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Citrus Certification Programs in Brazil

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ABSTRACT. Brazil is the world's largest citrus producer and exporter of frozen concentrate orange juice and this paper reviews its citrus industry and notes its advantages and threats such as by disease. Although citrus is grown throughout the country, more than 90% is produced in 6 of 27 Brazilian States with the State of São Paulo leading the way with 80% of the national production. The predominant stock/scion combination countrywide is Pera sweet orange on Rangpur lime rootstock which accounts for more than 150 million trees. Despite a slower growth rate of the citrus industry in recent years, the annual demand for new trees is estimated at 15 million. We present information on research programs for citrus improvement as well as the scions and rootstocks used and the certification programs in the States of São Paulo, Sergipe, Bahia, Minas Gerais, Rio Grande do Sul and Rio de Janeiro.

According to the Food and Agricultural Organization of the United Nations (FAO) (6), Brazil has become the world's largest citrus producer (24.3 million metric tons or 24.6% of the world production in 1997) and exporter of frozen concentrate orange juice (961.2 thousand tons or almost 50% of the world exports in 1995) since the last decade. The demand for orange juice, especially from the United States and the European Community is the main reason for this tremendous expansion. The annual growth rate from 1960 to 1995 was 7.3%. Other factors contributing to the rapid growth of the Brazilian citrus industry include: i) the excellent ecology for citrus such as suitable climate, soil, water from Amazon to the South; ii) unlimited potential for development with a potential for more than one million ha increase; iii) very capable growers and excellent technological advice from agencies such as Campinas Agronomic Institute—IAC, Federal and State universities, Brazilian Corporation for Agricultural Research—EMBRAPA and other institutions; iv) generation of income (e.g., a capital income of \$US1 billion from frozen concentrate juice) and employment (e.g., 25,000 growers generate 400,000 jobs in São Paulo State alone); v) potential employment for people in rural areas (e.g., six million people have left the rural

areas of the Northeast region during the last decade).

Some problems and threats to the Brazilian citrus industry are as follows: i) high dependence on the concentrate juice market (e.g., 76.5% of production went to processed juice in 1995); ii) no coordinated citrus marketing organization like Outspan in South Africa or Sunkist in California; iii) rapid grove expansion which is frequently random and not well organized and has resulted in a low average yield is less than 2 boxes/tree; iv) diseases such as citrus variegated chlorosis (CVC), citrus canker, tristeza, leprosis, declinio, etc. and an apparent lack of means to stop their spread by transportation; v) dependence of the citrus industry on a single cultivar, the Pera orange on Rangpur lime rootstock, along with the lack of a uniform certification program; vi) lack of grower organizations to reinforce and support major changes and to push for a mandatory certification program.

The current citrus certification programs in the various Brazilian States are now presented with data on production and harvested areas (Table 1), research and development programs, scion/rootstock improvement programs, the availability and supply of certified budwood, the nursery industry, and the stages of the certification programs in the various States.

TABLE 1
CITRUS PRODUCTION BY STATES IN
BRAZIL (1997)

State	Production (×1,000 tons)
Bahia	720
Goiás	518
Pará	256
Paraná	150
Rio de Janeiro	168
Rio Grande do Sul	376
Santa Catarina	177
São Paulo	16,130
Sergipe	792
Others	280
Totals	19,567

A brief history of citrus certification programs worldwide. With the discovery of the virus nature of psorosis at the request of the Southern California Nurserymen's Association, a mother tree inspection service was inaugurated in California in 1936. This was the first certification program which, in 1957, led to the formation of the California Citrus Variety Improvement Program, later renamed as the California Citrus Clonal Program (20). Reuther (18), estimated a cost of \$500,000 for the first ten years of operation of the program. In 1961, the first virus free selections were planted in the key foundation block at Lindcove in Central California. Besides the impact on the development of the California citrus industry, this program was taken as a model for several countries, specifically Spain, South Africa, Cuba, Taiwan and others.

All citrus trees in Spain were found to have one or more virus and virus-like diseases causing losses estimated between 15 to 25% (13). With the advent of shoot-tip grafting, the citrus industry in Spain was changed dramatically by a citrus certification program set up in 1968 through a joint effort between the government and citrus growers. The Instituto Valenciano de Investiga-

ciones Agrarias—IVIA, released the first virus-free selections and 80 million trees were released between the period 1972 to 1998 (16).

