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ZONING OF CLIMATE FITNESS OF STRAWBERRY CROPS IN PERNAMBUCO STATE - BRAZIL

José Machado Coelho Júnior[1], Fernando de Oliveira Mota Filho, Ranyére Silva Nóbrega, Eugenia Cristina Pereira, Juliano Tadeu Vilela de Resende

[1]Prof. Dr. Universidade Federal Rural de Pernambuco. Doutor em Geografia. E-mail: josemachadocj@gmail.com

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ABSTRACT

The practice of strawberry culture in Brazil occurs in South and Southeast States of the country, with low emphasis to Northeast region, especially in Pernambuco. The strawberry is a fruit that has great financial return generating employment and foreign exchange for states and municipalities. The discovery conducive areas for cultivation can generate greater local development. Aiming the expansion of agricultural frontier of the strawberry, this work has aimed to indicate the suitable municipalities in Pernambuco to strawberry cultivation. Based on temperature and altitude data, a map of cities with potential was generated, where places and appropriate season for cultivation in Pernambuco were determined. The municipality of Poção was demonstrated as an excellent alternative to the strawberry cultivation in the months of June to October. Caetés, Garanhuns, Jucati, Paranatama, Saloá, Taquaritinga do Norte and Triunfo showed to be municipalities with medium potential for cultivation between July and August, except Triunfo, whose period is extended until September.

Keywords: cultivation in warm climate, cultivation in humid climate, *Fragaria ananassa*.

ZONEAMENTO DA APTIDÃO CLIMÁTICA DO MORANGUEIRO NO ESTADO DE PERNAMBUCO-BRASIL

RESUMO

A cultura do morangueiro no Brasil é praticada principalmente nos estados do Sul e Sudeste do país, com pouca ênfase na região Nordeste, principalmente em Pernambuco. O morango é uma fruta que apresenta grande retorno financeiro gerando empregos e divisas para estados e municípios. A descoberta de locais propícios ao cultivo poderá gerar maior desenvolvimento local. Visando expansão da fronteira agrícola do morango, neste trabalho objetivou-se indicar municípios aptos ao cultivo do morangueiro em Pernambuco. Com base nos dados de temperatura altitude foi gerado um mapa de municípios com potencial, onde foram determinados locais e épocas adequadas para o cultivo em Pernambuco. O município de Poção demonstrou-se uma excelente alternativa para o cultivo do morangueiro entre os meses de junho e outubro. Caetés, Garanhuns, Jucati, Paranatama, Saloá, Taquaritinga do Norte e Triunfo apresentaram-se como municípios de médio potencial para o cultivo de julho a agosto, exceto Triunfo, cujo período se estende até setembro.

Palavras-chave: cultivo em clima quente, cultivo em clima úmido, Fragaria ananassa.

INTRODUCTION

The strawberry belongs to the family Rosaceae and genus Fragaria. The Fragaria ananassa species is an original hybrid by crossing two species, *F. chiloensis* e *F. virginiana* (CONTI et al., 2002; TESSARIOLI NETO et al., 2003). The strawberry is a fleshy and juicy pseudo intense red coloration. Has in its true end fruits called achenes (ROCHA et al . , 2008).

It is rich in fructose, sucrose , vitamin C and vitamin B complex , riboflavin, pyridoxine , niacin, minerals (magnesium, manganese , calcium, iron , phosphorus and potassium) , antioxidant and low in carbohydrates (FERNANDES et al . , 2012) . When consumed in a well balanced meal and , due to the presence of malic acid , salicylic acid and citric increases iron absorption rates present in vegetables, meat and eggs (Rocha et al , 2008; . Bason et al , 2010; . Wasim et al . , 2012) .

The strawberry crop is influenced by temperature and photoperiod, this was lower (Virmond and RESENDE, 2006;. Verheul et al, 2007), so that the cold promotes vegetative growth, and the heat emission runners (LEDESMA et al, 2008;. SAVINI et al, 2008)..

Characterized by intense hand labor family, the strawberry is a crop of great economic and social importance in several countries, especially the United States and Europe, with significant increases in production in recent decades, including in Latin American countries (CAMARGO et al 2011;. MORALES et al, 2013 ROSA et al, 2013)... The cultivation of this fruit in Brazil started in Rio Grande do Sul, and was later taken to São Paulo, where it spread by their municipalities and other states (Resende et al., 2011).

The great interest in culture is its high profitability and high demand for labor, generating a significant increase for the economy and contributing to the social development process. For the country, the culture of revenue is around 160 million, involving the producer, partners and employees, respectively (IBGE, 2006). Brazilian production in 2006 was 3,016 tons planted on 376 hectares (FAO, 2011), being the largest producers the states of Minas Gerais, Rio Grande do Sul, Parana and Sao Paulo (Antunes et al., 2007; DIAS et al .; 2007), which together have 85% of all domestic production, while Pernambuco has 0.05% of this productivity (IBGE, 2006).

Data published in journalism vehicles demonstrate that the municipality of Gravatá / PE have stopped much of the state's strawberry production and currently is in decline. The reasons may vary from productivity to storage and sales systems. So are needed alternative ways to improve the production of this fruit, which will contribute to expansion of the agricultural frontier for the regions of hot climates in Brazil, providing greater local

development, such as the grape, peach and apple were planted in regions mild climates and are now commercial crops of the semiarid region of Pernambuco, like the city of Petrolina in the São Francisco valley.

