

Scientific research contribution to fruticulture development

José Clélio de Andrade¹, Moacir Pasqual², Wilson Magela Gonçalves³, Ângelo Albérico Alvarenga⁴, Ester Alice Ferreira⁵

^{1,4,5}Research Company of Minas Gerais (EPAMIG), Lavras, MG, Brazil, CP 176, CEP: 37200-000

^{2,3}Federal University of Lavras (UFLA), Lavras, MG, Brazil, CP 3037, CEP: 37200-000

Abstract - This study aimed to evaluate the research contribution on development of peach, apple and guava crops in Campos das Vertentes region, Minas Gerais State, Brazil. It was developed in two stages: the first one by consulting web of science base, where articles about these three fruit were being sought. The search for articles related to selected fruits was performed by ten key identification variables for each one of the following technologies: cultivars, seedlings, dormancy, pruning, fruit thinning, fruit protection/bagging, irrigation, harvesting, post-harvest and commercialization. The second stage was carried out by means of interviews with the peach, apple and guava producers in Barbacena, São João Del Rei and Lavras respectively, which were selected for being development poles of this region. The results were tabulated separately for the first stage and the second stage, confronted the results of interviews with the search of articles. It was concluded that research and technology generation has contributed to the development of peach, apple and guava crops in Campo das Vertentes area.

Key words: Innovation, Research, Fruit growing.

I. INTRODUCTION

Fruit farming has great social and economic importance, as well as food, being an important source of nutrients. According to IBRAF (2013), in the 1989-90 biennium, production was 420 million tons, in 1996 it exceeded 500 million tons and in 2009 it was 728 million tons. In Brazil, fruit production already accounts for 25% of agricultural production. It is one of the most demanding and technology-dependent sectors to achieve success in the business. Therefore, the activities of generation and transfer of technology have been intensified (IBRAF, 2013). Fruit cultivation has great social and economic importance, as well as food, being an important source of nutrients. According to IBRAF (2013), in the 1989-90 biennium, production was 420 million tons, in 1996 it exceeded 500 million tons and in 2009 it was 728 million tons. In Brazil, fruit production already accounts for 25% of agricultural production. It is one of the most demanding and technology-dependent sectors to achieve success in the business. Therefore, the activities of generation and transfer of technology have been intensified (IBRAF, 2013).

Currently, Brazil counts on thirty poles for the development of fruit growing that extends from Rio Grande do Sul to Rio Grande do Norte and Amazonia, where the production of the whole productive chain of fruit agribusiness (IBRAF, 2013) is developed. The technological innovation in Brazilian fruit growing is a segment of the economy that has most stood out in the last years and continues in full evolution, both in the production of fruits for table, as for industry. To this end, Brazil became the third largest producer of fruit in the world, behind only China and India, with a production of around 40 million tons / year, in an area of 2.5 million hectares (KIST et al., 2012). Technological innovation has been detected in Brazilian fruit growing, being inserted in all links of the productive chains. However, their profiles are heterogeneous in aspects of technology adopted, forms of implantation, among other factors (IBGE, 2013).

Temperate fruits, such as apples and peaches, because they are of temperate climate origin, have in Brazil a series of inhospitable factors that need to be improved genetically or adapted by new management techniques, such as seedling formation. Through methods of grafting, pruning, breaking dormancy, irrigation, among others, for the success of economic exploitation. Also, the native fruits of tropical climate, such as guava, also needed genetic improvement, creation of new management techniques, such as: formation of seedlings through grafting, pruning and irrigation methods, for successful exploitation (SANTOS, 2012 and PEREIRA & KAVATI, 2011). In order to obtain a better quality of fruits, it is necessary to obtain a better quality fruit in the coloring of the peel and pulp, fruit size, productivity and harvest of several harvests / year.

Today, with the advancement of research, Brazil produces enough apple for the domestic market and even allows the export of the fruit with excellent quality. Until the 1970, it produced only 10% and with little quality (Faschinello and Nachitigal, 2009). All this was only possible thanks to the technologies generated by the research that reached the producer, enabling successful economic exploitation (BARBOSA et al., 1992). Another example is the production of peach which, according to

Ojima et al. (1989) and Raseira et al. (1998), Brazil drastically reduced its importation thanks to research work in the areas of genetic improvement and adaptation of cultivars through agronomic evaluations and the development of new management techniques, such as: seedling formation through grafting, Pruning systems, dormancy breakdown, a technique that allowed the economic exploitation of the majority of temperate fruits in Brazil, irrigation and soil fertility. Thus, currently peaches of excellent quality are produced in the coloring of the bark and pulp, flavor and high productivity.