In 1972, guidelines for the South African Citrus Improvement Programme (CIP) were drafted and, in 1973, the program was launched under a joint project involving the South African government and citrus growers represented by Outspan International. Their first nursery trees were certified in 1976 under an Interim Scheme. In 1980, the program substantially progressed with the installation of the Outspan Foundation Block near Port Elizabeth which is far from commercial citrus areas (12).

In the 1960's, Cuba began a program to obtain virus-free nucellar lines and in 1986 established the "Program for Propagation of Citrus Certified Material". This was under the direction of the Instituto de Investigaciones de Cítricos (IIC). All citrus propagations on the island are derived from this program (11).

In 1994, in Argentina, the Instituto Nacional de Tecnología Agropecuaria (INTA) established "PRO-CITRUS-Citrus National Program" composed of a Center for introduction and production of foundation and increase blocks plus another center to evaluate, produce and release budwood in several regional centers. In 1997, 400,000 buds were released and the forecast for the year 2000 is 1.5 million buds (1).

In Uruguay in 1994, the Ministry of Agriculture established the "Official Program for Certification of Citrus Propagation Material". There are two foundation blocks containing 61 clones under the responsibility of the Ministry and the Instituto Nacional de Investigaciones Agropecuarias (INIA). By 1997 the program released more than 400,000 buds which supplies the demand of the 12 registered nurseries (3).

In 1961, the first Brazilian program for certification was established

as the “Registration Program of Citrus Mother Trees in the State of São Paulo”. This program became effective in 1969 and was under the responsibility of the Secretary of Agriculture and Food Supply (Instituto Agronomico de Campinas e Instituto Biologico). This program distributed almost 10,000 outstanding citrus trees of nucellar origin which was a great contribution for the development of the Brazilian citrus industry (19). In 1984, guidelines for this program were redirected by a Technical Commission trying to meet the increasing demands of the growing citrus industry, especially in São Paulo State. In 1997, using the same process a “Program of Citrus Mother Trees and Rules for Production of Citrus Certified Trees” was established (4). Finally, in December, 1997, the “Program of Citrus Mother Trees” was established by the Secretary of Agriculture and Food Supply of the State of São Paulo.

Citrus certification programs in Brazil. Although citrus trees are grown all over the country, more than 96% are produced in six of the Brazilian States.

The State of São Paulo

The State of São Paulo is responsible for 82.4% of Brazilian orange production and 75.6% of the cultivated area. In 1997 16.1 million tons were produced on 736,770 ha (9). In terms of orange fruit and orange juice concentrate, São Paulo State can be considered as the most productive State in the world, and the world’s largest exporter of concentrate juice and dried pulp (14). The growth rate during the period 1960 to 1995 for the harvested area was 8.6% and for production was 10.8% per year. The sweet orange varieties (95% of the total production) used in 1994 were: Pera (41%), Natal (26%), Valencia (23%), Hamlin

(7%), others (3%). For mandarins, the Ponkan is preferred (58%) and the Tahiti lime is predominant (90%). The predominant rootstock is the Rangpur lime which is used for 95% of the citrus (8). However, its percentage of use is dropping in new nursery production.

Research and development.

The Instituto Agronomico de Campinas at the Limeira Experiment Station was begun in 1928 and was renamed recently as Sylvio Moreira Citriculture Center (CCSM) has made great contributions for the citrus industry of Brazil. The Center conducted a strong improvement program with 34 experiment trials on scion and rootstocks and, in 1994, began a program to produce certified trees in a 7,000 m² screenhouse where 1,180 foundation block trees are held with accompanying increase blocks. Up to now, 300,000 buds have been released and the forecast for 1999 is 900,000. The Bebedouro Citrus Experiment Station, created in 1982, has also contributed to the development of the citrus industry. It has underway some 22 experiment trials on scion and rootstock improvement. In 1996, a 4,600 m² screenhouse was built to produce 1.5 million buds and the forecast for 1999 is for 400,000 buds.

