"XV EAAE Congress - Towards Sustainable Agri-Food Systems: Balancing between Markets and Society"

Technical efficiency in the Georgian hazelnut supply chain and policy recommendations

Rati Shavgulidze, MA, rati.shavgulidze@gmail.com

Dmitry Zvyagintsev, PhD, Dmitry.Zvyagintsev@fao.org

Introduction

Hazelnut production is concentrated in western Regions of Georgia. Hazelnuts provide important livelihood to about 40,000 small scale growers, 30 processing factories, and numerous other actors along the supply chain.

Georgian has been the 5th largest producer of hazelnuts worldwide in volume terms.[1] Average and compound annual growth rates of hazelnut production through 2006-2015 were 7 and 4 percent, respectively. Samegrelo Region has been the largest producer of hazelnuts, and during the last decade Region's annual average contribution in total hazelnut output has been 54 percent. In 2015 national output of hazelnuts totaled 36,400 tons.[2] Hazelnut production is concentrated among small scale diversified producers. Hazelnut production is characterized with low productivity and high degree of commercialization. Hazelnut grower linkages in input and output markets are underdeveloped. Growers market their output through village level intermediaries (collectors) and processing factories.

Georgia exports both, in-shell and shelled hazelnuts, and the proportion of former is relatively small. During 2006-2015, in Georgia hazelnut exports ranked 1st among exported agriculture products, and its annual average share in total agriculture exports has been 22 percent. Georgia's hazelnut export revenue in 2015 was $US 176 million.[3] Georgia has been the third largest exporter worldwide in terms of value of shelled hazelnuts, following Turkey and Italy, and 6th largest exporter of in-shell hazelnut after Unites States, Chile, France, Italy and Hong Kong. The share of Georgia's exports in total world exports on average has been 6 percent.[4]

Quality of Georgian hazelnuts has been variable. This coupled with underdeveloped linkages in major export markets, underlay the fact that commonly Georgian hazelnut are sold at a discount compared to other suppliers underlying lower prices and reduced profitability.

Actors in hazelnut supply chain have benefited in the frame of different Government and Donor support programs aimed at improving availability and accessibility of/ to saplings, finances, agriculture insurance, improving grower production, post-harvest handling and marketing skills and knowledge, etc. The most recent Government support to hazelnut sector included facilitation to the establishment of a hazelnut grower cooperative in major production region and investment in a warehouse facility that would have allowed cooperative member growers to handle properly their harvest and attain economies of scale in marketing. The other recent Government initiative has consisted of promotion of the introduction of warehouse storage ticket in hazelnut sector to improve hazelnut grower access to finances.

Data and Analytical Methods

To estimate costs and returns of major actors along hazelnut supply chain, gross margins, marketing margins and distribution margins were estimated. To measure and explain technical efficiency in hazelnut production in Samegrelo Region, stochastic frontier analysis has been used. Data has been collected by an empirical primary data survey.

[1] Source: International Nuts and Dried Fruits (INC), FAO, estimates
[2] Source: Georgia Statistical Service, estimates
[3] Source: Georgia Statistical Service, estimates
[4] Source: International Trade Center (ITC), estimates

Data Source

The study is based on 159 hazelnut growers 2014 cross-sectional production data. The information was collected through the survey of growers in 17 villages in Samegrelo Region during winter 2016 and was based on respondent-driven sampling.

Hazelnut Stochastic Frontier Model

The study applied Cobb-Douglas production functional form. Stochastic frontier production function that specified hazelnut output as a function of capital and labor (1) has been jointly estimated with technical inefficiency model (drainage, household size, and hazelnut nutrition) (2) in a single stage estimation procedure by the maximum likelihood (Coelli, Rao, and Battese, 1998). The empirical evidence compared to Voigt and Uvarovsky (2001), Lerman and Sutton (2006).

Stochastic Frontier Model (1)

$$\ln(OUTPUT_{it}) = \beta_0 + \beta_1 \ln(CAPITAL_{it}) + \beta_2 \ln(LABOR_{it}) + V_{it} - U_{it}$$

Inefficiency Model (2)

$$U_{it} = \delta_0 + \delta_1(DRAINAGE_{it}) + \delta_2(HHSIZE_{it}) + \delta_3(NUTRITION_{it}) + W_{it}$$

- $lnOUTPUT_{it}$ is natural logarithm of output of hazelnuts of farmer i in t^th period measured in kilograms;
- $lnCAPITAL_{it}$ is natural logarithm of total variable costs (reported, and not imputed) incurred by grower i in t^th period measured in GEL;
- $lnLABOR_{it}$ is natural logarithm of labor input of a grower i in t^th period measured in person/day;
- V_{it} is an error terms that captures the effects of unspecified explanatory variable and is independent of U_{it};
- U_{it} accounts for technical inefficiency in production and it ranges between zero and 1;
- *DRAINAGE* is a dummy variable and it =1, if there is a drainage system in the orchard, and it =0, if there is no drainage system in the orchard;
- *HHSIZE* is the number of members in the households.
- *NUTRITION* is a dummy variable and it =1, if grower has applied at least one type of fertilizer (N, C and organic fertilizers);

Results

a) Farmers

Socio-economic characteristics

Average age of hazelnut growers was 50 years. The size of producer households varied from 1 to 11 members, and on average, households comprised 4 members. Proportions of men and women in grower households were roughly alike. Majority of the heads of households (50 percent) and spouses (40 percent) had higher and secondary school education, respectively, and the smallest proportion of both, household heads (20 percent) and their spouses (10 percent), had professional education (table 1).

