



## **DETERMINANTS OF THE ADOPTION OF IRRIGATION TECHNOLOGIES BY CITRUS GROWERS OF THE STATE OF SÃO PAULO-BRAZIL**

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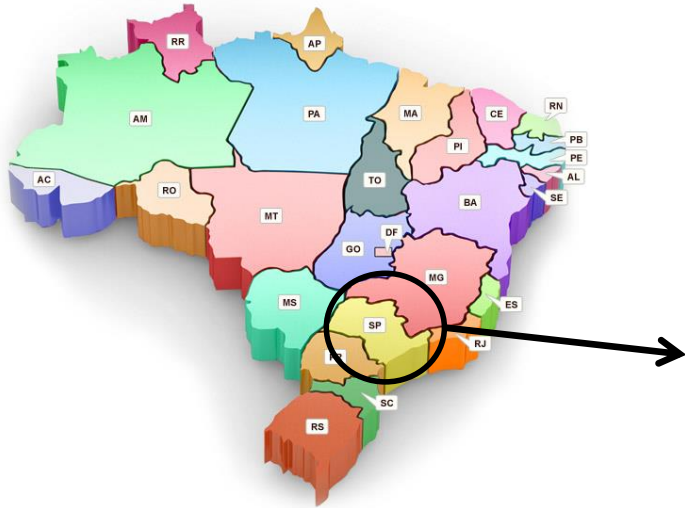
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# Introduction

- Brazil is the world's largest producer of fresh orange and orange juice.
- In 2014, Brazil produced more than 11 tons of fresh orange and about 1.0 million tons of orange juice (IEA, 2014; USDA, 2014).
- The state of São Paulo concentrates about 80% of the national production of both products (NEVES *et al.*, 2010).
- More than 90% of the orange juice produced is exported, and the main destinations include the European Union (EU) and the United States of America (USA) (CITRUSBR, 2013).

# Introduction



Source: <http://www.fotos-imagens.net/mapa-do-brasil.html>



Source: <http://www.fotos-imagens.net/mapa-do-brasil.html>



Source: LUPA (2008)

# Problem Statement

- Citrus growers fell from 35.883 in 1995/1996 to 10.100 in 2013 (LUPA, 2008; CONAB, 2013) in the Brazilian citrus belt (São Paulo and Minas Gerais Triangle region).
- Increase in production costs associated with the low prices paid per orange box that reduced the grower's profitability.
- Need to increase production factor yields, which can reduce the production costs per orange box.
- Adoption of irrigation systems is supposed to improve factor yields. This technology has presented positive results related to the increase of orange productivity (KOO & SMAJSTRLA, 1984; ZANINI *et al.*, 1998; SILVA *et al.*, 2009).

# Problem Statement

- In 2010, 130.000 hectares of orange groves were irrigated in the Brazilian Citrus Belt (NEVES *et al.*, 2010), corresponding to approximately 21% of the total planted area of orange in the belt (IBGE, 2011).

*Which are the factors that could increase the diffusion of the irrigation systems in the citrus orchards?*

# Objectives

- Identify and analyze the determinants of the adoption of irrigation systems by citrus growers of the state of São Paulo, Brazil.

# Conceptual Background

- **Models of technology adoption in agriculture**

- Epidemic
- Probit/Logit
- (...)

- **Determinants of adoption of irrigation systems in agriculture**

- Characteristics of the farmers (educational level, farming experience, participation in farmers' organizations and agricultural income).
- Characteristics of the farms and the agricultural production (size of the farm, the diversification of the production, and the availability of water).
- Systemic factors (access to rural credit and diffusion of information).

# Research Methodology

- Personal interviews were held, providing information on farmers and farm characteristics, as well as on the citrus production of 2013/14 crop season.
- Period: January to October 2014.
- Sample: 98 citrus growers, including 34 adopters of irrigation systems and 64 non-adopters.
- Descriptive statistics (mean, standard deviation and frequency) and a logit model.



**Table 1.** Description of the variables used to discriminate the group of adopters of irrigation systems from the non-adopters, and the hypotheses concerning the impact of the variables on the adoption of irrigation.

