

Technological Inclusion in Small Coffee Plantations in the South of the State of Minas Gerais, Brazil

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Received: February 21, 2021 Accepted: March 25, 2021 Published: March 26, 2021

doi:10.5296/jas.v9i2.18328

URL: <https://doi.org/10.5296/jas.v9i2.18328>

Abstract

World market is increasingly expanding in food production. Coffee has been underscored within the new scenario and positively impacts the economy of the country, together with other crop types. Current analysis assesses the insertion index of new technological resources and the fastness of the production process of coffee culture on small coffee plantations in the south of the state of Minas Gerais, Brazil. Field study comprised the analysis of 225 farms by an open and closed questionnaire. Data, analyzed by cluster analysis, revealed that small farms have invested in technologies and data access technology for harvest and production processing. Corroborating other scientific investigations, the above activity decreased the

labor force and consequently triggered an increase in profits for small producers.

Keywords: small producers of coffee, production process, technological resources

1. Introduction

World market is making every effort to supply increase in the demand for food products, and entrepreneurs and producers are eager to attend requirements for quality food through all the available methodologies possible (Nitzke et al., 2012; Ramos et al., 2015; Sedyama et al., 2014). Coffee production process in the southern region of the state of Minas Gerais, Brazil, has endeavored to comply with international standards in coffee production (Pereira et al., 2010). As an indirect result of the process, the coffee market has propped Brazilian economy, together with other agricultural products (Barra & Ladeira, 2016; Dos Santos et al., 2009).

The coffee production region, comprising Machado, Poço Fundo and other neighboring towns in the south of the state of Minas Gerais, has been in the limelight since it is mostly composed of small-sized farms which financially depend on their own production (Frederico, 2013; Frederico; Barone, 2015; Vilela; Rufino, 2010, Cunha and Putti, 2020; Cunha et al., 2017, Gabriel Filho et al., 2017).

Owing to the market's technological evolution, small producers must be in constant evolution to follow state-of-the-art technology. Technological investment has been underscored as the great strengthener in the fastness of the production process and of increase in profits, mainly with regard to decrease in production costs (Amarasinghe et al., 2015; De Assis Silva; et al., 2011; Lima et al., 2016; Perdoná et al., 2012; Ramalho et al., 2016; Rosa et al., 2010; Santinato et al., 2016; Xia et al., 2015). Further, the monitoring of pests which are abundant in the country's coffee plantations also make possible fast control action in the culture (Alves et al., 2011; Lopes et al., 2012).

Current investigation analyzes small coffee farms in the above region with regard to the implementation of new technologies in the coffee production process.

2. Method

The methodology employed in current field study (Gil, 2002) comprised a questionnaire with 22 open and closed questions, for data collection, based on themes indicated by a bibliographic survey. The questionnaire was submitted to the Committee for Ethics of the José do Rosário Vellano University (UNIFENAS) and approved by Protocol 62778216.8.0000.5143.

The geographic area was limited to the southern region of the state of Minas Gerais and comprised the following towns: Alfenas, Andradas, Bandeira do Sul, Boa Esperança, Botelhos, Cabo Verde, Campestre, Carvalhópolis, Guaxupé, Jacutinga, Machado, Nepomuceno, Paraguaçu, Poço Fundo, Poços de Caldas, São João da Mata, Silvianópolis and Turvolândia (Figure 1).

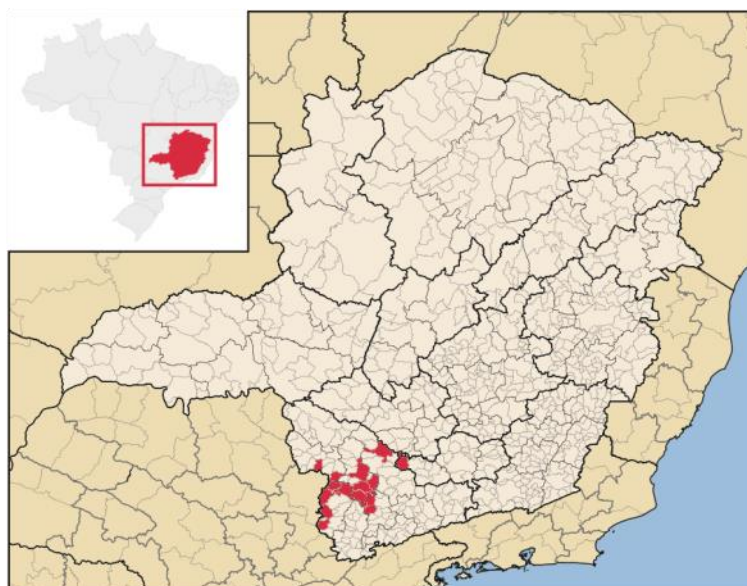


Figure 1. Map of the state of Minas Gerais with the municipalities in which the farms were evaluated

