INFORMATION TECHNOLOGY ON COFFEE FARMS[1]

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ABSTRACT: *A logit model is estimated in order to study Information Technology adoption in coffee growing in the state of Sao Paulo, Brazil. It is shown that the chances of IT adoption are higher in the most dynamic coffee region, the so-called High Mogiana, followed by the Low Mogiana region and the Southwestern-Central region. The renewal at the coffee growing zones is also related to IT adoption, and is represented by the ratio between the area of the new coffee plants and the total coffee area and by the increasing crop density (trees/ha). Other important factors are: absenteeism; membership of cooperatives, associations and syndicates; trading strategy; farmers graduated by a university; crop size. At last, IT adoption is closely related to modern farm management.*

Key-words: *coffee growing, Information Technology (IT), computers, World Wide Web, logit model.*

TECNOLOGIA DA INFORMAÇÃO NA CAFEICULTURA

RESUMO: *Um modelo logit é estimado para estudar a adoção da Tecnologia da Informação na cafeicultura do Estado de São Paulo. Mostra-se que as chances de adoção têm sido maiores na região mais dinâmica da cafeicultura estadual, a saber, a Alta Mogiana, seguida pelas regiões da Baixa Mogiana e Sudoeste-Centro. A renovação da cafeicultura também se relaciona com essa adoção, representada pelo percentual da área com plantas novas sobre o total e pela crescente densidade de cultivo. Outros fatores mostraram-se importantes: o absenteísmo; a qualidade de membro de cooperativas, associações e sindicatos; a estratégia comercial, o nível de escolaridade, o tamanho da exploração. Finalmente, a adoção da TI está fortemente relacionada à administração moderna da empresa rural.*

Palavras-chave: *cafeicultura, Tecnologia da Informação (TI), computadores, Internet, modelo logit.*

JEL Classification: *C35, O33, Q16.*

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1 - INTRODUCTION

In the last decade of the 20th century a new paradigm for social dynamics emerged with the so-called Knowledge Era, in which human knowledge flows even faster than money. In this context, Information Technology (IT) has been adopted as a useful tool in a wide array of fields, including that of agribusiness. The changing structure of the economy as a consequence of globalization has resulted in extremely competitive local markets. IT has assumed a special role in the productivity and efficiency gains of the Brazilian agribusiness, thus achieving new patterns of competitive development.

Computers are one of the symbols of the Knowledge Era, being used in most human activities and, in particular, in the production and trade of goods. Hence, computers are expected to be used in the Brazilian agribusiness, since the latter represents 30% of the gross national product. Although the state of Sao Paulo corresponds to only 3% of the country´s territory, it provides 17% of the national agricultural and cattle breeding production value (see TSUNECHIRO, 2004). This percentage may double if the total agribusiness production value is taken into consideration, since some large agro industrial groups are located in the state, such as the sugar and alcohol and the citrus juice sectors.

Brazil is still the world´s largest coffee producing and exporting country. Such economic activity has been revitalized in recent years, through the incorporation of new technologies. In 2003, 36% of the coffee farmers associated to the Guaxupe Cooperative, in the state of Minas Gerais[5], were using computers for rural administration, whereas 27% were accessing the World Wide Web (FRANCISCHINI and VALE, 2003). In the state of Sao Paulo, computer use by farmers is increasing at high rates, from 3.7% farms in 1995-96 to 6.9% in November 2000 (FRANCISCO and PINO, 2002); recent data show that 17% usually access the web for farm purposes and at least an additional 17% intended to do so (FRANCISCO and PINO, 2004).

This paper deals with the leading factors for IT adoption on coffee farms in the state of Sao Paulo, Brazil. In spite of the fact that coffee growing is a traditional rural activity in this state, a significant technological change was detected in the last decade of 20th century, with highly increasing cultivation density (PINO et al., 1999).

2 - METHODS

Data from a probabilistic sample survey of coffee farms in the state of Sao Paulo, applied in November 2004, were available. The sample size was 667, corresponding to a population size of 31,629 coffee farms, from a population of 300,567 farms in the state.

A logit model[6] for IT adoption is given by

$$p = \Pr[Y = 1 \mid \mathbf{X} = \mathbf{x}] = \frac{e^{\beta' \mathbf{x}}}{1 + e^{\beta' \mathbf{x}}} = \frac{1}{1 + e^{-\beta' \mathbf{x}}}$$

where

Y indicates the adoption of IT on a coffee farm (0=no; 1=yes),

$\mathbf{X}$ is a set of independent variables influencing Y,

p is the probability of IT adoption on a given coffee farm

β is a set of parameters to be estimated.