In the tropical fruits, such as guava, there was also a great advance in cultivation thanks to research on genetic improvement, adaptation of cultivars through evaluation techniques, formation of seedlings through bud grafting and grafting techniques. Pruning and irrigation that allowed the harvest of several harvests per year and at the moment of market demand, for both table and industry. (SANTOS, 2012 and PEREIRA & KAVATI, 2011). Still, we can highlight results in the use of cultural and phytosanitary practices that allowed the effective control of diseases.

According to Etzkowits (2003), the technological innovation of a country is based on the relationship between universities, companies and states, being relevant for both developed and emerging economies. For Brazil that is experiencing a transitional period for the creation of a knowledge-based society, this relationship is important for its development. The incentives for Brazilian R & D activities in the last decades have been undergoing significant changes, such as the creation of new research programs in the various areas, notably in agriculture, and in the fruit-growing sector there has been significant development.

The objective of this work was to evaluate the contribution of technologies generated by the research and published in publications of technical-scientific journals available on the internet in relation to the technologies adopted by the producers in the development of the Campo das Vertentes region of Minas Gerais, Brazil.

II. MATERIAL AND METHOD

The research was developed in the Campo das Vertentes region of the State of Minas Gerais, Brazil, located between the parallels 20°24' south latitude and the meridians 43°30' west longitude of Greenwich. It is a mesoregion, made up of thirty-six municipalities, grouped into three micro-regions: Lavras with nine municipalities; São João Del Rei with fifteen and Barbacena with twelve (IBGE, 2013).

The work was carried out in two stages: in the first one, secondary data were collected by analyzing the articles through a consultation on the website www.periodicos.capes.gov.br on the Web of Science database. We searched for articles on the peach, apple and guava culture in the world and in Brazil. After the search we tabulated the main magazines with these publications in the world and in Brazil as well as the main universities and research institutions that work with these cultures. In this stage, the articles for each of the three fruit trees were searched for ten variables: varieties, seedlings, dormancy, pruning, fruit thinning, fruit bagging / irrigation, harvesting, post harvesting and commercialization, participation in events Dissemination and transfer of technology and technical assistance. The second stage consisted of interviews with farmers in three municipalities in the Campo das Vertentes region of Minas Gerais, peach, apple and guava, selected to be evaluated in this research, for the pioneering of the producers to introduce these fruits in the municipalities of Barbacena, São João Del Rei and Lavras, respectively, where they were evaluated.

The data were collected through a questionnaire for interview with semistructured questions as a technique for collecting information. The questions presented had the objective of evaluating the contribution of the research in fruit growing based on the technological recommendations recommended by the research institutions and rural extension and university, through its stock of technical and scientific knowledge. In this way the degree of adoption of these technological recommendations by the fruit producers of the selected municipalities was evaluated.

The sampling of the number of producers for interviews was performed according to the criteria of Cochran (1965); in the locality with fifty other producers the sample was 10%, where there were from ten to forty producers of 20% and in places with at least ten 100% producers. Thus, for the peach tree in Barbacena, eight producers were interviewed out of a total of twenty-two, for apple in São João Del Rei two producers as well as for guava in Lavras two producers were interviewed because both localities had less than ten producers that exploit this commercially using high technology. All these producers being nominated by Company of Technical Assistance and Rural Extension of the State of Minas Gerais - EMATER-MG for the interviews.

III. INDENTATIONS AND EQUATIONS

The results presented and discussed come from the confrontation between the first stage and the second stage. The ranking of the main journals that publish scientific articles on peach, apple and guava in the world (Table 1) and in Brazil (Table 2) is presented first, followed by the results of the interviews referring to the ten variables analyzed for Peach, apple and guava: cultivars, seedlings, breakage of dormancy, pruning, irrigation, fruit thinning, fruit protection / bagging, harvest and post harvest, participation in events for diffusion and transfer of technology and technical assistance. It is observed that Acta Horticulturae is the magazine that publishes the most articles about the peach tree, apple tree and guava tree around the world. Second to peach and apple tree comes to Hortscience. The Brazilian Journal of Fruticultura is the third placed in number of articles on guava in the world. There are in Brazil numerous technical-scientific journals specialized in the publication of technologies generated by the research, such as those presented in Table 2.

TABLE 1
SCIENTIFIC JOURNALS IN THE WORLD WITH PUBLICATIONS ON PEACH, APPLE AND GUAVA CROPS FROM 1999 TO 2013.