Search regions where there is still no interest in the strawberry crop, but having good potential for cultivation can be an interesting alternative for the investment of new producers, farmers, family farming associations and the government itself. Pernambuco has three completely different physiographic regions as the Zona da Mata, Agreste and Sertao, beyond those within the meso there are small areas with microclimates mild temperatures favored by the altitude, which even promote winter festivals annually.

Because of the problem addressed in this study aimed to determine the most favorable areas for the strawberry crop according to the altitude and temperatures in the state of Pernambuco.

MATERIALS AND METHODS

The study area were municipalities of 5 Mesoregions of Pernambuco, located in Northeastern Brazil (Figure 1) , which were used temperature data and altitude in the municipalities of the state of Pernambuco.

Figure 1 - Brazil Maps (left) and Pernambuco (right) in Pernambuco map 1 Mesoregion Recife, Pernambuco 2 Mesoregion of Mata , 3 Mesoregion Agreste , 4 Mesorregion Sertão of Pernambuco and 5 Mesoregion San Francisco Pernambuco.

For climate analysis , air temperatures of data were used for the period 1961-1990 (normal current climatological in Brazil) weather stations located in Pernambuco, obtained in the Department of Atmospheric Sciences at the Federal University of Campina Grande . municipalities were selected with temperatures below 26 ° C and 16 ° C , maximum and minimum , respectively , because they have high and medium potential cultivation of culture (BUNNY JUNIOR, 2013) . This selection was conducted monthly throughout the climatological normal range and temperatures were above 16 ° C were typed with black color, who were between 15ºC and 16ºC were typed in blue and below 15 ° C were colored red for temperatures

minimum while paras maximum temperatures above 26ºC with black color were between 25 and 26C were colored with blue and below 25 ° C were colored red written .

Altitude is also a factor that affects the production and strawberry productivity, and Brazil, is planted at altitudes greater than 700 m in São Paulo and 800m in Rio Grande do Sul and Santa Catarina (Santos and MEDEIROS, 2003; snore, 1998). The altitudes of these municipalities were correlated with temperature data for identification of municipalities with potential for cultivation of strawberry, for each month, generating information appropriate time to your planting. The information of precipitation and relative humidity, two factors also important, but less intense that temperature and photoperiod, were not considered, since the strawberry crop is done in greenhouses and controlled irrigation. The altitudes were also medium cities have also been raised from data from weather stations in Pernambuco collected in CAD (2015). the parameters created by snore were followed (1998), which were classified municipalities that were below 600 m, between 600 m and 700 m and above 700.

As zoning of the product was prepared a map indicating the mesoregion and municipalities with high, medium and low potential for cultivation, based on the proposed by (Antunes et al, 2006;. Resende, 2001) and spatial interpolation of temperature and altitude data . It was also prepared a topographic map with medium and high potential for the study of the best places to cultivation. It was drawn to the recommendation of planting time according to parameters established by Roque (1998), with altitudes below 600 m, between 600 and 700 m above 700 m, whereas the planting should be a month before the temperatures favorable to fruiting and flowering (below 16 ° C) due to growth of strawberry plants are held in 60 days and the need for warmer temperatures for vegetative growth. It was established as a high potential parameter cultivation, maximum and minimum temperatures below or equal to 25 ° C and 15 ° C, respectively (Antunes et al, 2006;. Resende, 2001). The parameter of average potential cultivation was set to temperatures between 25 ° C and 26 ° C (maximum) and 15 ° C and 16 ° C (minimum). Municipalities with maximum and minimum temperatures above 26 ° C and 16 ° C, respectively, were considered as low potential for cultivation (Table 1).

Table 1 - Ranges of maximum and minimum temperatures and their potential for the strawberry cultivation in the municipalities of the State of Pernambuco.

Minimum temperature	Maximum temperature	Potential
< 15º C	<25ºC	Alto
16º C e 15º C	26ºC e 25ºC	Médio
> 16ºC	> 26ºC	Baixo

RESULTS AND DISCUSSION

In Brazil, the strawberry is grown at altitudes greater than 800 m, except in the states of Rio Grande do Sul and Santa Catarina (Santos and MEDEIROS, 2003). Santos and Medeiros (2003) describe the strawberry planting practice in Brazil occurs mainly at altitudes greater than 800 m, except in Rio Grande do Sul and Santa Catarina. Already snore (1998) also emphasizes the relationship between altitude and planting season. The author analyzed only to São Paulo, and recommended that in areas with elevations above 700 m to be held from February to March; already in places with altitude between 600 and 700 m, one should plant the strawberry plants in April and in regions with altitude less than 600 m is recommended planting in May.

With the climatological normals available in the Department of Atmospheric Sciences, UFCG notes that in Pernambuco there are places with maximum temperatures and minimum monthly average below 25 ° C and 15 ° C, respectively (Tables 2 and 3, in red), which meet the recommendation Antunes et al. (2006) and Resende (2001), considered high potential for cultivation and municipalities with temperatures between 25 and 26ºC and 15ºC and 16ºC (Tables 2 and 3, in blue), considered medium potential, which may also suit fruiting needs and vegetative growth of strawberry.

