EXECUTIVE SUMMARY

# 2021-2022 ORANGE CROP FORECAST FOR THE SÃO PAULO AND WEST-SOUTHWEST MINAS GERAIS CITRUS BELT

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Fundecitrus
SCIENCE AND SUSTAINABILITY IN CITRICULTURE

PES Crop Forecast Survey

markestrat Group

fea-RP

unesp Jaboticabal

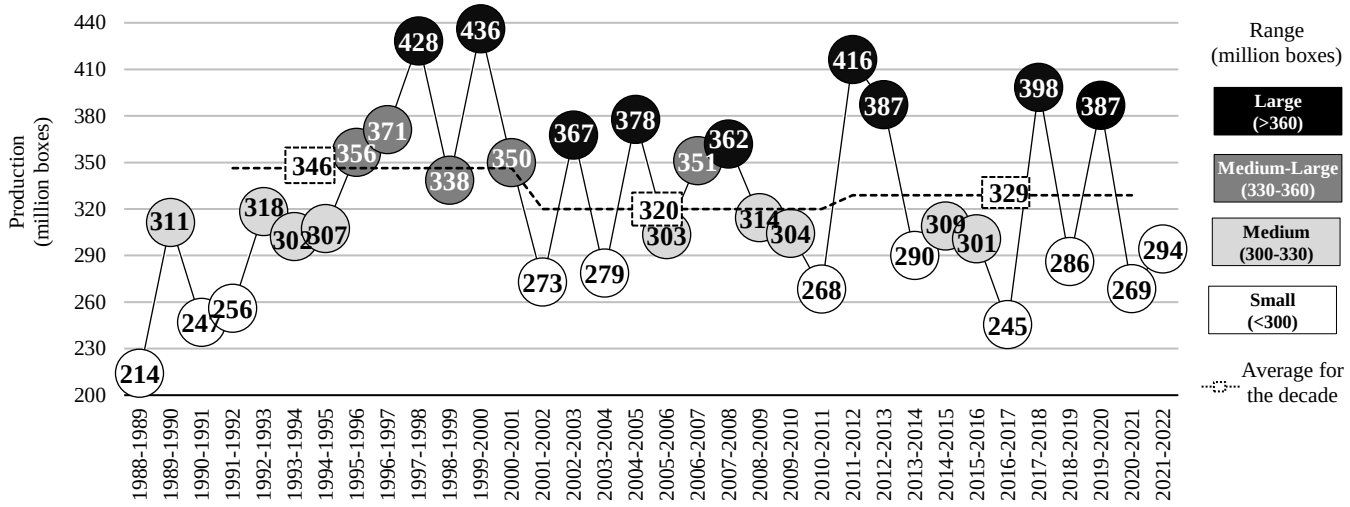
## 1 – 2021-2022 ORANGE CROP FORECAST

The 2021-2022 orange crop forecast for the São Paulo and West-Southwest Minas Gerais citrus belt, published on May 27, 2021 by Fundecitrus, in cooperation with Markestrat, FEA-RP/USP and FCAV/Unesp, is 294.17 million boxes (40.8 kg or 90 lb). Total orange production includes:

- 51.37 million boxes of the Hamlin, Westin and Rubi varieties;
- 16.87 million boxes of the Valencia Americana, Seleta and Pineapple varieties;
- 84.66 million boxes of the Pera Rio variety;
- 107.07 million boxes of the Valencia and Valencia Folha Murcha varieties;
- 34.20 million boxes of the Natal variety.

Approximately 26.09 million boxes are expected to be produced in the Triângulo Mineiro.

As compared to the final forecast of 268.63 million boxes in the previous crop, the current projection represents an increase of 9.51% although it is still below the average of 35 million boxes for the last ten crop seasons, which corresponds to a drop of 10.53%. Graph 1 shows production volumes since 1988-1989.




**Graph 1 – Orange production from 1988-1989 to 2020-2021 and 2021-2022 crop forecast**
Sources: CitrusBR (1988-1989 to 2014-2015) and Fundecitrus (2015-2016 to 2021-2022)

Although this is an on-year crop, the increase in the number of fruits per tree as compared to that in the previous crop season is lower than what was observed in the years the crop was also favored by high production cycles. The last on-year crop seasons were 2017-2018 and 2019-2020, years when the increase in the average number of fruits per tree in relation to previous crop seasons was 75% and 39%, respectively. In the current crop season, that increase is of only 12.50%, which means orange trees had the physiological conditions to bear a heavier fruit load than that of the previous cycle, owing to the reserves saved from the low production volume. Nevertheless, the adverse climate significantly affected that production volume, which shows that citriculture in the state of São Paulo and West-Southwest Minas Gerais is highly dependent on climatic factors, since approximately 70% of the planted area is rain-fed.

The citrus belt also faced opposite climate extremes in the beginning of this crop season: rains in the regions of Itapetininga, Avaré and Duartina in June and August 2020, which triggered the first bloom, while a long drought hit the remaining regions of the citrus belt and only ended in mid-October, when rains enabled good water conditions for plants in that part of the citrus belt to have a late first bloom at a period when a second bloom usually takes place. Before rains fell, that is, from September 30 to October 7, 2020, a strong

heat wave hit the whole citrus belt, with average maximum temperatures on the order of 42ºC, affecting the setting of first bloom fruits in the regions of Itapetininga, Avaré and Duartina, and in irrigated groves. Those fruits were still small, having a diameter of 0.5 to 3.0 centimeters and intense physiological drop caused by high temperatures.

Due to the erratic behavior of the climate and poorly marked seasons, with prolonged droughts and high temperatures at a time critical to the two mains blooms, there was a third bloom in many groves in December 2020 and January 2021, and a fourth bloom as of February 2021. In general, the first bloom accounts for 29.6% of the crop; the second bloom for 46.3%; the third bloom for 20.0%; and the fourth bloom for 4.1%. This year, the third and fourth blooms stand out as accounting for greater percentages of the crop, due to the unfavorable climate conditions in the early post-flowering stage.

Rains became scarce once again in April and May 2021, which was felt by orange trees, and evidenced by the small size of stripped fruits in this crop that weighed an average 81 grams each, as compared to a weight of approximately 100 grams at that time in regular years. However, more adversities to production should still arise from climate conditions.

According to Somar Meteorologia/Climatempo, the rainfall volume below the historical average should not change in the coming months. Rains are forecast to be scarce until October 2021, repeating the scenario observed last year. If this forecast is confirmed, the maturation period, which includes fruit development and filling, will also be affected. However, the effects of these unfavorable climate conditions are already included in this crop forecast, since the projected weight of the oranges at harvest is small (157.5 grams), below their average weight in the last six crops (167 grams), and the projected fruit drop rate (20.50%) is the second highest since 2015, the year when Fundecitrus first started carrying out the surveys. These parameters are similar to those observed in the previous season, but quite different from the average of the last crops.

The average yield in this crop is estimated at 850 boxes per hectare and 1.77 boxes per tree, as compared to 737 boxes per hectare and 1.55 boxes per tree harvested in the 2020-2021 crop season. The expected average yield per hectare has increased by 15.33% in relation to the previous crop, which is a higher rate as compared to the growth of 9.51% that is expected for production, confirming the trend of maintaining better managed groves, with higher yields, and eradicating groves with the worst yields per hectare. The groves of Valencia and Valencia Folha Murcha stand out in terms of increased yield per variety, with an expected increase of 25.71% as compared to the previous crop season, the highest among all varieties, which relates to the larger number and size of fruits of those varieties and the high concentration of trees in the category of older and more productive age, above 10 years, which account for about 67% of bearing trees. Tables 1 and 2 present yields per variety and variations in relation to the previous crop season.