Journal	Articles number
Peach tree:	
Acta Horticulturae	1,498
Hortscience	1,032
Phytopathology	514
Journal Of The American Society Horticultural Science	501
Journal Of Economic Entomology	385
Apple tree:	
Acta Horticulturae	3,598
Hortscience	1,725
Phytochemistry	968
Journal Of The American Society Horticultural Science	912
Journal Of Agricultural and Food Chemistry	869
Guava tree:	
Acta Horticulturae	242
Proceedings of the 1st International Guava Symposium	83
Revista Brasileira de Fruticultura	61
II International Symposium on Guava and Myrtacea	45
Food Chemistry	40

Source: Web of Science (January, 2014)

TABLE 2
NUMBER OF ARTICLES IN SCIENTIFIC JOURNALS IN BRAZIL WITH PUBLICATIONS ON PEACH, APPLE AND GUAVA CROPS, 1999 TO 2013.

Journal	Articles number
Peach tree:	
Revista Brasileira de Fruticultura	84
Pesquisa Agropecuária Brasileira	52
Ciência Rural	28
Ciência e Agrotecnologia	16
Bragantia	7
Apple tree:	
Revista Brasileira de Fruticultura	81
Pesquisa Agropecuária Brasileira	73
Ciência e Tecnologia de Alimentos	35
Ciência Rural	33
Ciência e Agrotecnologia	19
Guava tree:	
Revista Brasileira de Fruticultura	61
Pesquisa Agropecuária Brasileira	23
Ciência e Agrotecnologia	15
Ciência Rural	11
Ciência e Tecnologia de Alimentos	8

Source: Web of Science (January, 2014)

The Brazilian Journal of Fruticulture is the one that most publishes articles on peach, apple and guava, followed by the Brazilian Agricultural Research. Rural Science is the third for the peach tree and the fourth for the apple tree and the guava tree. The Science and Agrotechnology is the fourth for the peach tree and the third for apple and guava in number of published articles.

The cultivar selected for orchard formation is one of the most important components in the production system. It is a factor that can be changed without changing the cost of implementing the crop with fruit. The cultivars indicated by the research and technical assistance for the region Campo das Vertentes of Minas Gerais have as main parameter the low requirement in cold. Among those presented, all producers interviewed said that they cultivate 'Maciel' and 'Douradão' peach, 'Eva' cultivars for apple and 'Paluma' and 'Pedro Sato' guava.

Regarding the acquisition of seedlings, considering that these have a relevant role in the success of fruitful exploitation. A sound material with the desired genetic characteristics, produced by skilled and skilled nurseries, is of fundamental importance in the formation of an orchard. According to Oliveira et al. (2003) and Raseira et al. (2010), the seedlings indicated by the research and technical assistance must have good genetic characteristics, both of the rootstock and the canopy, healthy and formed by specialized and suitable nurseries. All the producers interviewed said that they acquire seedlings as indicated by the technical assistance.

The guava tree, because it comes from a tropical climate, has no need to break dormancy. On the other hand, the artificial dormancy break in temperate fruits was one of the great findings for the successful economic exploitation of these fruit trees in the region of the Campo das Vertentes of Minas Gerais. According to Nunes, Marondin and Sartori (2001) and Marafon et al. (2003), the effect of the internal factors such as the balance of the promoters and inhibitors of growth and external factors such as temperature, photoperiod and solar radiation. (2007). According to Oliveira et al. (2003), in the region of Campo das Vertentes, the amount of cold is not enough to break the natural dormancy of the buds, so that sprouting and flowering are carried out. For this, it is necessary the artificial dormancy break with chemical phytohormone. All peach and apple producers interviewed said they performed this procedure in accordance with the recommendations.

The pruning of fruit plants is a practice that aims to modify the vigor of the plants, to produce more and to improve the quality of the fruits, to maintain the plant with a size appropriate to its treatment and handling, to modify the tendency of the plant to produce more vegetative branches That fruitful or vice versa, lead the plant to a desired shape, suppress superfluous and inconvenient, diseased or dead branches, regulate the alternation of crops, so as to obtain crops regularly, according to Brickell, 1979. Ojima et al. (1989), Raseira et al. (2010) and Alvarenga, Oliveira and Gonçalves (2013), recommend pruning in the peach, apple and guava trees, so that the plant can bear the fruits load, maintaining balanced growth and avoiding crop alternation between good and bad harvests. Of stimulating the formation of flower buds, also ensuring a good distribution of the buds in the crown of the plant, improving the quality and size of the fruits. All respondents said they perform pruning according to recommendations.