The nursery industry. According to “The Fund for Development of the Citrus Industry in São Paulo State” (FUNDECITRUS), the number of nurseries increased from 157 in 1958 with a production of 1.3 million trees to 1,556 in 1996 producing 16 million trees. The number of nurseries decreased in 1998 to 972 with a production of 9.4 million trees. This decrease was mainly due to the occurrence of diseases like CVC and canker. Analyzing the survey data of

FUNDECITRUS in 1997, the situation of the nursery industry in São Paulo State is not encouraging; only 2.3% of the nurseries are under screen, 35.8% are registered, 80% are located less than 20 m from producing groves and more than 82% do not use any prevention against CVC, canker, nematode or *Phytophthora*. There is a Nurserymen Association located in Limeira. The annual demand for certified budwood up to the year 2000 is estimated to be about 9 million buds. The supply varied from 300,000 in 1998 to 2.4 million in the year 2000 which means that there will be a considerable deficit. A partnership involving IAC, EMBRAPA, National Council for Scientific and Technologic Development (CNPq) and four large nurseries was started in 1997. The objective was to produce 72,000 citrus trees in 1998 to 1999 from clean material obtained from IAC and under the legal requirements (EMBRAPA-SPSB/IAC). This could be the basis for starting a State certification program.

Stage of the certification programs. On Feb. 6, 1998, the State established the "Mother Tree Program and the Rules for Production of Certified Citrus Nursery Trees" in accordance with rules of the Ministry of Agriculture. This program will be coordinated by the Coordenadoria de Assistência Técnica Integral (CATI) (4). The Research Institutions are involved in terms of the selection and evaluation of cultivars and the production of mother trees and increase blocks.

The private sector, represented specifically by FUNDECITRUS, is involved and receptive to the project and is ready to establish joint efforts to implement the certification program as soon as possible. Diseases are the most serious threats to the São Paulo

State citrus industry: 10% of the citrus trees (20 million) are being eradicated due to the occurrence of citrus canker and CVC, which means losses estimated in \$US240 million. More than 200,000 citrus trees and two million nursery trees will be eradicated due to the spread of citrus canker. CVC is present in 34% of the citrus groves and 6 million citrus trees are at the terminal stage (15).

The State of Sergipe

The State of Sergipe ranks second in production of citrus with 792,000 tons (4% of the Brazilian orange production) on 42,330 ha (9). Sergipe had the highest growth rate during the period 1960 to 1995 with 11.8% for the harvested area and 12.5% for production per yr. There are 17 million orange trees and Pera orange on either Rangpur lime (50%) or Rough lemon (48%) rootstock is the predominant cultivar (21).

Research and development.

The State Secretary of Agriculture was responsible for the development of the citrus industry, especially in the 1970's. Under a partnership with EMBRAPA, a research program covering all improvement and cultural practices, plus a program to release nucellar lines obtained by EMBRAPA. Besides a collection of 97 varieties, the State Research and Extension Corporation (EMDAGRO), maintains six rootstock trials involving 23 cultivars. In 1990, three increase blocks containing 10,000 orange trees were developed. Recently an increase block containing micro-grafted orange, mandarin and acid lime was set up. However, after the detection of CVC in these outdoor blocks, they are now planning to repeat this work far from the citrus area (21).

The nursery industry. There are 70 registered nurseries (not

under screen), but only 37 are assisted by EMDAGRO. An output of 600,000 nursery trees was estimated for 1998.

The stage of certification programs. In the 1980's there was an attempt to have a joint effort between State and the Ministry of Agriculture but it was not successful.

The State of Bahia

The State of Bahia produces 719,000 tons (3.7% of Brazilian orange production) on 50,057 ha (9). Bahia and Sergipe States are located in the Northeastern region of Brazil under tropical conditions. The growth rate during the period of 1960 to 1995 was 8.2% for the harvested areas and 8.6% for production per yr. In recent years, this growth was due to the expansion of the citrus industry of Sergipe State. The combination of Pera orange on Rangpur lime rootstock is predominant (90%).

Research and development.

In 1961, the Ministry of Agriculture throughout the Research Institution for the East Region (IPEAL), started a research program on citrus improvement and cultural practices for the States of Bahia and Sergipe. Following the strategy used by IAC, it was given a priority for obtaining nucellar lines of the commercial varieties since all orange trees were believed to carry one or more virus and virus-like diseases.

