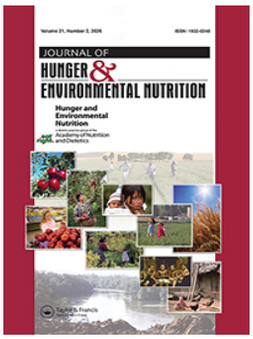

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Trends in agricultural production in the subregions of Antioquia, Colombia (2006–2022): an analysis to inform public policy

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ABSTRACT

This study analyzes the evolution of crop production in Antioquia from 2006 to 2022, revealing a shift toward agroindustrial models geared for export, marked by an increase in crops such as avocado, cacao, and oil palm tree, and a significant decline in staple foods like maize and beans. This trend reflects a productive reconfiguration that threatens regional food security and agro-biodiversity. Through time series and correlation analysis, patterns of crop substitution are identified. These findings deepen the understanding of the influence of national and international trade-oriented policies and highlight the urgent need to strengthen sustainable agricultural models aimed at guaranteeing the human right to adequate food.

KEYWORDS

Agriculture; agroindustry; food security; food systems; human right to adequate food

Introduction

In recent decades, Colombia has consolidated an economic model based on the export of natural resources – including coal, oil, nickel, emeralds, and gold – as well as agricultural products, notably coffee, palm oil, sugar, bananas, and flowers. However, the diversity of crops that has historically sustained food security and local peasant economies is increasingly being displaced by monocultures aimed at agroindustry, largely driven by neoliberal policies of economic globalization.[1]

This primary-export pattern has led to the sustained loss of food self-sufficiency, transformations in dietary patterns,[2] and a decline in crop diversity. While previous studies have shown that at the national level, between

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2017 and 2018, crop variety exhibited a rising trend – and that in certain departments, including Antioquia, there was notable crop heterogeneity during the 2006–2022 period[3]—this diversity is now under threat from the expansion of export-oriented agroindustrial crops.

Urrego-Mesa et al.[4] identify five periods in Colombia's socioecological agricultural transition:

Expansion of the coffee economy (1916–1932): Characterized by an extensive agricultural model with large estates, rural labor, and dependent relationships; agricultural diversity was significant, though coffee was the economic driver.

State intervention after the Great Depression (1933–1954): Protective policies and crop diversification emerged to ensure food security. The state began to assume a regulatory role, although land ownership remained concentrated.

State intervention and modernization (1955–1975): The State continued to support agricultural development through investments in infrastructure, research, and credit; however, the use of intensive technologies led to reduced crop diversity and increased dependency on agricultural inputs.

Economic liberalization and globalization (1976–1997): Colombian agriculture became integrated into global markets, increasing specialization in export crops and further reducing agricultural diversity.

Intensification and specialization (1998–2015): Globalization accelerated agricultural intensification, with greater reliance on external inputs and specialization in high-value crops. In these last two periods, land use pressure increased in the pursuit of crop efficiency and profitability, with implications for biodiversity and environmental sustainability.

The transition from traditional production systems focused on basic food crops to agroindustrial models responds to producers' pursuit of higher income and the growing demand of international markets. With the implementation of the Free Trade Agreement (FTA) between Colombia and the United States in 2012, the country increased its exports of coffee, bananas, and avocados, but also saw a rise in imports of yellow corn.[5] In 2016, national production of dry maize grain totaled 1,295,089 tons, while imports reached 4,586,534 tons.[6] Rice trade behavior between 2010 and 2015 illustrates this dynamic as well: exports decreased by approximately 92%, falling from 156 tons to just 13, while imports from the United States rose from 6298 to 82,193 tons.[7] This scenario highlights Colombia's growing dependence on food imports, particularly in departments such as Antioquia, Atlántico, Bogotá, Bolívar, Cundinamarca, and Valle del Cauca.[8]

With the enforcement of the FTA with the European Union, palm oil, bananas, and coffee became the leading Colombian agricultural exports to Europe, with palm oil showing the highest growth – exports rose by 252% between 2012 and 2018, surpassing traditional crops such as coffee.[9] Recent cooperation plans with China propose expanding the market presence of

Colombian products, including lemon and banana, which have gained admissibility (i.e., they meet sanitary and phytosanitary export requirements).[10]

This context indicates that exports are concentrated in a limited set of crops deemed more profitable and strategic within agribusiness. This is associated with a worrisome trend of replacing crops traditionally grown for local consumption or local markets. As such, the tension between agriculture for agro-export versus local food production remains a central topic of debate. The agroindustrial model has been linked to food insecurity, as it prioritizes market logics. In contrast, traditional production models – especially those based on family and peasant agriculture – have shown a positive correlation between crop diversity, agricultural productivity, and food availability,[3] which may translate into improved food security at the territorial level.

