Honey production in rural settlements in central Brazil

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ABSTRACT

The land distribution in rural settlements has been providing opportunities for rural activities in the field and promoting productive diversification. Beekeeping is a key activity in generating income for the rural population. Brazil has a great potential in producing honey due to climate characteristics, and natural and social resources. The objective of this study was to describe the honey production in municipalities with and without rural settlements, in Central Brazil (Goiás state). A t test for independent samples with significance level of 95% was carried out to evaluate the average amount of honey produced per year and the total production in municipalities with and without settlements. In addition, a polynomial regression test was carried out between the average yield and total production of honey of municipalities with and without settlements over the 17 years (1998 to 2014). The production from municipalities with rural settlements corresponds to 63% of the total, while only 37% comes from municipalities without rural settlements.

Keywords: Beekeeping, settlement, Brazilian savannah, Cerrado biome.

Producción de miel en asentamientos rurales en el centro de Brasil

RESUMEN

La distribución de la tierra en los asentamientos rurales ha estado proporcionando oportunidades para las actividades rurales en el campo y promoviendo la diversificación productiva. La apicultura es una actividad clave para generar ingresos para la población rural. Brasil tiene un gran potencial en la producción de miel debido a características climáticas y recursos naturales y sociales. El objetivo de este estudio fue describir la producción de miel en municipios con y sin asentamientos rurales, ubicados en el centro de Brasil (Estado de Goiás). Se realizó una prueba t para muestras independientes con un nivel de significancia del 95% para evaluar la cantidad promedio de miel producida por año y la producción total en municipios con y sin asentamientos. Además, se realizó una prueba de regresión polinómica entre el rendimiento promedio y la producción total de miel de municipios con y sin asentamientos durante los 17 años (1998 a 2014). La producción de los municipios con asentamientos rurales corresponde al 63% del total, mientras que sólo el 37% proviene de los municipios sin asentamientos rurales.

Palabras clave: Apicultura, asentamiento, sabana brasileña, bioma Cerrado

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INTRODUCTION

The land distribution in rural settlements provides opportunities for rural activities in the countryside and promotes productive diversification (Carvalho *et al.* 2009). Over 550,000 families benefit from the settlements, and are able to convert land with low productivity into highly productive areas. In addition to this motivation, there is also a social transformation, a struggle for the land, and a will to conquer certain socio-political positions (Sparovek *et al*. 2005).

The National Institute of Colonization and Agrarian Reform (INCRA) defines the settlements as groups of independent agricultural units, originating from a rural property owned by a single owner; the area is then divided into plots, which are distributed among families that do not have the economic conditions to buy a rural property, intended to family farming (INCRA 2016).

The types of crops managed in the settlements range from subsistence production to commercial agricultural production, such as dairy farming, poultry farming, swine farming, fish farming, beekeeping, grain farming, agricultural extractivism, stimulating the cultivation of plants, fruit growing, horticulture and others (Sparovek *et al.* 2005). The main uses are dairy farming, fruit growing, fish farming and apiculture, since they are exclusively related to the promotive and technical assistance activities of trade unions, associations and land pastoral.

Beekeeping is key in contributing to the income generation of men from the field in various regions of the country. In general, Brazil presents great potential for honey production due to climatic conditions and natural and social resources. In Bahia, northeastern Brazil, about 2.3% of the agricultural establishments are rural settlements, which comprise near 50% of the economic activities in the region, and up to 75% to produce honey and eggs (Leite *et al.* 2004).

In 2013, the country produced about 35,364 tons of honey, being one of the 15 largest producers in the world. Internally, the southern region is the largest producer, with 49% of the total, followed by the northeastern and southeastern regions, with respectively 18% and 17%. However, the Goiás state, in the midwestern region, still does not stand out in the national production, despite the beekeeping is one of the most promising economic activities in the midwest of Brazil, due to favorable environmental and climatic conditions, high climate diversity, forest ecosystems, topography and vegetation (Almeida and Carvalho 2009, Araújo *et al.* 2015), in addition to a variety of fruit trees (Itagiba 1997), which results in honey of excellent quality, suitable for economic exploitation and commercialization (Furtado 2007).

Beekeeping has many benefits, such as low implementation cost and high profitability, also it is a real business and social integration possibility. The reason is that beekeeping does not require exclusive dedication, enabling producers to develop other activities. The installation of apiaries does not require extensive land areas, and most importantly, it does not destroy, deforest or pollute, but contributes to the preservation and maintenance of the ecological balance (Souza 2004).

