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Factors influencing peach farmer income in the province of Tungurahua, Ecuador

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ABSTRACT: Tungurahua province has conditions suitable for growing deciduous fruit trees such as peach (*Prunus persica* L). This research aimed to identify the main factors influencing the production of this fruit crop and their effect on farmers income. Surveys were carried out directly to peach farmers in seven counties of Tungurahua such as Ambato, Cevallos, Mocha, Patate, Pelileo, Píllaro and Tisaleo. The results indicated that the most relevant factors were: farmer age, sown area, fruit selection, reason for fruit growing, type of production and production issues.

KEYWORDS: Fruit crop, income, profitability, *Prunus persica*, yield.

Factores que influyen en el ingreso de los productores de durazno en la provincia de Tungurahua, Ecuador

RESUMEN: La provincia de Tungurahua posee condiciones adecuadas para cultivar frutales caducifolios como el durazno (*Prunus persica* L.). Esta investigación tuvo como objetivo identificar los principales factores que influyen en la producción e inciden en la generación de ingresos económicos al agricultor. Encuestas fueron realizadas directamente a los productores de durazno en siete cantones de Tungurahua como son Ambato, Cevallos, Mocha, Patate, Pelileo, Píllaro y Tisaleo. Los resultados indicaron que los factores más relevantes fueron: edad del productor, superficie sembrada, selección de la fruta, razón para cultivar frutales, tipo de producción e inconvenientes de producción.

PALABRAS CLAVE: Frutal, ingresos, *Prunus persica*, rendimiento, rentabilidad.

JEL Classification/Clasificación JEL: Q10, Q11, D24, D31, Q13.

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1. Introduction

In the last decades, research on factors involved in fruit production systems has been focused on generating greater productivity in order to obtain results that allow farmers to continue the cultivation process without leaving aside the fruit quality (Larqué *et al*., 2009).

In Ecuador, since colonial times, peaches have been cultivated in the high valleys of the highlands by traditional management. The most important zone for this fruit crop is Tungurahua which has a total of 11,361 ha dedicated to permanent fruit crops, of which 457 ha exclusively grow peaches and 1,441 ha are associated with other crops (SINAGAP, 2012). Peach is the second most important deciduous fruit crop after the apple.

Deciduous fruit trees, such as peach, are classified as being of great economic importance in local and international markets due to their high profitability (Puentes, 2006); however, farmer income depends on fruit yield and currently, this fruit crop has a yield of 16.19 t ha^{-1} which is considered low given the fact that with adequate agronomic management peach can reach yields between 20 and 25 t ha^{-1} (INIAP, 2008). In Tungurahua, the average yield obtained is higher than the one reported in Mexico (around 4 to 6 t ha^{-1}) (Larqué *et al.,* 2009), but lower than the yield reported in Colombia (20 t ha^{-1}) (Puentes *et al.,* 2008).

In the last five years, Ecuador has imported approximately 27,000 ton of peach fruit mainly from Chile, Peru, United States of America and Spain, which represents an expense of around 22.5 millions of American dollars (BCE, 2017).

The objective of this research was to identify the main cropping and harvesting management factors influencing peach production and their effect on the income of farmers from Tungurahua.

2. Methods

2.1. Regional framework of the study area

Tungurahua province is located in the inter-Andean valley in the central area of Ecuador. It has an area of 3,369 km^2 made up of nine counties (Ambato, Baños de Agua Santa, Cevallos, Mocha, Patate, Pelileo, Píllaro and Tisaleo) and 53 parishes. This province presents climatic conditions suitable for peach growing. The sites where peach is cultivated have a height above 2,500 masl, average temperature between 16º and 17º C, annual precipitation between 400 to 1,000 mm, and relative humidity of 50 to 85 % (INIAP, 2008).

2.2. Description of the survey

A survey consisting of 53 questions related to family composition, agricultural activities, use of technology, postharvest management, technical assistance, pest incidence, production costs, commercialization and income was carried out with peach producers in order to obtain information about farmer income. Surveys was carried out from September to December of 2016, and they were done directly to small peach farmers who were adult (more than 25 years old), had a sown area until 2 ha, stable tree production (crops with 3 or more years old) and obtain incomes from fruit sale.

2.3. Sample size

Surveys were carried out in seven counties of the province of Tungurahua (Figure 1) where peach is grown. Sample size (n) was determined using the following formula (Levi and Lemeshow, 2008):

$$n = \frac{N Z_{\alpha} S^2}{\delta^2 (N - 1) + Z_{\alpha} S^2} \qquad [1]$$

Where:

N: Total size of study population (N=4,000).

Z_{α}: Desired confidence level (1-α/2=95 %) according to the normal distribution (Z_{α}=1.96).

δ: Maximum allowable error between point estimate and actual value δ=180.

