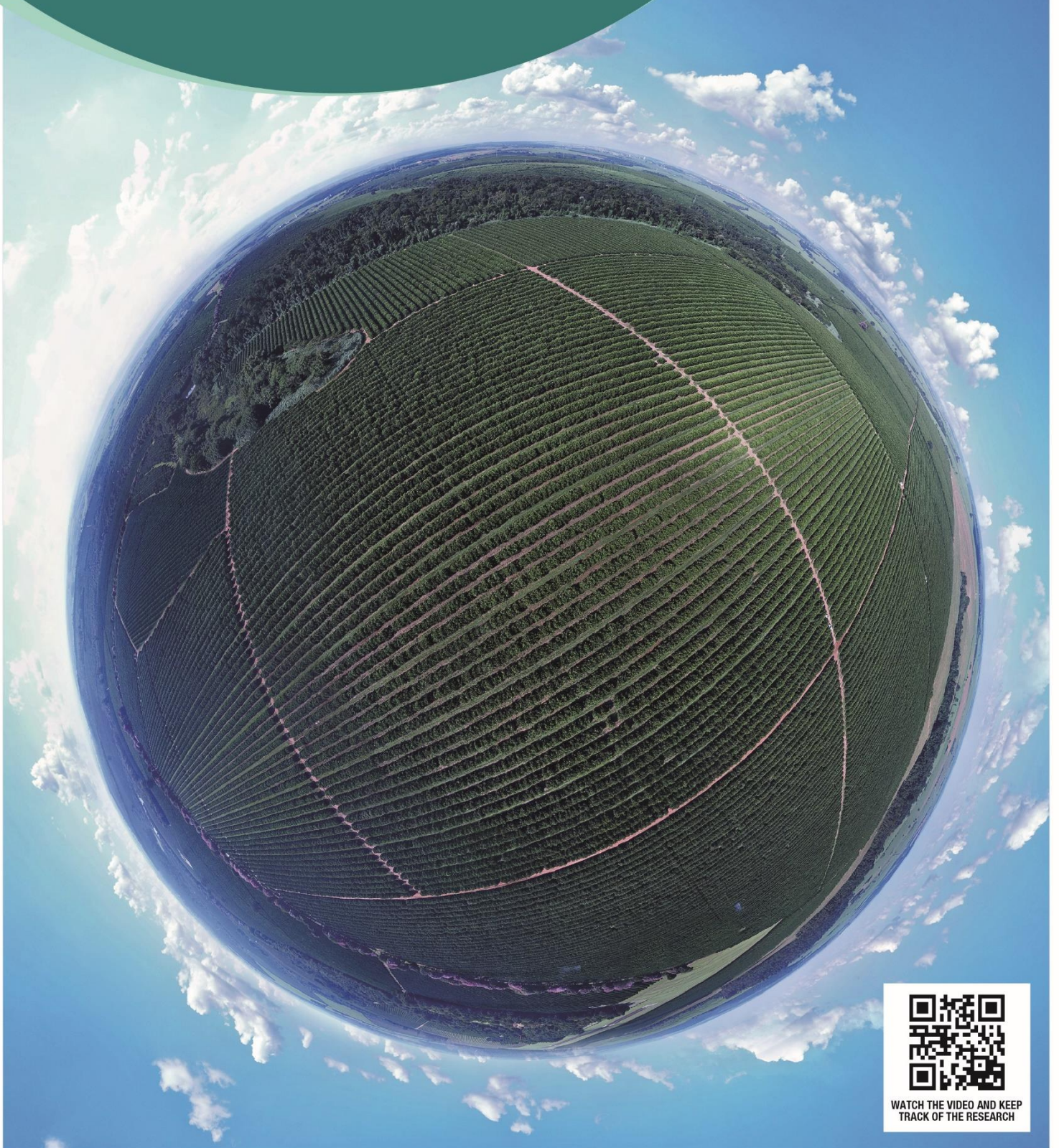# 2019-2020 ORANGE CROP FORECAST FOR SÃO PAULO AND WEST-SOUTHWEST MINAS GERAIS CITRUS BELT

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1 – 2019-2020 ORANGE CROP FORECAST

The 2019-2020 orange crop forecast for São Paulo and west-southwest Minas Gerais citrus belt, published on May 10, 2019 by Fundecitrus in cooperation with Markestrat, FEA-RP/USP and FCAV/Unesp, is 388.89 million boxes (40.8 kg / 90 lb). The total orange production includes:

- 76.97 million boxes of the Hamlin, Westin and Rubi varieties;
- 19.75 million boxes of the Valencia Americana, Seleta and Pineapple varieties;
- 116.20 million boxes of the Pera Rio variety;
- 128.30 million boxes of Valencia and Valencia Folha Murcha varieties;
- 47.67 million boxes of the Natal variety.

