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Biodiversity and health: prioritizing actions for productive inclusion, territorial development, and environmental conservation

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Abstract *The ArticulaFito Project conducted a broad analysis of the production base of plants with medicinal, cosmetic, and food value, mapping 26 value chains (CdV) of traditional peoples and communities and family farmers (PCTAFs). The objective is to define criteria to prioritize actions in order to strengthen the mapped CdV, maintaining the identified challenges and opportunities as a reference. Data Envelopment Analysis and Pareto Diagram methodologies were applied to quantitative data extracted from each CdV map. In this way, the CdV set was divided into four groups of performance levels. For each group, an action diagram was drawn, which, ordered the occurrences and their origins, enabling the reporting and indication, in order of priority, of the institutions and actors to be considered in the strengthening process. The group with the best performance had ten species, 70% in the cosmetic segment, in the Amazon biome, and in the northern region, with 80% native under an extractive regime and 20% exotic under a cultivation regime. The Action Diagram generated prioritized actions and investments, optimizing public resources in the productive inclusion of PCTAFs for the sustainable use of (socio) biodiversity.*

Key words *Biodiversity, Value chains, Productive inclusion, Governance, Health promotion, Healthy and sustainable territories*

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Introduction

Health is an essential dimension of citizenship. Law No. 8080, of September 19, 1990, also known as the Organic Law on Health, states that "health is a fundamental right of human beings, and the State must provide the necessary conditions for its full fulfillment". Coherent with this commitment, it institutes the principles and guidelines of the Unified Health System (SUS), and regulates the responsibilities of each sphere of government, as well as SUS's structure and governance and the complementary participation of the private sphere. By focusing on collective health, this law aims to achieve social well-being. To achieve this purpose, it considers the integration of the following factors to be crucial: food, housing, basic sanitation, environment, work, income, education, physical activity, transportation, leisure, and access to essential goods and services. In this sense, the analysis and implementation of social and health policies that interact with clinical, health, socioeconomic, and environmental dimensions are urgent[1].

In this context, the National Policy on Medicinal and Phytotherapeutic Plants (PNPMF, in Portuguese)[2] seeks to guarantee that the Brazilian population will have safe access to medicinal and phytotherapeutic plants, as well as their rational application so as to promote the sustainable use of biodiversity, the development of the production chain, and the national industry. It also establishes guidelines of a strategic and intersectoral nature, aimed at the conservation and enhancement of Brazilian biodiversity, and provides for the structuring of an entire complex production chain of medicinal plants and herbal medicines, from medicinal plants to herbal medicines.

The World Health Organization (WHO) recognizes that medicinal plants are an appropriate and preferred alternative in primary health care (PHC) and values traditional knowledge associated with biodiversity in health care[3]. Plant products have been highlighted as integrative and complementary public health practices in the SUS[4]; however, their incorporation into conventional services has proven to be a challenge[5].

The production segments of medicinal plants, herbal medicines, cosmetics, and food, covered in this study, demand a greater data availability. The lack of information compromises the management of these resources[6]. According to Hasenclever et al.[7], the delay in implementing public policies aimed at these segments illustrates a setback in both productive activities with herbal medicines and research activities with medicinal plants. One of the assumptions of contemporary theories of public administration believes that the systematic examination of performance, through monitoring and evaluation, contributes to improving management, as it produces the necessary information to identify and understand the causes of both successes and failures. The incorporation of an assessment as a systematic practice could provide managers with the information required to define intervention strategies in the health area[8].

Consequently, the prioritization of goals or actions is a rational response to the scarcity of public resources to carry out projects aimed at collective health and environmental health[9]. In an attempt to achieve the effectiveness of public policies in order to guarantee their implementation, the logic of better allocation of these limited resources can be applied through a decision-making process comprised of a series of steps that lead to decision-making. In all stages, the information channels exert great influence on the complex process of understanding the characteristics of the participants, the roles they play, the authorities, and the relationships among all of the actors[10].

The ArticulaFito[11,12] project, a joint initiative of the Ministry of Agrarian Development (MDA) and the Oswaldo Cruz Foundation (Fiocruz), is aligned with the PNPMF[2]. In this context, this project establishes articulated actions to support the implementation of these policies, involving the populations and traditional communities and family farmers (PCTAFs, in Portuguese) in local productive arrangements that contribute to sustainable territorial development. In addition, it aims to minimize health inequalities through social and productive inclusion, promoting Value Chains (CdV) of plant species from the Brazilian sociobiodiversity, which have PCTAFs as their productive base. These actions are in line with the Bioeconomy Brazil-Sociobiodiversity Program, which seeks to strengthen production systems based on species of medicinal plants, boosting health promotion, access to markets, and local development. From this perspective, it is essential that the formulation of intersectoral policies geared toward the use of sociobiodiversity be designed and scaled, taking into account the participation of its productive base, seeking to create healthy and sustainable territories.