The number of grower income sources was between 1 and 4, and on average, hazelnut growers had 2.2 income sources with 0.8 stdev.; 79 percent of growers had at least 2 income sources. The most often stated source of income has been hazelnut sales (94 percent), followed in descending sequence by formal employment (39 percent), retirement pension (36 percent), sales of agriculture products other than hazelnuts (30 percent), and transfers and others (each, 3 percent). The most frequently referred expenditure items in descending order comprised food (86 percent), healthcare (58 percent), hazelnut production (40 percent), education (23 percent), production of agriculture products other than hazelnuts (10 percent), ceremonies (9 percent), and other (6 percent).

The number of agriculture plots in the ownership of growers ranged between 1 and 12, and on average hazelnut growers have had 2.2 plots (1.5 stdev.). Nearly all adult members of households were involved in hazelnut enterprise.

Services and infrastructure

Hazelnut growers sourced production inputs (herbicides, fertilizers, pesticides) mainly either in their villages or a regional center, and very few

growers procured inputs in Tbilisi. In general, only about 14 percent of farmers were satisfied with the services provided by input suppliers, and merely around 12 percent and 9 percent of surveyed farmers considered availability and accessibility to input supplies as good, respectively. Approximately 20 percent and 30 percent of farmers thought availability and accessibility of/ to extension services to be good, respectively, and overall, 30 percent were content with the services provided by local extension service. On average, around 19 percent and 14 percent of farmers viewed availability and accessibility to financial services as acceptable, accordingly. Mechanical drying has not been common practice in the surveyed region. Majority of farmers were not satisfied neither with availability nor accessibility of/ to drying services, and only about 13 percent were satisfied with available services and infrastructure. More farmers were satisfied with accessibility to de-husking services than with availability. Underlying reason might be relatively small number of commercial quality de-husking service providers in the region. Overall, more than half of respondents were content with existing de-husking services. Similar to drying services, storage service has not been common in surveyed region. In general, roughly 20 percent of surveyed producers were content with available storage services (table 2).

Largely growers based all their production, harvest, and post-harvest decisions on their own experience and knowledge, with the exception of soil analysis. Former was recommended by local extension services. Few growers have approached extension service about proper layout of drainage canals, weed control measures, hazelnut tree nutrition, measures against diseases et al., and harvest and post-harvest handling practices. Even fewer growers have asked input suppliers for recommendations (table 3).

Factors impending hazelnut production and marketing

Growers considered heavy, hot winds in June-July as the most significant production impending factor. Reportedly, during this period substantial proportion of potential harvest has been lost. More than half of surveyed farmers (62 percent) have been exposed to heavy winds due to the lack of windbreaks. Only about 38 percent of surveyed farmers have benefited from windbreaks. From existing windbreaks, about 70 percent were man-made. The structure and layout of orchards have been deterrent for small-scale growers to establish windbreaks for protection of individual plots. The other production impending factors included drought, high input prices, knowledge and experience, and the quality of inputs. Growers were more price than quality conscious.

The most significant factor impending marketing was hazelnut price variability, followed in descending order by everyday cash needs (that prevent growers to store their harvest for future sales when prices increase), meeting buyer quality requirements, limited market information and competition among buyers, and a buyer power (table 4).

Hazelnut orchard

The distance between grower houses and hazelnut orchards ranged between 0 and 50 km, and average distance was 2.4 km with 6.8 stdev. Area of orchards of surveyed growers ranged between 0.1-5 ha, and an average orchard area was 1.2 ha with 0.9 stdev. Different tree spacing was employed by hazelnut growers. The most common practices comprised 5m x 5m, 4m x 4m, and 4m x 5m spacing. Age of hazelnut orchards was in the range of 1-60 years, and average age of orchards was 17.4 years with 11.3 stdev. Increase in hazelnut prices and consequent increased revenue of hazelnut growers during the last 10 years has triggered increased investments in renewal and expansion in the area of existing orchards.???? Hazelnut growers have maintained mainly 6-14 fruit bearing branches per tree.

Nutrition and orchard floor management

Cattle manure, nitrogen based fertilizer (N fertilizer), and complex fertilizer (C fertilizer) were used by growers for hazelnut tree nutrition. Only the fourth of growers have conducted soil analysis, and none of the growers have conducted leaf analysis. Moreover, growers did not consider type of soils during plant nutrition. More than half of growers (69 percent) have applied manure in their hazelnut orchards. The source of manure was mainly grower-owned cattle. Several farmers, in addition to own

cattle manure, have applied additional manure that was either procured for cash or obtained free of charge from fellow farmers. Majority of surveyed farmers (83 percent) applied N fertilizer, which was exclusively ammonium nitrate. More farmers (52 percent) have applied N fertilizer twice than once (48 percent). N fertilizer average application rate was 0.41 kg/ tree. C fertilizer was applied by 62 percent of growers. C fertilizer has been applied mainly once, and only 7 farmers applied C fertilizer twice during the production year. Few growers had recollection of the type of C fertilizer applied. On average, growers have applied 0.41 kg of C fertilizer per tree (table 5).

