PlaSA Colombia: A data-based systemic approach for transforming food systems

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Abstract

Food systems in Colombia, like in many countries around the world, face multiple challenges, such as climate risk, production inefficiencies, obesity, hunger, foreign dependency, food loss, and waste, food insecurity, climate shocks, inefficiencies in supply logistics, and overall, a lack of understanding of their interconnections, interdependencies, and trade-offs. Paradoxically, Colombia has abundant data on some of the main elements of its food systems (production, supply, marketing, transportation, nutritional status, among others); however, these data are often not easily accessible, not integrated, nor analysed together, limiting their usefulness in decision-making processes, planning, and the design of programmes and strategies. This document explores how a systemic approach can transform decision-making using data tools such as the food systems platform PlaSA Colombia, created by the Alliance of Bioversity and CIAT. This platform integrates and simplifies scattered data, facilitating public access and understanding and promoting informed decision-making. PlaSA aims to provoke debates about the type of food system desired and to influence public policies with information structured through multidimensional data, facilitating the construction of narratives, based on secondary data from public sources, that simplify complex data into clear images. Information gaps have motivated the scientific and academic community, now united in a Community of Practice on Food Systems (first in the country), to mobilise efforts and create collaborative networks to develop joint solutions. Collaborative exercises that have been carried out at the national level through PlaSA Colombia have made it possible to understand the impacts generated by roadblocks on GHG emissions and food supply, the cost of diets, and their affordability for major cities, and the Agro-climatic factors that affect productivity, among others, which are often overlooked in more fragmented approaches. In conclusion, improving collaboration is crucial to influencing decisions and promoting political and sectoral reforms. This study highlights the need for tools like PlaSA Colombia for a detailed and ongoing analysis, inviting regional, national, and local stakeholders to adopt similar approaches to enhance the resilience and sustainability of food systems.

Keywords: Challenges, climate change, collaboration, food security, food system, PlaSA Colombia, sustainability

Introduction

Five out of ten Colombian households (54.2%) are food insecure, meaning that they do not have regular access to sufficient, safe, and nutritious food, for adequate growth and development as well as to lead an active and healthy life (Ministry of Health and Social Protection, 2017). The impacts of everything that happens in food systems are measured in food and nutrition security, socioeconomic, and environmental indicators. If we wanted to know how the country's food systems are doing, we would find that according to the latest National Survey of Nutritional Status of Healthy Colombia (Ministry of Health and Social

Protection, 2017) food insecurity is exacerbated when it comes to households whose head of household is a woman (57.6%) or an indigenous person (77.0%). Regarding socioeconomic aspects, a comparative study between Colombia, Mexico, Chile, and Costa Rica conducted in 2022 by Banco de la República identified that, from the second half of 2021, food prices in Colombia increased by an average of 7 percentage points more than in the rest of the countries. The coincidence between the timing of this food inflation and the beginning of the National Strike suggests that these price increases could be associated with persistent effects on food production in the country. The road blockades affected not only food supply to major cities but also access to raw materials, mainly in the southwest of Colombia (Banco de la República de Colombia, 2022). According to the (Food and Agriculture Organization of the United Nations, 2023) there is inefficiency in the connections between production and consumption areas in terms of proximity. Trade within regions does not exceed 24%, which leads to product degradation, losses and waste that reach up to 50% in products such as cassava, mango and leafy vegetables. These situations generate high energy costs that translate into higher prices for society in general, significantly affecting consumers with lower purchasing power.

The call to radically transform global food systems to better serve diets, health and the environment has become increasingly prominent on the international development agenda in recent years, including in the context of city-regions (Global Panel on Agriculture and Food Systems for Nutrition, 2020). Several recent studies have emphasized the need for food systems metrics to better understand their interdependencies and help structure high-level decision making regarding sustainable diets (Gustafson et al., 2016). However, the availability of data on different parts of the food system, across geographies and for specific outcomes, varies widely and can be a constraint to developing appropriate metrics and tools (Béné et al., 2019); (Marshall et al., 2021). Data on the environmental impact of food systems are rarely integrated with data on nutrition and diet quality, as well as food availability data, in existing assessments and metrics of sustainable food systems (Gustafson et al., 2016).Data on diet quality, food environments, and supply chains (Reardon et al., 2021) between farm and point of consumption remain a critical information gap that hinders efforts to increase accountability and transformation of food systems (Marshall et al., 2021).