This project, since 2015, has been working on a data and information survey, through participatory workshops with the actors involved in

the production and value generation processes. During this period, 26 CdV maps of products derived from plant species, under the regime of cultivation or extractivism, were constructed, in the herbal, cosmetic, or food sectors, in the North, Northeast, South, and Southeast regions, in four Brazilian biomes[16]. The vertical and horizontal productive relationships of the 26 mapped enterprises, described by the actors involved in the chain links, during the workshops, record the situation at that current moment. This set of descriptions, systematized in the maps, allows for the analysis of the challenges and opportunities to be overcome and strengthened, along the chains, respectively, adding value from its production base to the final consumer.

These value relations are in turn proposed and agreed upon through the construction of a common Vision of the Future among the actors, thus enabling the elaboration of governance strategies, establishing agreements in favor of equity and transparency, in an environment of balance and dialogue between the different operators and other actors linked to a CdV. In this sense, the Vision of the Future makes it possible to overcome existing difficulties and conflicts of interest with a dialogued, procedural, and transformative mediation so as to achieve the results desired by all. It is important to note that this process is relevant in the structuring of differentiated markets in both the public and private sectors, considering not only the monetary value, but also the ethnic, gender, social, cultural, and environmental values, added to these mapped COCs, thus promoting fair trade.

In the mappings carried out by ArticulaFito[11,12], a broader range of data collection can be seen when compared to other available databases. In this survey, the percentages of the Amazon biome, of the North region, of the extractive regime, and of native origin can be highlighted, all with more than 50%, in the features of the set of mapped CdVs, also highlighting the herbal and cosmetic segments.

Therefore, following the guiding principles defined by the foundations of the PNPMF and other intersectoral policies aligned with it, this study seeks, based on the data and information collected and systematized by ArticulaFito, to contribute to the debate over the prioritization of investments, as well as to the formulation of public policies, with regard to productive inclusion, through the sustainable use of sociobiodiversity, of PCTAFs, for the herbal, cosmetics, and food sectors. The monitoring and prioritization of identified events can offer subsidies to develop action plans in the field of public health[13].

Therefore, the present study aimed to define the basic criteria to prioritize the investments necessary for the development of actions aimed at strengthening the mapped CdVs, based on the Problems and Opportunities identified in this study.

Bearing in mind the need to promote institutional arrangements for governance that enables the development of productive models based on sustainability, aligned with collective and environmental health, together with productive inclusion as a relevant strategy to mitigate and overcome the social determinants of health and promotie Healthy and Sustainable Territories.

Material and methods

The integration of methods that can create subsidies for decision-making, both in strategic planning and in the management of CdV, plays a major role, as these can include required technical, economic, and social aspects[14]. In this work, the integration of methodologies was carried out in order to encompass the amplitude of variables identified in the mappings.

The project uses the Value Links-B[15,16] methodology, created from the analysis of real experiences and lessons learned in rural development programs. This methodology is organized in stages, according to the project cycles. The first stage consists of identifying a CdV to be strengthened; the second analyzes the chain with a map design; the third establishes a common Vision of the Future among the actors of these CdVs; and the fourth seeks to identify Opportunities and Problems. At the same time, the impact of the project and the management of results are monitored. This set of steps provides users with the organization and essential elements for actions to improve the CdV. Based on this methodology, an instrument was created to share knowledge, formulate strategies, and structure information to promote these chains[12].

Definition of CdV groups by performance similarity

For the application of an evaluation system, variations in the intensities of the numbers of Stages or Steps (E) and Links by Fields of Action (CA) were observed in the set of 26 mapped CdVs, at the levels indicated by lines of different

colors in each CdV map. Thus, to measure these intensities, quantitative data were collected by counting the Stages and Links, in each of the represented levels in each CdV map.

One can view the Stages of the chain's value creation process in the first line or level of each CdV map. The following levels are called CA, differentiated according to the legend on each map. These are organized according to the Stages of the chain that they influence and to which they are linked. These CAs represent the Links, defined as the series of interconnected processes corresponding to the Stages, from inputs to consumption[11]. Each CA is defined as:

• CA 1 – horizontal and vertical cooperation: focused on establishing partnerships, alliances, and joint work between organizations. Collaboration between organizations operating in the same link in the chain is included here, for example, between producer associations and cooperatives.

• CA 2 – financial and non-financial services: are all the services necessary for the chain to improve its performance. Financial services are related to the existence and possibility of access to finance and credit. Non-financial services, in turn, refer to the existence and access to training, research, technical assistance, and rural extension.