In view of the importance of beekeeping in the generation and diversification of income for family farmers, as well as the possibility of sustainable production and the preservation of the environment, it is necessary to promote financing and educational policies that allow the increase of beekeeping activity in the region. For this, it is required to know the characteristics of beekeeping production in this area, so the objective of this study was to describe the honey production in municipalities with and without rural settlements of Goiás state.

MATERIAL AND METHODS

The Goiás state of is located in the central region of Brazil, and holds the Cerrado biome (Walter *et al*. 2008). The climate is classified as Aw, according to Köppen, and has average rainfall of 1,500 mm, with rainy summers and dry winters. The mean temperature is 23.4 °C ± 5 °C (Cardoso *et al*. 2014).

From a date of 246 municipalities in the Goiás state, information on honey production was

collected from 1998 to 2014 (IBM 2016), like so by the number of settlements and rural families (INCRA 2016).The amount of honey produced per year was assessed comparing the average and total production, over the 17 years, of municipalities with and without settlements. The results were evaluated using covariance analysis (ANCOVA), with the year of production as co-variable, with a significance level of 95%.

A polynomial regression was also carried out. The regressions were performed with a regression coefficien for a better fit, using the Akaike criterion (AIC) to choose the best model and the statistical significance of the relation (p). The polynomial regression was used, to calculate the relation between the number of families settled in the municipalities and the honey production. To perform the statistical analysis we used the PAST 2.17C software (Hammer *et al.* 2001).

Honey production in municipalities with and without rural settlements in 2014 was marked on the map, and the municipality marker shows the amount produced (kilograms, kg). The software ArcMap and the shapefile of the municipal boundaries for the State of Goiás were used to draw the map (SIEG 2016).

RESULTS AND DISCUSSION

Honey production in the municipalities

One hundred and twenty municipalities in Goiás produce honey, 42 with rural settlements and 78 with no settlements (Figure 1). Honey production throughout the Goiás state from 1998 and 2014 increased threefold, especially in 2007, 2013 and 2014. The average production of honey in the state is 122,800 kg/year.