Recent approaches acknowledge that food insecurity cannot be understood in isolation, but rather as intertwined with environmental, productive, and public health dynamics. Ecological degradation, climate change, and the agroindustrial model have negatively affected the availability, quality, and sustainability of food, with public health repercussions such as malnutrition and diet-related diseases.[11] Along these lines is the approach of food sovereignty, defined as people's right to nutritious and culturally appropriate food produced using sustainable methods, and their right to define their own agriculture and food systems[12]

In this context, the department of Antioquia serves as an illustrative case of agricultural restructuring in Colombia, where profitability and integration into global value chains have begun to shape production decisions and impact the food security of the population. Located in the northwest of the country, Antioquia is divided into nine subregions, each with a distinct agri-food profile. Recent studies show that the prevalence of food insecurity in Antioquia households was 67.0% in 2019,[13] rising to 72% in 2023 in households with members under 18 years old.[14] Notably, the highest rates of moderate and severe food insecurity were found in subregions with economies based on agroindustrial and extractive models. This phenomenon coincides with increasing rates of malnutrition and diet-related chronic diseases, disproportionately affecting the most vulnerable populations.

In order to contribute to the analysis of changes in the regional productive model and to provide evidence for decision-making, this study examines trends in agricultural production across each of Antioquia's subregions between 2006 and 2022.

Methodology

A descriptive comparison was conducted using time series data from 2006 to 2022 on the hectares cultivated with major crops in Antioquia, disaggregated by subregions. The data were obtained from the open-access AGRONET

repository of the Ministry of Agriculture.[15] The time series were developed through comparative series using the tidyverse and ggplot packages in R.[16,17]

Although various studies on food and nutrition security exist in Colombia, research exploring its determinants from a territorial and dynamic perspective – particularly regarding the evolution of agricultural production – is limited. Time series analysis offers a key methodological tool to more precisely observe transformations in the agricultural production model within each subregion, allowing the identification of trends, disruptions, and transitions that could be influencing food availability and stability.

Pearson correlation coefficients were calculated to determine the relationships between crop production across the subregions of Antioquia, in order to infer potential land-use substitutions. Coefficients of 1 represent a perfect positive relationship, 0 indicates no relationship, and −1 denotes a perfect inverse relationship. Coefficients close to 1 suggest that crop pairs exhibit parallel growth or decline within the subregion. Coefficients near −1 suggest that an increase in the cultivated area of one crop corresponds with a decrease in the other, implying a potential substitution effect between the two.

Crops were also evaluated over the study period, where coefficients close to 1 indicate a growth in cultivated hectares over time, while those near −1 reflect a decline in land use for that crop within the subregion. All coefficients and figures were generated using the corrplot package in R.[18]

Results

Agricultural production trends in the subregions of Antioquia

Between 2006 and 2022, agricultural production in Antioquia reveals patterns indicating a reconfiguration of the productive model toward greater specialization in agroindustrial crops and a progressive decline in traditional subsistence crops. Overall, coffee is the predominant crop in five of the nine subregions of Antioquia (Suroeste, Oriente, Occidente, Norte y Nordeste), when considering the number of hectares cultivated (Figure 1).

Simultaneously, there is expansion of crops such as avocado, cacao, and oil palm trees, particularly in subregions like the Oriente, Urabá, and Magdalena Medio, suggesting processes of agroindustrial reconversion and adaptation to global markets. In contrast, basic crops such as maize and beans show a sustained decline in most subregions, possibly being replaced by avocado, oil palm trees, and cacao (Figure 1).

During the period analyzed, the Bajo Cauca subregion exhibited a relatively stable productive structure, characterized by a low degree of diversification and the predominance of a few crops. Rice, maize, cassava, cacao, and plantain were the crops with the greatest cultivated area. The crops that experienced the highest growth were cacao (from 587 hectares (ha) in 2007 to 4074 ha in 2022),