Hazelnut growers viewed weed control as important activity. Proper weed control allowed easy detection of fallen ripe crop on the ground and resulted in the reduction in the proportion of harvest not collected. Nearly all surveyed growers (98 percent, 0.14 stdev) have implemented weed control measures; it comprised application of herbicides and grass cutting. Grass cutting was done either by fuel operated grass-cutter or a scythe. In a few cases farmers allowed their livestock to graze in the orchards.

Mulching of orchard floors has not been common practice among hazelnut growers. Only 14 farmers have applied mulch on their orchard floor. Mainly cut grass was used for mulching. Couple growers have used the mix of cut grass and manure for mulching purposes. The thickness of mulch cover varied between 1-10 centimeters.

Nearly half of surveyed growers (48 percent, 0.5 stdev.) experienced waterlogging in their orchards, and 42 percent (0.5 stdev) and 16 percent (0.4 stdev.) of them, thought poor drainage to have significant and moderately negative impact on the quality and volume of harvest, respectively. Implemented actions to address the problem of waterlogging included establishment of drainage canals within orchards, and in fewer cases maintenance of grass cover at about 10 cm level and filling depressions with the soil. Proportion of area affected by poor drainage has ranged between 3-100%, and on average it was 43 percent with 0.3 stdev. Establishment of drainage canals was very labor intensive, and associated with high expenditures if the labor outside from the family were employed. Also, availability of relevant equipment has been scarce. Furthermore, higher level drainage canals (secondary and primary) often required rehabilitation or were non-existent at all, and consequently there was no infrastructure to collect and direct water discharged from the orchards.

Measures against pests and diseases

Farmer limited knowledge of pests and diseases (names, occurrence periods, etc.), and measures against them (type of measure, period of implementation, type of pesticides, pesticide application rates, etc.) were evident during the interviews. Most of the growers did not have recollection of types of pesticides applied, and application rates. None of the growers had pest/ diseases monitoring systems in place, and they were not familiar with monitoring methods.

The most frequently encountered pests/ diseases included Eriophyes tristriatus/ Phytoptus avellanae, Oberea linearis, Phyllactinia suffulta, Beetle ("Ambrozia"), Moss, and Hyphantria cunea. Reportedly, during the last 10 years, occurrence of the majority of diseases/ pests either has reduced or remained unchanged. Increases in the number of occurrences were reported for Eriophyes tristriatus/ Phytoptus avellanae, Hyphantria cunea, and Alternaria. Based on grower, feedback, Eriophyes Tristriatus/ Phytoptus avellanae, Alternaria, and Xanthomonas have had either significant or moderate negative impact on hazelnut output volume and quality. As reported, the trend in occurrence of these pests/ diseases has been declining during the last 10 years. Measures against these pests/ diseases included both chemical and mechanical. Also, some farmers despite presence of these diseases/ pests did not apply any measures against them.

Harvest and post-harvest handling

Commonly farmers started harvest during the second half of August. In general harvest was carried out in multiple phases, mainly into two phases, and it lasted for 35-40 days. Around 70-80 percent of the crop was collected during the first phase of the harvest. Most frequently nuts remained on the

ground not collected up to 15 days. Around 20 percent of potential harvest remained on the ground not collected and lost. Yield levels ranged between 0.5 to 7 kg per tree, and average yield was 2.6 kg/ tree with 1.2 stdev.; extraction rate fluctuated between 25-45 percent, and average extraction rate was 36.5 percent with 0.37 stdev. Hazelnuts were taken out from the orchard in sacks. Commonly, sack carry capacity ranged mostly between 20-35 kg. Before drying hazelnut sacks were kept temporarily at house premises and/or yards. Sacks were kept mainly either within premises or outside under the cover; few farmers kept harvest outside, in the open. Only 13 percent of growers used jute sacks for collection and storage of hazelnuts, and the rest have used nylon/plastic sacks.

Hazelnuts were spread out as layers for drying. Period of drying varied among growers. More than 50% of farmers dried their harvest for up to 40 day period (Figure 33).

More than half of surveyed growers of growers (58 percent) dried their harvest in the conditions of good ventilation and in a shadow; the remaining of farmers dried their crop in the sun. Greater proportion of growers (73 percent) during drying mixed up the crop harvested during the different phases. On average, growers mixed up spread layers of hazelnuts 2-4 times per day. In general, the level of layers during drying was in the varied between 10-25 cm. Loss in weight of harvest after drying varied among growers. The most frequent losses have been 10-15% and 20-25%. Approximately the third of the farmers dried their harvest both while in husk and after de-husking. Around 46 percent of total time allocated to drying was devoted to drying de-husked kernels. The rest of the farmers first dried and then de-husked their harvest.