Table 2 - Monthly maximum temperatures of cities of Pernambuco, Brazil .

Cities	Physiographic zone	Altitude (m)	Maximum temperature (ºC)											
			Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Cachoeirinha	Agreste	780	29,3	29,1	28,6	27,6	25,5	24,1	23,5	24,5	26,3	28,7	29,6	29,7
Caetés	Agreste	854	29,3	29,0	28,5	27,6	25,4	24,0	23,4	24,5	26,4	28,8	29,5	29,6
Garanhuns	Agreste	866	28,9	28,7	28,2	27,3	24,9	23,5	22,8	23,9	25,8	28,2	29	29,2
Jucati	Agreste	821	29,3	29,1	28,6	27,7	25,5	24,1	23,4	24,5	26,3	28,7	29,6	29,7
Paranatana	Agreste	830	29,7	29,5	29	28,2	25,9	24,5	23,8	24,9	26,7	29,2	29,9	30,1
Poção	Agreste	1035	26,2	25,8	24,8	24,1	21,9	20,6	20,5	21,7	23,8	26,1	26,4	26,4
Saloá	Agreste	850	29,5	29,3	28,8	28,0	25,6	24,3	23,5	24,6	26,5	28,9	29,7	29,8
Taquaritinga do Norte	Agreste	785	28,5	28,3	27,6	26,6	24,7	23,3	22,9	23,8	25,6	27,9	28,7	28,8
Triunfo	Sertão	1010	28,2	27,2	26,2	26,0	24,5	23,7	23,8	25,5	27,4	29,2	28,9	28,7

Source: Department of Ciências Atmosféricas da UFCG, 2012.

Cities with temperatures below 16ºC for minimum temperatures and below 26 ° C for maximum temperatures were Cachoeirinha, Caetés, Garanhuns, Jucati, Paranatama, Poções, Saloa for physiographic region Zona da Mata and the city of Triunfo representing the Hinterland State Pernambuco (Tables 2 and 3). According to Tables 2 and 3, no Pernambuco municipality with altitudes below 600 m has met the maximum and minimum temperatures of 26ºC and 16ºC, respectively, for at least two consecutive months, considered low potential for cultivation of strawberry, where fits Gravesend, municipality with average altitude of 447 me regionally known as a producer of strawberries (Figures 1 and 2). In the 1980s and 1990s, the city was the

largest producer in the state of Pernambuco, but its production has declined and is currently non-existent, and the strawberries sold in this location and used in traditional strawberry party imported from the Holy Spirit, who also supply the state market. Another factor is the altitude factor ranging between 600 m and 700 m. The relationship between altitude and temperature within a certain margin of altitude, in Pernambuco do not favor the existence of milder temperatures conducive to strawberry cultivation. In the backlands of the State Santa Cruz da Baixa Verde, Brejinho and Santa Terezinha present altitudes above 700 meters, but the temperatures were not lower than that proposed by Antunes et al. (2006) and Resende (2001). In Agreste Buíque, Tupanatinga, Alagoinha, Capoeiras and Jupi also have the same conditions. For these cities, as presented on the topics of cities with altitudes below 700 meters, can also use lichens as a solution to improper temperature and fruiting own vegetative growth.

Table 3 - Monthly minimum temperatures of cities of Pernambuco, Brazil .

			Minimum temperature (ºC)											
Cities	Physiographic zone	Altitude (m)	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Cachoeirinha	Agreste	780	18,8	19,0	19,1	19,0	18,2	17,0	15,9	15,7	16,5	17,4	18,1	18,5
Caetés	Agreste	854	18,6	18,6	18,8	18,8	18,0	16,8	15,8	15,5	16,3	17,2	17,9	18,2
Garanhuns	Agreste	866	18,5	18,6	18,7	18,7	17,9	16,8	15,7	15,4	16,1	17,1	17,7	18,1
Jucati	Agreste	821	18,7	18,8	18,9	18,9	18,1	16,9	15,8	15,6	16,4	17,3	18,0	18,3
Paranatama	Agreste	830	18,7	18,7	18,9	18,8	18,0	17,0	15,9	15,7	16,5	17,5	18,1	18,4
Poção	Agreste	1035	17,7	18,1	18,2	18,3	17,3	15,9	14,8	14,1	14,7	15,7	16,4	16,9
Saloá	Agreste	850	18,6	18,6	18,8	18,8	18,0	16,9	15,9	15,6	16,4	17,3	18,0	18,3
Taquaritinga do Norte	Agreste	785	18,8	19,1	19,2	19,0	18,3	16,9	15,7	15,4	16,3	17,2	17,8	18,3
Triunfo	Sertão	1010	18,1	17,9	17,9	18,1	17,2	16,2	15,5	15,0	15,6	16,6	17,2	17,5

Source: Department of Ciências Atmosféricas da UFCG, 2012.

Mesorregion Recife

The Mesoregion Recife has all the cities with altitudes below 600 meters, therefore it is a hot climate region has no microclimate altitude. All temperatures throughout the year presented above 16ºC not meeting the recommendation of Antunes et al . 2006 and Resende (2001) (Figure 2) .