2.1 Analysis of the Discriminating Cluster

Cluster analysis was performed to group sampling items and groups with different characteristics. Similar objects are grouped in this type of analysis. For each sampling unit j , there is a vector of rates X_j , with p = variables (Mingoti, 2013).

$$X_j = [X_{1j}, X_{2j}, \dots, X_{pj}] \text{ with } j = 1, 2, 3, \dots, n.$$

Where X_{ij} is the rate for i measured in sampling object j . Data are transformed according to Euclidian measurements (Mingoti, 2013) and the hierarchical methodology of K-averages was taken into account (Krebs, 1999; Souza & Souza, 2006).

2.2 Analysis of Co-relationship

Pearson's co-relation was employed for a positive or negative relationship between the two elements, at 5% significance.

3. Results and Discussion

Data were presented by four different methodologies: analysis of variables (producer's primary characterization, the farm, type of coffee produced); Pearson's co-relationship of variables; class analysis; cluster (groupings) analysis. Sample comprised 225 filled questionnaires, although, according to the assay's scheme, not all questions were taken into account.

3.1 Initial Analysis of Data

Data on the coffee producer in the region under analysis comprise: age (32.44%, over 54 years old; 16.44%, between 36 and 41 years old; 14.67%, between 42 and 47 years old; 13.33%, between 30 and 35 years old; 12.45%, between 48 and 53 years old; 10.67%, below

29 years old); schooling level (47.56%, basic schooling; 28%, high school; 14.22%, undergraduate degree; 10.22%, postgraduate degree); technical training in agriculture (66.22% do not have any training in agriculture; 33.78% have some sort of training).

Most producers interviewed had low schooling level, coupled to low technical training in agriculture. The above is highly important since specialized technical knowledge within the farm's administration process is mandatory (Nagaoka et al., 2011). The age of most interviewed people is an item that should be underscored, namely, (32.44% were over 54 years old). In fact, they experienced several different events especially with regard to changes in sanitary rules that guide the coffee-producing market (Pereira et al., 2010).

Results on the farms under analysis revealed the following facts: farm size (44.44% of the farms were over 9 ha; the size of 25.33% varied between 3 and 6 ha; 17.33% varied between 1 and 3 ha; 12.9% varied between 6 and 9 ha). External consulting services were used by 53.78% of producers; 51.56% were not connected with the Internet; 48.44% were connected; 81% of producers monitored crop pests; 16% did not; 3% did not answer the question. Monitoring periodicity was executed by 50% between 3 to 6 months; 28% monitored every 30 days; 21% once a year; 1% did not answer).

Farms under analysis could be characterized as small, according to current norms (Inkra, 2013), although most owners highly considered specialized consulting services. Farm monitoring was given great care, corroborating with research that underscore such control for the success of the enterprise (Prado & Dorneles Junior, 2015).

The culture system and the plantation of other crops together with coffee were also assessed. In fact, 86.23% of farms deal with conventional culture system; 8.44% deal with organic crop system; 4% featured a mixture of organic and conventional system; 1.33% identified their type of crop system as ecological, possibly referring to an agricultural-forest system (De Souza et al., 2014). Data corroborate research that identifies the conventional production system as the most used model in Brazil since the 19th century (Lopes et al., 2012). Intercropping comprised beans, corn, banana, soybean, yams, oil, tobacco, papaya, graviola, passion flower, honey and roses. Cultures actually increased family earnings or one's own consumption.

3.2 Relationship Between the Variables

A further perspective of the analysis, assessment was performed following Pearson's co-relationship (Table 1).