• CA 3 – social, environmental, and quality standards: refers to the existence or need to meet social, environmental, and/or quality standards for a product or process in the chain. This CA includes health inspections, certifications, and participatory guarantee and social control systems.

• CA 4 – institutional/regulation: these are all of the regulations, laws, and rules of the game in which the chain is inserted and which it needs to know and adapt to in order to operate properly (e.g., environmental, health, fiscal, labor, tax legislation, etc.).

A CdV allows for the understanding of the value-added flow to the final consumer[17]. Therefore, it was considered that the links represented in the observed CdV help to create or add value to the consumer of the medicinal plants. Hence, their quantification may reflect this capacity. The interactions between the links represented in the CdV are desirable and are proportional to the number of links. Therefore, the more links in the chain, the more value can be added to the product.

In this sense, the presented variables were obtained through the numbers obtained by counting each Stage and Link represented or described in each map. Table 1 shows the quantities of the seven variables represented in each of the CdV maps. Columns CA2 and CA3 that contained zeros were disregarded, as they indicate the non-existence of this level. Column P refers to the number of Participants. Column D shows the Diversity of institutions. We chose to use the variable D and not P, as it reflects the diversity of institutions involved in the territory covered by each workshop. Thus, the four variables selected to be considered in the proposed assessment model were: E, CA1, CA4, and D (Table 1).

The Data Envelopment Analysis (DEA)[18] methodology was used, with unit input used as a multicriteria tool[19], applied in layers[20,21] to form groups of similarity of performance classes in the assessment of the set of the 26 studied CdVs. The applied DEA methodology is in line with the Value-Links-B methodology, as it enables the incorporation of variables of different dimensions, related to multiple criteria, in the intended analysis.

Based on the definition of efficiency[22], as the maximum ratio between a weighted sum of products (outputs) and a weighted sum of resources (inputs), DEA uses this concept to make a comparative analysis between the efficiencies of a set of productive units or Decision-Maker Units (DMU), which, in this study, are the 26 CdVs. The DEA approach was developed to form an assessment system, in which one does not wish to consider only the financial aspect[23]. Working as a tool to measure efficiency, this approach is capable of incorporating various resources and products to calculate efficiencies that reflect the performance of each CdV. The efficiencies revealed for each CdV function as a performance score that can vary from 0 to 1, with 0 being inefficient and 1 being efficient[24]. This methodology was chosen for the intended analysis in this work, as it enables the incorporation of the available quantitative data, generating indices of performance for each string.

Our study chose to implement an alternative classification for DMUs according to their location in the revealed iso-efficiency or performance similarity layers. Layers are used to achieve an alternative means of grouping with the DEA. These are obtained as follows[20]: the DMUs with 100% efficiency form layer one. These DMUs are then removed from the analysis set, and the DEA model is applied again, with the remaining DMUs. The efficient DMUs in this subset form layer two. The process is repeated until all DMUs have been dropped from the initial set.

All selected variables (Table 1) were considered as outputs, as they are identified as products

Table 1. Variables extracted from the 26 maps of value chains.

Nº CdV	Products of Value Chain	E	CA1	CA2	CA3	CA4	P	D
1	Medicinal tea – calêndula	6	11	4	3	6	24	15
2	Medicinal tea – espinheira santa	6	7	4	4	3	24	15
3	Medicinal tea – guaco	5	4	0	8	2	29	18
4	Capim Cidreira	5	2	0	2	4	29	18
5	Carapiá poder	5	3	0	1	2	33	24
6	Umburana seeds	6	4	0	0	1	33	24
7	Cavalinha Tea	6	4	0	1	2	33	24
8	Artisen pill – babosa	5	2	0	0	1	43	26
9	Medicinal tea – hortelã	5	3	0	2	1	43	26
10	Sucupira seeds	5	5	0	2	2	45	26
11	Pilocarpine of jaborandi leaves	5	5	0	0	4	43	30
12	Fava d'Anta pods	7	5	0	1	3	33	24
13	São Caetano melon extract	6	7	2	4	3	35	24
14	Arnica extract	7	8	4	2	4	35	24
15	Carnaúba wax	8	11	2	1	3	35	24
16	Copaíba oil and soap	5	7	0	1	3	42	31
17	Andiroba oil	5	6	0	1	3	42	31
18	Pracaxi oil	5	3	0	1	3	42	31
19	Andiroba repelent	6	4	0	5	4	45	30
20	Buriti oil and cosmetics	6	3	0	1	3	35	28
21	Tucumã butter and bicho de tucumã oil	7	6	0	2	3	35	28
22	Macaúba oil	5	3	0	1	2	43	26
23	Extra virgin oil and babaçu flour	5	4	0	4	3	45	30
24	Castanha do Pará nuts	5	9	0	3	3	45	30
25	Jambu vegetable and liquor	5	5	0	1	2	35	28
26	Bacuri in natura, pulp, seed, and peel, and bacuri butter	6	7	1	2	2	35	28

CdV – value chain; E – stage; CA1 – field of action 1; CA2 – field of action 2; CA3 – field of action 3; CA4 – field of action 4; P – participants; D – diversity.