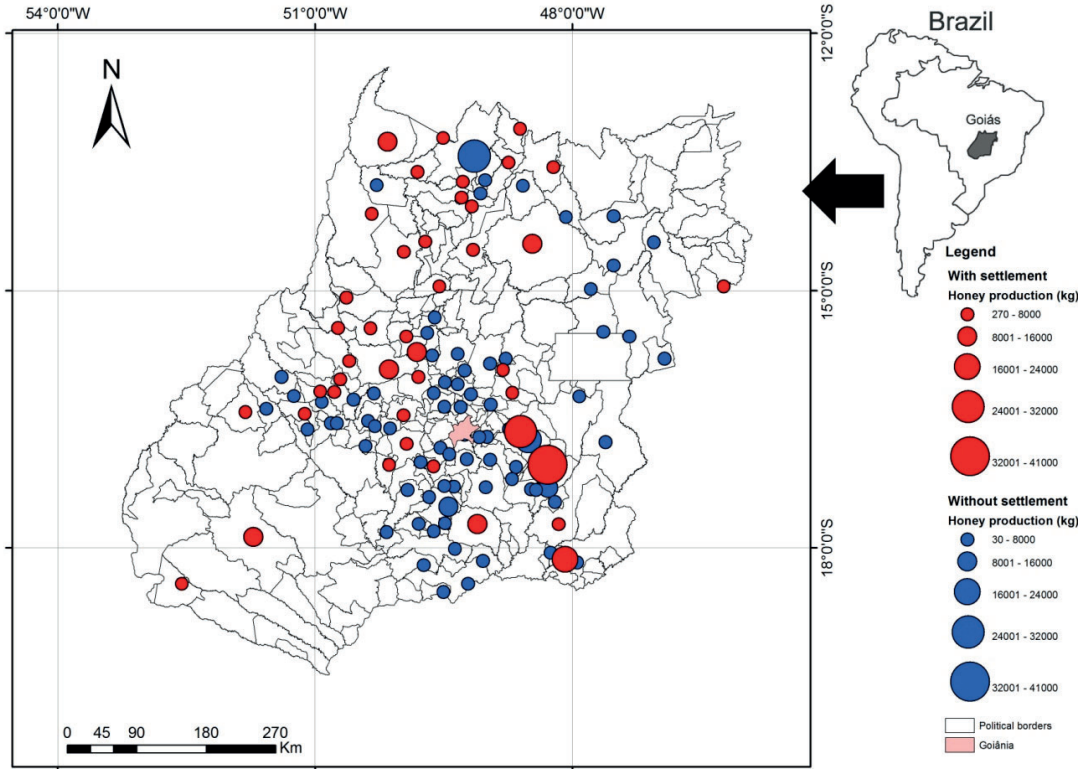

Figure 1. Distribution of honey-producing municipalities with and without rural settlements in the State of Goiás. The size of markers shows the amount of honey produced in 2014.

The largest production yet was recorded in 2014 (353,000 kg; Figure 2). Production in municipalities with rural settlements increased four-fold (388%) in the period evaluated, there was also a significant increase even in areas without settlement, but in two and a half times (250%).The average production in areas with settlements was higher than in areas without settlements due to the exclusive dedication of the families to family agriculture. The settlers depend exclusively on this type of production, since they are families that depend on subsistence agriculture to live and they provide the labor necessary for each type of work (Le Tourneau and Bursztyn 2010).

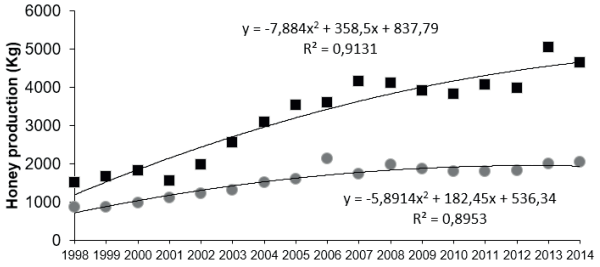

Figure 2. Average amount of honey produced in kilograms/ year in municipalities with and without rural settlements between 1998 and 2014 (ANCOVA, F1.32=106.8, P=0.000) (black square: mean municipality with settlement; gray ball: Mean municipality without settlement).

Beekeeping activities in settlements in the central region of Brazil are not yet widely explored. This may be due to the absence of technical excellence in bee management and in the absence of technical and educational assistance (Reis *et al*. 2004). This study verified that, even with more municipalities producing honey without rural settlements, total production was higher in the municipalities with settlements. The municipalities without settlement that produce honey occur around the metropolitan region of Goiânia, and may show a logistic advantage in producing and selling bee products.

The average annual honey production of municipalities with rural settlements since 1998 was higher than in municipalities without settlement (Figure 2). However, the total annual production of municipalities with settlements was lower until 2006. Production increased from 2007, reaching values higher than the recorded for municipalities without settlements (Figure 3).

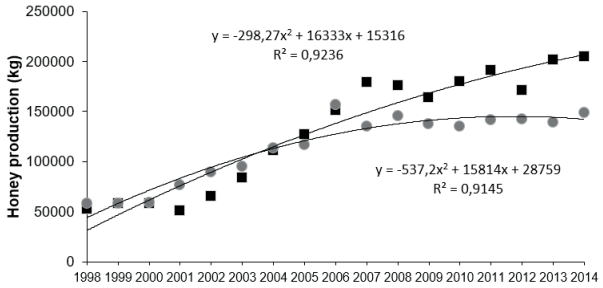

Figure 3. Total honey production, in kilograms per year, in municipalities with and without rural settlements between 1998 and 2014 (ANCOVA, F1.32 = 5.22, P=0.02) (black square: mean municipality with settlement; gray ball: mean municipality without settlement).

The production coming from municipalities with rural settlements corresponds to 63% of the total honey produced in the state during 2014, while only 37% are from municipalities without settlements. Municipalities with rural settlements produced on average 3,236.45 kg of honey per year, while municipalities without settlements produced less than half of this value (1,559.76 kg of honey per year; ANCOVA, F1,32 =106.8, P=0.000) (Figure 4).

The municipalities with rural settlements had a total honey production approximately 130,992 kg/year, and municipalities without settlement the total honey production was 114,677 kg/year (ANCOVA, F1,32 =5.22, P=0.02). A production 13.5% higher in municipalities with rural settlement (Figure 5).

Goiás, Montividiu do Norte, Mundo Novo and Minaçu are among the municipalities with the highest number of families settled. However, the number of families was not directly related with the total and average honey production per

year of each municipality with rural settlement (P>0.001), which shows that not all the families work with beekeeping.