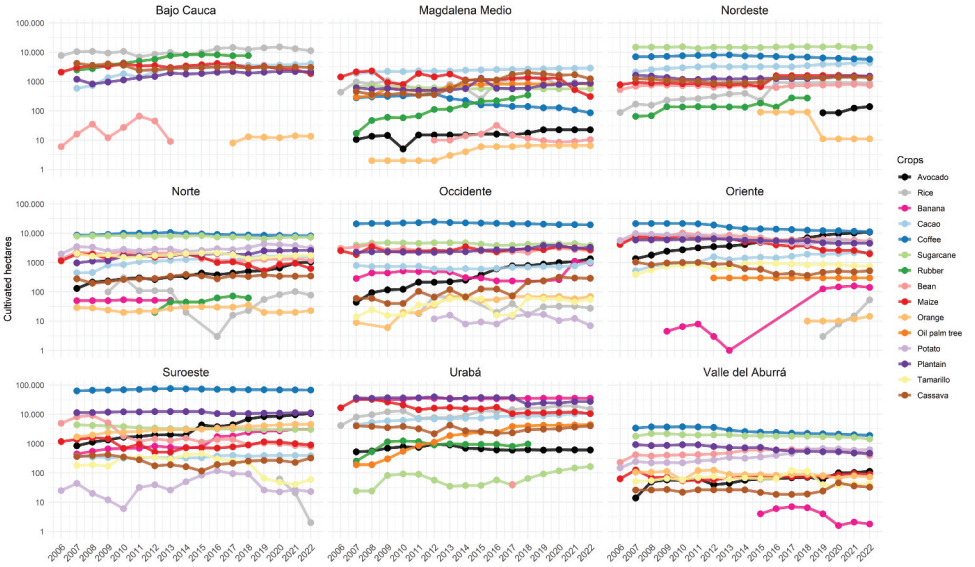

Figure 1. Time series of cultivated area by major crops per region in Antioquia between 2006 and 2022/2025).

representing a sevenfold increase over 15 years, and plantain, whose cultivation area doubled in just five years (from 823 ha in 2008 to 1965 ha in 2013). Rubber, in turn, tripled its cultivated area within seven years, beginning with 2497 ha in 2007 and reaching 8248 ha in 2014. In contrast, cassava and maize showed sustained decreases in this subregion over the analysis period (Figure 1).

During 2006–2022, the Magdalena Medio subregion displayed a relatively diverse productive structure, although it was marked by significant transformations in the composition of cultivated crops. Cacao consolidated as the principal crop, followed by maize, cassava, plantain, oil palm tree, rubber, and coffee. However, this hierarchy shifted over time due to dynamics of expansion or contraction in the cultivated area. Maize, for example, experienced a dramatic 80% reduction in planted area between 2020 and 2022, declining from 1300 ha to 309 ha. Similarly, cassava saw its area reduced from 2000 ha in 2020 to 1239 ha in 2022. Conversely, plantain and rubber crops exhibited exponential growth: plantain expanded twentyfold in just eight years, while rubber did so over ten years. Cacao also increased its coverage by 1.5 times between 2007 and 2022. Meanwhile, crops such as rice, oil palm tree, and sugarcane exhibited cyclical behavior, with periods of expansion, stabilization, and contraction (Figure 1).

In the Nordeste subregion, the main crops were sugarcane, coffee, cacao, plantain, and maize, followed by cassava, rice, and beans. Although coffee emerged as one of the most important agricultural products in the subregion, it exhibited a declining trend in cultivated area, decreasing from 8141 hectares in 2013 to 5710 ha in 2022. This reduction, while significant in absolute terms, did not show a statistically strong correlation with time (Figure 2). In contrast,

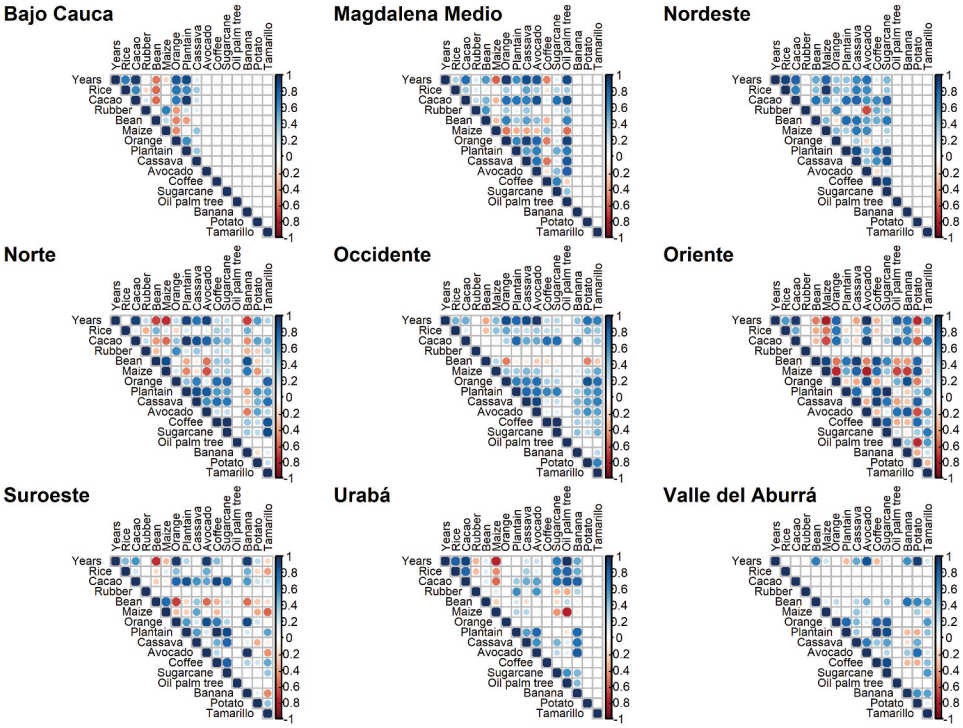

Figure 2. Pearson correlation coefficients between crops and time by subregions of Antioquia.