27.21 million boxes of the estimated production are expected to be produced in the Triângulo Mineiro.

The projected figure is 36% above the previous one of 285.98 million boxes, and 21% larger than the average crop size for the last ten years. The grove yield recovery was triggered mainly by a climate that favored bloom and fruit set, differently from that of last crop. The average yield per hectare in this crop season is estimated at 1,051 boxes per hectare and 2.24 boxes per tree, which represents an increase in comparison to the 756 boxes per hectare and 1.63 boxes per tree harvested in the 2018-2019 crop.

Among citrus belt sectors, the southwest presents the highest yield, with 1,227 boxes per hectare and 2,42 boxes per tree, keeping its rank with above average rates and smaller amplitude between crop seasons, of exact 2,7% as compared to the yield of the previous crop season. The largest yield increases are seen in the northwest and north sectors, of 128% and 78% respectively. The yield grew 47% in the central sector and 22% in the south sector.

BEARING TREES

Bearing trees total 173.973 million, a 0.74% decrease as compared to the previous inventory. This decline results from a larger proportion of area eradicated last year in relation to new plantings in 2016 that start bearing fruit this season. Varieties included in this forecast account for 97% of trees and also 97% of the area of orange groves in the citrus belt.

Information about bearing trees was collected from the Tree Inventory of São Paulo and West-Southwest Minas Gerais Citrus Belt: Snapshot of Groves in March 2019, taken from the 2018 primary base – created by mapping groves from September 08, 2017 to January 29, 2018 – and from counting existing trees in 5% of orange plots, from January 07 to March 08, 2019. Plots for counting were drawn through stratified random sampling.

FRUITS PER TREE

The average number of fruits per tree in April 2019, disregarding the fruit drop along the crop season, is 783. In this season, groves presented a more intense bloom determined both by the low production in the previous crop, with increased nutritional reserves in plants, and the long-term water stress trees were subject to during floral induction.

The average rainfall in the citrus belt from April to June 2018 totaled only 69 millimeters, which is nearly a third of the rain that usually falls in that time period (1981-2010). After the prolonged drought, non-irrigated groves bloomed following rains that fell in early August in the central, south and southwest sectors, and in mid-September, in the north and northwest sectors. Regions where rains fell only in September have the largest concentration of irrigated areas in the citrus belt, except for Altinópolis, located in the north sector. In order to advance flowering, irrigation started in July 2018.

During post-bloom, temperatures remained mild. In some cities, maximum temperatures reached 35ºC (95ºF), although just for few consecutive days. In addition to mild temperatures, spring and summer rains kept the water available, favoring the setting of flowers and fruitlets, which resulted in a more homogeneous production.

The first bloom from July to September 2018, accounts for 84.1% of the total production. The second bloom, which started in October and November 2018, is estimated at 10.2%. Together, these blooms correspond to 94.3% of the production and should be harvested at the same time. The third bloom, in December 2018 and January 2019, corresponds to 3.2%. The fourth bloom, which started in February 2019, corresponds to 2.5%. For the forecast, all fruits from first, second and third blooms were fully considered. A fruit set rate of 33% was applied to fruit from the fourth bloom. In the separation of fruits per bloom, off-season fruits were also identified and resulted from late and sporadic flowers from the previous crop season, not accounted for in the current crop forecast.

The number of fruits per tree is closely related to the characteristics of each variety. In April 2019, when trees were stripped for the group of earlies Hamlin, Westin and Rubi, an average of 1,114 fruits per tree were counted. As already known, varieties of these groups are more productive than the others, therefore their yield is estimated to be 42% above average in this crop. Next in the sequence are: the late season Natal variety with 853 fruits per tree; the other earlies with 834 fruits per tree; the late season Valencia and Valencia Folha Murcha with 735 fruits per tree; and last, the Pera Rio variety, with 665 fruits per tree.