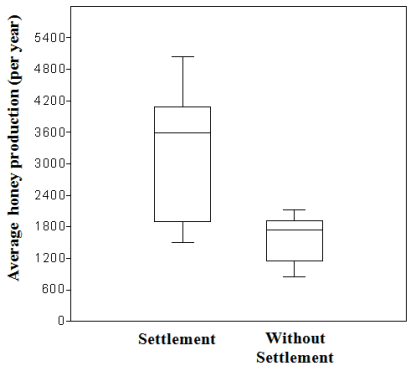

Figure 4. Average honey production/year in municipalities with (3.236,45 kg) and without settlement (1.559,76 kg) (F1.32 = 106.8; P=0.000).

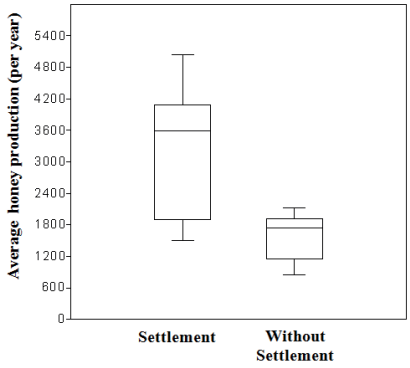

Figure 5. Total honey production/year in municipalities with (130.992 kg) and without rural settlement (114.677 kg) (F1,32 = 5.22; P=0.02).

The municipalities that produced the most honey were Goiandira (20,000 kg), Jataí (13,100 kg) and São Miguel do Araguaia (11,130 kg), the first four in the southern region, and the other in the northwestern region. The municipalities with no settlement were Porangatu (24,990 kg), Vianopolis (23,500 kg), Pires do Rio (15,000 kg), Pontalina (8,400 kg) and Uruana (7,200 kg). Porangatu is found in the northern region of the state, Vianópolis, Pires do Rio and Pontalina in the south, and Uruana in the midwestern region.

The municipalities of Uruana, São João da Paraúna, Anápolis and Porteirão did not present rural settlements and had low honey production (7,200 kg, 120 kg, 1.300 kg, 80 kg respectively). Over than 70% of these municipalities are occupied by crops such as soybean and pasture (Sano *et al.* 2008). This low honey production may be consequence of the type of agricultural production that does not contribute to beekeeping, as well as of the exaggerated use of agrochemicals that can negatively affect bee populations, which are essential for ecosystem functioning, stability, and agricultural production (Malaspina *et al.* 2008).

Over 70% of Chapadão do Céu (production of 2,450 kg) is also occupied by agriculture, but besides having settlements, it houses a part of the Emas National Park, a conservation unit that consequently contributes to honey production. The municipalities of Bonópolis, Crixas, Novo Planalto and Araguapaz have their areas occupied by less than 1% of agricultural crops (Sano *et al.* 2008) and the rest by small areas occupied by family farmers, present or not in rural settlements. Santa Tereza de Goiás and Campinaçu have less than 1% of the area occupied by agriculture and have no settlement. These municipalities showed a low production of honey in 2014 (1,260 kg and 200 kg respectively).

Honey production and its relation to the number of families

In this study, the number of families settled was not related with the production of the honey, which probably occurs because not all the families of settlers exhibit bee breeding and apicultural productions. The municipalities of Orizona (16 families), Silvania (64 families), Goiandira (18 families) and Jataí (436 families) encompassed the largest honey productions and had rural settlements. Both and Both (2009) verified that honey complements income in between 10 and 30% of 59 families of family farmers in Capitão do Poço, Pará. This increase in income became so relevant that it encouraged the increase in the number of beekeepers from 2004 (65 beekeepers) to 2007 (105 beekeepers).

The production of Capitão do Poço (state of Pará), amounted to 48 tons of honey in 2004, in 1,961 hives, in 2007 jumped to 94 tons, in 3,670 hives, increasing the total honey production in 92.55% (Both and Both 2009). The increase in production is more related to the increase in the number of beekeepers and hives than to the increase in productivity related to the improvement of beekeeping techniques and practices. This increase in the number of beekeepers related to the family production system is also observed in northern Goiás. A similar beekeeping production situation occurs in Moreilândia, Pernambuco, where most beekeepers preferably use family or cooperative labor, and the main reason for starting the activity is to increase family income. Most beekeepers are small family farmers, small landowners and have low level of accumulated capital, but see beekeeping as an activity that can be adapted to their characteristics, leading to diversification in rural areas, to the increase in income level and consequently to the improvement of their quality of life, in addition to not endangering the environment (Barbosa *et al.* 2013).