Majority of farmers (73 percent) used de-husking services. Only few farmers de-husked their crop in phases. Although, most of the producers used factory made de-husking equipment, they were not content with the quality of the service; de-huskers did not remove completely husks requiring additional manual labor input. Most of the producers stored de-husked and dried kernels in nylon/ plastic sacks, and few farmers kept the harvest in jute sacks.

Labor

Hazelnut production has been highly labor-intensive enterprise. Labor employed in hazelnut production consisted of paid and unpaid labor. Former category included family members and relatives/ friends, etc., while latter – seasonal workers. Seasonal workers came mainly from urban areas, outside of hazelnut growing region; also, small proportion of seasonal workers was represented by resource poor local rural residents. Activities requiring the most significant labor input included harvest, pruning/ shaping, and drying. Family member contribution to total input has been greater than that of hired laborers. Hired labor wage rate was in the range of 20-30 GEL/man/day, and subject to agreement it was either inclusive or exclusive of meals. Female laborers contribution to total labor input has been most significant in harvesting and de-husking (table 6).

Sales

All growers sold in-shell hazelnuts. Farmer prices trended upward from the start of the marketing year through April. Monthly sales also followed price pattern, but only through December (Figure 1).

Proportions of farmer sales to collectors, factories, and speculators have been 42 percent, 45 percent, and 13 percent, respectively. Pre-harvest sales have been insignificant. Major buyers during pre-harvest sales were collectors and speculators.

Grower gross margin

Gross margins were estimated for four different scenarios as follows:

- Volume of output *adjusted* to weight loss after drying and total variable costs *with* imputed labor, de-husking and manure costs
- Volume of output *not adjusted* to weight loss due to drying and total variable costs *with* imputed labor, de-husking and manure costs

- Volume of output *adjusted* to weight loss after drying and total variable costs *without* imputed labor, de-husking and manure costs
- Volume of output *not adjusted* to weight loss due to drying and total variable costs *without* imputed labor, de-husking and manure costs (Table Y).

Tables 7-8 illustrate significant differences between accounted and non-accounted costs and prices. In general, growers have not considered unpaid labor and organic fertilizer when estimating their expenditures. The largest proportion of expenditures was on labor followed by those on inputs, services, and transportation in descending order.

b) Hazelnut collectors

Socio-economic characteristics

Hazelnut collection in terms of time and income has been the main livelihood activity for the surveyed collectors. Majority of collectors had secondary-school education, and only 5 and 8 collectors had a higher and professional education, accordingly. Age of collectors ranged between 25-65 years, and average age was 48 years. The most experienced collectors have been in this business for 30 years, and the least experienced for one year.

Upstream market linkages

Most of the collectors (16) have had long-term business relations with growers. Collectors have ensured lasting business connection with growers by offering transparency in weighting of delivered hazelnuts and fair prices. The number of farmers with whom collectors transacted and the number of villages served, ranged between 10-450 persons and 1-25 settlements, accordingly.

The volume of hazelnuts handled by collectors varied between 20-300 tons, and on average, the volume handled per collector was 93 tons (61 stdev).

In most cases growers delivered hazelnut to collectors. None of the collectors has practiced pre-harvest purchases; payments to growers were made upon delivery. On average, collectors rejected 28 percent of hazelnuts supplied by farmers. Reasons of rejections in descending order of frequency have been rancid and molding fruit, blank shells, high water content, and blank shells disguised in quality supplies.

Majority of collectors have thought that the quality of hazelnuts supplied by growers largely either has worsened or remained unchanged; collectors have identified unfavorable weather conditions as major determinants of quality.

Value addition

In general, collectors did not store purchased hazelnuts because of the lack of relevant infrastructure and "every evening collection" practice followed by factories. In case of storage, duration was mostly up to 4 days. None of the collectors processed/ added value to the handled hazelnuts. Out of 5 collectors, 4 have evaluated their temporary storage premises as of average quality, and only one has assessed storage infrastructure as adequate. However, majority of collectors did not consider as relevant need for improvement in the condition of storage premises, and only one collector thought improvements to be needed.

The spread between collector buy and sales prices on average has been 0.11 GEL/kg. Established collectors, in general, worked on a low margin, but handled large volumes; while new entrants' margins were high and the volumes handled low.

Collector total variable costs included bought hazelnut cost, transportation costs and labor costs for hazelnut weighting, and loading and unloading. Bought hazelnut price had the largest proportion in total variable costs. Table 9 presents breakdown of variable costs and respective proportions.

Downstream market linkages

On average, every collector has worked with 5 factories. The majority of collectors (17) had long-term business relations with factories. In most cases hazelnuts were collected by factories at "collection" sites and few collectors made deliveries to factory gates. In general factories did not have volume requirements for deliveries. Factory quality requirements in order of importance included adequate moisture content, size of a fruit, and

supplies free from cracked and mechanically injured shells, rancid and molding fruit, blank shells, and blank shells disguised in quality supplies. On average, factories have rejected 13 percent of deliveries made by collectors. Reasons for rejections in order of frequency were rancid and molding fruit, blank shells, high moisture content, and blank shells disguised in quality supplies.