Irrigation is an important practice recommended by research and, consequently, by technical assistance during the dry or summer period, to avoid water stress and to normalize the physiological system of plants (RASEIRA et al., 2010). It is recommended by the research for the peach tree crop, especially in the dry season, which coincide with the coldest period of the year and also with the time of breaking of dormancy, therefore bud buds of flowering and fruiting, (RASEIRA Et al., 2010). All the producers responded that they irrigate by the drip system, according to the recommendations, for the three crops.

Fruit thinning is a very old practice and aims to reduce the fruit load in the plant, with the purpose of protecting the plant, enabling conditions for homogenous production in size and appearance and to facilitate cultural treatment. According to Raseira et al. (2010), recommend the thinning operation of the fruits of the peach tree plant to enable better fruit formation in appearance and flavor, creating better conditions for aeration and light incidence, thus improving the physiological state. Also, to facilitate cultural dealings and harvesting. All respondents said they do the thinning, for all three cultures.

Protecting the fruit is the most important practice to eliminate the attack of the fruit fly, other insects and birds. It is an operation that can be performed by spraying with chemicals, or manually, using fruit bagging with TNT bag or butter paper. According to Raseira et al. (2010) and Monteiro et al. (2007), the protection of the fruit of the peach tree, either by spraying with chemicals or by hand, through bagging, is an important operation to protect the fruits of the fruit fly and other insects, thus guaranteeing more quality to the fruits. In guava, according to Souza, Mancin and Melo (2013) and Pereira (2011), the protection of fruits is very important. It is recommended to make the bagging when the fruit is destined for consumption in

natura, since besides protecting the fruits there is the advantage of valuing the production like organic. All the producers interviewed said to carry out operations to protect the fruits.

The research and the market recommend that the fruits be harvested in a way that does not lose its integrity, disqualifying them in the market. After harvesting the fruits, they should be taken to the packing house or shed to be standardized, graded, packaged and stored in accordance with standards and standards established by the Ministry of Agriculture (RASEIRA et al., 2010 and MONTEIRO et al. All producers interviewed said they follow the established standards. Of these 62%, they use the refrigeration of the fruits because they commercialize the production with the market of the northeast, notably Fortaleza-CE and Recife-PE, the rest, 38%, do not refrigerate because they send the production to the Central of Slaughtering of the State of Minas Gerais - CEASA - MG.

For Alvarenga, Oliveira and Gonçalves (2013), the research recommends that preventive practices be done against diseases of fungal and physiological origin, in order not to damage the product. To do so, one must harvest the fruits at the correct time, to eliminate the foci of inoculate. The fruits after harvesting should be sorted, packaged and stored, preferably under refrigeration. According to Souza, Mancin and Melo (2013) the guava fruit harvest must be done manually and, when the fruits are bright dark green coloring, starting to lighten, this is the ideal harvesting point. After harvest, the fruit should be sorted, packed and stored for marketing. All producers carry out the recommended standards and market the fruits in free markets, wineries and supermarkets.

The events carried out for diffusion and transfer of technologies are of fundamental importance for the dissemination and improvement of production techniques. It is in these events that the producers, extension agents, researchers and other members of the productive chains exchange experiences on the new technological innovations realized. For peach trees and apple trees, all producers interviewed said they participated in these events sporadically in the southern states of the country, notably São Paulo and Paraná. Of these, 45% said they already attended technological events outside the country, notably in the USA. As for guava, all the producers interviewed said that they do not participate in these exclusive events to deal with the guava culture, since they do not exist in the region or are not properly divulged.

In the evaluations of technical assistance, all said that they receive special and specialized technical assistance in a continuous and programmed way, regarding the production process and information on new technologies and market tendencies.

IV. CONCLUSION

The research has contributed to the generation and publication of several technologies for the cultivation of peach, apple and guava.

Producers in the Campo das Vertentes have adopted most of the technologies generated and recommended by the research.

The adoption of the technologies generated by the research has contributed to the development of the cultivation of peaches, apples and guavas in the Campo das Vertentes Region of Minas Gerais, Brazil.