Mesorregion Mata Pernambuco

The Mesoregion Mata Pernambuco presents all cities with altitudes below 600 meters, therefore it is a hot climate region has no microclimate altitude. All temperatures throughout the year presented above 16ºC not meeting the recommendation of Antunes et al . 2006 and Resende (2001) . So all the cities that Mesoregion has low potential for cultivation of strawberry , requiring other forms such as the use of air-conditioned greenhouses (Figure 3).

Figure 2 - Representation altimetry and strawberry cultivation potential in Mesoregion Recife through Digital Terrain Modeling. Blue municipalities with altitude below 600 meters and low potential for cultivation of strawberry

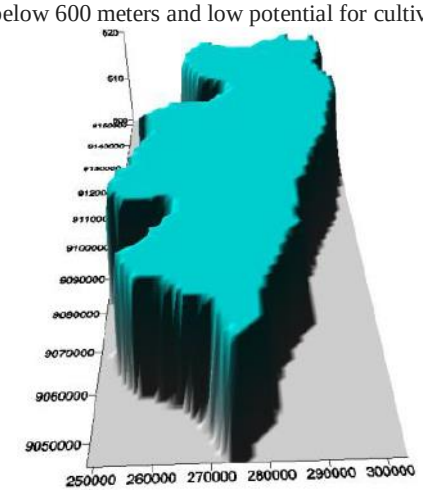
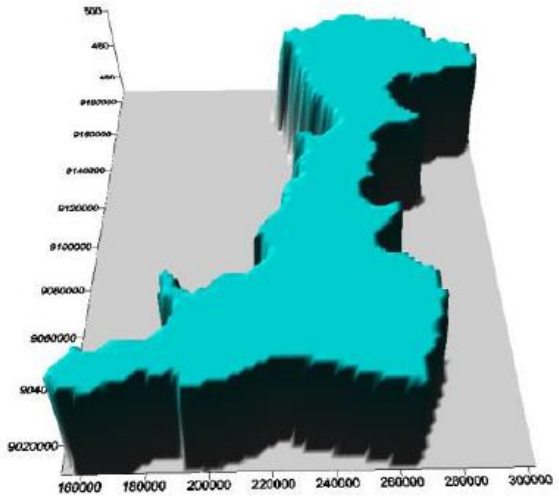


Figure 3 - Representation altimetry and strawberry cultivation potential in Mesoregion Mata of Pernambuco through Digital Terrain Modeling. Blue municipalities with altitude below 600 meters and low potential for cultivation of strawberry .



Mesorregion Agreste

In Mesorregion Agreste has only eight cities with temperatures below 16ºC. According to Table 2 and Figure 4, were selected cities with minimum temperatures below 16 ° C with at least two consecutive months and is considered medium or high potential for strawberry cultivation, where are city Gravesend (447 m) known as a major producer of strawberry in the decades of 1980-1990, the city was the largest producer in the state, but its production was being in decline and is now zero. The decline of strawberry production in Gravesend may be related to low potential for cultivation, because as evidenced here, presents maximum and minimum monthly temperatures higher than recommended by Antunes et al. (2006) and Resende (2001). Another factor is altitude ranging between 600 to 700 meters. As the cultivation of strawberry plants requires significant care and intensive hand labor and family qualified, it is possible, as an alternative to these municipalities, especially as Gravesend, which

has tradition in the cultivation and the parties to use more controlled greenhouses with temperatures below 15 ° C, but the cost will rise because of the cooling means, but that can be reduced through political and livestock cooperatives to help decrease the use of pesticides, since it is a culture that requires plenty of phytosanitary care.

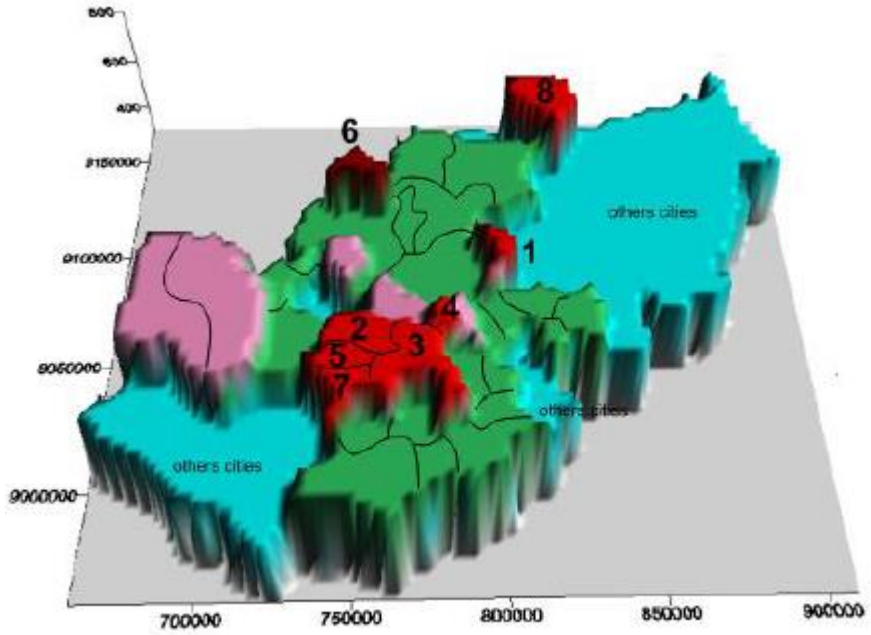
One of the innovative ways that you can investigate is the use of lichens, living beings formed by the association of algae and fungi. Are organisms that alter the chemical and microbial properties of soil by leaching of their secondary metabolites (Silva et al, 2012;. Tiger et al, 2012.). Thus, it appears as an alternative for improving soil conditions by changing the chemical composition and soil microbiology supporting the reduction of the indiscriminate use of toxic products. In the Northeast, several species of lichens Cladoniaceae family have been tested in order to verify its interaction with the underlying soil. The results are promising, which justifies the extension of this study with economic crops (Silva et al., 2012). The lichens, for example, may be a viable alternative in such cases, since reduce the incidence of bacteria and fungi in soil, rocks and plants (Martins et al, 2010;. Silva et al, 2010;.. Santos et al, 2015;. TIGER et al, 2015), reducing the need for pesticides that are quite expensive and time, and may use the gain to another technology, such as the use of chillers.