In this problematic context, the Bioversity & CIAT Alliance has been developing studies and tools that contribute to the understanding of food systems, their main challenges and opportunities at local and regional scales. One such tool is the Food Systems Profiles, a study that connects fragmented or disparate data and contributes to increasing the capacities of decision-makers to see the 'big picture' and make the most efficient decisions to improve the sustainability of food systems. Each profile is formed through collaboration with various public and private stakeholders; these stakeholders play a key role in the collection of secondary data, as well as in the feedback and validation of the results obtained. They also contribute to the identification of key messages that emerge during the process and become recommendations for the formulation of policies and intervention programs. One of the main findings of this data collection process was the impossibility of analyzing food systems according to geographical or political boundaries, since their very dynamics connect the different regions of the country, among themselves and with the outside world. Therefore, it is necessary to look beyond a single territory and begin to analyze their interconnections and dependencies. Additionally, the existence of sufficient data at the national level was identified, which is constantly collected, but in a dispersed and disjointed manner. In response to the above, within the framework of the OneCGIAR's National Policies and Strategies project and in conjunction with a community of practice, it is proposed to build, based on the availability of existing data, a monitoring system to provide centralized information and support understanding, analysis and decision making on food systems in Colombia.

Methodology and materials.

The organization of data related to Colombian food systems not only seeks to group information of multiple dimensions, categories and themes, but also to structure them in a way that facilitates reading and the construction of narratives by users. For this purpose, a web tool called Food Systems Platform, PlaSA Colombia, was designed, which reports, monitors and analyzes the associated data. It synthesizes and democratizes information that is currently dispersed. This tool presents updated information that serves as input for decision making, especially for those who formulate policies and design public and private intervention and development programs.

The data contained are mostly from public sources with millions of records. In this sense, the platform can support the dissemination of fragmented information and the continuity of analysis. To this end, it processes and translates the complexity of the raw data into simple images using thematic dashboards. The properties attributable to this technological innovation are: a) to integrate the different authors that generate disjointed information and actions, b) to identify key indicators for the generation and evaluation of public policy, c) to identify dilemmas and/or points of tension, d) to establish narratives and support the interpretation of key aspects and e) to disseminate actions and progress of the system, in addition to anticipating and managing the handling of potential system crises. The data are associated with food system components following the Food Systems Conceptual Framework of the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (Pingault et al. 2017). Data analytics is shared among the organizations participating in this community, developing new indicators, applying algorithms and machine learning among other computational resources.

PlaSA Colombia Community

The effort to collect the different types of information and generate discussions about them, has the collaboration of different public and private partners such as: Universidad de los Andes, Universidad Javeriana Cali, Universidad ICESI, Universidad de La Salle, Universidad Autónoma de Occidente, Universidad Abierta y a Distancia, Universidad EAFIT, Central de Abastos del Valle del Cauca - CAVASA, Banco de la República, Corpovalle and Agrosavia. So far, in its first phase, together with these partners, 9 boards have been developed.

Types and sources of data

The following table lists the main data, its description, the variables contained and the source from which it is obtained.