Ten years later, 12,000 citrus trees from this new material were released to the Federal and State organizations, nurserymen and growers and more than 1.5 million buds, of which approximately one million were Pera orange, were also released. This is the basis of the current citrus industry in the North and Northeastern regions where an estimated 100,000 ha containing 40

million trees of the Pera clones, D6 and D9. Another achievement was the increase in the use of nucellar clones from 5% to 100% through a joint effort coordinated by the State Commission of Fruit Crops. Since 1984, the National Research Center for Cassava and Tropical Fruit Crops/EMBRAPA, released micrografted and pre-immunized budwood and developed increase blocks especially for the nurserymen and the State Northeastern organizations. In 1994, a breeding program was started in order to obtain rootstock tolerant to drought and high aluminum.

The nursery industry. There are approximately 100 nurserymen who are non-registered and grow citrus outdoors and not under screen. They produce 300,000 citrus trees. A Citrus Nurserymen Association was created in Cruz das Almas in April, 1998 with 80 members. Although certified material from EMBRAPA is to be released, there is neither control of its utilization by the nurserymen nor any kind of survey to check for the occurrence of diseases. Although CVC was detected at the North Coast, there is no report of its spread to date.

The stage of the Certification Program. The State agent from the Ministry of Agriculture published the "Rules, patterns and procedures for the production of the inspected trees according to a Federal law of 1977. In June, 1996, the State Secretary of Agriculture decided to forbid the introduction of fruits, budwood, and citrus trees from those States where canker, CVC, and other diseases occur. There is no evidence that a certification program has begun despite the concerns from the Government. The growers are not aware about the threats of disease and the need for certification.

The State of Minas Gerais

Minas Gerais State ranks fourth in Brazilian orange production with 518,080 tons on 43,776 ha (9). The growth during the period 1960 to 1995 was 3% for the harvested area and 2.8% in production per yr, partially influenced by the citrus industry of São Paulo State. The Pera orange (70%) on Rangpur lime (100%) is the predominant variety (5).

Research and development. The Federal University of Viçosa (UFV) maintains a collection of 52 varieties (EMBRAPA/CNPMF origin) and an increase block where 500,000 buds were released in 1998 (22).

The nursery industry. According to the Agricultural Institute of Minas Gerais (IMA) there were 233 nurserymen who produced 2 millions citrus trees in 1997 (10). The nurseries are located mainly in the municipality of Santa Euzébia, where there is a Citrus Nurserymen's Association. There are 280 specialized fruit trucks for transporting fruit trees especially citrus. The IMA is in charge of assisting the nurserymen by supplying buds from the UFV Viçosa which should produce 4 million trees. However, the occurrence of CVC could affect this projection.

Stage of the Certification Program. In accordance to Federal law, the State established norms to control the production and transit of citrus trees including the identification of nematodes in 1997.

The State of Rio Grande do Sul. Located at the southern border with Argentina and Uruguay and under less tropical conditions, the State of Rio Grande do Sul has the best climatic conditions for producing fresh fruits for export. It ranks 5th in orange production with 375,840 tons on

27,757 ha (9). However, despite these comparative advantages, the growth rate is only 2% per year from 1960 to 1995. Differing from the other states, the Valencia orange on *Poncirus trifoliata* is the predominant variety and rootstock used (17).

Research and development. The Taquari Experiment Station, named recently as the Fruit Crops Center in Taquari, is responsible for citrus research. There is a germplasm bank of 395 accessions and the Center maintains trials on scion and rootstock (135 hybrids of trifoliolate × sweet orange).

The nursery industry. There are 210 nurserymen and a Citrus Nurserymen's Association in São Sebastião do Cai. In 1998, two million nursery trees were produced. As citrus canker and CVC are endemic, obtaining clean budwood became a serious problem which has been partially resolved by importing virus tested selections from Uruguay. Nurserymen are receiving assistance and loans from the State Secretary of Agriculture to produce citrus trees of higher quality including that grown under screen (2).

Stage of the Certification Program. The State Government created a "Program for Development of the Citrus Industry" with emphasis on production of certified trees in accordance with the Ministry of Agriculture (2). EMBRAPA is involved in helping to clean up the commercial varieties.