S^2: Estimated variance of the analyzed variable (estimated from the maximum range of the analyzed variable: R).

$$R = X_{max} - X_{min} \qquad [2]$$

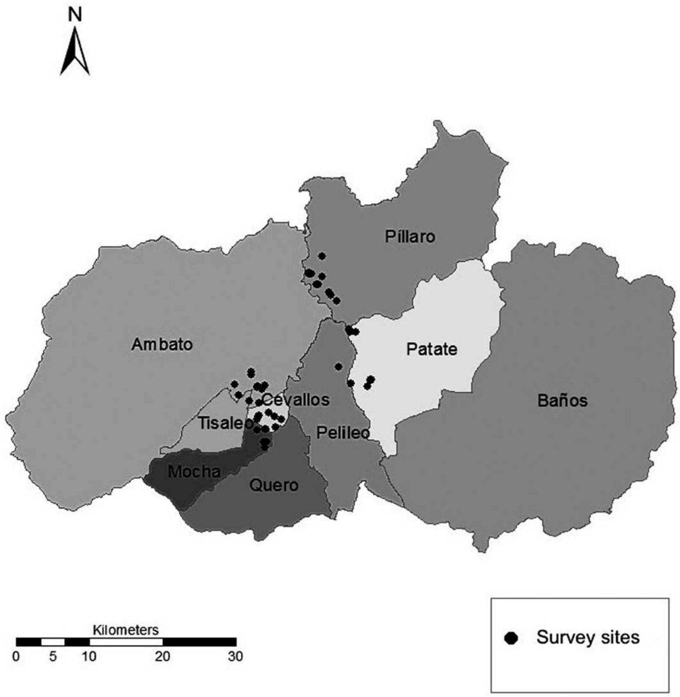
When the variable followed a normal distribution, the difference between the maximum and minimum data was about ± 2σ, therefore the standard deviation of each variable could be estimated from a range R= 2,800 (value previously obtained based on a survey of 10 producers):

$$S = \frac{R}{4} \qquad [3]$$

Thus *n* was estimated in 58 production units which were distributed according to the representative production areas.

MAP 1

Sampling areas in the province of Tungurahua



Source: Own elaboration.

2.4. Statistical Analysis

The regression model described the relationship between the variable response (income) and the set of variables X_1, X_2, X_3,...,X_p that represented the independent predictors with some linear relationship with the dependent variable. It is common that many of the variables used in a multiple regression model are not associated with the response variable. This means setting the regression terms (coefficients) at zero value, and thus obtaining a model that is more easily interpretable (Muller and Fetterman, 2002). To carry out this exclusion, the technique of least squares for the estimation of coefficients was used and a stepwise selection procedure was incorporated in order to obtain a more parsimonious linear model (Markovsky and Van Huffel, 2007). This method also involved identifying a subset of variables related to the net farmer income.

The regression model can be expressed with the following formula:

$$Y = \beta_0 + \beta_0 X_1 + \ldots + \beta_p X_p + \varepsilon \quad [4]$$

Where:

Y = net income of farmer (absolute value USD)

β = regression coefficients

X = independent variables that explain the statistical model.

Independent variables recorded were classified according to geographic information (location (county), altitude (m), temperature (°C) and precipitation (mm)); demographic information (farmer age (years), level of education (elementary, high school, university) and number of family members (units)); production system (sown area (m^2), harvest indicators (fruit color and flavor), fruit storage (yes or no), fruit selection (yes or no), main activity of the farmer (job), dedication time to fruit growing (hour per week), reason for fruit growing (crop knowledge, profitability, tradition), type of orchard (monoculture, associated), type of production (conventional, organic and combined), irrigation (yes or no), production issues (climatic conditions, training, commercialization, imports, pests) and causes for production losses (fruit rot, excess maturity, postharvest management)); property (land ownership (yes or no)); and access to technical support (technical assistance (yes or no) and associativity (yes or no)). These kind of variables have been applied in other studies (Herforth *et al.,* 2015).

It is recommended to include as predictors or factors involved in the development of a variable those that present a level of linear association with the variable within a level of significance equal or lower than 10 %. Association tests were performed using simple linear regression tests for quantitative variables (t-value for regression coefficient and p-value for decision) and one-way ANOVA for qualitative variables (F test and decision p-value). Data obtained were analyzed using the statistical software R version 3.1.0.

3. Results and discussion

3.1. Statistical Model (ANOVA)

Twenty-nine variables were analyzed but the ANOVA detected statistical significance for only six factors that were directly influencing income generation (Table 1).

The associative analysis of the variables (Table 2) showed how much each factor was influencing in the farmer income after the selection procedure.