Table 1. Matrix of Pearson's co-relation with regard to questions proposed

	Age	Area	Schooling	Agricultural Training	Consulting Service	Access to Internet	Crop System	Hired workers	Automated harvest	Coffee Drier	Coffee washer	Coffee Pulper	Pest Monitoring	Frequency of Monitoring	Recommended Dosage	Form of Application	PPEs usage	Intoxication Problem	Package return	Knowledge on NR31
Age	1	0.129	-0.109	0.186	-0.032	0.230	0.159	0.054	-0.066	0.101	0.019	-0.068	0.020	0.066	0.080	0.037	-0.042	-0.086	-0.012	0.070
Area	0.129	1	0.301	-0.055	-0.098	-0.083	0.055	0.463	-0.007	-0.360	-0.467	-0.203	-0.164	-0.229	-0.016	-0.073	0.030	-0.012	-0.081	-0.080
Schooling	-0.109	0.301	1	-0.438	-0.032	-0.142	0.028	0.463	-0.143	-0.192	-0.239	-0.194	-0.199	-0.157	0.009	-0.005	-0.015	0.065	-0.024	-0.131
Agricultural Training	0.186	-0.055	-0.438	1	-0.035	0.173	-0.080	-0.175	0.116	0.052	0.101	-0.003	0.110	-0.004	0.024	0.084	-0.024	-0.003	0.028	0.215
Consulting Service	-0.032	-0.098	-0.032	-0.035	1	0.114	0.089	-0.051	0.002	0.183	0.150	0.105	0.099	0.130	0.051	0.077	0.063	-0.056	0.076	0.127
Access to Internet	0.230	-0.083	-0.142	0.173	0.114	1	0.034	-0.098	0.017	0.144	0.107	0.062	0.050	0.057	-0.007	0.010	0.026	-0.103	-0.007	0.255
Crop System	0.159	0.055	0.028	-0.080	0.089	0.034	1	0.047	-0.075	0.002	-0.063	-0.030	-0.182	0.024	0.000	-0.045	-0.058	-0.145	-0.148	-0.037
Hired workers	0.054	0.463	0.463	-0.175	-0.051	-0.098	0.047	1	-0.303	-0.310	-0.420	-0.305	-0.168	-0.144	-0.019	-0.029	0.038	0.045	-0.014	-0.129
Automated harvest	-0.066	-0.007	-0.143	0.116	0.002	0.017	-0.075	-0.303	1	0.120	0.212	0.200	0.119	0.103	0.077	0.074	0.007	0.044	0.069	0.196
Coffee Drier	0.101	-0.360	-0.192	0.052	0.183	0.144	0.002	-0.310	0.120	1	0.495	0.233	-0.013	0.201	0.110	0.109	-0.025	-0.187	0.162	0.217
Coffee washer	0.019	-0.467	-0.239	0.101	0.150	0.107	-0.063	-0.420	0.212	0.495	1	0.394	0.090	0.122	0.033	0.180	-0.017	-0.117	0.100	0.212
Coffee Pulper	-0.068	-0.203	-0.194	-0.003	0.105	0.062	-0.030	-0.305	0.200	0.233	0.394	1	0.122	0.170	0.053	-0.133	0.057	-0.050	0.042	0.070
Pest Monitoring	0.020	-0.164	-0.199	0.110	0.099	0.050	-0.182	-0.168	0.119	-0.013	0.090	0.122	1	0.000	0.215	0.015	0.135	-0.085	0.134	0.116
Frequency of Monitoring	0.066	-0.229	-0.157	-0.004	0.130	0.057	0.024	-0.144	0.103	0.201	0.122	0.170	0.000	1	-0.017	0.215	-0.017	1	-0.047	0.020
Recommended Dosage	0.080	-0.016	0.009	0.024	0.051	-0.007	0.000	-0.019	0.077	0.110	0.033	0.153	0.215	-0.017	1	-0.047	0.020	-0.219	0.136	0.070
Form of Application	0.037	-0.073	-0.005	0.084	0.077	0.010	-0.045	-0.029	0.074	0.109	0.180	-0.133	0.015	0.081	-0.047	1	-0.025	-0.032	0.024	0.087
PPEs usage	-0.042	0.030	-0.015	-0.024	0.063	0.026	-0.058	0.038	0.007	-0.025	-0.017	0.057	0.135	-0.057	0.020	-0.025	1	0.020	0.154	0.041
Intoxication Problem	-0.086	-0.012	0.065	-0.003	-0.056	-0.103	-0.145	0.045	0.044	-0.187	-0.117	-0.050	-0.085	-0.054	-0.219	-0.032	0.020	1	0.027	-0.152
Package return	-0.012	-0.081	-0.024	0.028	0.076	-0.007	-0.148	-0.014	0.069	0.162	0.100	0.042	0.134	0.113	0.136	0.024	0.154	0.027	1	0.059
Knowledge on NR31	0.070	-0.080	-0.131	0.215	0.127	0.255	-0.037	-0.129	0.196	0.217	0.212	0.070	0.116	0.159	0.070	0.087	0.041	-0.152	0.059	1

* Rates in bold are different from zero, with a significance level of 0.05.