Source: Authors.

to be maximized. The unitary input marks, indicates, and enables the existence of the DMU in the proposed DEA model. The SIAD[25] software was used to calculate the performance indices and define the CV groups.

Prioritization of the events

In a second approach to the data presented in this study, for each defined CdV group, in the Vision of the Future section of each CdV map[11], the events described for each presented Problem or Opportunity were observed. These are discriminated in a manner that is often impossible to be semantically grouped, as they refer to the peculiar and specific situations of each CdV. An event favorable to the process of creating and adding value to the final consumer is considered an Opportunity, while an unfavorable event, a Problem, is considered that within the chain or of the CdV group. Therefore, to verify a pattern of behavior in the frequency or distribution of these Problems and Opportunities, we decided to work with the origins or addresses of these events, represented by a caption that informs the CA and the E to which they are each related.

Each described Problem or Opportunity is linked to an E and a CA of the value creation process, represented through legends and colors, respectively, in each CdV. In this way, the frequency of the occurrence of each detected Problem or Opportunity was obtained, both in relation to a horizontal axis, represented by the CAs or line of the CdV map, as well as to a vertical axis, repre-

sented by the Process Stages or columns of the CdV map. This consideration allows, in addition to prioritizing, ordering, or ranking each Problem or Opportunity by the frequency in which it is mentioned, as well as pinpointing, with coordinates (CA x E), the region on the map where it occurs. In other words, this resource makes it possible to point out where actions aimed at facing the Problems and taking advantage of the identified Opportunities should be proposed, for each of the defined CdV groups, in order of priority (Figure 1).

The graph resource of the Pareto Diagram[26,27] was applied to the absolute, relative and accumulated frequencies of the events extracted from the Vision of the Future related to each CdV map, in an adaptation called, in this study, the Action Diagram, where the causes or origin of the events are the addresses of each Problem or Opportunity, in each CdV group defined in the first approach. In this sense, both the Problems and the Opportunities were ordered, in an attempt to prioritize, guide, and provide a foundation for the recommendations of actions to strengthen the management of the CdV of the plant species focused on in this study.

To standardize and enable a uniformity that would enable the representation in the Action Diagram, the Stages of the value generation process, indicated in the CdV maps, were grouped into five Steps (Figures 1 and 2), where Step 1 (E1) refers to the introduction of inputs at the beginning of the process, Stage 2 (E2) deals with production, Stage 3 (E3) with post-harvest, Stage 4 (E4) with trade, and Stage 5 (E5) with consumption, given that Steps 1, 4, and 5 follow what is described and represented on the maps. However, Stage 2, called production, brought together the Stages of production, management, and collection, as these Stages were considered consolidated in the same environment, the field, and elaborated by similar categories of actors. Likewise, Stage 3, called post-harvest, brought together the stages of processing, benefiting, and transformation, as they are interconnected activities and practiced by actors and in characteristic and similar environments.

Results and discussion

Table 2 shows the result of the first round of the application of the DEA model, with all the DMUs, where the composition of the first layer is observed, indicated by all of the CdVs with a standard efficiency equal to 1. The model was ap-

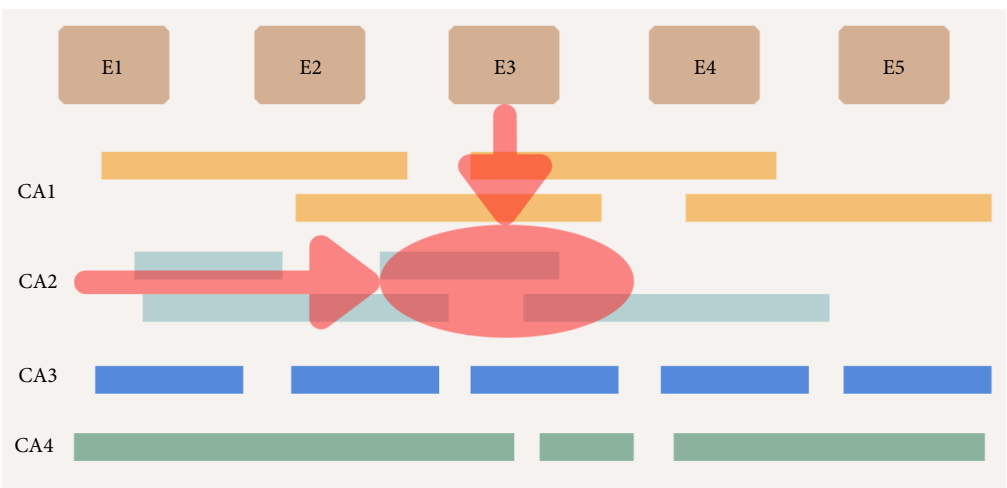

Figure 1. Explanatory model of the diagram pinpointing the region of the CdV group of where to interfere, from the citation of the address of the event, both for the problem and for the opportunity.