In recent years, the value of honey marketed in the Goiás state increased by about 207% from 1998 to 2013, even with state production increasing by more than 300%. These values of honey in recent years have also encouraged beekeepers, since the increase in prices makes the activity more profitable and small production viable (Araújo *et al*. 2015). The largest honey producers in the State of Goiás are the municipalities of Orizona, Silvânia, Goiandira, Porangatu, Vianópolis, Jataí, São Miguel do Araguaia, Goiás and Niquelândia, in descending order of production. Except for Vianópolis and Goiandira, all other municipalities present rural settlements.

Within each rural settlement, even with several families and settlements, only few families raise bees. The activity, although considered easy to manage, requires an initial investment in hives and equipment, in addition to training and capacity building, so only a few families remain in the beekeeping activity.

Traditionally, the beekeeping activity in the rural settlements begins with investments from rural extension agencies of the State or the pastoral of the land reducing the investment of the rural producer, encouraging them to enter a this new activity.

Considerations in the preservation of the environment

The link between the academic community and honey producers it is very important because access to knowledge on the benefits of pollination becomes more accessible and it is possible to apply studies and research alongside. It is noteworthy that most plant species depend directly on pollinators (Winfree *et al.* 2009) and that the biodiversity as well as the populations of pollinators are reducing (Decourtye *et al.* 2010). Therefore, the reduced natural population of plants and bees threatens the stability in food crop production, so it is relevant for the producers to know the scientific research on the reduction of pollinators to avoid greater environmental.

Beekeeping operates in a way that it does not interfere with crops such as soybeans, corn, beans and sugarcane, since native vegetation areas are the most appropriate for beekeeping for having high levels of food resources, constituting an ideal site to install colonies insight each place (legal reserves, permanent preservation areas and environmental protection areas; Almeida and Carvalho 2009). Based on the Forest Code, the permanent protection areas (PPAs or APPs in portuguese) focus on preservation as a whole (e.g., water resources, geological balance, biodiversity), while ensuring the wellbeing of society.

The area of native vegetation, Legal Reserve, also fits these preservation and conservation goals, being mandatory to allocate 20% of the area in each rural property; this area can be used for beekeeping activities since this is an allowed activity within this protection area. Environmental Protection areas also focuses on protective actions and can serve as areas for research and implementation of environmental education programs (Código Florestal Brasileiro 2012). These three areas are considered unconventional alternatives and can be managed between production spaces bringing the possibility of a better

result for conservation of vegetation fragments near these monocultures.

The conservation of these nearby areas, and of their ecosystem balance, has been a great point of discussion for agroecologists, since it is enables the production of several crops and a cooperation in the use of the area. For farmers, beekeeping is perceived as a secondary activity, but this has changed dramatically in recent years, because with the right investments for technologies, the production and marketing of honey becomes more and more a primary activity (Both and Both 2009, Barbosa and Souza 2013, Oliveira and Sales 2013).

It is traditionally known that the agricultural industry is providing many jobs and income to the country because they have a high economic value for the society (Zimmermann 2009). However, it is known that the agribusiness handles innumerable environmental impacts such as habitat loss, fragmentation, soil and groundwater contamination and impoverishment, river contamination, soil compaction, sedimentation among others (Klink et al. 2005).

Rural settlements can also have negative impacts on land use, if without a good technical and educational support. With the proposer support and help of technicians and students (from agroecology or not), the benefits are great in regards to the negative consequences. The development of settlers becomes viable with the correct use of natural resources and the possibility of an optimal and cooperative result.

The mere implementation of apiaries for small producers already comes with an important step for conservation, which is the understanding of the need for conservation actions and its application. The benefits can be perceived in the short or medium term.

Guidelines for public policies

Family farmers do not have the necessary support from the government, and even less from public policies, to improve production nor are they offered technical assistance (Medina 2012). Without this help, small family farmers are unable to grow with their products.

Nevertheless, it is important to know that there is no point in having only technical support in delivering the technology. Technology exists to help family farmers, whether in increasing their production, conserving their products, or in providing sustainable use of resources. However, orientation, dialogue, teaching, transfer of knowledge and ways of dealing with this technology are necessary because without it, this assistance will be pointless (Medina 2012).