Approximately 2,200 trees were stripped. Trees to be stripped were distributed proportionally to the total orange trees in the citrus belt and stratified according to their region, variety and age. Plots of trees for stripping were drawn by the method of stratified random sampling. Aiming at the increase of the estimate precision, 360 more trees, of ages lower than those in the age groups of the groves they were part of, were also stripped. These trees correspond to replacements made mainly to offset tree losses caused by greening, citrus canker and other diseases. Trees were stripped from March 14 to April 25, 2019. Fruit harvested was taken to a tree stripping laboratory in Araraquara, where each sample was separated into the different blooms they were from. Fruit was quantified by automatic counting equipment and then weighed.

The average number of fruits per tree may vary plus or minus 17 fruits, which corresponds to 2.1% of the average number of fruits per tree obtained at stripping. This figure is within the expected error of 2% to 3% used in sizing the sample. The yield deviation distribution analysis for each stripped tree in relation to the stratum average shows that sample data is randomly distributed according to a normal distribution.

DROP RATE – fruit drop index from tree stripping to final plot harvest

The projected average drop rate is 17.5%, distributed as follows: 10.5% for the early Hamlin, Westin and Rubi; 11.0% for the other early varieties; 17.5% for the mid-season Pera Rio variety; 21.5% for the late Valencia and Valencia Folha Murcha varieties; and 22.0% for the late Natal variety. This rate is applied to the number of fruits in the tree in April 2019, when trees are stripped. The result of this calculation is the estimate of the number of fruits that will be available in the tree at harvest, since part of the oranges in the tree in the beginning of the crop season will fall throughout that period due to physiological drop, mechanized activities, pests and diseases and adverse climatic conditions.

Should this fruit drop rate hold, it will be one of the highest rates since the first crop forecast by Fundecitrus. Major reasons for this projection are the increased greening severity and the rise in the populations of fruit borer and fruit fly during the last crop season, which then became the main cause of fruit drop. Losses caused by these pests are expected to remain large this crop season, due to the availability of fruit in transition between the last and the current crop. This is what likely enabled the continuity of the insect life

cycle, since they could have migrated from the fruits produced from the third and fourth blooms of the previous crop, which were atypically produced in a larger proportion, to the fruits from the first and second blooms of this crop. Other reason supporting this projection of a larger drop rate is the highly concentrated fruit production from the first and second blooms, which may result in some operational difficulties.

Monthly and continuous monitoring by Fundecitrus as of May 2019 in 1,200 orange plots visited up to their complete harvest serves as basis to correct the rate projected at the time of this publication and consequently to correct the production estimate as well. This year, fruit collection nets were added to 300 plots to be monitored with the aim of both obtaining a more precise drop rate and identifying fruit drop causes. Counting of fruits on branches of monitored trees in all 1,200 sample plots will also be part of the test.

FRUITS PER BOX – fruit size, that is, number of oranges to reach the weight of 40.8 kg box (90 lb) at harvest

The final fruit size projection is 260 fruits per 40.8 kg box, that is 296 fruits per box for the group of early varieties made up by Hamlin, Westin and Rubi; 270 fruits per box for the group of other early varieties; 266 fruits per box for the mid-season variety Pera Rio; and 235 fruits per box for the late varieties Valencia and Valencia Folha Murcha; and 242 fruits per box for the late variety Natal.

The average size of 260 fruits per box is equivalent to oranges weighing 157 grams at harvest. The high number of fruits per tree is one of the factors that should limit the development of fruits in this crop season, due to increased competition for plant reserves, since number of fruits and fruit size at harvest are inversely proportional.

The final fruit size was estimated by a regression model that considered the final fruit size (fruits per box at harvest) as the dependent variable and the number of fruits per tree counted at stripping, the initial fruit size (fruits per box at stripping), the sum of the production from the first and second blooms in relation to the total production and the rainfall accumulated from May to July as independent variables. Data from the last eleven crops, 2008-2009 to 2018-2019, was used in the regression and is presented in Table 1. Results obtained show an adjusted R^2 of 0,92. That means the four independent variables together explain 92% of the variation in the final fruit size (fruits per box at harvest), at a coefficient that can vary from 0 to 100%, which shows how important these variables are for the final fruit size. The comparison between the final fruit size estimated by this model and the final fruit size observed in the last eleven crops presents an average error of $\pm$ 2%.