cacao doubled its cultivated area between 2007 and 2022 (from 2122 ha to 4359 ha, respectively). Similarly, rubber showed a steady increase in land use, especially between 2007 and 2018, growing from 65 ha to 273 ha, respectively. Meanwhile, crops such as plantain, cassava, and beans maintained relatively stable cultivated areas (Figure 1).

In the Norte subregion, the predominant crops during the study period were coffee, followed by sugarcane, potato, plantain, beans, tamarillo (tree tomato), maize, cacao, and avocado (Figure 1). Coffee and sugarcane stood out as the most cultivated products in the subregion, suggesting a structural role within the productive system. Maize exhibited a progressive and pronounced decline beginning in 2014, dropping from 1965 ha to 626 ha cultivated in 2022. Coffee, beans, and potatoes showed cyclical behavior, with fluctuations over time, yet maintained considerable cultivated areas, with coffee occupying 8144 ha as of 2022. Among the crops that showed increases in cultivated area were plantain (from 2257 ha in 2007 to 3329 ha in 2022), cacao (from 448 ha in 2006 to 1553 ha in 2022), and avocado (from 44 ha in 2007 to 1351 ha in 2022) (Figure 1).

In the Occidente subregion during the study period, agricultural production was characterized by the predominance of coffee, followed by sugarcane, beans, maize, plantain, avocado, cacao, and banana. Coffee, despite its

importance, showed a sustained decrease from 24,480 hectares cultivated in 2012 to 19,526 ha in 2022. Sugarcane also declined in cultivated area (from 4762 ha in 2012 to 3852 ha in 2022). In contrast, crops such as maize, cacao, and banana experienced increases in cultivated area: maize showed peaks near 3500 ha in 2008, 2014, and 2020; cacao and banana reached their peaks in 2022, with 1040 ha and 977 ha, respectively. Cultivated area also increased over the study period for avocado, cassava, oranges, plantain, potato, and tamarillo.

During the same period, the Oriente subregion presented a diversified agricultural structure, with coffee as the predominant crop. However, this crop showed a marked decline, decreasing from 21,355 ha in 2007 to 11,290 ha in 2022. A similar trajectory was observed for maize, which fell from 8185 ha in 2010 to 2000 ha in 2022, and for potato, which declined from 9893 ha in 2007 to around 5000 ha in recent years. On the other hand, avocado showed the greatest increase, expanding from 1361 ha in 2007 to 10,990 ha in 2022; cacao also increased, from 524 ha in 2007 to 2210 ha in 2022. Cultivated areas of oranges, oil palm tree, banana, tamarillo, and rice also increased. Crops that increased at the beginning of the period and then experienced a slight decline included plantain and sugarcane, with peak values of 4561 ha and 5045 ha, respectively (Figure 1).

The Suroeste subregion established itself as the leading coffee-producing area in Antioquia. However, despite its dominant position, cultivated area decreased from 75,972 hectares in 2013 to 67,664 ha in 2022. This subregion also produces plantain, avocado, beans, oranges, sugarcane, maize, banana, tamarillo, cassava, and cacao. Other crops with a declining trend were beans and sugarcane. Beans, although reaching a peak of 9223 ha planted in 2008, dropped to around 1200 ha from 2010 onward. Sugarcane also showed a sustained decrease, from 4373 ha in 2007 to 3038 ha in 2022. Maize exhibited more variability but has remained around 1000 ha cultivated over the past five years. In contrast, avocado – similar to trends observed in other subregions – showed explosive growth, increasing from 841 ha in 2007 to 10,740 ha in 2022. Significant increases were also reported in the cultivated areas of oranges and banana, which grew from 1694 ha and 445 ha in 2007 to 4524 ha and 3071 ha in 2022, respectively. Cacao also showed a rising trend, although more gradual (Figure 1).

The Urabá subregion exhibited an agricultural system structured around two high-relevance export crops: plantain and banana, which maintained a dominant presence in land use throughout the 2006–2022 period. These crops were followed by maize, rice, cacao, oil palm tree, cassava, rubber, and avocado. Banana maintained a stable cultivated area since 2011, with approximately 35,000 hectares. Plantain, in contrast, showed cyclical behavior with periods of increase and decrease; however, since 2017, it has exhibited a growing trend, reaching 27,000 ha. Cacao expanded its cultivated area from 4381 ha in 2007 to 10,586 ha in 2022, indicating continuous growth.