**Table 1 – Yield per hectare and variety for the 2015-2016 crop to the 2021-2022 crop**

| Group of varieties | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 | 2021-2022[e] |
|---|---|---|---|---|---|---|
| | (boxes/ hectare) | (boxes/ hectare) | (boxes/ hectare) | (boxes/ hectare) | (boxes/ hectare) | (boxes/ hectare) |
| Hamlin, Westin and Rubi… | 744 | 1,235 | 833 | 1,319 | 797 | 892 |
| Other earlies..... | 744 | 1,008 | 810 | 1,121 | 827 | 914 |
| Subtotal for earlies..... | 744 | 1,184 | 828 | 1,273 | 804 | 897 |
| Pera Rio..... | 596 | 945 | 633 | 943 | 671 | 739 |
| Valencia and V.Folha Murcha. | 597 | 1,016 | 826 | 998 | 739 | 929 |
| Natal..... | 650 | 1,063 | 765 | 1,082 | 803 | 849 |
| **Total.....** | **634** | **1,033** | **756** | **1,045** | **737** | **850** |

[e] Estimate.

**Table 2 – Variation in yield per hectare for varieties as compared to previous season's**

| Group of varieties | 2017-2018 in comparison to 2016-2017 | | 2018-2019 in comparison to 2017-2018 | | 2019-2020 in comparison to 2018-2019 | | 2020-2021 in comparison to 2019-2020 | | 2021-2022[e] in comparison to 2020-2021 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (boxes/ hectare) | % | (boxes/ hectare) | % | (boxes/ hectare) | % | (boxes/ hectare) | % | (boxes/ hectare) | % |
| Hamlin, Westin and Rubi… | 491 | 66.0% | -402 | -32.5% | 486 | 58.4% | -522 | -39.6% | 95 | 11.9% |
| Other earlies..... | 264 | 35.5% | -198 | -19.6% | 311 | 38.4% | -294 | -26.2% | 87 | 10.5% |
| Subtotal for earlies..... | 441 | 59.2% | -357 | -30.1% | 445 | 53.8% | -469 | -36.9% | 93 | 11.6% |
| Pera Rio..... | 349 | 58.5% | -312 | -33.0% | 310 | 48.9% | -272 | -28.8% | 68 | 10.2% |
| Valencia and V.Folha Murcha. | 420 | 70.3% | -190 | -18.7% | 172 | 20.9% | -259 | -26.0% | 190 | 25.7% |
| Natal..... | 413 | 63.5% | -298 | -28.0% | 316 | 41.3% | -279 | -25.8% | 46 | 5.7% |
| **Total.....** | **399** | **62.9%** | **-278** | **-26.9%** | **290** | **38.3%** | **-308** | **-29.5%** | **113** | **15.3%** |

[e] Estimate.

Regarding yield per sector, greater homogeneity is expected due both to the significant yield reduction in the Southwest as compared to that in the previous crop and to the increase in the other sectors. The Northwest sector, encompassing the regions of Votuporanga and São José do Rio Preto, which had been the most affected by the climate last season, now ranks first among the sectors ordered from the highest to the lowest yield increase between the current and previous crops. The 725 boxes per hectare that should be produced in that sector represent a growth of 54.9% in relation to the 2020-2021 crop. The North sector, comprising the regions of Triângulo Mineiro, Bebedouro and Altinópolis, ranks second with an increase of 38.7% and an expected yield of 899 boxes per hectare. The Central sector, encompassing the regions of Matão, Duartina and Brotas, ranks third with an increase of 22.3% and 816 boxes per hectare projected for this crop. The South sector, encompassing the regions of Porto Ferreira and Limeira, ranks fourth with an increase of 7.7% and 781 boxes expected to be harvested per hectare. The Southwest sector, encompassing the regions of Avaré and Itapetininga, is the only one with a drop in production, equivalent to 12.1% lower than that of the last crop and an expected 972 boxes per hectare. Tables 3 and 4 present yields per sector and variations in relation to the previous crop season.

**Table 3 – Yield per hectare of sectors for the 2016-2017 crop to the 2021-2022 crop**

| Sector | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 | 2021-2022[e] |
|---|---|---|---|---|---|---|
| | (boxes/ hectare) | (boxes/ hectare) | (boxes/ hectare) | (boxes/ hectare) | (boxes/ hectare) | (boxes/ hectare) |
| North..... | 495 | 1,108 | 606 | 1,070 | 648 | 899 |
| Northwest..... | 376 | 882 | 404 | 924 | 468 | 725 |
| Central..... | 616 | 984 | 707 | 1,032 | 667 | 816 |
| South..... | 664 | 989 | 770 | 936 | 725 | 781 |
| Southeast..... | 950 | 1,154 | 1,195 | 1,217 | 1,106 | 972 |
| **Total.....** | **634** | **1,033** | **756** | **1,045** | **737** | **850** |

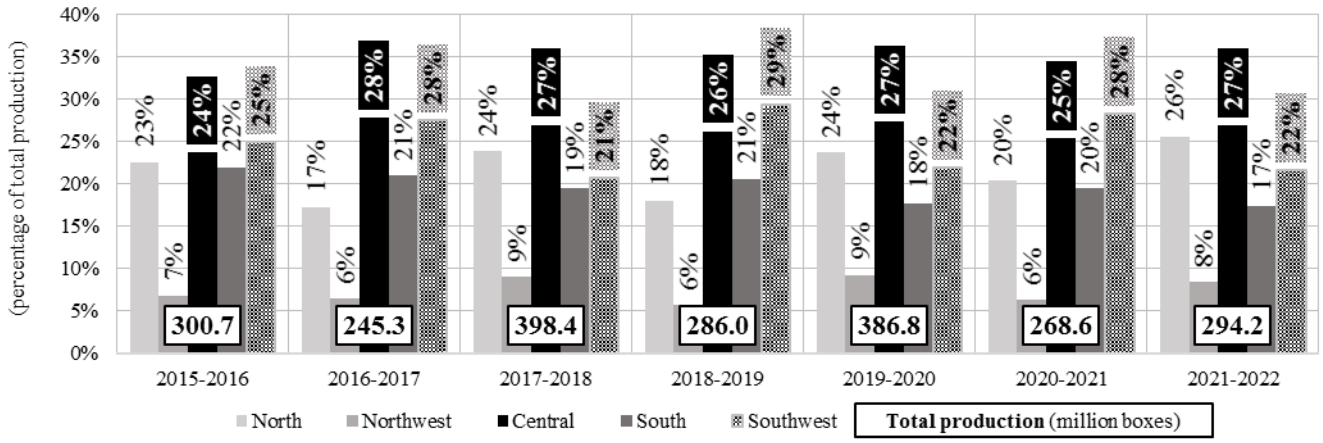
[e] Estimate.