Collectors have thought that the factory quality requirements have become more stringent during the recent years. According to collectors, basis for long-term relations with factories from their side have been supply of quality crop, and from a factory side in a descending order of importance fair price, provision of transportation services, and allocation with operating cash.

Most of the collectors were not able to conclude whether competition has increased among factories.

Source of finance

The sources of operating cash for collectors included factory allotments, loans from financial institutions, own savings and loans from private individuals in order of descending order of frequency. Loan periods ranged between 7-36 months, and that of interest rates, between 1.8-2.5 %/month. In general, collectors used private property as a collateral when borrowing from financial institutions.

Competition

Most of the collectors thought that the number of fellow collectors has increased during the recent years due to profitability, and increase in the number of factories. Moreover, most of the collectors have thought that competition between collectors has increased because of increased demand on hazelnuts, and high revenue generation potential.

Source of market information

For the majority of collectors, the source of international market information has been factories. According to the collectors, prices were determined by factories, and they thought there was a limited effect of production and price levels in Turkey and in international markets on local prices. In general, collectors were not interested in developments in international markets.

c) Hazelnut processing factories/ exporters

Upstream market linkages

All factories have had established long-term business relations with hazelnut growers and collectors with the exception of one factory that did not maintain long-term business relations with collectors. Factories maintained lasting business connections by employing different approaches to hazelnut suppliers (table 10).

Factories sourced hazelnuts approximately from 400 growers and 19 collectors, and on average, every factory sourced hazelnuts in 25 villages. None of the factories has made purchases pre-harvest. Around 22 percent and 78 percent of total procurement were made at production/ collection sites and at a factory gate, respectively, and about 24 percent and 76 percent of total procurement were bought from farmers and collectors, accordingly. Factories allocated collectors with operating cash free of interest.

Usually, all exporters made payments for hazelnut supplies upon delivery. In addition, some factories practiced payments within 1-5 days after delivery, and only one used to make payments prior to a delivery.

Factory main quality requirements included adequate moisture content and size of nuts, crack and mechanically injury free surface of shell, absence of rot/ mold, adequate size of a kernel, and absence of blank shells.

Commonly, factories more frequently rejected deliveries made by collectors than to those made by farmers. On average, 30 percent and 6 percent of deliveries made by collectors and growers have been rejected by factories, accordingly.

The most important factors underlying rejections in an ascending order of frequency have been high moisture content, blank shells disguised in quality nuts, shrink kernels, rancid and molding fruit, and shells with surface defects.

According to the majority of surveyed factories (7), the number of collectors has increased during the recent years, while 3 thought that the number did not change. Stated reasons of increase in the number of collectors have been as follows: increase in hazelnut output, profitability and limited effort required, absence of tax obligations, good relations with factories, increased number of factories, and relatively easy access to operating cash. Seven exporters thought that the competition between collectors had increased, while three thought that it remained unchanged.

Based on surveyed exporters the quality of supplied hazelnuts remained either unchanged or deteriorated during the recent years. Factors underlying deterioration in the quality of supplies consisted of unfavorable weather conditions and poor production practices at farm level including poor drying.

Value addition

Major determinant of the duration of hazelnuts storage at factory premises has been the price level in export markets, and the period ranged from 2 to 70 days.

With the exception of two factories, all factories reported condition of their processing and storage premises to be adequate; former, have evaluated their processing and storage infrastructure as being below adequate conditions. With the exception of three factories, all exporters have stated that their processing and storage infrastructure to require improvements.

Value addition at factory-level included drying, cracking, peeling, sorting, packaging in jute bags, storage and management of moisture content (table 11).

Bought hazelnut price was the major component of total variable costs, and the labor cost had the smallest share in value addition cost. Transportation costs were mainly represented by outlays on international shipments (table 12).

Downstream market linkages

The major export destination markets have been EU member countries. The second largest market has been CIS, and small proportion of exports has been supplied to the Middle-East and Asian markets. The proportions of shelled and in-shell hazelnut exports in total hazelnut exports were around 95 percent and 5 percent, respectively. In-shell hazelnuts have been supplied to Iran, Turkey, Lebanon, China, Iraq, and to some members of CIS in Central Asia.

All exporters have had long-term established business relations with buyers in export markets. On average, every exporter supplied hazelnuts to 8 buyers in export markets. The proportions of end-user buyers and intermediaries have been roughly the same, but the share of former was slightly higher. Average price difference between end-user and intermediary prices in export markets has been approximately 0.4 EUR/kg. Table 13 presents factory views that have shaped long-term business relations with buyers in export markets.

Quality requirements of buyers in export markets included adequate moisture content and size of kernels, and absence of cracks and mechanical defects, rancid and molding fruits, and aflatoxin. Reportedly, shipments made by surveyed factories have never been rejected by international buyers.

Different factors have influenced price levels of Georgian hazelnuts in export markets including buyer negotiation power, general price levels in export markets, production output and price levels in Turkey, and a market power of international and Turkish traders and intermediaries.