Similarly, rice doubled its cultivated area during the same period (from 8051 ha to 15,158 ha). Nevertheless, the most pronounced proportional increase in this subregion was observed in oil palm trees, which grew from 190 ha in 2007 to 4469 ha in 2022—demonstrating a clear upward trend and establishing itself as an emerging crop. Rubber and avocado, although with more modest surface areas, have shown stability in their cultivated area since 2018 and 2014, respectively. In contrast, maize experienced a significant decline in planted area, decreasing from 32,983 ha in 2007 to 10,510 ha in 2022 (Figure 1).

In the Valle de Aburrá subregion, although smaller scale of agricultural production compared to other regions of Antioquia, significant activity was maintained in crops such as coffee, sugarcane, plantain, potato, and beans, which constitute a diversified and traditional agricultural base. During the 2006–2022 period, coffee was the most representative crop, although it showed a sustained downward trend beginning in 2011. Similarly, sugarcane and plantain experienced moderate declines between 2008 and 2022 (from 2200 ha to 1440 ha and from 925 ha to 469 ha, respectively). Potato and beans have maintained values close to 600 ha over the past decade; however, beans showed an atypical decrease in 2022, when only 391 ha were recorded (Figure 1).

Growth, decline, and potential crop substitution in the subregions of Antioquia

The correlation coefficients obtained indicate that, between 2006 and 2022, the cultivated area of cacao, plantain, oranges, and rice in the Bajo Cauca subregion experienced sustained growth, while the area dedicated to beans progressively declined (Table 1). This dynamic suggests a land-use substitution process, where crops like cacao and rice may be replacing beans, as indicated

Table 1. Growing, declining, and possible substitute crops by subregion of Antioquia during 2006 and 2022 ×.

Subregion	Growing	Declining	Possible substitutes
Urabá	Rice, cacao, oil palm tree, sugarcane, and banana	Maize	For maize: oil palm tree, cacao, rice, and sugarcane.
Valle de Aburrá	Potato, avocado, and beans	None	Not applicable
Oriente	Cacao, oranges, oil palm tree, banana, tamarillo, rice	Maize, potato, and beans	For maize: avocado, oranges, cacao, and oil palm tree. For beans: oranges and avocado.
Suroeste	Oranges, avocado, banana, and cacao	Beans	For beans: oranges, avocado, and banana.
Magdalena Medio	Oranges, oil palm tree, cassava, avocado, cacao, and beans	Maize and coffee	For maize: oranges and oil palm tree. For coffee: oranges and cassava.
Nordeste	Rice, cacao, maize, cassava, and beans	None	Not applicable
Norte	Cacao, plantain, avocado, cassava, and potato	Maize, banana, and beans	For maize: avocado and cacao. For banana and beans: avocado.
Occidente	Avocado, cassava, oranges, plantain, potato, and tamarillo	None	Not applicable
Bajo Cauca	Cacao, plantain, oranges, and rice	Beans	For beans: cacao and rice.

*Correlation coefficients available in Figure 2.

by their negative correlations. Maize showed a moderately negative correlation with time, evidencing a reduction in cultivated area over the period analyzed. Similarly, the negative correlation between oranges and maize suggests a possible substitution of maize by fruit crops, which have gained a stronger presence in Bajo Cauca (Figure 2).

Similarly, in the Nordeste subregion, the correlation coefficients by crop indicate that products such as rice, cacao, maize, avocado, cassava, and beans exhibit positive relationships with time, suggesting moderate expansion of their cultivated areas over the study period. None of the crops evaluated in Nordeste showed a significant reduction in the number of hectares cultivated (Table 1). The only significant negative correlation observed was between avocado and rubber, which suggests that these crops may be competing for land use, with a possible substitution of one for the other (Figure 2).

In Magdalena Medio, correlation coefficients showed that the number of hectares used for the production of oranges, oil palm trees, cassava, avocado, cacao, plantain, and beans has increased over time, while land dedicated to maize and coffee has declined (Table 1). In particular, the correlation between the growth in oranges and the decline in maize indicates a potential substitution, a phenomenon also observed between oil palm trees and maize, as evidenced by their inverse cross-correlations. Similarly, coffee shows negative correlations with the expansion of crops such as oranges and cassava, suggesting that its role within the regional production system has progressively weakened (Figure 2).

In the Norte subregion, the most notable negative correlations were found for maize, beans, and banana, indicating a loss of cultivated area during the period analyzed. Specifically, maize showed significantly negative correlation coefficients with both avocado and cacao, suggesting that these products may be gradually replacing maize production in the subregion. Similarly, avocado exhibits negative correlations with banana and beans, indicating that avocado may be displacing these crops (Table 1, Figure 2).