**Table 4 – Variation in yield per hectare of sectors in relation to the previous crop season's**

| Sector | 2017-2018 in comparison to 2016-2017 | | 2018-2019 in comparison to 2017-2018 | | 2019-2020 in comparison to 2018-2019 | | 2020-2021 in comparison to 2019-2020 | | 2021-2022[e] in comparison to 2020-2021 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (boxes/ hectare) | % | (boxes/ hectare) | % | (boxes/ hectare) | % | (boxes/ hectare) | % | (boxes/ hectare) | % |
| North..... | 613 | 123.6% | -502 | -45.3% | 464 | 76.6 | -422 | -39.4% | 251 | 38.7% |
| Northwest..... | 505 | 134.2% | -478 | -54.2% | 520 | 128.7 | -456 | -49.4% | 257 | 54.9% |
| Central..... | 368 | 59.7% | -277 | -28.1% | 325 | 46.0 | -365 | -35.4% | 149 | 22.3% |
| South..... | 325 | 49.0% | -218 | -22.1% | 166 | 21.6 | -211 | -22.5% | 56 | 7.7% |
| Southwest..... | 204 | 21.5% | 41 | 3.5% | 22 | 1.8 | -111 | -9.1% | -134 | -12.1% |
| **Total.....** | **399** | **62.9%** | **-278** | **-26.9%** | **289** | **38.2%** | **-308** | **-29.5%** | **113** | **15.3%** |

[e] Estimate.

With the reduced yield in the Southwest, that sector loses share to the other sectors in relation to total production. As shown in Graph 2, the Central sector accounts for 27% of the production, the North for 26%, the Southwest for 22%, the South for 17% and, finally, the Northwest for 8%.




**Graph 1 – Share of sectors in total orange production for the 2015-2016 crop to the 2020-2021 crop**

## BEARING TREES

Bearing trees total 166.56 million and occupy an area of 346,123 hectares in this crop. These values represent, respectively, a reduction of 4.41% and 5.03% as compared to the previous inventory of March 2020.

Field surveys carried out this year show that from April 2020 to March 2021 there was a significant increase in the eradication of groves, from 3.70% in 2020 to 7.26%, in 2021. This increase is related to the two consecutive years of intense drought.

The groves that suffered most from the drought were those grown in more critical regions without irrigation and with a high planting density of orange trees grafted onto Swingle citrumelo rootstock, which is more susceptible to water deficit. In the past crop, when the climate was extremely adverse, the yield of those groves dropped drastically and in extreme cases there was a high mortality of plants, which accelerated the process of eradicating the most affected adult trees and plots.

Under those conditions, the mortality of orange trees increased in adult groves, caused by diseases such as citrus blight and citrus sudden death (CSD), mainly for trees grafted onto the Rangpur lime rootstock, which is susceptible to both diseases. Citrus sudden death reappeared last year in the regions of Bebedouro, São José do Rio Preto and the southwest of Triângulo Mineiro, where climatic conditions were extremely unfavorable.

The greening effects associated with water deficit were more marked in the regions of Brotas, Porto Ferreira, Limeira, Matão and Duartina, which have the highest incidence of the disease. In those locations there was a more intense drop of oranges, affecting the yield and contributing to increased eradication.

Another important and decisive fact for the greater eradication of the groves is the cycle of high prices for other agricultural commodities, such as corn, soybeans and sugar, which appeared as another crop option.

In this new 2021 inventory, groves accounted for as eradicated total 28,738 hectares. Since the last inventory, 2,988 hectares were abandoned. Both eradicated and abandoned groves put together comprise an accumulated loss of 31,726 hectares since the 2020 inventory. Using this area and the estimated average density of eradicated groves of 471 plants per hectare as an assumption to estimate the number of eradicated and abandoned trees, a total of 15 million plants are estimated to have been excluded from the productive

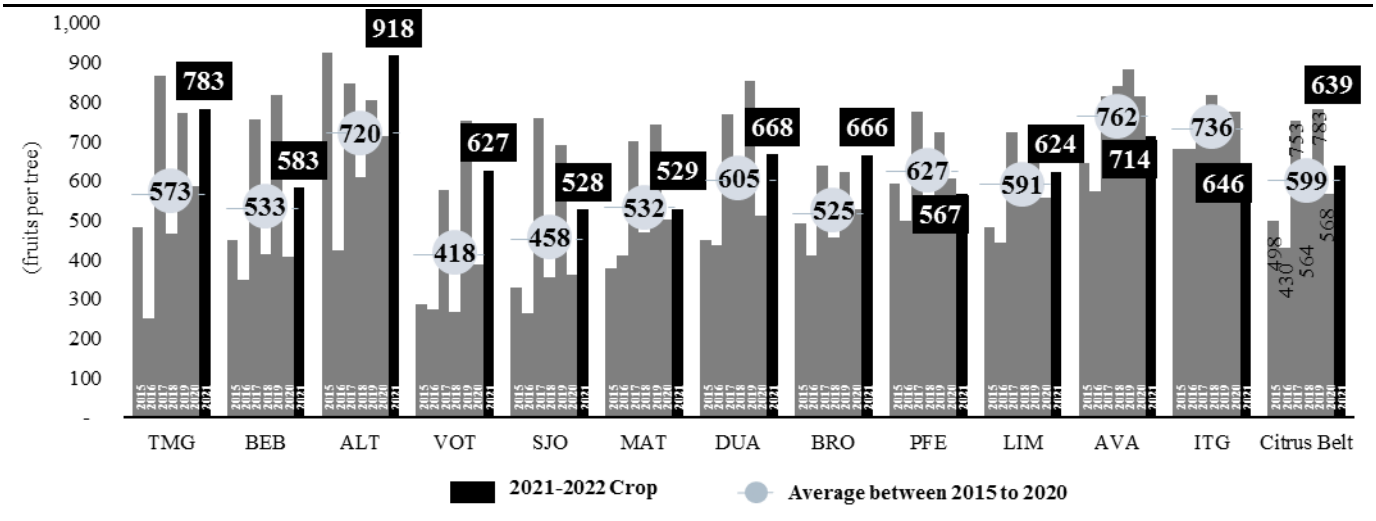
area for these two reasons. Moreover, there are other variables influencing the total bearing trees in this crop, such as the 2018 planting, the number of resets in plots that start bearing fruit from one year to another and tree mortality.

Varieties included in this forecast comprise 97% of the area of orange groves in the citrus belt. Information on bearing trees was obtained from the Tree Inventory of the São Paulo and West-Southwest Minas Gerais Citrus Belt: Snapshot of Groves in March 2021, taken from the 2018 primary base – created by mapping groves from September 8, 2017 to January 29, 2018 – and from counting existing trees in approximately 5% of orange plots from February 1 to March 18, 2021. Plots for counting were drawn through stratified random sampling.

Due to restrictions imposed by the Covid-19 pandemic, the new mapping previously scheduled to be carried out in August 2020 was postponed to August 2021. Therefore, the information related to groves planted in 2018 that started bearing fruit in this crop and were included in this forecast was estimated from data provided by the CDA-SP (São Paulo State animal and plant health protection agency) of the São Paulo State department of agriculture and supply, on the number of citrus nursery plants marketed under the permit to transit plants (PTV) in the State of São Paulo, and from surveys carried out by Fundecitrus. This data may change until the end of the crop season if there is a significant variation in the estimated number of trees that were planted in 2018 and in counts from field surveys in this new scan of the citrus planted areas.