Data relative to final fruit size (fruits per box at harvest), number of fruit per tree counted at stripping, initial fruit size (fruits per box at stripping) and the sum of the production from the first and second blooms in relation to the total production for the series from 2008-2009 to 2014-2015 was provided by orange juice companies associated to Fundecitrus – Citrosuco, Cutrale and Louis Dreyfus, which separately have estimated the production for the citrus region since 1988, with the use of objective methodology. Data was supplied individually and under a formal confidentiality agreement to an independent consulting firm for the determination of the average. Individual data supplied by each company was kept confidential. Data relative to the crops 2015-2016 to 2018-2019 comes from results of estimates performed by Fundecitrus. Data on rainfall accumulated from May to July was supplied by Somar Meteorologia.

Data used in the model to estimate the final fruit size in this crop comprises figures from the 2019 stripping and the rainfall predicted for May to July 2019 in volumes equivalent to the climatological average (1981 – 2010) calculated with information from the Climatempo website. Final fruit size estimated by the regression is 263 for the 2019-2020 crop. This size was corrected by the regression that used the observed size as the dependent variable and the estimated size as the independent variable. The size projected by this other regression is 260 fruits per box for the 2019-2020 crop.

Table 1 – Data for the 2008-2009 crop to the 2018-2019 crop and data used to estimate the final fruit size in the 2019-2020 crop

Crop	Fruits per tree at stripping	Initial fruit size at stripping	Sum of productions from first and second blooms	Accumulated rainfall from May to July	Final fruit size observed at harvest	Final fruit size estimated by the model	Error	Absolute error
	(number)	(fruits/box)	(%)	(millimeters)	(fruits/box)	(fruits/box)	(%)	(%)
2008-2009	659	421	79%	80	255	256	1%	1%
2009-2010	624	431	77%	143	250	242	-3%	3%
2010-2011	532	457	97%	64	271	257	-5%	5%
2011-2012	859	401	96%	116	269	270	0%	0%
2012-2013	764	439	95%	268	250	244	-2%	2%
2013-2014	515	338	87%	247	224	215	-4%	4%
2014-2015	646	373	92%	102	256	252	-2%	2%
2015-2016	498	391	90%	204	226	235	4%	4%
2016-2017	430	358	90%	214	222	224	1%	1%
2017-2018	753	393	91%	184	246	251	2%	2%
2018-2019	564	446	82%	36	259	264	2%	2%
2019-2020	783	411	94%	133[e]	(X)	263	(X)	(X)

Source: Fundecitrus (2015-2016 crop to 2019-2020 crop), CitrusBr (2008-2009 crop to 2014-2015 crop), Somar Meteorologia and Climatempo.

(X) Not applicable.

[e] Estimated.

The result of the equation used to estimate the crop is corrected by the application of a correction factor. That is necessary because of the variables not considered in the calculations, such as harvested fruits that wind up not being used, diverse planting densities that are not included in the stratification of groves, or losses of trees throughout the crop season caused by eradications, abandonments or deaths. The correction factor of 0.10 applied in this crop is the same used since the 2017-2018 crop and represents the average of the indexes of the 2015-2016 and 2016-2017 crops estimated by Fundecitrus.

2 – OBJECTIVE SURVEY METHOD FOR THE ORANGE CROP FORECAST

In order to perform this estimate, the objective method used in previous crop seasons was maintained, which is based on quantitative data – field measurements, counting and weighing of fruit – applied to the equation represented below.

$$\text{Forecast production} = \frac{\text{Bearing trees} \times \text{Fruit per tree} \times (1 - \text{Drop rate \%}) \times (1 - \text{CF \%})}{\text{Fruit per box}}$$

where CF is the correction factor

Results from the inventory and tree stripping were obtained throughout the survey, then compiled and restricted until the date of this publication to the following professionals: Antonio Juliano Ayres (Fundecitrus general manager); Fernando Alvarinho Delgado and Roseli Reina (PES supervisors); Vinícius Gustavo Trombin (executive coordinator linked to Markestrat); Marcos Fava Neves (political-institutional and methodological coordinator linked to FEA-RP/USP and Markestrat), and José Carlos Barbosa (methodology analyst linked to the department of Math and Science of FCAV/Unesp). All of them were subject to confidentiality obligations with regard to PES information before its announcement was made public, according to agreements signed between each of them and Fundecitrus. As for antitrust practices, they were all complied with through the adoption of measures necessary to prevent any communication or sharing of individual information with competitive content among the orange juice companies that collaborate with Fundecitrus in this project or between these and citrus growers.