Table 1 data sources integrated to PlaSA Colombia

Database	Description	Variables	Sources of information

Food supply and mobilization	It shows the regions that supply food to the different municipalities in Colombia.	-Food group -Type of food -Municipality of origin -Municipality of destination -Department of origin -Department of destination Tons of food -Tonnes of food -Year	Price and Supply Information System (DANE, 2023)
Food miles	It shows the kilometers that food travels to reach the country's regions, weighted by quantities, places of origin and distances traveled.	-Municipality of origin -Municipality of destination -Year -Food group -Type of food -Distance in kilometers	Price and Supply Information System (DANE, 2023) (Google Maps, 2023)
Distribution of livestock in Colombia	Details information on the livestock system in Colombia, number of farms, and age of cattle.	-Year -Department -Municipalities -Total number of farms -Cattle by age	(Instituto Colombiano Agropecuario ICA, 2022)
Environmental impact of food movement.	Shows the amount in tons of greenhouse gases generated by food transportation in the country.	-Tons of greenhouse gas emissions. -Year -Municipality of origin -Municipality of destination	Price and Supply Information System (DANE, 2023)
Minimum dietary cost.	It shows the minimum daily cost of three types of diets: healthy, nutritious and subsistence, by demographic group and gender.	- Gender -Type of food -Age -Amount of food in grams. - Local food information -Prices for sale to the public. -Nutritional components of the food. -Nutritional requirements. -Household income -Household expenditures	(CAVASA, 2022) Price and Supply Information System (DANE, 2023) Quality of Life Survey (DANE, 2022) Large Integrated Household Survey (DANE, 2022)
Food mobilization: routes and trips by vehicle type	It shows the path of food according to the size (number of axles) of the truck.	-Quantity of food -Food -Municipalities of origin -Municipalities of destination -Year -Axis of trucks	Cargo Manifest (Ministry of Transportation, 2022).
Credits by type of producer.	Shows the number and value of agricultural loans by type of producer, total from 2010 to 2022.	-Type of producer -Year -Municipality -Number of credits	(FINAGRO), 2022)

		-Credit value	
Bank loans by gender	Number and value of agricultural loans by gender	-Type of producer -Year -Municipality -Number of credits -Credit value -Gender	(FINAGRO), 2022)
Municipal performance measurement	Evaluates municipal performance versus its development plans, good public expenditure management and compliance with budget execution requirements.	-Year - Performance points (quantity) -Municipalities -Sectors (education, health, public services)	(National Planning Department DNP, 2022).
Fiscal performance indicator	Evaluates the fiscal performance of each municipality in Colombia.	-Year - Performance points (quantity) -Municipalities.	(National Planning Department DNP, 2022).
Health Indicators	Shows the diseases occurring per year and per municipality in Colombia.	-Municipality -Type of disease -Year -Disease incidence indicator	(Alianza Bioversity International y el Centro Internacional de Agricultura Tropical, 2023)
Biofortified crop nutrition indicators.	Shows the composition of food consumption and concentration of vitamins and nutrients in biofortified crops.	-Concentration and prevalence of vitamin A, Zinc. -Deficiency in vitamins and micronutrients. -Prevalence of anemia in children. -Percentage of consumption by vegetable group.	A spatial perspective to introducing biofortified staple food crops in Colombia. (Funes Jose et al., 2015)

PlaSA Colombia Indicators, Metrics and Calculations

The tool not only translates complex data into simple images and treatments, but also generates its own metrics from the same data. Among the developed indicators contained in the platform, three key ones are listed: a) Calculation of the minimum cost of three diets (energy sufficient, nutritious, and healthy), b) Kilometric food and c) Calculation of equivalent GHG in food mobilization. The platform presents the calculations per year from 2018 to 2022 at the municipal level.

Diet cost

In collaboration with the Universidad Javeriana Cali and Banco de la República, a study was conducted to calculate the minimum cost and affordability of three types of diets for Cali: an energy sufficient diet, a nutrient adequate diet and a healthy diet.

- A diet sufficient in energy is defined as one that provides the necessary calories to cover the estimated energy requirement according to age, sex and level of physical activity.
- The nutrient adequate diet provides, in addition to calories, adequate levels of macro and micronutrients (carbohydrates, proteins, fats, vitamins and minerals) within their minimum and maximum limits to prevent deficiencies and avoid toxicity. The minimum cost of a nutrient-adequate diet is determined by the lowest cost set of available foods that, for the location and period of study, meet the estimated energy requirements, as well as the lower and upper limits of macronutrients and micronutrients (Herforth, et al, 2020).
- The healthy diet adheres to the recommendations of the national dietary guidelines (GABA) while complying with the condition of variety within and between food groups with the ultimate goal of promoting long-term health (Herforth, et al, 2020).

The methodology for estimating the minimum cost of diets operates through a linear programming model with an equality constraint and a non-negativity constraint; it is based on the model developed by Kachwaha et al. (2021) and Bai et al. (2020). The affordability analysis for the three types of diets corresponds to an affordability approach with representative household and individualized diets.