## FRUITS PER TREE

The average number of fruits per tree in May 2021, disregarding fruit drop throughout the crop season, is calculated at 639. In general, the number of fruits per tree increased as compared to that in the previous crop, but in three regions there was a decrease: 16% in Itapetininga, 13% in Avaré and 6% in Porto Ferreira. The Itapetininga region showed the greatest reduction in this crop season and was the only region in the entire citrus belt that had an increase in the previous crop. The regions of Avaré and Porto Ferreira have accumulated two consecutive crops with a reduction in the number of fruits per tree. Graph 3 shows the number of fruits per tree stripped from 2015 to 2021 in the citrus belt and the separate data for each of the twelve regions.




**Graph 3 – Number of fruits per tree stripped by region in 2015 to 2021**

The number of fruits per tree is strongly influenced by the low-volume and irregular rainfall that marked the first development phase of this crop. Between the months of June and August 2020, significant rains were recorded only in the Southwest and in the region of Duartina, in contrast with the drought that

prevailed in the rest of the citrus belt, which resulted in quite different conditions for flowering induction and initiation.

In the regions of Itapetininga, Avaré and Duartina, the accumulated rainfall in June 2020 was 178, 138 and 110 mm respectively, resulting in an average of 132 mm for the entire area. Those rains triggered the flowering of orange trees between the months of July and August 2020, which is called the first bloom due to its time of occurrence. The development of this bloom was favored by the rains recorded in August 2020, with an accumulated 140 mm in Itapetininga, 93 mm in Avaré, and 108 mm in Duartina, that is, an average rainfall of 107 mm.

In the other regions of the citrus belt comprising Triângulo Mineiro, Bebedouro, Altinópolis, Votuporanga, São José do Rio Preto, Matão, Brotas, Limeira and Porto Ferreira, the occurrence drought with no significant rain lasted from June to early October 2020. The few rains that fell were light and scattered, hitting only a few cities. The average rainfall in that area of the citrus belt was 21 millimeters in June, 2 millimeters in July, 15 millimeters in August, and 12 millimeters in September. Limited by this severe water deficit, with no conditions for the first bloom, plants in rain-fed groves in those regions entered a long stage of vegetative rest resulting in the accumulation of reserves.

The use of irrigation helped to mitigate the damage caused by the water deficit in those regions. Irrigation is present in about 30.14% of the citrus belt area, of which 88% is concentrated in those regions where the drought prevailed. The high share of irrigated areas in those regions in relation to the total area of the citrus planted area results from the period of more intense drought and higher temperatures from the south to the north of the citrus belt, making irrigation more important the farther north of the citrus belt.

Data on the share of irrigated areas in relation to the total area was retrieved from the last mapping completed in 2018 and will be updated this year with the new mapping. However, considering the sample surveys, a trend of increased irrigated area can already be noticed, especially in the Votuporanga region. The water deficit severity in recent years across the Northwest sector that in addition to Votuporanga also includes the region of São José do Rio Preto, associated with the use of more water-demanding rootstocks and higher planting density, is making irrigation indispensable to achieve a satisfactory yield in this sector.

In the vast majority of irrigated groves, irrigation started in June to promote the first orange bloom. However, on many farms, due to scarce rainfall, water reservoirs were below capacity, which made the use of irrigation unfeasible in all plots with systems installed. In many locations, the appropriate water supply had to be restricted, affecting flowering, fruit setting and development.

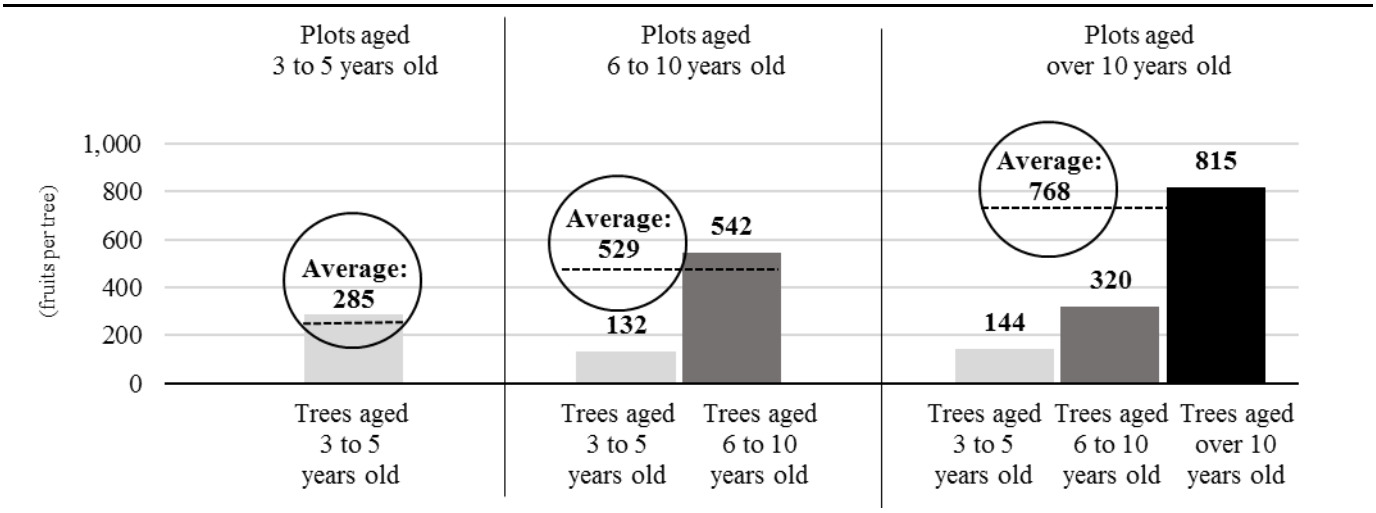
In September 2020, with the climate event La Niña forming, a strong heat wave hit the whole citrus belt, raising temperatures to the range of 36ºC to 42ºC in virtually all cities in the citrus belt during the eight days between September 30 and October 7, 2020. Under those high temperatures, plants aborted a large part of first bloom fruitlets of an approximate size of up to 3 cm in diameter, which had been produced in the regions of Itapetininga, Avaré and Duartina, and also in irrigated groves.

As of October 10, 2020, rains resumed throughout the citrus belt, creating favorable conditions for flowering that due to its time of occurrence is called the second bloom. That was the first flowering in the rain-fed groves of the South, Central (excluding Duartina), North and Northwest sectors of the citrus belt. These plants, which did not use reserves with the first bloom and had undergone a long period of vegetative rest, produced an abundant bloom that resulted in good setting.

Due to the uncertain climate, the third and fourth blooms happened in several groves. For the forecast, all fruits from the first, second and third blooms were considered as a whole. A fruit set rate of 25% was applied to fruits from the fourth bloom, since it was a late bloom and because the physiological drop of small and weak fruits had not taken place before stripping ended this year. In the separation of fruits per

bloom, off-season fruits were also identified as a result from late and sporadic flowers from the previous crop season, not accounted for in the current crop forecast.

Three to five-year-old plots present yield of 285 fruits per tree this crop season. For six to 10-year-old plots, an average of 529 fruits per tree is estimated, with 542 fruits per tree for original plantings and 132 fruits per tree for three to five-year-old resets. Plots over 10 years old have an expected average of 768 fruits per tree and a yield of 815 fruits per tree for original plantings, 320 fruits per tree for six to 10-year-old resets and 144 fruits per tree for three to five-year-old resets. Yield rates are presented in Graph 4.