The State of Rio de Janeiro

The inclusion of the State of Rio de Janeiro is to honor the late Dalmo Giacometti. He was the first Brazilian researcher to talk about the advantages of a certification program. He started a citrus research program at the

Ecological and Agricultural Research Institution in Rio de Janeiro State in 1954 and the first results were shown in the paper "The Budwood Registration Program for the Rio Citrus Areas" presented at the Second Conference of the International Organization of Citrus Virologists (7). At that time, Rio de Janeiro was the second largest Brazilian citrus producer. Today it ranks in 8th with 168,140 tons on 16,217 ha (9). The growth rate during the period 1960 to 1995 was negative. The predominant variety is "Folha Murcha" (a type of Valencia) on Rangpur lime (95%) (23).

Research and development. The State research and extension corporation (PESAGRO) is in charge of a research program for scion and rootstock improvement. There are seven experiment trials on scions and two on rootstocks.

The nursery industry. There are ten non-registered nurseries producing 300,000 nursery trees.

Stages of a Certification Program. There is no available data on any certification program in this State.

Other State Citrus Producers Over 100,000 tons are produced in Par (North region), Santa Catarina and Paran (both in the South Interamerican Citrus Net (IACNET)).

General Discussion. In 1997, the IACNET, in a joint effort with the Ministry of Agriculture, EMBRAPA, CNPq, the São Paulo Secretary of Agriculture and FUNDECITRUS, promoted an International Workshop on Citrus Certification in Limeira with representatives from the USA, Argentina, Cuba and Uruguay joining representatives from the States of São Paulo, Bahia, Minas Gerais and Rio Grande do Sul in Brazil. Along with experts

from the foreign countries, the workshop had the participation of 400 people from all the Brazilian States. As a result of this meeting, the following regional recommendations were sent to the Minister of Agriculture and State Secretaries of Agriculture:

The North and Northeast regions. (States of Rondônia, Acre, Amazonas, Pará, Roraima, Piauí, Ceará, Pernambuco, Sergipe and Bahia): i) establishment of a board to coordinate implementation of a program for certification; ii) need for a survey to identify the diseases in the various States; iii) selection of local cultivators; iv) indexing of the selected cultivars; v) obtaining virus free selections; vi) a program for re-indexing all selections; vii) registration and certification of propagation material; and viii) implementation of a program for inspection of nursery trees.

The Southeast and Central West regions. (The States of São Paulo, Minas Gerais, Rio de Janeiro, Distrito Federal, Goiás, Mato Grosso and Mato Grosso do Sul): i) voluntary programs at first and mandatory in the future with participation of all official and private sectors being desired; ii) mother trees and increase blocks must be maintained under screen free of the possible vectors of CVC and severe strains of CTV. Mother trees to produce seeds can be maintained without screen but not isolated; iii) certified nursery trees must be produced in containers and under screen to avoid the presence of vectors.; iv) cooperative partnership of the involved States should be encouraged for supporting the acquisition and maintenance of the outstanding propagation material and the tree certification services; v) Federal and State organizations should provide financial support to implement mother tree

registration programs and nursery tree certification in the States and stimulate the participation of the nurserymen.

The South region. (The States of Rio Grande do Sul, Parana and Santa Catarina): i) foundation and increase blocks must be maintained under screen free of insects and with an antechamber and foot-bath; ii) increase trees should be maintained under the responsibility of official organizations and authorized private companies; iii) nursery trees should be produced under screen and in containers on blocks above the soil level; mother trees producing seed for rootstocks should be maintained in blocks and under the official responsibility or authorized private companies; v) nurseries should be limited to those producing more than 10,000 trees; vi) recommendation for the extinction of the "aggregate's nurseries".

SUMMARY

There is an urgent need of Citrus Certification Programs (mandatory or not) in Brazil. This is unquestionable due to the following facts: i) the important economic and social value of the Brazil citrus industry; ii) the occurrence of some very serious

endemic diseases; iii) the distribution of the citrus all over the country; iv) the relative non-existence of efficient inspection of the nursery industry; v) the non-existence of quarantine to adequately control the transport of live material; vi) the poor integration among the Governmental Agencies; vii) growers are not adequately associated; viii) nurserymen are not sufficiently aware of the threats and the need for a certification program.

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