The relationship between altitude and temperature within a certain margin of altitude, in Pernambuco do not favor the existence of milder temperatures conducive to strawberry cultivation.

There are municipalities in Pernambuco that have altitudes between 600 and 700 meters, as Araripina, Arcoverde, Cedar and Itapetim in the backlands of Pernambuco State and the State of Agreste most municipalities have altitudes ranging from 600 to 700 meters, mainly in the center of region including micro Valley Ipojuca, Fen Pernambucano, Ipanema Valley and Garanhuns, but all do not have monthly average temperatures that meet proposed by Antunes et al. (2006) and Resende (2001). However, other perspectives may be envisioned to mitigate or solve the problem. Coelho Júnior (2013) presents varieties of strawberry plants suitable for the hot weather, especially if your planting has as a goal the food industry, given the high levels of vitamin C and other nutrients found in experimental crops, such as cultivating Festival subjected to lichen cladonia verticillaris showed high ascorbic acid content and its pseudo presented low pH. While work rabbit Jr. et al. (2012) reported that cultivate Ventana had higher amounts of vitamin A compared to other cultivars tested in cultivation in warm weather, and besides, it showed higher amount of sugar, despite its production does not meet the productivity needs, color and size to the in-kind industry (RABBIT JUNIOR et al, 2014).

Another finding in hot weather, with the use of lichens, using the cultivar Festival was obtained by BUNNY JUNIOR et al., (2013) with the use of Cladonia salzmannii when the inclusion of lichen increased the amount of soluble solids and the rate of SS / AT (soluble Solids titratable acidity). Because of this, it can be inferred that such treatments have the potential to reach different market prices for consumption also in nature, because satisfying consumer demand enjoying the sweetest fruit. This may be due to the environmental and nutritional conditions during the cultivation. Lichens release various substances that are linked to their cell wall, including carbohydrates, which is why it can be responsible for the increase of soluble solids in pseudofruits (Silva et al., 2012).

Figure 4 - Representation altimetry and strawberry cultivation potential in Meso Agreste through Digital Terrain Modeling. Blue municipalities with altitude below 600 meters and low potential in green municipalities between 600 and 700 meters with low potential, rose above 700 meters with low potential in red above 700 meters with average potential and deep red above 700 with high potential for cultivation of strawberry . Source : Author , 2015 .



So , with these alternatives addressed , even at altitudes and temperatures that do not favor the cultivation in these cities , you can find alternatives using lichens Cladonia verticillaris and Cladonia salzmannii alone or together to reduce the amount of pathogens that affect the crop , reducing the amount used pesticides, strawberry increased nutritional qualities , even in hot temperatures.

In cities with altitudes above 700 m, only Cachoeirinha , Caetés , Garanhuns , Jucati , Paranatama , Saloa and Taquaritinga North in Agreste and Triumph in the Hinterland are municipalities able cultivation of strawberry plants , they present minimum temperatures

between 15 ° C and 16 ° C from July to August (Figures 1 and 2). These municipalities have an average potential to the strawberry crop , whose cultivation should be done at the beginning of May until August , except Triomphe, the only municipality whose activity can extend up to September (Tables 2 and 3).

Cachoeirinha has only two months (July and August) with temperature below 16ºC: July (15.9ºC) and August (15.7ºC). As the strawberry crop has 60 days for vegetative growth and fruit planting can be carried out in May (Table 2). Cachoeirinha features places with altitudes above 700 meters, but as you can see not all places have 700 meters unlike the data in Table 2 which lists the city as a whole. This city has only less than 5% of its area can be allocated to the cultivation of strawberries and location of this crop should be in the north of the city. The digital terrain model also shows that there are two small areas in the north that may be growing with average potential (Figura5).