Variable	Description	Expected Signal of the impact on adoption
<b>Citrus varieties grown (VARIET)</b>	Number of varieties of citrus grown by the producers in the properties	(+)
<b>Income (INCOCITR)</b>	Percentage of the agricultural income obtained through citrus activities	(+)
<b>Technical assistance (TECHASSIST)</b>	The dummy (Yes/No) variable assumes value 1 for farmers who pay technical assistance; and 0 if otherwise	(+)
<b>Education level (EDUC)</b>	Number of years of formal education of the farmer	(+)
<b>Citrus area (CITRAREA)</b>	Percentage of the citrus area in the total area of the farm	(+)
<b>Price received (PRICE)</b>	Average price received per box of orange in the crop season of 2013/2014	(+)
<b>Participation in farming cooperatives and/or associations (PARTIORG)</b>	The dummy (Yes/No) variable assumes value 1 for farmers who participate in farming cooperatives and/or associations; and 0 if otherwise	(+)
<b>Rural credit (CREDRUR)</b>	The dummy variable assumes value 1 for farmers who obtained rural credit in crop season 2013/2014; and 0 if otherwise	(+)
<b>Commercialization channels (COMMERCHAN)</b>	The dummy variable assumes value 1 for farmers who sell 50% or more of the production to juice processor companies; and 0 if otherwise	(+)

Source: authors (2015)

# Results

**Table 2.** Descriptive statistics and statistical hypotheses of the variables analyzed for the two groups of citrus producers.

Variables (continuous)	Group 1: adopt irrigation systems 34 citrus producers		Group 2: do not adopt irrigation systems 64 citrus producers		Decision H <sub>0</sub>	
	Mean	Standard Deviation	Mean	Standard Deviation	p value	Hypothesis
VARIET	3.56	1.28	2.81	1.50	0.016	Reject*
INCOCITR	60.62	34.12	44.03	33.48	0.023	Reject*
EDUC	13.88	5.30	11.81	4.90	0.056	Reject**
CITRAREA	62.30	33.36	61.16	28.25	0.858	Accept
PRICE	9.53	3.27	9.59	5.20	0.952	Accept
Variables (nominal)	Freq. (n) (1)	Freq. (n) (0)	Freq. (n) (1)	Freq. (n) (0)	p value	Hypothesis
CREDRUR	24	10	25	38	0,315	Accept
TECHASSIST	21	12	27	36	0,053	Reject**
PARTIORG	29	5	56	8	0,759	Accept
COMMERCHAN	17	17	35	29	0,658	Accept

Source: authors (2015)

# Results

**Table 3.** Coefficient estimates of the logit model for analysis of the determinants of adoption of irrigation systems by the citrus producers interviewed.

Variable	Coefficient	Wald Statistic	P-value
Constant**	-2,466	3,222	0,073
VARIET**	0,311	3,060	0,080
INCOCITR*	0,024	7,584	0,006
TECHASSIST**	0,877	2,892	0,089
EDUC**	0,088	2,778	0,096
CITRAREA	-0,014	2,221	0,136
PRICE	-0,079	1,705	0,192
PARTIORG	-0,481	0,461	0,497
CREDRUR	0,647	1,326	0,249
COMMERCHAN	-0,825	2,292	0,130
<p><b><u>Predicted Overall Percentage: 72,1 %</u></b>  <b><u>Nagelkerke R<sup>2</sup>: 0,281</u></b>  <b><u>LR Statistic (8gl): 101,02</u></b></p>			

Source: authors (2015)

# Discussion

- ↑ Level of education (EDUC) of the producer = ↑ chance of adoption of an irrigation system (+).
- ↑ Access to paid technical assistance (TECHASSIST) = ↑ chance of adoption of an irrigation system (+).
- ↑ Composition of income by citrus activities (INCOCITR) = ↑ chance of adoption of an irrigation system (+).
- ↑ The number of varieties grown (VARIET) = ↑ chance of adoption of an irrigation system (+).

# Conclusions

- Formulation of public policies that could provide, especially, technical assistance to producers.
- Providing information could enhance the efficiency in the use of the production factors, improving the investments and allowing farmers to adopt irrigation in the orchards.
- In the same direction, the design of rural credit policies for farmers who want to adopt irrigation in their orchards could speed up the diffusion of this technology.

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