Reportedly, buyer quality requirements in export markets have become more stringent (7 exporters), while 3 factories stated that the extent of requirements has not changed. Underlying reasons for increased requirements have been as follows: more stringent regulations in EU market, increased number of suppliers to EU market, increased number of end-users, and emergence of "new" pests/ diseases in major producer countries.

Competition

According to 6 exporters, the number of factories in Georgia involved in processing and export of

hazelnuts has increased, while the number remained unchanged and declined, according to 2 factories. Reported reasons of the increase in the number of factories have been increase in hazelnut output, high profit margin, and increased business linkages in EU markets; and underlying reasons for decline and no change in the number of exporters have been high risk, limited access to operating cash, and price fluctuation in export markets.

Majority of factories thought that in parallel to the increase in the number of exporters, competition between factories has also increased, three thought that competition level remained unchanged, and only one thought that it has declined. Reportedly, factories have been competing on price and have been trying to establish business relations with end-users.

Access to finance

All exporters, with the exception of one factory, borrowed from the banks for operating cash; the latter has reinvested profits. Loan period was from 8 to 12 months, and average monthly interest rate was 0.83 percent. As a collateral factories used their own private and business assets.

Source of international market information

The sources of international market news for exporters have been internet, private business connections, other exporters, intermediaries, and traders.

d) Gross, marketing and distribution margins

Table 14 presents gross, marketing and distribution margins of farmers, collectors and exporters based on July 2014 – January 2015 prices.

Results indicated that the highest gross margins were generated by growers (14.25 GEL/kg), followed by exporters (1.36 GEL/kg) and collectors (0.23 GEL/kg) in descending order.

Marketing margin estimates showed percentage of the final weighted average selling price taken by growers, collectors, and exporters. The major proportion of marketing margin was taken by growers (90 percent), followed by exporters (9 percent) and collectors (1 percent) in decreasing succession.

Estimates of distribution margins demonstrated proportions of profit taken by exporters and collectors; exporters have taken the major share of total profits beyond farmer level. They have received a share of 88 percent in the distribution margin, while collectors – 12 percent.

e) Technical efficiency

The maximum likelihood estimates of determinants of technical inefficiency are presented in Table 15.

Hypothesis testing on appropriateness of the model

Both, the first and the second null hypothesis that (1) technical efficiency effects are absent in the model, and (2) that these inefficiency effects are not stochastic are rejected at 1 percent significance level, each.[5]

Results

The inputs in the stochastic frontier, capital and labor, are significant at the 1 percent level[6], and the signs are as expected. Both, capital and labor are positively associated with hazelnut output.

All coefficients in inefficiency model are significant at the 5 percent level. The negative signs of the drainage in hazelnut orchards (DRAINAGE), hazelnut tree nutrition (NUTRITION), and household size (HHSIZE)[7], are inversely related with inefficiency, implying that more family labor input, and implementation of measures against waterlogging in hazelnut orchards and improved nutrition of hazelnut trees would positively contribute to technical efficiency.

[5] The source of the critical values for both the first and the second null hypothesis tests are Kodde and Palm (1986). In the first null hypothesis estimates of likelihood ratio value (λ) of the model test statistics is 33.7 (df=5), and that in the second null hypothesis test is 10.7 (df=1). In these tests degrees of freedom (df) are the number of restrictions.

[6] The source of critical values of inputs in stochastic and inefficiency models are z-tables

[7] an increase in the number of members in the family could increase technical efficiency if it results in increased labor devoted to hazelnut production given high labor intensive nature of hazelnut production

Obtained technical efficiency estimates ranged between 14-93 percent, and average technical efficiency score was 56 percent with 0.21 standard deviation (figure 2).

The estimate of the average technical efficiency score implies that hazelnut output can be increased by 44 percent with the use of same level of inputs and improving management practices.

Derived variance parameter (γ), 0.91, indicates that 91 percent of variation among hazelnut growers performance can be explained by technical inefficiency.

Partial elasticity coefficients of capital and labor are positive and inelastic, and total 0.43 percent and 0.09 percent, respectively. For each, capital and labor, results show that 1 percent increase in capital and labor would lead to less than proportional increase in hazelnut output. The returns to scale coefficient that is the sum of partial elasticities, and is 0.52, indicates on decreasing returns to scale - less than proportional increase in hazelnut output by 1 percent increase in capital and labor.

Conclusions and policy implications

The objective of the study was to estimate technical efficiency in hazelnut production, and identify socio-economic factors that influence technical efficiency levels. The study has estimated production frontier jointly with technical inefficiency model by a maximum likelihood approach. Estimate of technical efficiency level was 56 percent. The results of the study revealed that availability of family labor input, implementation of measures against waterlogging in the orchards, and improved nutrition of hazelnut trees to be significant factors that influence efficiency. Results of the study have important policy implications. The study recommends policy makers to promote and institute transparency in pricing, to improve outreach of need-based extension, and improve access of hazelnut growers to production inputs and finances.