Ages and planting years: 3 – 5 years (2016 to 2018), 6 – 10 years (2011 to 2015) and over 10 years (2010 and previous years)
**Graph 4 – Age-stratified number of fruits per tree in the plot**

In May 2021, when the trees were stripped, an average of 780 fruits per tree for the group of early Hamlin, Westin and Rubi varieties; 696 fruits per tree for the late Valencia and Valencia Folha Murcha varieties; 638 for the late Natal variety; 614 fruits per tree for the other early varieties; and 531 for the Pera Rio mid-season variety.

The method used consists of tree stripping, that is, the advanced harvest of all fruits in the tree, regardless of the bloom they are from. In this crop season, trees were stripped from March 26 to May 17, 2021. Fruits harvested were taken to a tree stripping laboratory in Araraquara, where each sample was separated into the different blooms it was from. Fruits were quantified by automatic counting equipment and then weighed.

Due to the Covid-19 pandemic, a decision was made jointly with the PES Technical Committee to maintain the number of samples collected in the previous crop season, which had been reduced in order to shorten the period of the survey execution and, thus, mitigate the risk of contagion and transmission of the new coronavirus. This strategy was required to keep up the development of the survey in face of several challenges, as for instance, lockdown, border closures and limitations of food and lodging services in several municipalities. Prevention measures included social distancing, use of two overlaid masks, one surgical mask and one fabric mask, alcohol-based sanitizer, quarantine of employees belonging to risk groups or of employees with flu symptoms, weekly monitoring of workers by means of a health questionnaire, disinfection of surfaces and floor of the stripping sample laboratory and guidance on the disease through the distribution of posters.

Sample size was 1,560 trees selected by a drawing. An initial drawing by the method of stratified random sampling included 1,200 trees distributed proportionally amongst all orange trees in the citrus belt and stratified according to their region, variety and age. For increased estimate precision in some strata with a lower number of samples, 14 additional trees were stripped. An additional drawing included 360 resets of ages lower than the age groups of their groves. These resets correspond to replacements made mainly to

offset tree losses caused by greening, citrus canker and other diseases. The tree population in this last drawing comprises plots that were counted in full to update the inventory and that meet the stratification criteria.

The stratification factor "region" is comprised of 12 groups encompassing the 320 cities where there are farms with mature orange groves. In addition to the subdivision into the 12 regions, the following charts present the five subdivisions of the factor "variety" and the six subdivisions of the factor "age". Combinations of these factors result in 360 strata.

**Chart 1 – Regions of the citrus belt included in the drawing, by sector**

| Sector | Region | Abbreviation |
|---|---|---|
| North..... | Triângulo Mineiro | TMG |
| | Bebedouro | BEB |
| | Altinópolis | ALT |
| Northwest..... | Votuporanga | VOT |
| | São José do Rio Preto | SJO |
| Central..... | Matão | MAT |
| | Duartina | DUA |
| | Brotas | BRO |
| South..... | Porto Ferreira | PFE |
| | Limeira | LIM |
| Southwest..... | Avaré | AVA |
| | Itapetininga | ITG |

**Chart 2 – Variety groups included in the drawing, by maturity time**

| Maturity time | Variety group |
|---|---|
| Early..... | Hamlin, Westin and Rubi |
| Other early..... | Valencia Americana, Seleta and Pineapple |
| Mid-season..... | Pera Rio |
| Late..... | Valencia and Valencia Folha Murcha |
| | Natal |

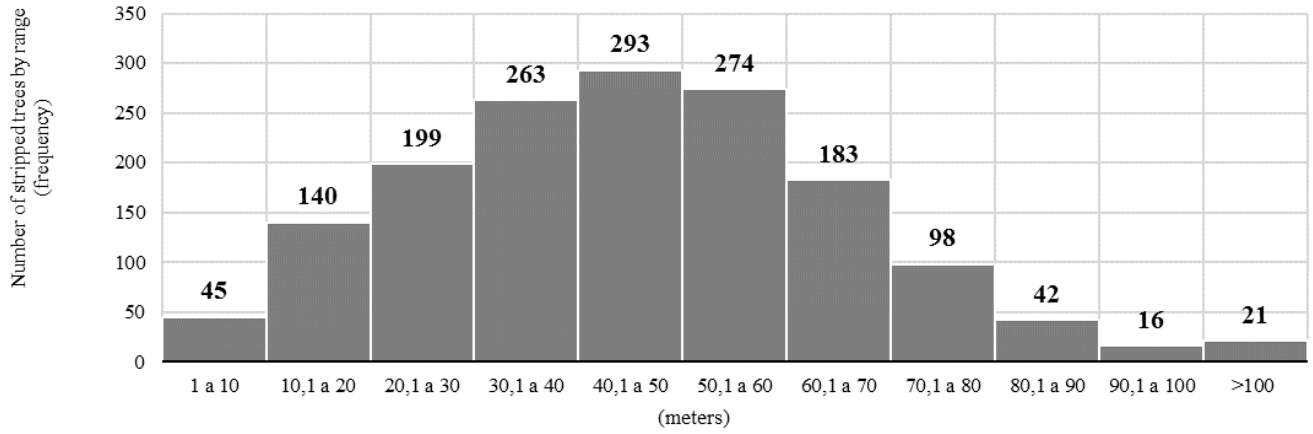
**Chart 1 – Age groups from the combined age of plots and age of trees**

| Age of plots[1] | Age of trees[2] |
|---|---|
| 3 to 5 years..... | 3 to 5 years |
| 6 to 10 years ..... | 3 to 5 years |
| 6 to 10 years ..... | 6 to 10 years |
| Over 10 years ..... | 3 to 5 years |
| Over 10 years ..... | 6 to 10 years |
| Over 10 years ..... | Over 10 years |

[1] Ages and planting years: 3 to 5 years (2016 to 2018), 6 to 10 years (2011 to 2015) and over 10 years (2010 and previous years).
[2] Estimated from information provided by growers on years resets were planted in the plot and from visual aspects of plants such as trunk circumference, height and shape of canopy, among other factors.

For the 1,200 trees in the first drawing, the location in the plot of the tree to be stripped is predetermined and varies every crop season. This makes the selection of the tree unbiased, that is, free from interference of the survey agent. Otherwise, the choice could be skewed towards trees with more or less fruit. For the 2021-2022 crop, the tree in the drawn plot is the one located in the 20th planting hole in the 12th row. If there is a vacancy or dead tree in that position, or yet a tree of an age different from that of trees originally planted in the plot, the third plant down is selected. Should that situation repeat itself, three more plants down are counted, until a tree of the drawn age is found. If the plot does not have 12 or more planting rows, the counting restarts in the existing rows until number 12 is reached. For the second drawing of 360 resets, the stripped tree is found in the plot after visual aspects are considered, such as trunk circumference and size of canopy.