REFERENCES

- [1] ALVARENGA, A. A.; OLIVEIRA, D. L.; GONÇALVES, E. D. Aspectos da cultura da macieira em regiões de inverno ameno. Boletim Técnico EPAMIG, Belo Horizonte, n. 101, 2013, 40 p.
- [2] BARBOSA, W.; CAMPO-DALL'ORTO, F. A et al. O pessegueiro no sistema de pomar compacto: VI. Frutificação efetiva e raleio químico em seleções IAC. Bragantia, Campinas, v. 51, p. 63-67, 1992a.
- [3] BRICKELL, C. A poda. Portugal: Publicações Europa-América, 1979, 228p.: II.
- [4] COCHRAN, W. G. Técnicas de Amostragem. Rio de Janeiro: Editora Fundo de Cultura e USAID, 1965, 428 p.
- [5] Etzkowitz, H. Innovation in innovation: the triple helix of university-industry-government relations. Social Science Information, London, v. 42, n. 3, p. 293-296, 2003.
- [6] HOFFMANN, A.; NACHTIGALL, G. R. Fatores edafo-climaticos. In: NACHTIGALL, G.R. (Ed.). Maçã: produção. Bento Gonçalves: Embrapa Uva e Vinho; Brasília: Embrapa Informação Tecnológica, p. 25-31, 2004.
- [7] INSTITUTO BRASILEIRO DE FRUTICULTURA - IBRAF, 2010. Produção Brasileira de Frutas, 2009. Available in: <[http://www.ibraf.org.br/estatisticas/Produção Brasileira de Frutas 2009 – Final.pdf](http://www.ibraf.org.br/estatisticas/Produção%20Brasileira%20de%20Frutas%202009%20-%20Final.pdf)>. Accessed: december 2013.
- [8] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA – IBGE. Banco de dados. Produção agrícola municipal. Available in: <<http://www.sidra.ibge.gov.br/bda/agric>>. Accessed: december 2013.
- [9] KIST, B. B.; VENCATO, A. Z et. Al. Anuário Brasileiro Da Fruticultura, Editora Gazeta: Santa Cruz do Sul, 2012, 128 p.

- [10] MARAFON, A. C.; HERTER, F. G et al. Concentrações de carboidratos em tecidos de pessegueiro (*Prunus persica* (L.) Batsch) cv. Jubileu em plantas com ou sem sintomas de morte-precoce durante o período de dormência. *Revista Brasileira de Fruticultura*, Jaboticabal, v. 29, n. 1, p. 75-79, 2007.
- [11] MONTEIRO, L.B.; MIO, L. L. M. de. Et al. Avaliação de atrativos alimentares utilizados no monitoramento de mosca-das-frutas em pessegueiro na Lapa-PR. *Revista Brasileira de Fruticultura*, v. 29, n. 1, p. 72-74, Apr. 2007.
- [12] NUNES, J. L. da.; MARONDIN, G.A.; SARTORI, I. A. Cianamida hidrogenada, thidiazuron e óleo mineral na quebra da dormência e na produção do pessegueiro cv. chiripá. *Revista Brasileira de Fruticultura*, Jaboticabal, v. 23, n. 3, p. 493-496, Dec. 2001.
- [13] OJIMA, M.; CAMPO-DALL'ORTO, F. A et al. O. Aurora-1 e Aurora-2: novos cultivares de pêssego doce de polpa amarela. In: CONGRESSO BRASILEIRO DE FRUTICULTURA, 10, Fortaleza, 1989. Anais... Fortaleza: Sociedade Brasileira de Fruticultura, p.422-425, 1989.
- [14] OLIVEIRA, A.P.de.; NIENOW, A. A.; CALVETE, E. O. Capacidade de enraizamento de estacas semilenhosas e de cultivares de pessegueiro tratadas com AIB. *Revista Brasileira de Fruticultura*, v. 25, p. 282-285, 2003.
- [15] PEREIRA, F.M.; KAVATI, R. Contribuição da pesquisa científica brasileira no desenvolvimento de algumas frutíferas de clima subtropical. *Revista Brasileira de Fruticultura*, Jaboticabal, v. 33, 2011, 92 p.
- [16] RASEIRA, A.; PEREIRA, J. F. M et al. Instalação e manejo do pomar. Org. MEDEIROS, C. A. B.; RASEIRA, M. C. B. A cultura do pessegueiro, Brasília: EMBRAPA-SPI; Pelotas: Embrapa-CPACT, p. 81-87, 1998.
- [17] RASEIRA, M. C. B.; NAKASU, B. H. et al. Pessegueiro: cultivar BRS Kampai. *Revista Brasileira de Fruticultura*, v. 32, n. 4, p. 1275-1279, Dec. 2010.
- [18] SANTOS, J. P. Ecofisiologia da goiaba. Universidade do Estado da Bahia. Available in: <http://pt.scribd.com/doc/24497565/A-Cultura-Ecofisiologia-Da-Goiaba>. Accessed: august 2013.
- [19] SOUZA, O. P.; MANCIN, C. A.; MELO, B. Cultura da goiabeira, 2011. Available in: <http://www.fruticultura.iciag.ufu.br/goiabao.html>. Accessed: december 2013.