In the Occidente subregion, no product showed a significant decline in the number of hectares used except for beans, which experienced fluctuations in cultivated area before settling at 2628 ha in 2022. The only significant negative correlation was observed with oranges (Figure 2). This contrasts with the Oriente subregion, where the temporal correlation analysis between year and cultivated area revealed significant results for several crops. Among crops used in traditional diets, maize stood out with negative correlation coefficients with avocado, oranges, cacao, and oil palm trees – suggesting that these crops could be replacing maize production (Table 1). Beans showed a strongly negative correlation (greater than 50% in magnitude) with oranges and avocado. Likewise, potato presented negative correlations with crops such as cacao, oranges, avocado, and oil palm trees, which – due to their cultivation at

different altitudes – may indicate more of a regional inverse production relationship than direct substitution (Figure 2).

Through correlation analysis, significant positive coefficients were identified between time and the cultivation of avocado, oranges, banana, and cacao in the Suroeste subregion, confirming their expansion over time. It was also observed that beans showed negative correlations with these products, suggesting that they may be displacing bean cultivation (Table 1).

In the Urabá subregion, the correlation analysis revealed significant positive coefficients for cacao, rice, and oil palm tree, reflecting continuous expansion during the analysis period. In contrast, significant negative correlations were found for maize, reaffirming its relative decline in importance in Urabá (Figure 2).

Finally, in the Valle de Aburrá subregion, the analysis of correlation coefficients did not reveal strong negative relationships between the main crops and time, suggesting that productive substitution processes have been relatively limited in this subregion. However, positive proportional relationships were identified among certain crops, indicating joint behavior in the expansion or contraction of land use. This is the case for coffee, sugarcane, plantain, and oranges; as well as for bean and banana, and for avocado and potato, showing that these crop pairs have jointly increased their land use (Figure 2).

Discussion

The analysis of agricultural production trends in Antioquia between 2006 and 2022 reveals several transformations, characterized by an increasing concentration of production in agroindustrial crops, some of which are intended for export markets. The notable expansion of crops such as avocado, cacao, and oil palm tree contrasts with the decline of traditional food crops, including beans and maize, as well as one of the region's main export products: coffee. These data point to a process of crop substitution that could negatively impact local diversity, food sovereignty, and food security. This situation has also been documented at the national level, with rising dependence on food imports. For example, the 2016 Food Balance Sheet indicated that 20% of bean supply was dependent on imports.[6]

The progressive loss of traditional crops represents not only a structural transformation of the agri-food system but also a direct threat to food and nutritional security and the region's food culture. According to FAO,[19] reduced diversity in foods available for human consumption compromises diet quality by limiting the intake of essential micronutrients, fibers, and bioactive compounds that are key to health. This trend also entails greater dependence on export-oriented monocultures and globalized supply chains, which are less resilient in the face of climatic or economic crises. In this regard, Altieri and Toledo [20] argue that the displacement of agroecological and

peasant systems – based on biological diversity and traditional knowledge – by low-diversity agroindustrial schemes that rely heavily on external inputs erodes both food self-sufficiency and territorial control of local communities.

The pattern observed in Antioquia is not exclusive to its subregions but forms part of a broader national and global trend. In Latin America, the phenomenon of converting coffee-growing lands to other agricultural uses (pasture, sugarcane, cacao, citrus) or to urban development is recurring. This shift is mainly driven by processes such as urbanization, migration, the decline of small-scale farming, and the diversification of rural livelihoods,[21] which converge and – either directly or indirectly – affect coffee yields and profitability. Contributing factors include price instability, labor shortages, limited institutional support, outbreaks of coffee rust, climate change, and the emergence of alternative agricultural or labor markets.[21,22]

In Colombia, an examination of crop dominance in recent years reveals the rise of Hass avocado, driven by international demand and supportive policies aimed at facilitating access to global markets. This has led to its expansion in departments such as Antioquia, Tolima, and Caldas, positioning Colombia as the fourth-largest producer worldwide and contributing to the displacement of coffee production.[23,24] In Antioquia, data from the present study indicate notable transformations, especially in the Oriente and Suroeste subregions, where the replacement of beans and maize stands out. This is similar to what was observed in Brazil's semi-arid region between 1985 and 2018, during which there was a significant decrease in the areas cultivated with beans, cassava, and maize.[25]

Another crop gaining ground in Colombia is cacao. According to the National Federation of Cacao Growers (Fedecacao), the departments of Santander, Antioquia, Arauca, and Tolima accounted for nearly 70% of national production, surpassing historical records in 2024 due to expansion in cultivated area, investment in technology, plantation renewal, and genetic improvement. Santander led with 28,044 tons (41% of the national total), followed by Antioquia with 7154 tons (11%).[26] Furthermore, cacao production plays a role in Colombia's crop substitution policies for illicit crops, and through its cultivation, processing, and commercialization, it has become part of rural development and peacebuilding initiatives.[27]