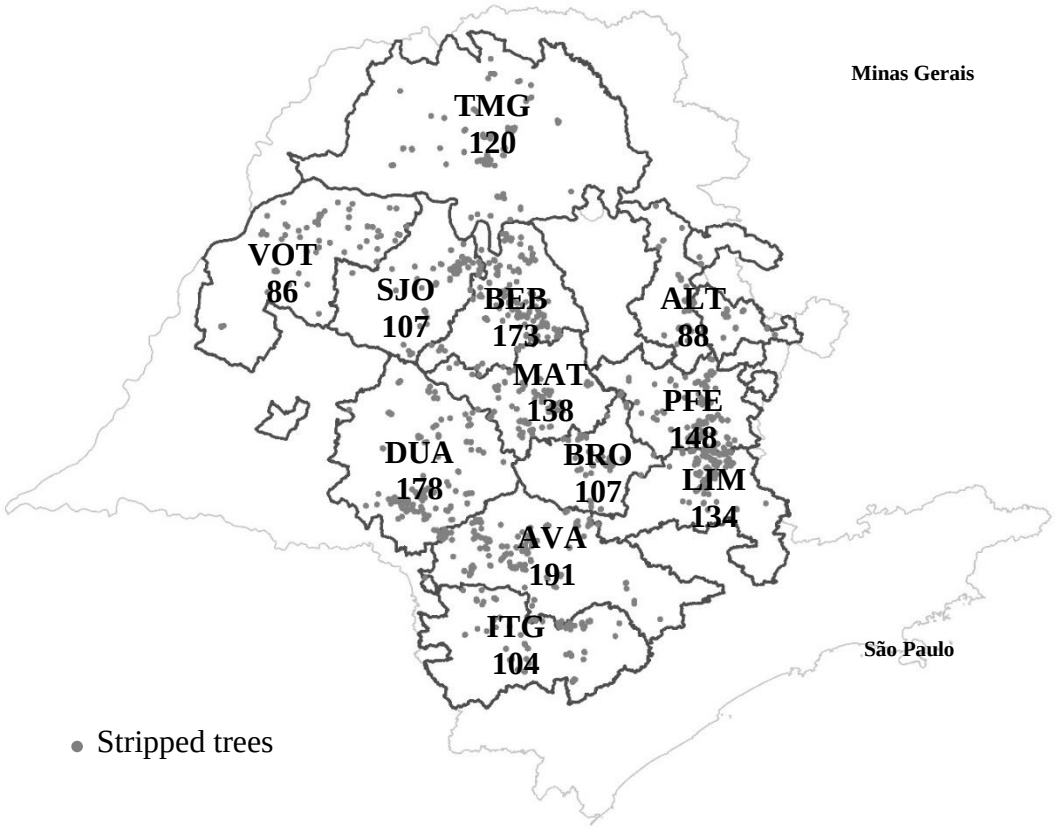
Graph 5 presents the distance (in meters) from the stripped tree to the nearest border of the plot, which shows the majority of classes with similar frequencies, with a central figure between 40 and 50 meters of distance from the stripped tree to the nearest border. Most of the 45 plots with the shortest distances, from one to ten meters, are small – approximately 70% of them have up to four hectares.




**Graph 5 – Histogram of distances from the stripped tree to the nearest border of the plot**

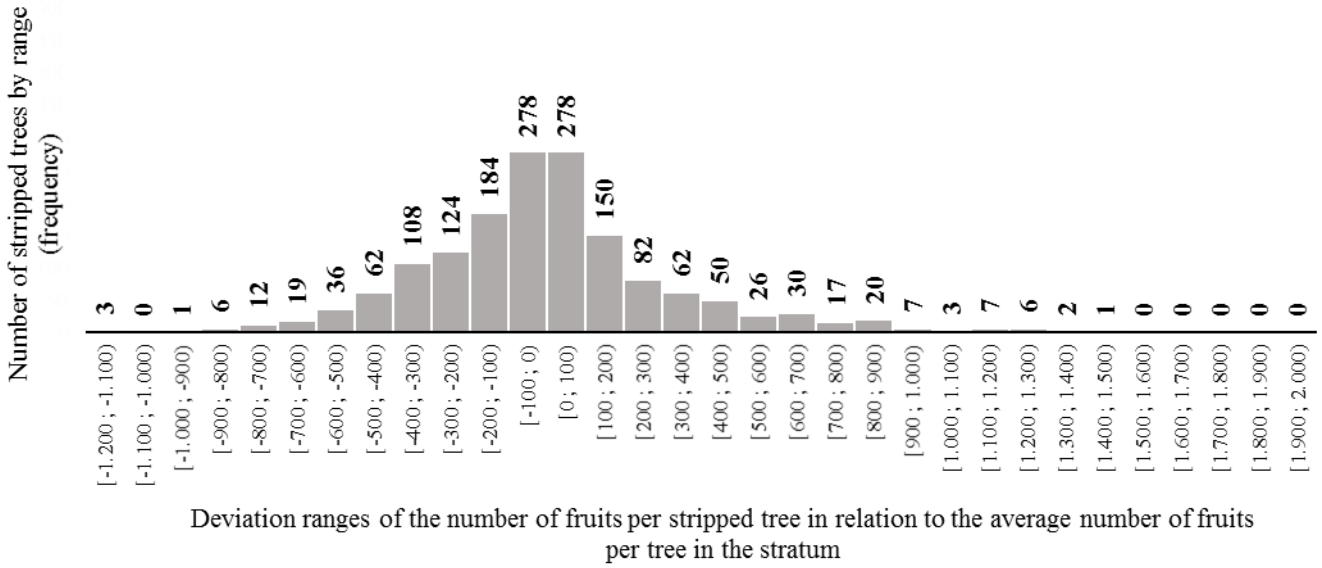
Figure 1 shows the location and number of stripped trees in each sector of the citrus belt.

**Figure 1 – Location and total number of trees stripped per region**



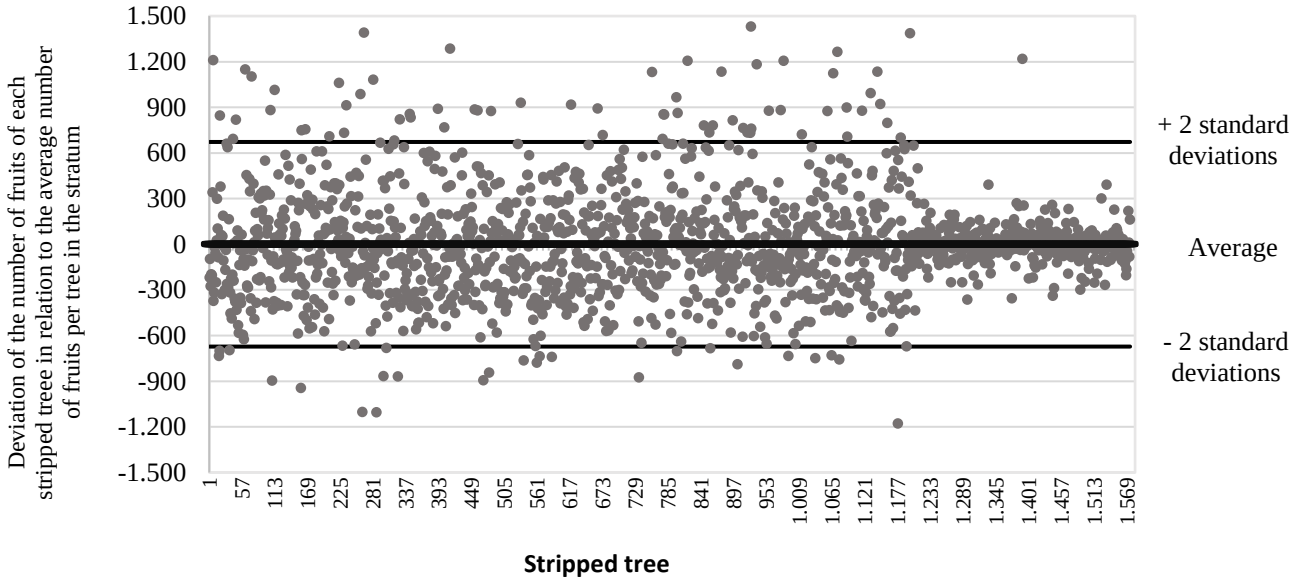

The average number of fruits per tree may vary plus or minus 17 fruits, which corresponds to ± 2.60% of the average number of fruits per tree obtained at stripping. This figure is within the expected error of 2% to 3% always used in sizing the sample. The yield deviation distribution analysis for each stripped tree in relation to the stratum average shows that sample data is randomly distributed according to a normal

distribution, as presented in Graph 6. Out of the total samples, eight were discarded upon showing great discrepancy in relation to the others.