E – process stage; CA – field of action covered.

Source: Authors.

plied three more times, until the formation of the fourth group. The revealed composite efficiency score was considered to calculate the average performance score for each group.

First approach – performance similarity groups

In this way, four groups or classes of performance similarity were obtained (Chart 1), where the composition of the groups can be observed, with the names of the CdV and their features[14]. The underlined chains are from exotic species, a total of six, in the entire set of 26 CdVs. In this, nine CdVs with their products derived from their respective plant species are present in the National List of Medicinal Plants of Interest to the SUS – RENISUS[31]: 1) medicinal tea from Calendula (*Calendula officinalis*)), 2) medicinal tea from *Espinheira Santa* (*Maytenus ilicifolia*), 7) Horsetail tea (*Equisetum sp*), 8) Aloe vera (*Aloe vera*) artisanal pill, 9) Mint medicinal tea (*Mentha villosa*), 13) St. Caetano melon extract (*Momordica charantia*), 16) Copaiba oil and soap (*Copaifera langsdorffii*), 17) Andiroba oil (*Carapa guianensis*) and 19) Andiroba repellent (*Carapa guianensis*) (Table 1), are distributed among the four CdV groups described in this study (Table 1).

Group 1, evaluated with the best performance and average score of 55% (Table 2), presented ten CdVs, including 70% in the cosmetic segment, in the Amazon biome, and in the northern region; 80% are native under extractivism, and 20% are exotic under cultivation. The Northeast region has 20% and the South region 10% of the CdV of this group, with four species mapped in the workshop in Macapá, Amapá; three in the workshop in Marabá, Pará; two in the workshop in Natal, Rio Grande do Norte; and one at the workshop in Foz de Iguaçu, Paraná (Chart 1). This group presents the largest numbers of species, values and production, in the data collected by the 2017 Agricultural Census[28] and by Imazon[29]. In addition to containing the highest number of CdVs (1, 16, 17, 19) with plant species included in RENISUS[30].

Group 2, the second in performance and with an average score of 51%, consists of seven CdVs, 43% of which are mapped in the cosmetic sector, in the Amazon biome, in the North region, and in the state of Pará (Table 1). The Atlantic Forest biome, the phytotherapeutic and food segments, the Southeast region, the Belém workshop, exotic species, and the cultivation regime each present 28.5% of the chains mapped (Table 1). Therefore, it is the most diversified group and with the second largest number of species, values, and production, in the data collected by Census[28] and by Imazon[29]. Containing two CdVs (2 and 13) with plant species included in RENISUS[40].

Table 2. Scores revealed by the applied DEA model.

	Efficiency/performance			
DMU	**Standard**	**Inverted**	**Compound**	**Compound***
CdV1	1.00	1.00	0.50	0.78
CdV2	0.80	1.00	0.40	0.62
CdV3	0.68	1.00	0.34	0.53
CdV4	0.81	1.00	0.41	0.63
CdV5	0.81	1.00	0.40	0.63
CdV6	0.86	1.00	0.43	0.67
CdV7	0.86	0.85	0.50	0.78
CdV8	0.86	1.00	0.43	0.67
CdV9	0.86	1.00	0.43	0.67
CdV10	0.87	1.00	0.43	0.67
CdV11	1.00	1.00	0.50	0.78
CdV12	0.94	0.75	0.59	0.92
CdV13	0.88	0.83	0.52	0.82
CdV14	1.00	0.73	0.63	0.99
CdV15	1.00	0.73	0.64	0.99
CdV16	1.00	1.00	0.50	0.78
CdV17	1.00	1.00	0.50	0.78
CdV18	1.00	1.00	0.50	0.78
CdV19	1.00	0.83	0.58	0.91
CdV20	0.95	0.83	0.56	0.87
CdV21	1.00	0.71	0.64	1.00
CdV22	0.86	1.00	0.43	0.67
CdV23	0.97	1.00	0.49	0.76
CdV24	1.00	1.00	0.50	0.78
CdV25	0.92	1.00	0.46	0.71
CdV26	0.97	0.83	0.57	0.88

* Normalized efficiency.

Source: Authors.

Group 3, also with seven CdVs and an average score of 44%, presented the highest percentage of species mapped in the herbal medicine segment (71%) (Table 1). The two species in the food segment are the only ones in the group quantified in the Agro Census.