The following independent variables were considered:

a) Crop density (trees/ha). It is known that the most technically advanced farmers have been increasing the number of trees per hectare since the 90's (PINO et al., 1999);

b) Coffee area (ha). The business farms usually cultivate larger areas and are expected to adopt new technologies sooner, as compared to the family farms;

c) Producing region (Figure 1). The state´s major producing region is called High Mogiana, in the

[5]Also in Caconde, São José do Rio Pardo, and Guaranésia, in Sao Paulo State.

[6]See Aldrich and Nelson (1984), Greene (1997) and SAS® (2002) for methodological details.

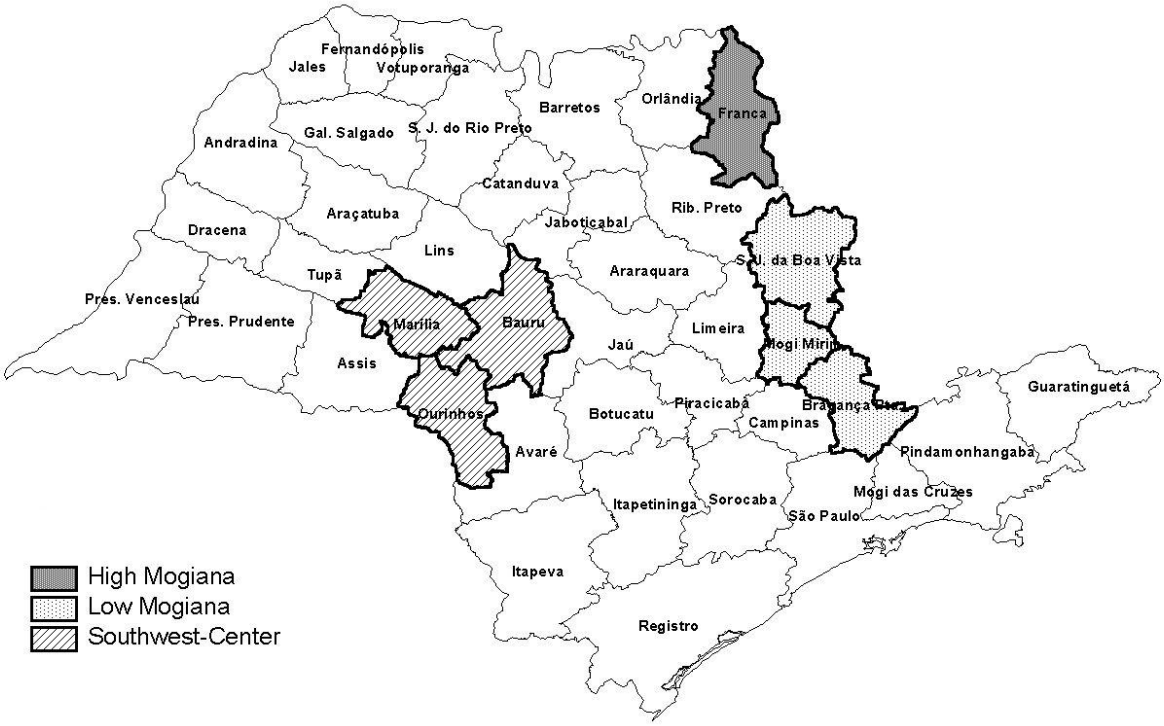

Figure 1 – Coffee Producing Regions, Sao Paulo State, Brazil, 2004.
Source: "Instituto de Economia Agrícola" *[Institute of Agricultural Economics]*.

neighborhood of the Guaxupe region, in the state of Minas Gerais[7]. The second largest producing region is called Low Mogiana[8], and the third one is called Southwestern-Central[9]. Three dummy variables were defined as 1 = the farm belongs to the given region, 0 = the farm does not belong to any of the three regions. The other areas are considered marginal or declining in coffee production;

d) Graduate farmer (0=no; 1=yes). The farmers graduated by a university are expected to adopt new technologies faster than those with lower educational levels;

e) Experience in coffee cultivation (years). Farmers with a long-term investment in coffee are expected to be more motivated to incorporate new technologies;

f) New coffee plants area / total coffee area ratio (%). It is known that the most technical farms are increasing their planted area, the opposite occurring with the least technical ones;

g) Member of a producer´s cooperative, or association or syndicate (0=no; 1=yes). The association

[7]Includes the following municipal districts: Altinópolis, Batatais, Cristais Paulista, Franca, Itirapuã, Jeriquara, Patrocínio Paulista, Pedregulho, Restinga, Ribeirão Corrente, Rifaina, Santo Antonio da Alegria, São José da Bela Vista.