**Graph 6 – Histogram of deviations of fruits per tree at stripping**

Graph 7 shows the dispersion of deviations of each stripped tree in relation to the stratum average. It is observed that 95% of samples fall within the average (639 fruits) ± 2 standard deviations.




**Graph 6 – Deviation on the number of fruits at each stripping in relation to the stratum average**

The tree harvested upon permit from citrus growers is indemnified at R$ 44.00 through an online payment system where citrus growers can register and redeem the amount due.

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

The projected average drop rate is 20.50%, distributed as follows: 12.00% for the early Hamlin, Westin and Rubi varieties, 12.00% for other early varieties; 22.00% for the mid-season Pera Rio variety; 24.00% for the late Valencia and Valencia Folha Murcha varieties; and 23.20% for the late Natal variety. This rate is applied to the number of fruits in the tree in May 2021, when trees were 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 due to physiological drop, damage caused by machines, pests and diseases, and adverse climatic conditions.

If this rate is confirmed, it will be the second highest in the historical series, just below the rate observed in the past crop, when the climate was extremely atypical. The main reasons for this projection are the climate forecast, which indicates accumulated rainfall below the average until October 2021, and the intensification of phytosanitary problems, such as the increased incidence of orange trees with greening symptoms in the citrus belt, which went from 19.02% in 2019 to 20.87% in 2020. Another reason that may continue to cause fruit drop in this crop season is the fruit peel cracking, observed in the past harvest due to severe drought, which led to reduced or halted orange growth, which was eventually resumed with the return of the rains, however, the internal structure of the peel had already lost its plasticity and the fruits suffered peel cracking, resulting in premature drop, as shown in Table 5.

**Table 5 – Fruit drop rates by causes from the 2015-2016 crop to the 2020-2021 crop**

| Causes | Drop rate | | | | | |
|---|---|---|---|---|---|---|
| | 2015-2016 | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 |
| | (percentual | (percentual | (percentual | (percentual | (percentual | (percentual |
| Physiological and mechanical……..... | N/A | 5.99 | 7.45 | 5.16 | 5.15 | 6.63 |
| Greening..... | N/A | 1.37 | 4.06 | 2.70 | 4.39 | 3.71 |
| Fruit borer and fruit fly…….... | N/A | 2.34 | 2.70 | 5.70 | 4.29 | 4.76 |
| Black spot..... | N/A | 3.75 | 2.16 | 2.02 | 2.12 | 2.98 |
| Leprosis..... | N/A | 0.25 | 0.62 | 0.82 | 1.30 | 1.70 |
| Canker..... | N/A | 0.03 | 0.31 | 0.30 | 0.38 | 0.37 |
| Fruit peel cracking ..... | N/A | N/A | N/A | N/A | N/A | 1.45 |
| **Total.....** | **17.49** | **13.73** | **17.31** | **16.70** | **17.63** | **21.60** |

N/A – Non-available data, as survey of causes for fruit drop started in the 2016-2017 crop or due to irrelevant reasons.

Monthly and continuous monitoring by Fundecitrus as of June 2021 in 1,200 orange plots visited up to their complete harvest serves as basis to correct the drop rate projected at the time of this publication and consequently to correct the production estimate as well.

## FRUITS PER BOX – fruit size, i.e., number of oranges to reach the weight of 40.8 kg (90 lb box) at harvest

The final fruit size projection is 259 fruits per 40.8 kg box, namely 305 fruits per box for the group of early varieties comprising Hamlin, Westin and Rubi; 259 fruits per box for the group of other early varieties; 260 fruits per box for the mid-season Pera Rio variety; 240 fruits per box for the late Valencia and Valencia Folha Murcha varieties; and 243 fruits per box for the late Natal variety.

The average size of 259 fruits per box is equivalent to oranges weighing approximately 157.5 grams at harvest. 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 percentages of 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, 2010-2011 to 2020-2021, was used in the regression and is presented in Table 6. The result obtained shows an adjusted $R^2$ of 0.93. This means that the four independent variables together explain 93% of the variation in the final fruit size (fruits per box at harvest), 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 absolute error of 2.67%.

Data relative to final fruit size (fruits per box at harvest), number of fruits per tree counted at stripping, initial fruit size (fruits per box at stripping), the sum of the production percentages from the first and second blooms in relation to the total production for the series from 2009-2010 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 methodologies. 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 2015-2016 to 2020-2021 crops comes from results of estimates developed by Fundecitrus. Data on rainfall accumulated from May to July was supplied by Somar Meteorologia/Climatempo.

Data used in the model to estimate the final fruit size in this crop comprises figures from the 2021 stripping and the rainfall predicted for June to August 2021 in volumes equivalent to the climatological average (1981 – 2010) calculated with information from the Climatempo website. 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 result that was obtained was adjusted to 259 fruits per box since the stripping was performed at a later period than in prior years, and based on the climate forecast from Somar Meteorologia/Climatempo, which indicates rainfall levels below the historical average until October 2021, in addition to accumulated rainfall below normal ranges in the months of April and May of 2021, which were not sufficient to maintain the soil moisture content at satisfactory levels.

**Table 6 – Data for the 2010-2011 crop to the 2020-2021 crop and data used to estimate the final fruit size in the 2020-2021 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) | (%) | (%) |
| 2010-2011…. | 532 | 457 | 97% | 64 | 271 | 257 | -5% | 5% |
| 2011-2012…. | 859 | 401 | 96% | 116 | 269 | 268 | -1% | 1% |
| 2012-2013…. | 764 | 439 | 95% | 268 | 250 | 239 | -4% | 4% |
| 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 | 234 | 4% | 4% |
| 2016-2017…. | 430 | 358 | 90% | 214 | 222 | 225 | 2% | 2% |
| 2017-2018…. | 753 | 393 | 91% | 184 | 246 | 248 | 1% | 1% |
| 2018-2019…. | 564 | 446 | 82% | 36 | 259 | 253 | -2% | 2% |
| 2019-2020…. | 783 | 411 | 94% | 95 | 261 | 269 | 3% | 3% |
| 2020-2021…. | 568 | 511 | 85% | 96 | 258 | 261 | 1% | 1% |
| 2021-2022…. | 639 | 505 | 76% | 95[ha] | (X) | 252 | (X) | (X) |

Sources: Fundecitrus (2015-2016 crop to 2021-2022 crop), CitrusBr (2008-2009 crop to 2014-2015 crop), Somar Meteorologia and Climatempo.
(X) Not applicable.
ha Historical average (quarter after fruit stripping).