Group 4, with an average performance score of 43% and with two mapped CdVs, both of exotic species and included in RENISUS, presents the lowest performance (Table 1), showing one species with quantified data in the Census[10].

These results suggest the need to establish criteria to include a greater number of sociobiodiversity species in RENISUS, in an attempt to be one more element that induces a socioproductive inclusion. Therefore, the structuring of CdV,

Chart 1. The four groups and their characteristics.

Group	CdV	Speciea	Morphology	Workshop	State	Region	Regime	Sector	Biome
1	1	*Calendula officinalis L*	Herbaceous	Foz do Iguaçu	PR	Sul	Cultivo	Fitoterápico	Mata Atlântica
	11	*Pilocarpus microphyllus*	Shrub	Marabá	PA	Norte	Extrativismo	Fitoterápico	Amazônia
	14	*Solidago virgaurea*	Herbaceous	Natal	RN	Nordeste	Cultivo	Cosmético	Caatinga
	15	*Copernicia prunifera*	Shrub	Natal	RN	Nordeste	Extrativismo	Cosmético	Caatinga
	16	*Copaifera langsdorffii*	Shrub	Macapá	AP	Norte	Extrativismo	Cosmético	Amazônia
	17	*Carapa guianensis Aubl.*	Shrub	Macapá	AP	Norte	Extrativismo	Cosmético	Amazônia
	18	*Pentachletra macroloba*	Shrub	Macapá	AP	Norte	Extrativismo	Cosmético	Amazônia
	19	*Carapa guianensis*	Shrub	Macapá	AP	Norte	Extrativismo	Cosmético	Amazônia
	21	*Astrocaryum aculeatum*	Shrub	Belém	PA	Norte	Extrativismo	Cosmético	Amazônia
	24	*Bertholletia excelsa*	Shrub	Marabá	PA	Norte	Extrativismo	Alimento	Amazônia
2	2	*Maytenus ilicifolia*	Shrub	Foz do Iguaçu	PR	Sul	Cultivo	Fitoterápico	Mata Atlântica
	4	*Cymbopogon citratus*	Herbaceous	Petrópolis	RJ	Sudeste	Cultivo	Fitoterápico	Mata Atlântica
	12	*Dimorphandra mollis*	Shrub	Montes Claros	MG	Sudeste	Extrativismo	Cosmético	Cerrado
	13	*Momordica charantia*	Herbaceous	Natal	RN	Nordeste	Extrativismo	Cosmético	Caatinga
	20	*Mauritia flexuosa*	Shrub	Belém	PA	Norte	Extrativismo	Cosmético	Amazônia
	23	*Attalea sp*	Shrub	Marabá	PA	Norte	Extrativismo	Alimento	Amazônia
	26	*Platonia insignis*	Shrub	Belém	PA	Norte	Extrativismo	Alimento	Amazônia
3	3	*Mykania sp*	Herbaceous	Petrópolis	RJ	Sudeste	Cultivo	Fitoterápico	Mata Atlântica
	5	*Dorstenia brasiliensis*	Herbaceous	Montes Claros	MG	Sudeste	Extrativismo	Fitoterápico	Cerrado
	6	*Amburana cearensis*	Shrub	Montes Claros	MG	Sudeste	Extrativismo	Fitoterápico	Cerrado
	7	*Equisetum sp*	Herbaceous	Montes Claros	MG	Sudeste	Cultivo	Fitoterápico	Cerrado
	10	*Pterodon emarginatus*	Shrub	Palmas	TO	Norte	Extrativismo	Fitoterápico	Amazônia
	22	*Acrocomia aculeata*	Shrub	Palmas	TO	Norte	Extrativismo	Alimento	Amazônia
	25	*Acmela oleracea*	Herbaceous	Belém	PA	Norte	Cultivo	Alimento	Amazônia
4	8	*Aloe vera*	Herbaceous	Palmas	TO	Norte	Cultivo	Fitoterápico	Amazônia
	9	*Mentha villosa*	Herbaceous	Palmas	TO	Norte	Cultivo	Fitoterápico	Amazônia

Source: Authors.

based on sociobiodiversity, represents a viable alternative to promote productive inclusion in order to promote the health and quality of the life of people and ecosystems on the planet[5,7].

Second approach – prioritization of events in each CdV group

Overlapping the two approaches: the evaluation system applied to the CdV maps to group by performance similarity, with the citation frequency analysis of the Problems and Opportunities described in the Vision of the Future, the Action Diagram was generated (Figure 2) in order to aid in the diagnosis, prioritization, and orientation of the actions aimed at strengthening the mapped CdVs, promoting an increase in sustainable production, as well as in environmental and collective health. In this context, according to Matsuchita[31], the acknowledgment of therapy, with products from the raw materials of active plants, as a pharmacological and economic medical resource, has led several countries to adopt this modality as a strategy to be implemented in the promotion of public health policies.

