired goals of NGOs in Azerbaijan's hazelnut production.

Our study puts forward strong empirical evidence of the role of NGOs and their association with technical efficiency in hazelnut production. The results provide important insights for policymakers to carefully formulate and implement policies that facilitate positive outcomes—paying attention to the supporting conditions. Therefore, we recommend policy development directed at increasing both farmers' and NGO accountability towards the resources used. Specifically, evidence of the impact of the intervention on hazelnut production ought to be presented by both farmers and NGOs. Accountability will cultivate a sense of responsibility that will automatically address any potential misappropriation or misallocation of resources, thereby promoting economic and social sustainability. Also, instigation of policy measures to improve the organization of NGOs and involvement of key stakeholders especially extension officers from the Ministry of Agriculture would greatly improve hazelnut productivity and sustain production. Bearing in mind that NGO intervention in hazelnut production has been recognized, convincing analysis of the existing NGO expenditure coupled with the outcome derived ought to be a serious policy concern to warrant improved farmers' technical efficiency.

We cautiously conclude that effective organization of NGOs is very essential in improving the technical efficiency of hazelnut farmers. Particularly, organization of training programs, untimely subsidy delivery and lack of effective communication with farmers are the issues that NGOs need to be dealing with for their interventions to have the intended impact. This will not only boost productivity but also lead to a triple win—increased GDP for the country via exports, increased income for farmers and an outstanding reputation for NGOs.

Finally, the limitations of the study are two-fold. First, time was a limitation on our part which only allowed for the collection of cross-sectional data. A panel data would have a better capacity to explain the phenomena, but such data were unavailable. Second, ensuring the data accuracy of other areas was also a challenge leading to investigation in only one region. The policy implication would be richer if consideration of other areas was made and comparisons made. Nevertheless, the findings of the present study make an important contribution to the literature considering that there is a dearth of studies on the technical efficiency of hazelnut farmers.

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Appendix A

Table A1. SFA maximum likelihood estimates.

Stochastic Frontier Production Function		Technical Inefficiency Function	
lnOutput	**Coefficient (Std. Err.)**	**Explanatory Variables**	**Coefficient (Std. Err.)**
lnCapital	0.574 (0.655) **	Age	−0.236 (0.052) ***
lnLand	0.199 (0.084) ***	Education	0.026 (0.007) ***
lnLabor	0.465 (0.380)	Specialization	−0.011 (0.018)
lnCapital_land	0.226 (0.190)	Membership	0.040 (0.046)
lnCapital_Labor	0.339 (0.126) ***	Farm Size	−0.004 (0.002) **
lnLand_labor	0.153 (0.106)	Training	−0.021 (0.016)
0.5ˣlnCapital_2	−0.076 (0.043) *	Subsidy	−0.037 (0.047)
0.5ˣlnLand_2	−0.157 (0.165)	Training and Subsidy	−0.016 (0.033)
0.5ˣlnLabor_2	−0.092 (0.074)	Constant	−0.536 (0.204) ***
Model Diagnostics			
Scale elasticity	1.238	Lambda	0.639 (0.070) ***
Log-likelihood	59.761	Mean	0.644
Wald chi2	1506.180 ***	Endogeneity (F-value)	1.35
Observations	300		

Notes: Figures in parenthesis are standard errors of the coefficients while *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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