Food miles-WASD

To understand the role of distances in food supply, kilometer distances were used as an appropriate and simple to interpret metric, also known as "Weighted Average Source Distance -WASD", this instrument allows estimating the distance that food travels from its origin to its final destination, taking into account the volume mobilized (Blanke and Burdick 2005; Paxton 1994; Pirog and Benjamin 2005). In the case of the Colombian food system, food supply flows are configured as complex structures due to the large number of combinations, territories and foodstuffs involved, as well as the long distances involved to reach the destination municipalities.

Greenhouse Gases Equivalents GHGeq

A large part of the environmental impacts due to pollution and greenhouse gases are generated by emissions in the food production stage and land transportation. A limitation to measure this impact is the proper estimation; geographical elements, types of roads, vehicle fleet, volume and distances traveled, among others, must be considered. In this sense PlaSA Colombia developed calculations on each of the food supply flows, quantifying the emissions of carbon dioxide, nitrous oxide and methane (CO_2,N_2O and CH_4) associated with diesel and the land transport system (Nutresa and GAIA 2013; Simón Fernández et al. 2014). This requires a significant battery of biophysical parameters including CO_2 emission factors, calorific factors and diesel density, among others. The parameters and metrics used have been validated by several studies in Colombia (Rodríguez et al., 2020), (Colombian Academy of Exact Sciences, 2003) FECOC (Arrieta et al., 2016).

Results

For the construction of the tool, nearly 100 million municipal and regional data were processed, grouped in dashboards with high visual development to facilitate user navigation, whether institutional, academic or civil society. In such a way that what was previously inaccessible to society due to computational demands, or the dispersion of information is now within everyone's reach. In this sense, this chapter of the document presents some of the available dashboards, together with a description of the content. Of course, for more information, you can access www.plasacolombia.com.

Food supply

The food supply system is presented in two parts to facilitate navigability, the first by food group or category and the second with a better resolution, the types of food, specifying the different references or names of these. On one of the boards corresponds to the supply board where you can navigate between the municipalities of origin and destination, identify the quantities mobilized, facilitating quick queries by municipality or by groups or types of food. It also presents an example of Bogota, where it quickly identifies the foods that by 2022 arrived in greater volume to this market, such as the top potato (325 thousand tons), tomato (114 thousand tons) and carrot (113 thousand tons). It also lists the main food supplying municipalities such as Granada-Meta, Aquitania-Boyacá and Villapinzón-Cundinamarca, mainly.

Food miles or distances traveled from the supply system

The convenience of food proximity is key to food sovereignty and to reducing the inefficiencies of the system, since it reduces dependence on imported food or long supply chains, because to the extent that proximity relationships are generated, short circuits are generated between production and consumption, tending to promote proximity relationships with local markets (Marchetti et al., 2020).

On the supply board shows that the food groups that supply the city of Bogotá in 2022 will have to travel around 207 kilometers, and that fish is the type of food that moves the most to reach this destination market with 368 kilometers, while vegetables and tubers travel between 138 and 186 kilometers. The above allows us to have an approximation of those supply circuits that are present in Colombia and that help to identify those markets that may or may not be potentialized in terms of the proximity between production and consumption of foodstuffs.

Comparative reports between cities

Performing comparative analyses of supply, food kilometers and other indicators by municipality without the platform would be a complex exercise. However, the dashboard provides a space to do so by offering a simple and accessible environment. On the supply board presents the comparative case between the cities of Bogota and Santiago de Cali, for which synthetic indicators are generated that summarize the position of each of these on the supply from the same department and the same municipality, in that sense it is observed that to supply the city of Bogota food traveled about 202 km mobilizing 2293 thousand tons while for Cali, it traveled about 248 km and was supplied with 483 thousand tons.

Estimation of GHG equivalents from food mobilization

Following the methodology for calculating emissions, the platform makes it possible to identify the GHG generation of supply routes, taking into account the distance on the route, the quantities mobilized, and the type of vehicle fleet. It is also possible to perform comparative analyses by municipality. In the case shown in the environmental impact assessment, plantains and green peas are the foods that generate the highest GHG emissions when transported to supply the city of Bogotá, with 9.2% and 6.1%, respectively. In comparison with the city of Cali, the capira potato and onion are the foods with the largest carbon footprint in emissions, representing 8.3%.