In each Action Diagram, it is possible to observe the absolute frequency obtained by counting the number of times that a certain address (CA, E) of the Problem or Opportunity is mentioned, in all chains of the group, thereby allowing one to pinpoint up to twenty Target Positions in each Action Diagram in order of priority, where the most cited or demanded Problems or Opportunities are considered the highest priority, or even to acquire the relative frequency of each AC or E separately. Thus, it is possible to prioritize or order the regions of the chain that most demand actions to solve Problems or take advantage of Opportunities, helping the manager

Action diagram – Group 1							
Problem	**E 1**	**E 2**	**E 3**	**E 4**	**E 5**	**Total**	**Frequency**
CA 1	5	9	4	3	3	24	32.43%
CA 2	2	7	4	4	1	18	24.32%
CA 3	6	9	7	1	1	24	32.43%
CA 4	2	0	2	2	2	8	10.81%
Total	15	25	17	10	7	74	100.00%
Frequency	20.27%	33.78%	22.97%	13.51%	9.46%		
Opportunity	E 1	E 2	E 3	E 4	E 5	Total	Frequency
CA 1	2	7	5	2	4	20	31.75%
CA 2	4	2	7	5	3	21	33.33%
CA 3	5	5	2	0	2	14	22.22%
CA 4	0	4	2	1	1	8	12.70%
Total	11	18	16	8	10	63	100.00%
Frequency	17.46%	28.57%	25.40%	12.70%	15.87%		
Action diagram – Group 2							
Problem	**E 1**	**E 2**	**E 3**	**E 4**	**E 5**	**Total**	**Frequency**
CA 1	0	6	2	1	0	9	23.68%
CA 2	0	5	5	2	0	12	31.58%
CA 3	2	0	7	0	0	9	23.68%
CA 4	0	0	6	2	0	8	21.05%
Total	2	11	20	5	0	38	100.00%
Frequency	5.26%	28.95%	52.63%	13.16%	0.00%		
Opportunity	E 1	E 2	E 3	E 4	E 5	Total	Frequency
CA 1	0	1	3	4	2	10	29.41%
CA 2	0	4	3	3	0	10	29.41%
CA 3	1	3	1	4	2	11	32.35%
CA 4	0	1	1	0	1	3	8.82%
Total	1	9	8	11	5	34	100.00%
Frequency	2.94%	26.47%	23.53%	32.35%	14.71%		

it continues

Figure 2. Action diagram with the target position highlighted and the respective absolute and relative frequencies for each CdV group, referent to the diagnosed problems and opportunities.

Action diagram – Group 3							
Problem	**E 1**	**E 2**	**E 3**	**E 4**	**E 5**	**Total**	**Frequency**
CA 1	1	6	2	1	1	11	37.93%
CA 2	0	5	1	0	0	6	20.69%
CA 3	2	4	0	2	0	8	27.59%
CA 4	0	1	2	1	0	4	13.79%
Total	3	16	5	4	1	29	100.00%
Frequency	10.34%	55.17%	17.24%	13.79%	3.45%		
Opportunity	E 1	E 2	E 3	E 4	E 5	Total	Frequency
CA 1	0	1	2	1	3	7	24.14%
CA 2	1	6	3	0	0	10	34.48%
CA 3	3	2	2	0	2	9	31.03%
CA 4	0	1	1	0	1	3	10.34%
Total	4	10	8	1	6	29	100.00%
Frequency	13.79%	34.48%	27.59%	3.45%	20.69%		

Action diagram – Group 4							
Problem	**E 1**	**E 2**	**E 3**	**E 4**	**E 5**	**Total**	**Frequency**
CA 1	0	1	0	0	0	1	12.50%
CA 2	0	2	1	0	0	3	37.50%
CA 3	0	0	2	2	0	4	50.00%
CA 4	0	0	0	0	0	0	0.00%
Total	0	3	3	2	0	8	100.00%
Frequency	0.00%	37.50%	37.50%	25.00%	0.00%		
Opportunity	E 1	E 2	E 3	E 4	E 5	Total	Frequency
CA 1	2	1	2	0	0	5	71.43%
CA 2	0	0	1	0	0	1	14.29%
CA 3	0	0	1	0	0	1	14.29%
CA 4	0	0	0	0	0	0	0.00%
Total	2	1	4	0	0	7	100.00%
Frequency	28.57%	14.29%	57.14%	0.00%	0.00%		

Figure 2. Action diagram with the target position highlighted and the respective absolute and relative frequencies for each CdV group, referent to the diagnosed problems and opportunities.

Field of action: CA1 – partnerships, alliances, and group work; CA2 – financial services, training, research and technical aides; CA3 – social standards, environments, and quality; CA4 – regulations, norms and laws.