3.3 Technologies in Harvesting and Crop Processing

There was a negative co-relation between the number of farm employees and the variables automated harvest (-0.303), coffee drier ($r = -0.310$; $p = 0.05$), coffee washer ($r = -0.420$, $p = 0.05$) and coffee pulp machine ($r = -0.305$, $p = 0.05$). Technologies in the production process decreases costs and, consequently, profit increase for producers (Santinato et al., 2016; Xia et al., 2015).

Data analysis also identified a positive co-relation between the introduction of new technologies (coffee drier – $r = 0.183$, $p = 0.05$ and coffee washer – $r = 0.150$; $p = 0.05$) and demand for external consulting services. When the farmer is updated technologically, there is also a demand for specialized knowledge on the equipments used.

Another interesting characteristic derived from the data is that the introduction of one of the technologies analyzed has a positive co-relation with the others.

There was a positive co-relation between schooling level and the farm area ($r = 0.301$; $p = 0.05$). Analyses also showed a positive co-relation with regard to the number of employees on the farm ($r = 0.463$; $p < 0.0001$). Data analysis reveals the impact of job generation on farms when there is an increase in schooling level. Investment on siblings' education is highly appreciated since they may administer the farm and shun being used as mere force labor to the detriment of higher schooling (Frederico & Barone, 2015).

Corroborating analysis above, an increase in the number of employees has a negative co-relation with technologies employed (coffee drier – $r = -0.360$, $p = 0.05$, coffee washer – $r = -0.467$, $p = 0.05$, coffee pulp machine – $r = 0.203$, $p = 0.05$).

Another characteristic shown in the survey revealed that increase in farm area decreased the monitoring of pests ($r = -0.164$, $p = 0.05$) and its frequency ($r = -0.229$, $p = 0.05$). In fact,

increase in farm area makes difficult the monitoring process with higher pest risks due to their presence on all farms (Vilela & Rufino, 2010).

3.4 Analysis of Classes

So that results could be made easier, data were divided into four different classes (Table 2).

Table 2. Relation of classes and their compatible variables identified in the research data

Class	1	2	3	4
Producers	25	15	24	20
Age (years)	36 - 41	30 - 35	over 54	over 54
Farm area	*	over 9 ha	over 9 ha	over 9 ha
Access to the Internet	*	yes	No	yes
Schooling level	Basic	*	Basic	Undergraduate
Crop system	Conventional	Conventional	Conventional	Conventional
Employees	No	*	No	No
Agricultural training	No	yes	*	No
Automated harvest	Yes	yes	yes	Yes
Coffee bean drier	Yes	yes	yes	Yes
Coffee bean washer	Yes	*	yes	Yes
Coffee pulp machine	Yes	yes	yes	Yes
Monitoring	3 - 6 months	3 - 6 months	30 days	3 - 6 months
Consulting services	*	*	yes	Yes

3.5 Cluster Analysis (Groupings)

Two groups may be underscored in grouping. The first group related investment in consulting services to frequency of farm monitoring. Results show the importance of an external support in the administration and control on farms (Embrapa, 2004; Prado & Dorneles Junior, 2015).

Corroborating Pearson's co-relation, the relation between harvest automation, the number of employees, coffee bean drier, washer and pulp machine on the farm and pest monitoring is another item that should be underscored. It must be emphasized that investment in technology in coffee production decreased external labor force on small farms and, consequently, an increase in profit (Perdoná et al., 2012; Sette et al., 2010; XIA et al., 2015). Such activity underscores the labor of small farmers with coffee plantation as their main income (Frederico, 2013; Frederico & Barone, 2015; Vilela & Rufino, 2010).

Increase in the monitoring of coffee plantations and investment in new technologies is a highly important item. The above activity enhances profit since it avoids losses caused by pests usually found in coffee plantations (Alves et al., 2011; Androcioli, 2010; Lopes et al., 2012).

4. Conclusion

Results reveal the validity of investments in technologies for the automation of farm labor. There is a trend that farms using technology in their administration, harvest and processing decrease the number of employees. This fact decreases costs and, consequently, increases profits for the small farm producer.

Farm monitoring is more focused upon when automation is implemented. Results indicate that automation provided a fast harvest and processing which provide farmers with more time for other administrative activities.

Acknowledgments

José do Rosário Vellano University - UNIFENAS; Federal Institute of Southern Minas Gerais, IFSULDEMINAS - Campus Machado; Poço Fundo Family Farmers' Cooperative, COOPFAM; Technical Assistance and Rural Extension Company - EMATER-MG (Machado / MG and Poço Fundo / MG); Machado Agrarian Cooperative - COOPAMA; and Minas Gerais State Research Support Foundation - FAPEMIG.

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