Caetés has only two months (July and August) with temperature below 16ºC: July (15.8ºC) and August (15.5ºC). As the strawberry crop has 60 days for vegetative growth and fruit planting can be carried out in May (Table 2). Cachoeirinha features places with altitudes above 700 meters, but as you can see not all places have 700 meters unlike the data in Table 2 which lists the city as a whole. This city has more than 85% of its area can be allocated to the cultivation of strawberries and location of this crop should be in the north, center and northeast of the city. The digital terrain model also shows that there are two regions (East and West) that do not favor the cultivation and its greatest potential is in the center-north of the city (Figure 6).

Figure 5 – Altimetry Cachoeirinha . Source Author .

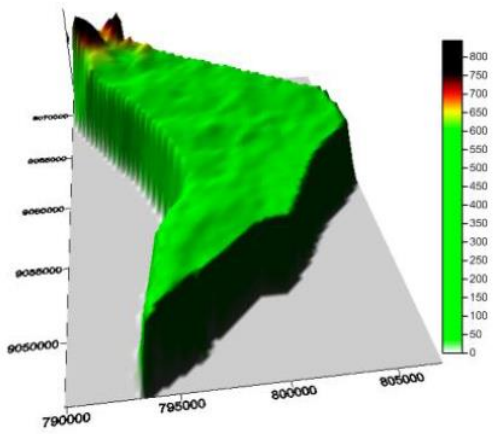
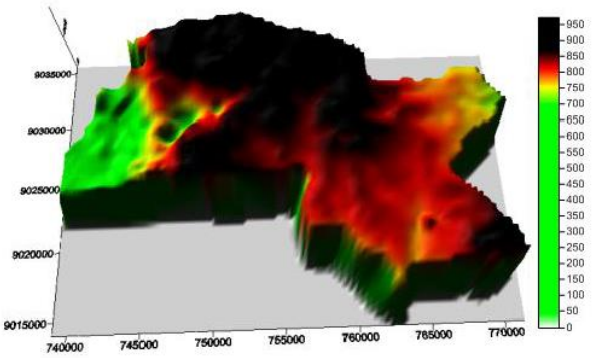


Figure 6 – Altimetry Caetés. source Author.



Garanhuns also features just two months (July and August) at temperatures below 16 ° C: July (15,7ºC) and August (15,4ºC). As the strawberry crop has 60 days for vegetative growth and fruit planting can be carried out in May (Table 2). Garanhuns features places with

altitudes above 700 meters, but as you can see not all places have 700 meters unlike the data in Table 2 which lists the city as a whole. The city has more than 60% of its area conducive to strawberry cultivation and its location is central and south of the city. The digital terrain model also reports that there is isolated spots that are concentrated in the north and southwest of the city for the cultivation of this fruit presenting growing medium potential (Figure 7).

Jucati also features just two months (July and August) at temperatures below 16 ° C: July (15,8ºC) and August (15.6ºC). As the strawberry crop has 60 days for vegetative growth and fruit planting can be carried out in May (Table 2). Jucati features places with altitudes above 700 meters, but as you can see not all places have 700 meters unlike the data in Table 2 which lists the city as a whole. The city has more than 95% of seats with the possibility of strawberry cultivation and is located throughout the city, mainly in the center-north (Figure 8).

Figure 7 - Altimetry Garanhuns . Source : Author 2015.

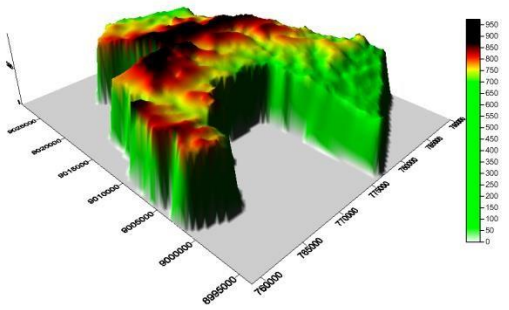
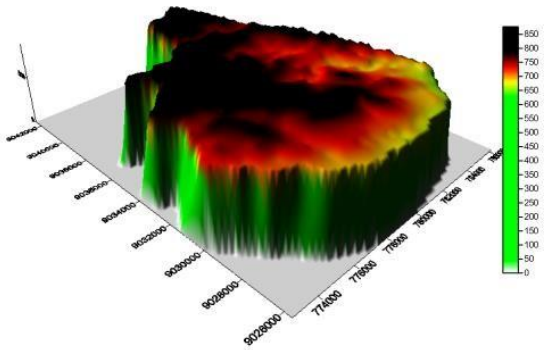


Figure 8 - Altimetry Jucati . Source : Author 2015



Paranatama also features just two months (July and August) at temperatures below 16 ° C: July (15,9ºC) and August (15,7ºC). As the strawberry crop has 60 days for vegetative growth and fruit planting can be carried out in May (Table 2). Paranatama features places with altitudes above 700 meters, but as you can see not all places have 700 meters unlike the data in Table 2 which lists the city as a whole. The city has more than 50% of its territory with medium potential to strawberry cultivation. The digital terrain model states that the best area of cultivation (medium potential) is located in north-central county (Figure 9).