This team, together with Fundecitrus vice-president Roberto Hugo Jank Junior, here representing president Lourival Carmo Monaco, who was absent due to commitments abroad, concluded the crop forecast on May 10, 2019, at 9:30 a.m., in a closed meeting with no external communication channel beyond participants. Following that, at 10 a.m., Fundecitrus vice-president began the public announcement of the crop forecast at the Fundecitrus auditorium in Araraquara-SP, which was broadcast live on the website www.fundecitrus.com.br. Fundecitrus general manager Antonio Juliano Ayres presented the detailed data. After the crop forecast announcement, the Executive Summary of the 2019-2020 orange crop forecast was made available on the Fundecitrus website. The complete report including the 2019 tree inventory and the 2019-2020 orange crop forecast will be available on May 24, 2019 on www.fundecitrus.com.br.

3 – TABLES OF DATA

The following tables present the 2019-2020 orange crop forecast per sector, age, bloom and variety. The margin of error of the production estimate in the strata is higher than that of the production estimate in the citrus belt as a whole. Possible variations in fruit size and fruit drop rate may change the forecast and will be accounted for throughout the crop by ongoing field monitoring for production estimate updates.

Table 2 – 2019-2020 Orange crop forecast by sector

Sector	Mature groves area	Average density[1] of mature groves	Bearing trees	Fruit per tree at stripping[2]	2019-2020 Orange crop forecast		
					Per tree	Per hectare	Total
	(hectares)	(trees/ hectare)	(1,000 trees)	(number)	(boxes/ tree)	(boxes/ hectare)	(1,000,000 boxes)
North.........................	85,662	480	40,297	802	2.29	1,078	92.35
Northwest..................	38,761	462	17,630	717	2.03	924	35.81
Central......................	102,613	477	47,762	778	2.23	1,036	106.33
South.........................	73,291	465	33,000	729	2.09	940	68.88
Southwest..................	69,721	521	35,284	850	2.42	1,227	85.52
Total.......................	**370,048**	**482**	**173,973**	**783**	**2.24**	**1,051**	**388.89**

[1] Calculation considers the total number of trees in the plot, that is, bearing and non-bearing trees (2017 and 2018 resets).
[2] Weighted average per total stratum fruit.

Table 3 – 2019-2020 Orange crop forecast by tree age groups (continues below)

Age of plots	Mature groves area	Average density[1] of mature groves	Bearing trees by age group				Fruit per tree at stripping by age group of trees[2]			
			3 – 5 years	6 – 10 years	Over 10 years	Total	3 – 5 years	6 – 10 years	Over 10 years	Total
	(hectares)	(trees/ hectare)	(1,000 trees)	(1,000 trees)	(1,000 trees)	(1,000 trees)	(fruit/ tree)	(fruit/ tree)	(fruit/ tree)	(fruit/ tree)
3 – 5 years............	31,262	648	19,637	-	-	19,637	**291**	-	-	291
6 – 10 years..........	101,625	561	1,970	53,429	-	55,399	156	**652**	-	635
Over 10 years….....	237,161	426	3,300	5,465	90,172	98,937	170	424	**1,025**	963
Total....................	**370,048**	**482**	**24,907**	**58,894**	**90,172**	**173,973**	**264**	**631**	**1,025**	**783**

- Represents zero.
[1] Calculation considers the total number of trees in the plot, that is, bearing and non-bearing trees (2017 and 2018 resets).
[2] Weighted average per total stratum fruit.

Table 3 – 2019-2020 Orange crop forecast by tree age groups (continued)

Plots age	2019-2020 Orange crop forecast by tree age group				2019-2020 Orange crop forecast by tree age group			
	3 – 5 years	6 – 10 years	Over 10 years	Total	3 – 5 years	6 – 10 years	Over 10 years	Total
	(boxes/ tree)	(boxes/ tree)	(boxes/ tree)	(boxes/ tree)	(1,000,000 boxes)	(1,000,000 boxes)	(1,000,000 boxes)	(1,000,000 boxes)
3 – 5 years............	0.83	-	-	0.83	**16.32**	-	-	16.32
6 – 10 years..........	0.45	1.86	-	1.81	0.88	**99.62**	-	100.50
Over 10 years….....	0.48	1.21	2.93	2.75	1.58	6.60	**263.89**	272.07
Total..................	**0.75**	**1.80**	**2.93**	**2.24**	**18.78**	**106.22**	**263.89**	**388.89**

- Represents zero.
[1] Calculation considers the total number of trees in the plot, that is, bearing and non-bearing trees (2017 and 2018 resets).