[8]Includes: Aguaí, Águas da Prata, Caconde, Casa Branca, Divinolândia, Esprito Santo do Pinhal, Itobi, Mococa, Santa Cruz das Palmeiras, Santo Antonio do Jardim, São João da Boa Vista, São José do Rio Pardo, São Sebastião da Grama, Tambaú, Tapiratiba, Vargem Grande do Sul, Artur Nogueira, Conchal, Cosmópolis, Engenheiro Coelho, Estiva Gerbi, Holambra, Itapira, Jaguariúna, Mogiguaçu, Mogimirim, Santo Antonio da Posse, Águas de Lindóia, Amparo, Atibaia, Bom Jesus dos Perdões, Bragança Paulista, Joanópolis, Lindóia, Monte Alegre do Sul, Nazaré Paulista, Pedra Bela, Pedreira, Pinhalzinho, Piracaia, Serra Negra, Socorro, Tuiuti, Vargem.

[9]Includes: Agudos, Arealva, Avaí, Bauru, Borebi, Cabrália Paulista, Duartina, Iacanga, Lucianópolis, Pederneiras, Piratininga, Presidente Alves, Reginópolis, Ubirajara, Álvaro Carvalho, Alvilândia, Fernão, Gália, Garça, Lupércio, Marília, Ocauçu, Oriente, Oscar Bressane, Pompéia, Quintana, Vera Cruz, Bernardinho de Campos, Canitar, Espírito Santo do Turvo, Fartura, Ipauçu, Óleo, Ourinhos, Piraju, Ribeirão do Sul, Salto Grande, Santa Cruz do Rio Pardo, São Pedro do Turvo, Sarutaiá, Taguaí, Tejupá, Timburi, Xavantes.

enables farmers to access new technologies, such as IT;

h) Absenteeism (0=no; 1=yes). Brazilian farmers living outside their farms usually have other economic activities (related or not to coffee), which makes the contact with IT easier;

i) Coffee stocks maintained at the cooperative/total production ratio (%). This variable indicates capitalized farmers, who are expected to adopt IT;

j) Coffee area/total cultivated area (%). It is assumed that the more important the coffee activity in the farm business, the easier the use of IT in such activity.

Even though other variables were available and tested, their effect seems to be included in the others. For instance, the probability of IT adoption is expected to be higher on large business farms, sometimes belonging to an enterprise rather than an individual farmer, than on small family farms. However, this effect seems to be diluted by the effects of other variables, such as coffee area, absenteeism and stocks.

3 - RESULTS DISCUSSION

The logit model estimation results for Information Technology adoption by coffee farmers appear in Table 1. The likelihook statistics show satisfactory goodness of fit (90.5% of the predicted values fitting observed values). The variables importance may be analyzed from two points of view: according to the variables order in stepwise procedure and according to the odds ratio or, in the case of continuous variables, the marginal probabilities. By the latter criterion, the regional variables are more relevant to explain computer use on coffee farms. Thus, the chance of IT adoption by a coffee grower at the High *Mogiana* region is 19 times higher than that in marginal or declining areas. Indeed, this is the most dynamic coffee growing region in the state. The odds ratio is much smaller in the other regions: thrice for the Low *Mogiana* and twice for the Southwestern-Central.

Coffee growing renewal is closely related to IT adoption. It may be represented by the ratio of the new coffee plants area over the total coffee area and by the increasing crop density (trees/ha). The chance of IT adoption is 8 times greater when the ratio of new plants is high, whereas the crop density is the first variable to enter the model. New plantations are usually based on better, more productive and disease-resistant genetic material, and on the setting of plants at more compact intervals. These techniques imply a modern farm management, using specific computer software.

Absenteeism is also related to a larger use of computers in coffee growing. Urbanites have easier access to IT since the Internet use in rural areas depends on telephonic facilities and providers that are not focused on those clients´ profile. Alternatively, the wireless access relies on expensive technologies, usually resulting in low quality and low speed signals. As a consequence, the chance of an urban-dwelling coffee growers including IT in their economic activities is almost 4 times greater.

The coffee farmers that take part in formal organizations, such as cooperatives, associations and syndicates, have a twofold chance of using computers, as an outcome of the efforts in training and qualification carried out by these organized structures.