Changes in agricultural production activities can be explained by the convergence of multiple economic, social, political, and environmental factors at both the national and international levels. Notably, the neoliberal economic model promotes agroindustrial production to meet international market demands. As a result, food production for domestic consumption has declined, increasing the country's dependence on imported food and compromising food security.[1] The expansion of commercial crops such as avocado, oil palm tree, and cacao in various subregions of Antioquia, as observed in this study, not only implies transformations in agricultural land use but also

presents significant ecological and social risks. In particular, oil palm tree cultivation in Colombia has been associated with severe environmental impacts, including deforestation, loss of biodiversity, pressure on water sources, and pollution from intensive agrochemical use.[28,29] This expansion, promoted under highly profitable agroindustrial models – as seen in countries like Mexico and Brazil – has also led to land grabbing and the displacement of diversified peasant farming systems, thereby weakening local food economies.[30]

The expansion of monoculture in the Global South, driven by agro-exports, is intrinsically linked to the loss of biodiversity and forest cover,[31] due to the replacement of forests, staple crops, and mixed agricultural systems with monocultures.[31,32] Examples of this are oil palm and cocoa: Since the 1960s, in Indonesia and Malaysia, the expansion of oil palm has led to deforestation and the displacement of family farming, especially rice cultivation, affecting livelihoods and food sovereignty in the region.[32] Similarly, in Côte d'Ivoire and Ghana, the largest cocoa producers, the increase in cocoa cultivation area has been at the expense of primary forests, agroforestry, and land used for food cultivation, altering habitats, reducing biodiversity, and compromising food self-sufficiency[33,34]

In the Colombian context, the rise of Hass avocado has likewise proven problematic. In the municipality of Sonsón, substantial transformations have been recorded in productive livelihoods due to the replacement of diversified agricultural systems with intensive monocultures that generate economic dependency, social conflict, and disruption of traditional agroecological practices.[35] This phenomenon calls into question the sustainability of food systems as well as local food sovereignty and security. While these crops may contribute to monetary income, their exclusionary logic and environmental risks compromise the availability and accessibility of basic food products. Similarly, in the case of cacao, although its production has been promoted as a sustainable alternative, there are concerns that its orientation toward global markets may displace polyculture practices that are fundamental to food system resilience.[36]

These findings call for a critical review of agricultural and rural development policies, accounting for food sovereignty and agroecological approaches that prioritize peasant livelihoods and environmental sustainability. This necessitates revisiting domestic policies that have largely reinforced an agroindustrial, export-oriented model, rather than those aimed at strengthening food production to meet the population's nutritional needs. It also involves advancing the implementation of policies already defined in Colombia, most notably the Rural Reform, which formed part of the peace agreements to end the armed conflict with the FARC guerrillas.[37] Some of these developments were outlined in the Agricultural and Rural Development Policy 2018–2022 [38] and

in the National Rural Plan outlining the System for the Progressive Guarantee of the Right to Food.[39]

The goals of these plans and policies were later incorporated into the 2022–2026 National Development Plan under the pillar of transformation for the Guarantee of the Human Right to Food, which, among other indicators, proposed increasing production by 3,795,288 tons [40] across 45 prioritized product chains, distributed among the different food groups in the national food basket.[41] While the achievement of this indicator prominently includes export-oriented products such as Hass avocado, oil palm tree, sugarcane, coffee, and banana, it also includes crops expected to supply the domestic market. These include rice, maize, beans, cassava, potato, plantain, and bulb onion, among others, for which productivity improvements are anticipated.[38] Additionally, Decree 684 of 2024 is noteworthy. This decree regulates the National System for the Progressive Guarantee of the Right to Food (SNGPDA) and defines the "Zero Hunger Program," which includes among its lines of action the strengthening of local production, supply, and distribution systems, as well as the empowerment of communities and organizational processes[42]].

The insistence on developing public policy actions is based on evidence showing that agricultural growth and productivity have historically been closely tied to favorable political and economic conditions that support the agrarian sector.[43] Today, such policies must also demonstrate a commitment to integrating multiple dimensions of rural development, making it a priority to regulate and implement the public policy on agroecology, established in 2024 through Resolution 0331 of the Ministry of Agriculture and Rural Development.[44] This policy was developed in a participatory manner and is the result of the consolidation of agroecology as a technical, economic, political, and cultural alternative led by social movements.[45]