The municipality Poções has a high potential for cultivation of strawberry, with temperatures below 26 ° C in February to September and minimum below 16 ° C between June and October, and below 15 ° C from July to September and can be planted in May. The digital terrain model informs that in northern extreno the city has high potential to strawberry cultivation and the center has medium potential for cultivation. These results demonstrate are promising, since Poções has an HDI of 0.571 considered low, and GDP of only US $ 42,070 (IBGE, 2010). Therefore, the cultivation of strawberry plants can be an important alternative for Poções and adjacencies, since this activity with average R $ 41,500 per hectare yields, may

move the economy of this municipality and greatly influence family farms, small and medium producers, for cultivation big hand labor demand (IBGE, 2006; 2010). socioeconomic investments for the strawberry crop could be deployed, including by creating similar festivals held in the Gravesend.

Added cultivation favored by the altitude and temperature studies of the best strawberry cultivars can be realized in Poções municipality as well as the introduction of alternative methods for improving the quality of pseudofruits as well as increased plant growth and productivity. Coelho Júnior (2013) reports that the use of lichens verticillaris C. and C. salzmannii in experimental crops positively influences the characteristics of the plant and soil, promoting increased productivity, possibly by action of barbático acids, fumarprotocetrárico and protocetrárico, which further studies may be synthesized and added to the culture, part of the crop management (Figure 10).

Figure 9 - Altimetry Paranatama . Source : Author , 2015.

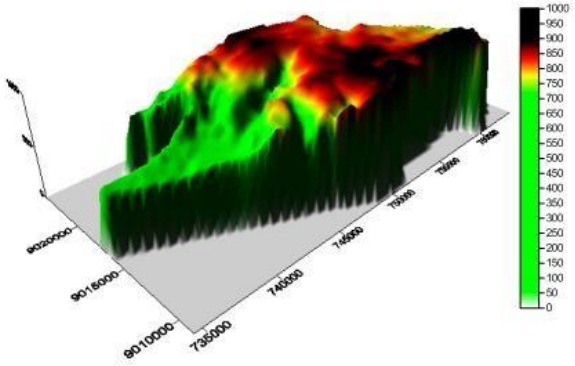
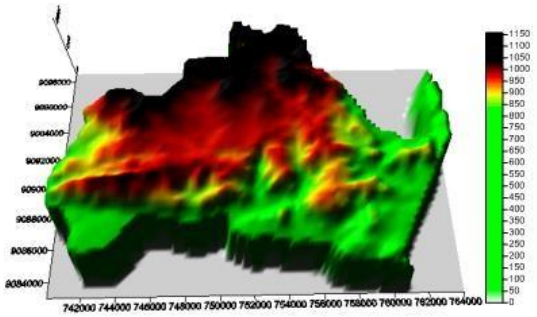


Figure 10 - Altimetry Poções . Source : Author , 2015 .



Saloa also features just two months (July and August) at temperatures below 16 ° C: July (15,9ºC) and August (15.6ºC). As the strawberry crop has 60 days for vegetative growth and fruit planting can be carried out in May (Table 2). Saloa features places with altitudes above 700 meters, but as you can see not all places have 700 meters unlike the data in Table 2 which lists the city as a whole. The city has less than 15% of area that has medium potential to ciltivo of strawberry and according to the numerical modeling of the land that averagely own area for cultivation located in the center of the city and some isolated spots north of that city (Figure 11).

Taquaritinga do Norte also features just two months (July and August) at temperatures below 16 ° C: July (15,7ºC) and August (15,4ºC). As the strawberry crop has 60 days for vegetative growth and fruit planting can be carried out in May (Table 2). This city has places

with altitudes above 700 meters, but as you can see not all places have 700 meters unlike the data in Table 2 which lists the city as a whole. Taquaritinga North has less than 5% of its territory with average potential for cultivation of strawberry and this location is north of the city, according to information from the digital elevation model (Figure 12).

Figure 11 - Altimetry Saloa . Source : Author , 2015**.**

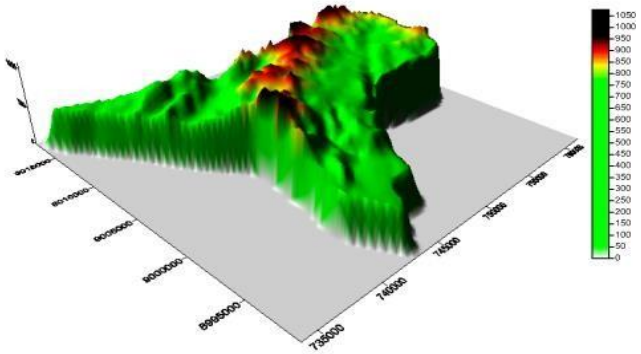
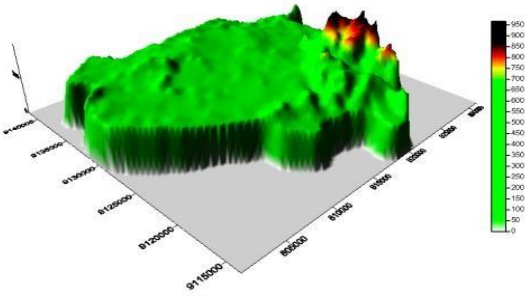


Figure 12 - Altimetry Taquaritinga do Norte . Source : Author , 2015 .