Calculation of minimum cost for three per diems, case study city of Cali

The platform simplifies the results of the analysis of minimum costs for three types of diets: a) survival, b) nutritious, and c) healthy diet, which has been detailed in the methodology chapter of this document. The minimum per diem cost board shows the distribution of foods according to the diet definitions, quantities and daily cost by demographic group. The results are linked to age and gender capturing the differences between caloric and nutritional demands. In this example, the average cost per 1000 kilocalories of a healthy diet is $3,927, and this is made up of 6% fats, 17.3% sugars, 23.3% meats, eggs and legumes, 17.3% cereals and roots, and 35.6% fruits and vegetables. On the other hand, the daily cost of a healthy diet for the 19-30 age range is $11,284 for men and $7,931 for women.

Accessibility to survival, nutritious and healthy diets. Case study city of Cali

In line with the study of the minimum cost of diets, the Platform presents the impact on food accessibility for each solution of the model on households in the city of Cali. On the minimum per diem cost board plots the distribution of households by expenditure deciles and monthly per diem costs. It is observed that only 38.2% of Cali households can access a healthy diet, estimating that the lowest deciles must triple or double their daily food expenses to have access to this diet, added to the fact that 1.35 is the average number of times that households must increase their food expenses to be able to cover the cost of a healthy diet.

Municipal production, yields, harvested areas and value added

PlaSA Colombia also reports supply data for the agricultural economic sector at the municipal level. The food production board and its financing show the production zones of a specific crop, as well as access to some synthetic indicators, cumulative values, and ranking cross-referenced with economic reports such as the value added of the primary sector by the municipality. This provides an overview of the contribution of a territory and the foodstuffs located there. In that sense, it is observed that by 2020 in Colombia 18% of the municipal value added was generated in the primary sector, with 5,452 hectares sown, 4,994 hectares harvested, and 47,066 tons of food produced, with a 9.4 yield (Ton\ha) where tomato, pineapple, strawberry, cabbage, sugar cane, carrot, among others, 92% of the sown area is harvested.

Discussion

The data currently available on the impact of the country's food systems are leading politicians, decision-makers and the general public to increasingly recognize the need for transformation and joint action. This is to ensure that all people have access to healthier and more nutritious food, work to provide decent livelihoods, are environmentally sustainable and reduce their contribution (and vulnerability) to climate change. However, there are large information gaps that need to begin to be addressed from the academic, public and private spheres. This includes: i) data linked to consumption patterns and habits, closely related to social determinants such as food prices, income, knowledge, time, equipment, and social and cultural norms, that allow a better understanding of consumer behavior opening a new avenue towards the implementation of strategies for collective change, ii) permanent information on food losses and waste, iii) analysis of interactions, trade-offs and trade-offs between the different components of food systems, diets and climate change, mainly.

The different tools used to monitor the elements of the food system are not effectively integrated, resulting in duplication of efforts, fragmentation of information and an excess of studies on the same topics or the same territories. Some others lack advanced analytical capabilities and high-impact dissemination mechanisms. The mission of data collection can be advanced through intersectoral alliances that optimize the collection and analysis processes and the integration of new modules to PlaSA Colombia. However, data alone is not the answer; it is necessary to generate analyses and debates that result in political advocacy, research generation, infrastructure investment, improvement of intervention programs and, in general, the planning of the type of food system to be created.

PlaSA Colombia as a digital tool will improve evidence-based decision making by food system actors to mitigate threats and risks. This, in turn, will improve the integration of food system actors, reduce information asymmetries and existing inefficiencies, and contribute in the long term, to greater food and nutrition security resulting from evidence-based decisions and intervention programs based on up-to-date data. PlaSA Colombia will allow for a constant updating of data and will also reinforce the precision of the intervention of political actors.

This platform is a beautiful opportunity to mobilize many different disciplines to meet and exchange discourses and knowledge. It is also a space for science and technology to face the challenges and develop innovations aimed at monitoring in real time such relevant aspects as diet quality, accessibility, and fragility of the supply system on which we all depend.

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