In this context, the final report by the United Nations Special Rapporteur on the Right to Food, Olivier De Schutter, presented to the Human Rights Council, argues that it is insufficient to focus solely on increasing agricultural productivity. On the contrary, he warns that this reductionist view has marginalized fundamental issues such as equitable access to nutritious, culturally appropriate, and sustainably produced food. Instead, he advocates prioritizing models that strengthen food sovereignty, actively support family and peasant farming, and protect common goods such as soil and water. The transformation of food systems must therefore be guided by the goal of guaranteeing the human right to adequate, safe, and sustainable food, aligning with social justice, territorial equity, and ecological resilience in the face of climate change and the growing concentration of corporate power in the agri-food sector.[46]

These international recommendations coincide with recent historical milestones in Colombia's legal and political framework. Specifically, Legislative Act 01 of 2025 amended Article 65 of the Constitution,[47] which elevates the

human right to adequate food to constitutional status. This reform requires the State to guarantee protection against hunger and malnutrition through a progressive, intercultural, and territorial approach, explicitly promoting food security, food sovereignty, and food autonomy. Likewise, instruments such as the recently adopted Food Guide Based on Biodiversity and Real Food have been developed with these goals in mind (2025).[48] The dietary guidelines are aimed at promoting healthy and sustainable eating, which in turn is a very powerful mechanism for protecting food production and, therefore, food sovereignty. In this sense, Colombia is undergoing a paradigm shift by focusing on promoting real food based on the country's biodiversity and the food culture of its territories, with an emphasis on environmental sustainability.

These policies and instruments in Colombia change focus to a perspective based on productivity and public health that prioritizes the preservation of food biodiversity and agroecological models as essential pillars for ensuring that food systems are socially just and ecologically resilient.

Conclusions

Between 2006 and 2022, the subregions of Antioquia, Colombia experienced a sustained decline in the area cultivated with traditional food crops such as maize, beans, potatoes, and coffee. This reconfiguration has favored the expansion of commercial crops such as avocado, cacao, and oil palm tree. The loss of crops traditionally associated with the local diet and peasant life presents serious risks to food and nutritional sovereignty and security, as it limits dietary diversity, alters traditional food patterns and cultures, and increases dependence on external markets to guarantee the right to adequate food.

The analysis of agricultural production trajectories at the departmental level, based on time series and correlation coefficients (between year and hectares cultivated from 2006 to 2022), made it possible to identify transformations that manifest uniquely in each subregion. Notable examples include the growth of cacao in Bajo Cauca, Magdalena Medio, and Nordeste; the expansion of avocado in Oriente, Norte, and Suroeste; and the decline of maize in Magdalena Medio, Norte, and Urabá. The overall cultivated area also reveals increases in crops such as rice, avocado, cacao, oil palm tree, cassava, plantain, and oranges, while the crops showing the steepest decline is maize, followed by beans. The latter experienced significant decreases in the subregions of Oriente, Suroeste, Norte, and Bajo Cauca.Congreso deCongreso de,

From the analysis of inverse correlations between crops, hypotheses emerge regarding possible substitution processes: maize may be displaced by commercial crops such as cacao, oil palm tree, rice, sugarcane, and avocado, while beans may be replaced by crops with higher demand in external markets such as oranges, banana, and avocado. Structurally significant crops such as

sugarcane, coffee, and potatoes display complex cyclical and territorial dynamics that warrant analysis beyond aggregate trends.

As for coffee – a historically emblematic crop within the agricultural and cultural landscape of Antioquia – it shows a general trend of decline, particularly in traditionally coffee-growing subregions such as Suroeste, Occidente, and Nordeste. Although coffee remains the dominant crop in several subregions in terms of area cultivated, its overall cultivated surface has decreased steadily, suggesting an ongoing process of territorial reconfiguration.

The availability of data and these findings reveal the expansion of agroindustrial production models that promote the spread of high-value commercial monocultures, especially for international markets. This trend fosters the homogenization of the countryside, reduces agrobiodiversity, and consequently increases dependence on global markets and inputs. Recovering productive diversity, strengthening local food systems, and ensuring the right to food that is sufficient, healthy, culturally appropriate, and environmentally sustainable must become strategic priorities for the future of Antioquia's rural areas.

Finally, the results of this study may well reflect the tensions experienced by other territories and countries in Latin America, given that the states in the region have followed similar paths in establishing economic models such as neoliberalism and adopting free trade agreements, which have resulted in a transition to corporate food systems that have profoundly undermined food sovereignty.

Study limitations

Future studies could incorporate other food products which, although cultivated on fewer hectares, are nonetheless essential for ensuring adequate nutrition for the population – such as vegetables, small fruits, and animal-based products including pork and poultry. The current study only considered the most important crops in Antioquia in terms of cultivated area, without considering the impact of secondary crops that might affect food security. Additionally, we did not consider living stock, aviary, and pork land use because variables that quantify the land use of these activities could not be found. Future studies might consider the availability of these databases and resources.

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