A coffee grower´s trading strategy also affects IT adoption positively. The proportion of coffee stocks maintained at the cooperative over the total production almost doubles the chance of using computers. This variable is related to capitalized farmers, as well as to the activity size, as measured by the coffee planted area (the second variable to enter the model, indicating that the larger the coffee plantation the higher the chance of adopting IT) and the proportion of coffee area over the total farm area. Coffee is a commodity, daily quoted in boards of trade, hence the opportunity for speculative attitudes of farmers. In this case, IT is necessary to follow the price lists and quotations as quickly as possible. The trading question is expected to be one

Table 1 - Information Technology Adoption by Coffee Farmers, Logit Model Estimated Parameters, Sao Paulo State, Brazil, November 2004

Variable	Stepwise order	Parameter estimate	Chi-square[1]	Odds ratio			Marginal effect[2] (%)
				Estimative	95% confidence interval		
					Lower	Upper	
Intercept	0	-8.1887	9679.3				
Cutivation density (tress/ha)	1	0.0006	2554.8	1.001	1.001	1.001	0.005
Coffee planted area (ha)	2	0.0500	711.8	1.051	1.047	1.055	0.371
High Mogiana region	3	2.9310	2233.7	18.747	16.601	21.170	-
University level education	4	0.2415	172.9	1.273	1.228	1.320	-
Experience in coffee cultivation (years)	5	0.0204	264.3	1.021	1.018	1.023	0.151
New coffee plants area/total coffee area ratio (%)	6	2.0291	156.6	7.607	5.536	10.453	15.042
Low Mogiana region	7	1.1211	335.0	3.068	2.721	3.460	-
Member of a producer cooperative, association or syndicate	8	0.8593	329.9	2.362	2.152	2.591	-
Absentee farmer	9	1.2734	424.9	3.573	3.165	4.033	-
Coffee stocks maintained at the cooperative/total production ratio (%)	10	0.6015	239.4	1.825	1.691	1.969	4.459
Coffee area/total cultivated area (%)	11	0.9522	63.5	2.591	2.050	3.275	7.059
Southwestern-Center region	12	0.5423	54.5	1.720	1.489	1.986	-

[1]All significant at p-value < 0.0001.
[2]For continuous variables only.
Source: "Instituto de Economia Agrícola" *[Institute of Agricultural Economics]*.

of the main factors inducing IT adoption on coffee farms, inasmuch as the coffee business tends to become more sophisticated, so as to include the direct export of origin certified product.

Some variables based on the farmer himself showed to be important. For instance, the chance of farmers with a university degree adopting new technology is 1.3 times higher than for those with lower educational levels. This is consistent with the results obtained by other authors (FRANCISCO and MARTIN, 1999; IGBARIA; ZINATELLI; CAUAYE, 1998).

Although the increment of just one tree per hectare or the increment of one planted hectare seems to only slightly increase the probability of adopting IT, these are the first and second variables to enter the model in the stepwise procedure. Indeed, the increase in crop density is related to a search for productivity gains in the production factors, and therefore a propensity to establish efficient controls, which is in turn better achieved by using IT. Again, the increase in the planted area is related to crop specialization, which is better managed by using computers.

4 - CONCLUDING REMARKS

In the last five years (1999-2003) the Brazilian coffee growing suffered the harsh consequences of price decline. During this period, investments on coffee cultivation were restrained to those payable along the same crop year. From this point of view, the evidence that computer use on coffee farms near its average use in other agricultural activities seems to be satisfactory. From now on, given the expressive price recovery, a new scenario is expected with a highly increasing IT adoption.

The fast raise in computer use in the most

dynamic state coffee region, i.e., the High *Mogiana,* verified in this paper, traces the trend for the other regions. The profile of coffee growers using IT points out to a businessperson focused on productivity (more area with new plants), a member of formal organizations (cooperatives, associations and syndicates), with defined trading strategies (more stocks maintained in cooperatives), living in urban areas, and probably with a high educational level. As a matter of fact, the introduction and diffusion of several other innovations in farm production and farm management are based on the same farmer´s profile, with a significant impact on the productivity and on the beverage quality (certified products are usually demanded by this class of growers).

There is not only one factor determining the investment decision to acquire IT in the agricultural context. There are many software products (systems) available for coffee farmers: for calculating production costs considering the rural activity calendar; for dosing fertilizers according to soil characteristics and chemical soil analysis combined with the trees ages; for using precision agriculture with georeferencing for cultivation handling; and for commercial strategies based on production sharing, quality and term, among others. These applications and others are effective tools for a better farm management; even though not directly involved with productivity increase in the short run, they may reduce substantially the economic losses, contributing to a sustainable exploration, remarkably when the prices are disadvantageous for coffee growers.

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