The result of the equation used in the crop estimate is corrected by the application of a correction factor. That is necessary because of 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, and 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 (technical supervisor); Roseli Reina (specialist); 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 president Lourival Carmo Monaco in remote attendance, finalized the crop forecast on May 27, 2021, at 9:30 a.m., in a closed meeting at Fundecitrus, with no external communication channel beyond participants. Following that, at 10 a.m., Fundecitrus president began the public announcement of the crop forecast by videoconference, broadcast live at Fundecitrus channel on Youtube (www.youtube.com/fundecitrus). Next, Fundecitrus general manager Antonio Juliano Ayres presented the detailed data at the Fundecitrus auditorium in Araraquara-SP, with no in-person attendance. After the crop forecast announcement, the Executive Summary of the 2021-2022 orange crop forecast was made available on the Fundecitrus website. The complete report, including the 2021 tree inventory and the 2021-2022 orange crop forecast, will be available on June 18, 2021 at www.fundecitrus.com.br.

## 3 – TABLES OF DATA

The following tables present the 2021-2022 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 subsequent variations in fruit size and fruit drop rate may change the forecast and will be accounted for throughout the crop season by ongoing field monitoring for production estimate updates.

**Table 7 – 2021-2022 Orange crop forecast by sector**

| Sector | Mature groves area | Average density[1] of mature groves | Bearing trees | Fruit per tree at stripping[2] | 2021-2022 Orange crop forecast | | |
|---|---|---|---|---|---|---|---|
| | | | | | Per tree | Per hectare | Total |
| | (hectares) | (trees/ hectare) | (1,000 trees) | (number) | (boxes/ tree) | (boxes/ hectare) | (1,000,000 boxes) |
| North..... | 83,983 | 478 | 39,665 | 688 | 1.90 | 899 | 75.46 |
| Northwest..... | 34,003 | 477 | 15,971 | 559 | 1.54 | 725 | 24.65 |
| Central..... | 97,099 | 487 | 46,479 | 617 | 1.70 | 816 | 79.20 |
| South..... | 65,597 | 493 | 31,254 | 595 | 1.64 | 781 | 51.22 |
| Southwest..... | 65,441 | 518 | 33,191 | 694 | 1.92 | 972 | 63.64 |
| **Total.....** | **346,123** | **491** | **166,560** | **639** | **1.77** | **850** | **294.17** |

[1] Calculation considers the total number of trees in the plot, that is, bearing and non-bearing trees (2019 and 2020 resets).
[2] Weighted average per total stratum fruit.

**Table 8 – 2021-2022 Orange crop forecast by tree age group (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..... | 36,225 | 641 | 22,530 | - | - | 22,530 | 285 | - | - | **285** |
| 6 – 10 years..... | 75,567 | 596 | 1,403 | 42,587 | - | 43,990 | 132 | 542 | - | **529** |
| Over 10 years..... | 234,331 | 434 | 2,789 | 5,767 | 91,484 | 100,040 | 144 | 320 | 815 | **768** |
| **Total.....** | **346,123** | **491** | **26,722** | **48,354** | **91,484** | **166,560** | **262** | **516** | **815** | **639** |

[1] Calculation considers the total number of trees in the plot, that is, bearing and non-bearing trees (2019 and 2020 resets).
[2] Weighted average per total stratum fruit.

**Table 8 – 2021-2022 Orange crop forecast by tree age group (continued)**

| Plots age | 2021-2022 Orange crop forecast by tree age group | | | | 2021-2022 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..... | 0.78 | - | - | 0.78 | **17.67** | - | - | 17.67 |
| 6 – 10 years..... | 0.37 | 1.50 | - | 1.46 | 0.52 | **63.79** | - | 64.31 |
| Over 10 years..... | 0.39 | 0.88 | 2.25 | 2.12 | 1.09 | 5.06 | **206.04** | 212.19 |
| **Total.....** | **0.72** | **1.42** | **2.25** | **1.77** | **19.28** | **68.85** | **206.04** | **294.17** |

[1] Calculation considers the total number of trees in the plot, that is, bearing and non-bearing trees (2019 and 2020 resets).

**Table 9 – 2021-2022 Orange crop forecast by bloom**

| Bloom | 2021-2022 Orange crop forecast | Percentage of the orange crop forecast by bloom |
|---|---|---|
| | (1,000,000 boxes) | (percentage) |
| 1st..... | 86.88 | 29.6% |
| 2nd ..... | 136.28 | 46.3% |
| 3rd..... | 58.93 | 20.0% |
| 4th ..... | 12.08 | 4.1% |
| **Total.....** | **294.17** | **100.00%** |

**Table 10 – 2021-2022 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..... | 32.0 | 37.1 | 5.2 | **29.8** | 46.2 | 32.5 | **37.3** | 29.2 | 23.1 | 12.4 | **23.4** | 19.4 | 21.7 | **20.6** | 35.8 | 56.7 | **41.6** | **29.6** |
| 2nd..... | 60.6 | 39.9 | 85.8 | **55.1** | 16.6 | 43.6 | **34.0** | 48.5 | 38.4 | 65.7 | **45.7** | 57.7 | 50.8 | **54.2** | 38.3 | 23.3 | **34.1** | **46.3** |
| 3rd..... | 5.7 | 15.3 | 7.7 | **10.7** | 25.4 | 15.8 | **19.2** | 17.9 | 36.1 | 15.6 | **27.3** | 19.8 | 24.7 | **22.3** | 22.6 | 16.8 | **20.9** | **20.0** |
| 4th..... | 1.7 | 7.6 | 1.3 | **4.4** | 11.8 | 8.1 | **9.4** | 4.4 | 2.4 | 6.3 | **3.6** | 3.1 | 2.8 | **2.9** | 3.3 | 3.3 | **3.3** | **4.1** |

[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 11 – 2021-2022 Orange crop forecast and its components by variety group**

| Variety group | Mature groves area | Average density[1] of mature groves | Components of May/2021 forecast | | | | 2021-2022 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..... | 57,598 | 450 | 25,410 | 780 | 305 | 12.00 | 2.02 | 892 | 51.37 |
| **Other early:** | | | | | | | | | |
| Valencia Americana, Seleta, Pineapple..... | 18,467 | 499 | 9,003 | 614 | 259 | 12.00 | 2.88 | 914 | 16.87 |
| **Mid-season:** | | | | | | | | | |
| Pera Rio..... | 114,531 | 529 | 59,147 | 531 | 260 | 22.00 | 1.43 | 739 | 84.66 |
| **Late:** | | | | | | | | | |
| Valencia and VFolha Murcha[3] | 115,222 | 477 | 54,121 | 696 | 240 | 24.00 | 1.98 | 929 | 107.07 |
| Natal..... | 40,305 | 477 | 18,878 | 638 | 243 | 23.20 | 1.81 | 849 | 34.20 |
| **Total.....** | **346,123** | **491** | **166,560** | **639** | **259** | **20.50** | **1.77** | **850** | **294.17** |

(X) Not applicable.
[1] Calculation considers the total number of trees in the plot, that is, bearing and non-bearing trees (2019 and 2020 resets).
[2] Weighted average per total stratum fruit.
[3] V.Folha Murcha – Valencia Folha Murcha.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