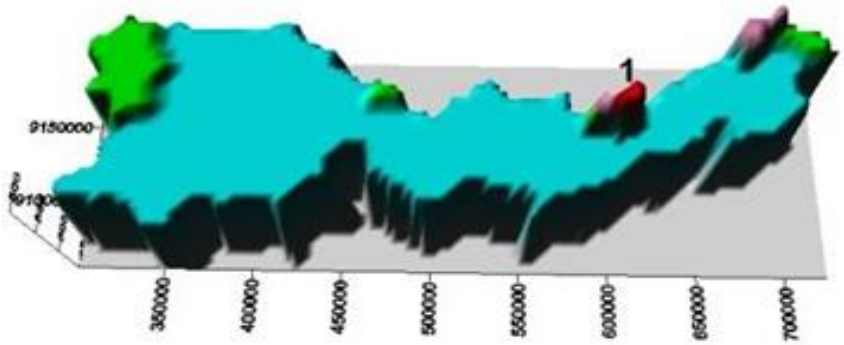
Mesorregion Sertão of Pernambuco

The Mesoregion Sertão of Pernambuco has only one municipality (Triunfo) with temperatures below 16ºC. According to Table 3 and Figure 13 , the cities with minimum temperatures below 16 ° C have been selected in at least two consecutive months, considered average potential cultivation (between 16ºC and 15ºC) and below 15 ° C high potential .

Tabela 3 - Temperaturas mínimas mensais dos municípios da Mesorregião Sertão de Pernambuco que apresenta médio ou alto potencial ao cultivo do morangueiro.

City	Altitude	Minimum temperature ºC											
	(m)	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Triunfo	1010	18,1	17,9	17,9	18,1	17,2	16,2	15,5	15	15,6	16,6	17,2	17,5

Figure 13 - Aaltimetry representation and strawberry cultivation potential in Mesoregion Hinterland of Pernambuco through digital terrain model . Blue cities with altitude below 600 m with low potential in green cities with altitude between 600 and 700 meters with low potential in pink cities above 700 meters high with low potential and red cities above 700 meters with average potential (1 Triumph) . Source : Author , 2015.



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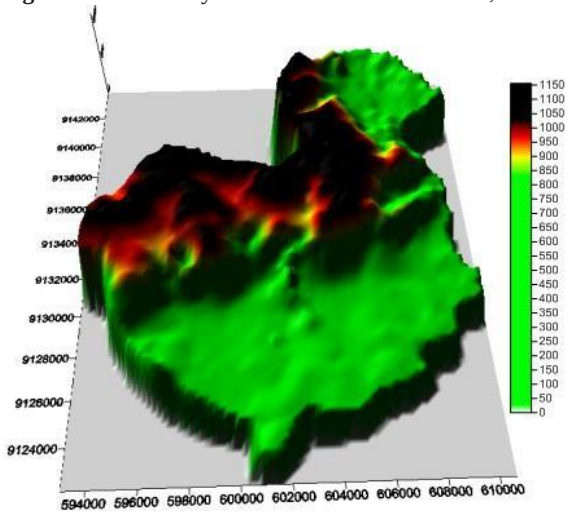
Triunfo also features just two months (July to September) with temperatures below 16ºC : July (15.5ºC) , August (15.5ºC) and September (15.6ºC) . As the strawberry crop has 60 days for vegetative growth and fruit planting can be carried out in May (Table 2). This city has places with altitudes above 700 meters , but as you can see not all places have 700 meters unlike the data in Table 3 which lists the city as a whole. This city has more than 40 % of its area devoted to cultivation of strawberry and its location lies to the northwest of the county (Figure 14).

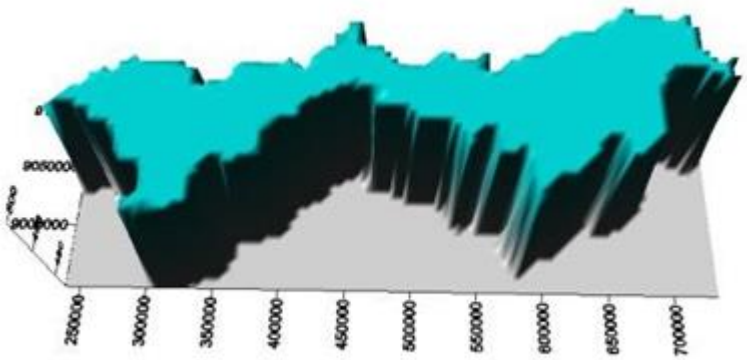
Figure 14 - Altimetry of Triunfo. Source : Author , 2015 .



Mesorregion São Francisco of Pernambuco

The Mesoregion São Francisco presents all cities with altitudes below 600 meters, therefore it is a hot climate region has no microclimate altitude. All temperatures throughout the year presented above 16ºC not meeting the recommendation of Antunes et al . 2006 and Resende (2001) . So all the cities that Mesoregion has low potential for cultivation of strawberry , requiring other forms such as the use of air-conditioned greenhouses (Figure 15).

Figure 15 - Altimetry representation and potential cultivation of strawberry in Mesoregion San Francisco Pernambucano through digital terrain model . Blue municipalities that are below 600 meters and have a low potential for cultivation of strawberry .



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