Annex

Table 1. Age, household size, and education level

	mean	std	min	max
Age	50.4	12.9	21	76
HH size	4.0	1.7	1	11
Man	2.2	1.0	1	6
Woman	2.0	1.0	1	6
Education				
HH head				
Higher (y=1; n=0)	50%	0.5		
Professional (y=1; n=0)	20%	0.4		
Secondary (y=1; n=0)	40%	0.5		
Spouse				
Higher (y=1; n=0)	30%	0.5		
Professional (y=1; n=0)	10%	0.3		
Secondary (y=1; n=0)	40%	0.5		

Source: 2016 Field Survey, estimates

Table 2. Availability, accessibility and the level of content

	Availability			Accessibility			Level of content		
	P	A	G	P	A	G	P	A	G
Production inputs (y=1; n=0)									
Mean	45%	41%	11%	40%	44%	8%	14%	37%	43%
Std	0.5	0.5	0.3	0.5	0.5	0.3	0.4	0.5	0.5
Extension (y=1; n=0)									
Mean	35%	45%	16%	30%	33%	25%	25%	30%	34%
Std	0.5	0.5	0.4	0.5	0.5	0.4	0.4	0.5	0.5
Agriculture loans (y=1; n=0)									
Mean	48%	30%	11%	47%	27%	12%			
Std	0.5	0.5	0.3	0.5	0.4	0.3			
Drying service (y=1; n=0)									
Mean	72%	15%	9%	67%	12%	11%	12%	16%	62%
Std	0.5	0.4	0.3	0.5	0.3	0.3	0.3	0.4	0.5
De-husking service (y=1; n=0)									
Mean	19%	41%	39%	16%	27%	56%	59%	23%	16%
Std	0.4	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.4
Quality storage (y=1; n=0)									
Mean	68%	16%	14%	60%	10%	18%	21%	6%	60%
Std	0.5	0.4	0.3	0.5	0.3	0.4	0.4	0.2	0.5

Source: 2016 Field Survey, estimates

Table 3. Sources of recommendations

	Own	Family	Friends, etc.	Extension	Input supplier	other
Drainage						
mean	44%	5%	3%	10%	0%	4%
std	0.5	0.2	0.2	0.3	0.0	0.2
Weed control						
Mean	65%	4%	3%	11%	2%	9%
Std	0.5	0.2	0.2	0.3	0.1	0.3
Manure application						
mean	52%	8%	3%	2%	1%	4%
std	0.5	0.3	0.2	0.1	0.1	0.2
N fertilizer application						
mean	59%	6%	4%	13%	1%	9%
std	0.5	0.2	0.2	0.3	0.1	0.3
C fertilizer application						
mean	42%	1%	4%	17%	0%	4%
std	0.5	0.1	0.2	0.4	0.0	0.2
Measures against diseases, et al.						
mean	35%	1%	4%	23%	1%	7%
std	0.5	0.1	0.2	0.4	0.1	0.3
Harvest						
mean	86%	7%	4%	6%	1%	6%
std	0.5	0.3	0.2	0.2	0.1	0.2
Post-harvest handling						
mean	74%	6%	6%	9%	1%	4%
std	0.4	0.2	0.2	0.3	0.1	0.2

Source: 2016 Field Survey, estimates

Table 4. Production and marketing impending factors

Production Impending		Marketing Impending	
Wind	84%	Price fluctuation	74%
Drought	41%	Everyday cash needs	20%
N fertilizer price	30%	Buyer quality requirement	19%
Herbicide price	28%	Limited market information	12%
C fertilizer price	27%	Limited competition among buyers	8%
Waterlogging	23%	Buyer power	6%
Pesticide price	20%	Other	4%
K& E	17%		
Other	16%		
N fertilizer quality	12%		
C fertilizer quality	11%		
Rain	11%		
Herbicide quality	6%		
Pesticide quality	6%		

Source: 2016 Field Survey, estimates

Table 5. Hazelnut nutrition

	mean	std	min	Max
Manure application (y=1; n=0)	69%	0.5		
Frequency of application (appl/ # year)	2	1	1	6
Application rate (kg/tree)	24	16	5	100
N fertilizer application (y=1; n=0)	83%	0.4		
Frequency of application (#/ year)	2	0.6	1	4
Application rate (kg/tree)	0.41	0.3	0.1	2
C fertilizer application (y=1; n=0)	62%	0.5		
Application rate (kg/tree)	0.41	0.2	0.05	2

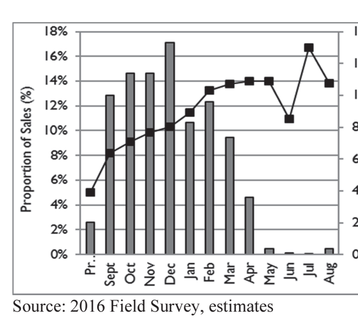
Source: 2016 Field Survey, estimates

Table 6. Labor input and composition

Activity	Activity in % of total labor	Hired labor in % of total labor	Female labor in % of total labor
Pruning/ Shaping	18%	21%	9%
Drainage	5%	15%	3%
Weed control	9%	3%	5%
Nutrition	5%	15%	9%
Diseases et al.	3%	9%	4%
Harvest	40%	44%	54%
Drying	12%	0.13%	5%
De-husking	7%	10%	45%
Marketing	2%	7%	20%