In addition to the well-developed orientation, settlements that produce honey because they are located in areas with native vegetation (even if remnants and fragments) can become even more important for regional development with the implementation of public policies that favor family agriculture and academic knowledge with its vast theoretical base and applicability.

CONCLUSIONS

Honey production is higher among municipalities with rural settlements among all municipalities in the Goiás state. On the other hand, the municipalities that do not have rural settlements have the highest honey production in the metropolitan region of Goiânia, associated with practical logistics, being close to the consumer market. The presence of rural settlements may encourage a greater production of honey, since the settlers depend on subsistence and become dedicated exclusively to it.

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Appendix. Municipalities producing honey with and without rural settlement in the State of Goiás.

Municipalities with rural settlement			Municipalities without rural settlement	
Municipality	**Families settled**	**Honey production (Kg)**	**Municipality**	**Honey production (Kg)**
Abadiânia	32	690	Água Fria de Goiás	30
Amaralina	427	500	Aloândia	120
Anicuns	41	981	Alto Paraíso de Goiás	220
Araguapaz	306	1,120	Amaralina	500
Bonópolis	176	1,830	Amorinópolis	170
Chapadão do Céu	40	2,450	Anápolis	1,300
Corumbá de Goiás	11	650	Aragoiânia	75
Crixás	407	700	Arenópolis	450
Faina	153	600	Bela Vista de Goiás	2,700
Fazenda Nova	193	1,000	Bom Jesus de Goiás	160
Formoso	25	3,500	Buriti Alegre	220
Goiandira	18	20,000	Cabeceiras	608
Goiás	699	10,000	CachoeiraDourada	140
Heitoraí	83	9,360	Caldazinha	1,000
Ipameri	77	1,100	Campinaçu	200
Iporá	32	5,000	Catalão	1,700
Itaberaí	232	2,332	Ceres	2,000
Itapaci	44	1,300	Cezarina	360
Itapirapuã	166	3,000	Cocalzinho de Goiás	2,600
Itapuranga	13	3,800	Colinas do Sul	1,100
Jandaia	34	1,600	Córrego do Ouro	550
Jataí	436	13,100	Cristalina	2,090
Jaupaci	55	750	Cristianópolis	1,100
Mara Rosa	45	1,600	Cromínia	2,500
Matrinchã	52	270	Diorama	150
Minaçu	551	3,450	Edealina	150
Montividiu do Norte	672	1,300	Edéia	280
Morrinhos	120	9,000	Estrela do Norte	1,200
Mundo Novo	558	200	Firminópolis	90
Mutunópolis	122	4,500	Flores de Goiás	2,163
Niquelândia	356	10,000	Formosa	2,832
Nova Crixás	226	500	Gameleira de Goiás	2,300
Novo Brasil	15	59	Goiânia	480
Novo Planalto	228	1,200	Goiatuba	2,290
Orizona	16	1,180	Guapó	480
Palmeiras de Goiás	316	41,000	Hidrolândia	2,100
Paraúna	33	300	Inhumas	1,849
Rialma	66	1,650	Israelândia	250
São Luiz do Norte	66	1,300	Itaguaru	4,800
Silvânia	64	11,130	Itapaci	1,300
Trombas	34	26,500	Itauçu	228
Uruaçu	98	2,320	Itumbiara	650
Varjão	60	1,300	Ivolândia	200
			Jaraguá	800

Joviânia	120
Leopoldo de Bulhões	1,000
Luziânia	1,030
Mairipotaba	500
Moiporá	110
Montes Claros de Goiás	380
Montividiu do Norte	1,300
Mundo Novo	200
Nova Aurora	1,600
Nova Veneza	59
Ouro Verde de Goiás	140
Palmelo	220
Petrolina de Goiás	750
Piracanjuba	3,000
Pirenópolis	4,300
Pires do Rio	15,000
Planaltina	680
Pontalina	8,400
Porangatu	24,990
Porteirão	80
Sanclerlândia	3,500
Santa Cruz de Goiás	550
Santa Rosa de Goiás	2,100
Santa Tereza de Goiás	1,260
São Francisco de Goiás	1,000
São João da Paraúna	130
São João D'Aliança	960
São Luis de Montes Belos	210
São Miguel do Passa Quatro	2,100
SenadorCanedo	500
Turvânia	180
Uruana	7,200
Urutaí	300
Vianópolis	23,500
Vicentinópolis	250