TABLE 1

Analysis of variance (ANOVA) for the 29 variables analyzed

Variables	F-value	p-value
Geographic information		
County location	0.92	0.47 ns
Altitude	0.25	0.62 ns
Temperature	1.47	0.23 ns
Precipitation	0.01	0.93 ns
Demographic information		
Farmer age	3.86	0.05*
Level of education	1.84	0.17 ns
Number of family members	0.08	0.78 ns
Production system		
Sown area	7.24	0.008**
Harvest indicators	0.52	0.47 ns
Fruit storage	0.06	0.81 ns
Fruit selection	3.68	0.06*
Main activity of the farmer	0.32	0.81 ns
Dedication time to fruit growing	1.02	0.32 ns
Reason for fruit growing	6.52	0.002**
Type of orchard	0.80	0.37 ns
Type of production	2.70	0.07*
Irrigation	0.26	0.61 ns
Production issues	1.99	0.10*
Causes for production losses	0.30	0.96 ns
Property		
Land ownership	0.62	0.54 ns
Access to technical support		
Technical assistance	0.41	0.52 ns
Associativity	0.03	0.87 ns

*Significant, **highly significant, ns not significant.
Source: Own elaboration.

TABLE 2

Regression coefficient of the variables that affect the income of peach producers

Variable	Regression coefficient (β)	Standard deviation	t-test	p - value
Farmer age	-42.50	± 20.32	-2.09	0.039*
Sow area	0.07	± 0.02	3.35	0.001**
Fruit selection	1,097.04	761.53	1.44	0.152ns
Reason for fruit growing (Profitability)	-1,220.12	2,082.15	-0.59	0.559ns
Reason for fruit growing (Tradition)	-2,476.34	822.02	3.01	0.003**
Type of production (Chemical)	1,588.32	637.03	2.49	0.014*
Type of production (Organic)	-573.97	807.51	-0.71	0.478ns
Media = 4,985.02 USD				
$R^2 = 0.25$				

*Significant, **highly significant, ns not significant
Source: Own elaboration.
Note: The sign (positive or negative) of the value of β indicates the trend in USD.

In terms of farmer age, a negative trend could be observed, indicating that for each year of increase in age, income decreases by an average of 42.50 USD. This effect is related to the fact that the capacity to carry out fieldwork is reduced with increased age because peach farmers in the province of Tungurahua had an age range between 28 and 87 years old. It means that 85 % of the labor force is made up of farmers who are over 50 years old and 51 % of them belong to the group denominated "old age" (> 65 years old). Larqué *et al.* (2009) affirmed that the age of the producer is the main determinant for the agronomic practices and this represents an impact on the yield of the crop.

In terms of sown area, for every square meter that the area of crop increases, there will be a profit of 0.07 USD. Currently, peaches are grown in small productive units (mostly less than 0.5 ha), which is similar to the situation in other countries such as Colombia (Puentes *et al.,* 2008) and Mexico (Larqué *et al.,* 2009). The later author mentions that the size of the orchard affects crop production.

Fruit selection was a factor that showed a positive trend, which indicates that farmers who carry out this practice will obtain better sales income. This coincides with findings established by Larqué *et al.* (2009) who determined that fruit showing high quality (selected fruit) is a technical aspect that affects commercialization in peach production. A prior fruit selection, mainly based on size, contributes to the negotiation in obtaining a better price (Larqué *et al.,* 2009). In this study, approximately 85 % of the farmers perform fruit selection.

It was determined that one of the main reasons for maintaining peach orchards is tradition (inherited orchards). This, however, has a negative effect because orchards may lack adequate agronomic management, which affects production and the monetary income decreases, a trend which also mentioned by Aular and Casares (2011).

In this study, three types of production were identified: a conventional type which uses exclusively agrochemicals, an organic type which uses fertilizers from animal or vegetal origin and also biological products, and a combined type which use both chemical pesticides (in low percentage) and organic agricultural supplies. The combined type was predominant (67 %); while the organic type was observed in 12 % of the farms, and the conventional type in 20 %. There was a positive influence on increasing incomes with conventional management because agrochemicals produce short-term results in the crop; whereas a negative trend was observed in the organic type because it requires an exclusive target market.

Production issues were not chosen in the joint model but the individual analysis (ANOVA) showed statistical significance. Two main production issues were identified influencing negatively farmer income, coinciding with what was found by Aular and Casares (2011). They were: the lack of training, where farmers with out enough training lose 2,850 ± 1,658 USD; and the incidence of pests which cause a loss of 2,163 ± 847 USD. Larqué *et al.* (2009) mention that training is a predominant factor in increasing peach crop productivity and thus farmer income. In Ecuador, various pathogens have been reported as affecting peach fruit (Abata *et al.*, 2016a; 2016b) and consequently producing fruit losses and reducing the income.

4. Conclusion

Among deciduous fruit, peach has an important role in the cultivated area of Tungurahua province, therefore farmers grow this fruit crop to obtain incomes. The main factors affecting farmer income in peach production were: farmer age, sown area, fruit selection, reason for fruit growing, type of production and production issues. Strategies to improve peach farmer income should take into account these factors in order to make this crop more profitable in Ecuador. For example, the use of higher plant densities may help to overcome the farm size problem. In addition, crop and harvest management technologies have to be transferred (training) and adopted by local farmers to enhance pest control and improve plant productivity and thus increase crop profitability. Finally, there is a need of younger workforce in the production system to optimize the field labor. These recommendations jointly with a better marketing system may help to increase competitiveness in this agricultural sector in Ecuador.

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