Source: 2016 Field Survey, estimates

Figure 1. Monthly prices and disposition



Source: 2016 Field Survey, estimates

Table 7. Hazelnut Grower Gross Margin Estimates

	Output Adjusted		Output not Adjusted	
	GEL/kg	Percent	GEL/kg	Percent
Costs imputed	5.61	66%	6.00	71%
Costs reported	7.38	87%	7.51	89%

Source: 2016 Field Survey, estimates

Table 8. Components of Total Unit Variable Costs

	Output Adjusted		Output not Adjusted	
	GEL/kg	Percent	GEL/kg	Percent
Costs Imputed				
Labor	1.39	48%	1.2	48%
Inputs	1.33	46%	1.14	46%
Services	0.13	4%	0.11	4%
Transport	0.05	2%	0.04	2%
Total	2.9	100%	2.49	100%
Costs Reported				
Labor	0.51	45%	0.44	45%
Inputs	0.47	41%	0.4	41%
Services	0.11	10%	0.09	10%
Transport	0.05	4%	0.04	4%
Total	1.13	100%	0.97	100%

Source: 2016 Field Survey, estimates

Table 9. Collector Total Variable Cost Breakdown

	Total Variable Cost	
	GEL/kg	%
Hazelnut procurement	8.51	99.76%
Transportation cost	0.01	0.14%
Labor cost	0.01	0.10%
Total	8.53	100.00%

Source: 2016 Field Survey, estimates

Table 10. Employed approaches for the lasting business relations in order of importance

Market Actor	Factors
with Farmer	Premium on quality of supplied hazelnuts; transparency in weighting; pre-payment; premium on volume of supplied hazelnuts; transportation service
with Collector	Cash allocation for hazelnut procurement and collection

Source: 2016 Field Survey, estimates

Table 11. Hazelnut processing costs, GEL/ton

	Drying	Cracking	Peeling	Bagging	Storage
Mean	53	53	25	6	5
Stdev	35	17	20	2	
Min	35	45	13	5	5
Max	150	100	60	10	5

Source: 2016 Field Survey, estimates

Table 12. Factory Total Variable Cost Breakdown

	Total Variable Costs	
	GEL/kg	Percent
Labor	0.002	0.02%
Transportation	0.14	1.53%
Processing	0.15	1.65%
Hazelnut procurement	8.63	97%
Total	8.92	100%

Source: 2016 Field Survey, estimates

Table 13. Factors that Shaped Long-term Business Connections

Actor	Contributing Factors
Exporter/ factory side	Fulfillment of contract terms and conditions: quality, time of delivery, volume, packaging, etc.
Export market buyer side	Timely payments; sharing of transportation cost; pre-payment; facilitation to the establishment of market linkages

Source: 2016 Field Survey, estimates

Table 14. Gross, Distribution and Marketing Margins

Actor	Item	Unit	Value
Exporter/ factory	Sales price	GEL/kg	24.00
	Buy price	GEL/kg	21.91
	Processing cost	GEL/kg	0.72
	Gross margin	GEL/kg	1.36
		%	6%
	Marketing margin	%	8.70%
	Distribution margin	GEL/kg	2.09
		%	88.00%
Collector	Sales price	GEL/kg	21.91
	Buy price	GEL/kg	21.63
	Handling cost	GEL/kg	0.05
	Gross margin	GEL/kg	0.23
		%	1%
	Marketing margin	%	1.19%
	Distribution margin	GEL/kg	0.28
		%	12.00%
Grower	Sales price	GEL/kg	21.63
	Production cost	GEL/kg	7.38
	Gross margin	GEL/kg	14.25
		%	66%
	Marketing margin	%	90.11%

Source: 2016 Field Survey, www.agra-net.com, estimates

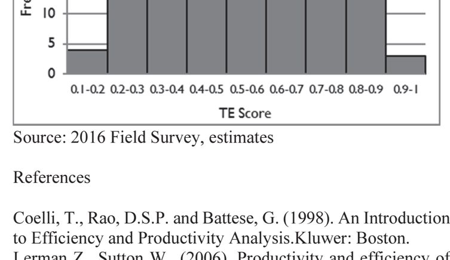
Table 15. Technical efficiency from Cobb-Douglas frontier production function[8]

Variable	Parameter	Coefficient
Stochastic Frontier Intercept	β_0	4.47*
lnCAPITAL	β_1	0.43*
lnLABOR	β_2	0.09***
Inefficiency model Intercept	δ_0	1.71*
DRAINAGE	δ_1	-0.47***
NUTRITION	δ_2	-0.59***
HHSIZE	δ_3	-0.11***
Sigma squared 0.33*** Gamma 0.91* Lambda 33.7*		

Source: 2016 Field Survey, estimates

[8] * - significant at p<0.001; ** - significant at p<0.01; *** - significant at p<0.05

Figure 2. Technical Efficiency Estimates



Source: 2016 Field Survey, estimates

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