Table 4 – 2019-2020 Orange crop forecast by bloom

Bloom	2019-2020 Orange crop forecast	Percentage of the orange crop forecast by bloom
	(1,000,000 boxes)	(percentage)
1st..	327.31	84.17%
2nd	39.70	10.21%
3rd...	12.29	3.16%
4th	9.59	2.47%
Total..	**388.89**	**100.00%**

Table 5 – 2019-2020 Orange crop forecast in percentage of bloom by region

Bloom	North[1]				Northwest[2]			Central[3]				South[4]			Sothwest[5]			Total
	TMG	BEB	ALT	**AVE[6]**	VOT	SJO	**AVE[6]**	MAT	DUA	BRO	**AVE[6]**	PFE	LIM	**AVE[6]**	AVA	ITG	**AVE[6]**	
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1st.........	89.9	77.8	66.0	**79.9**	84.0	83.1	**83.5**	83.0	86.4	87.0	**85.4**	85.7	82.0	**83.9**	87.7	88.3	**87.9**	84.2
2nd.........	5.4	16.1	31.4	**14.9**	9.9	11.2	**10.6**	7.6	6.8	8.1	**7.2**	8.5	13.8	**11.1**	8.8	4.9	**7.9**	10.2
3rd.........	2.6	2.8	2.0	**2.6**	3.4	3.4	**3.4**	5.1	3.7	2.7	**4.0**	3.4	2.7	**3.1**	2.1	4.4	**2.6**	3.2
4th.........	**2.1**	**3.4**	**0.7**	2.7	**2.7**	**2.3**	2.5	**4.2**	**3.1**	**2.3**	3.3	**2.4**	**1.5**	2.0	**1.4**	**2.4**	1.6	2.5

[1] North: TMG – Triângulo Mineiro, BEB – Bebedouro, ALT – Altinópolis.
[2] Northwest: VOT – Votuporanga, SJO – São José do Rio Preto.
[3] Central: MAT – Matão, DUA – Duartina, BRO – Brotas.
[4] South: PFE – Porto Ferreira, LIM – Limeira.
[5] Southwest: AVA – Avaré, ITG – Itapetininga.
[6] AVE – Weighted average per total stratum fruit.

Table 6 – 2019-2020 Orange crop forecast and its components by variety group

Variety group	Mature groves area	Average density[1] of mature groves	Components of May/2019 forecast				2019-2020 Orange crop forecast		
			Bearing trees	Fruit per tree at stripping[2]	Fruit estimated per box	Estimated drop rate	Per tree	Per hectare	Total
	(hectares)	(trees/ hectare)	(1,000 trees)	(number)	(number)	(%)	(boxes/ tree)	(boxes/ hectare)	(1,000,000 boxes)
Early:									
Hamlin, Westin and Rubi.....	57,807	455	25,482	1,114	296	10.50	3.02	1,331	76.97
Other early:									
Valencia Americana, Seleta, Pineapple...................	17,692	469	8,016	834	270	11.00	2.88	1,269	19.75
Mid-season:									
Pera Rio................................	125,453	514	62,869	665	266	17.50	1.85	926	116.20
Late:									
Valencia and VFolha Murcha[3]	126,023	472	58,269	735	235	21.50	2.20	1,018	128.30
Natal....................................	43,073	460	19,337	853	242	22.00	2.47	1,107	47.67
Average..............................	**(X)**	**482**	**(X)**	**783**	**260**	**17.50**	**2.24**	**1,051**	**(X)**
Total....................................	**370,048**	**(X)**	**173,973**	**(X)**	**(X)**	**(X)**	**(X)**	**(X)**	**388.89**

(X) Not applicable.
[1] Calculation considers the total number of trees in the plot, that is, bearing and non-bearing trees (2017 and 2018 resets).
[2] Weighted average per total stratum fruit.
[3] V.Folha Murcha – Valencia Folha Murcha.