Stage: E1 – inputs; E2 – production; E3 – post-harvest; E4 – business; E5 – consumption

Source: Authors.

in decision-making or defining action strategies, since, with the knowledge of the CA and E, one can postulate the respective institutions and actors that are involved in each pinpointed Problem or Opportunity (Figure 2).

Therefore, first and foremost, the Target Positions indicated in the diagram, defined by the coordinates (CA, E), highlight the priority points to be observed. After, one should consider the CAs in descending order of relative frequency indicated in the diagram; these indicate the participating institutions that require interference. Finally, the same must be done with the Steps indicated in the diagram, which, in this case, reveal the involved actors, throughout the process, in an orderly manner, both for Problems and Opportunities, in each group of CdV analyzed (Figure 2).

The red coloring for Problems or green for Opportunities of the sorted Target Positions, attenuate as the absolute frequency of the respec-

tive address decreases. Target positions marked with the same number indicate a tie and zero indicates no citation (Figure 2).

Therefore, this same topic, approached theoretically in the work of Villas Bôas and Gadelha[33], in the present study, gains an application with data and quantitative methods to guide actions so as to promote this sector of importance in both socioeconomic development and public health.

It is important to point out that, in the frequencies indicated in the diagrams in Figure 2, all 149 Problems and 133 Opportunities analyzed within the Vision of the Future[11] were considered, in the set of CdVs, ordered and represented in the Action Diagram (Figure 2). In this way, the decision-maker can follow the order of priorities, including the possibility of observing the frequencies of both the CAs and the Steps to which they are related in each group of CVs.

Therefore, this diagnosis of the potential and needs pointed out by the actors makes it possible to guide Action Plans in the territories for the support and strengthening of the mapped chains. This may result in productive inclusion, with the generation of employment and income, as a strategy to promote the quality of life and health in the territories[12].

Group 1

In figure 2, the Target Positions (CA1, E2) and (CA3, E2) are tied, with the highest absolute frequencies, cited nine times each, and marked with more intense red. These also indicate the organizations of farmers and workers, as well as the standards and certifications, in the Stage of production, handling, and collection in the field, as being the address of the most recurrent Problem in the group, followed by target positions (CA2, E2) and (CA3, E3), in second place.

It can also be observed that CA1 (32.43%), CA3 (32.43%), and E2 (33.78%) are the areas with the highest total percentage of relative frequency in the group, also indicating these as regions with a greater demand for Problems in this group.

This diagnosis corroborates the work of Coslovsky[32], where restrictions were detected in sanitary standards related to contamination by aflatoxins as the main problem in the productive chain of Brazil nuts, in Brazil. This Problem finds its initial origins in E2, the chestnut collection phase in the field, followed by Storage problems in E3, as well as by the lack of technical assistance, rural extension, standards, and certification, in this chain, which is also recurrent in Group 1 (Figure 2).

For Problems, this alignment of the most frequently targeted positions with the most cited CA and E regions indicates a greater definition of the shape of the Problems, with a consequent concentration of institutions and actors involved, to be prioritized in the entire set of CdVs of Group 1 (Figure 2). However, the manager should not disregard the other frequencies, in the scale of target positions (absolute frequencies) and percentages of citations of the regions (relative frequencies), indicated in the diagram. These also demand attention in a descending order of priority.

For Opportunities, the target positions, which tied and were cited seven times each (CA1, E2) and (CA2, E3), point to partnerships, alliances, and joint work of producers in the Stage of production, management, and collection in the field; along with access to credit, training, and research in the post-harvest stage (processing, improvement, transformation), as the most envisioned Opportunities in Group 1. That is, the highest absolute frequencies coincide with the highest relative frequencies in the diagram, indicating a consequent concentration of institutions and actors involved, to be prioritized, for Opportunities as well, in the entire set of CdVs in Group 1 (Figure 2).

It was noted that some Problems or Opportunities had different addresses with the same description, as they affect more than one CA and/or one Stage in the CdV.

Group 2

In Group 2, both for Problems and for Opportunities (Figure 2), it is possible to highlight the prioritization of Target Positions that demand actions with the institutions involved by CA 3 related to standards, inspections, and certifications, in the post-harvest and trade stages. For Problems, the second Target Position points to CA 4 related to adjustments in the post-harvest Stage (E3). This result corroborates the diagnosis in the work of Hasenclever et al.[7], which points to the low quality of the inputs and the lack of standardization of the degree of concentration of the extracts provided due to the absence of a clear and specific regulation for the control and inspection of plant species used in the manufacture of herbal medicines, considering regulations to be one of the main obstacles in the sector. Booker et al.[34] also applied value chain analysis

to medicinal plants and detected the need for more effective quality control in each stage of the chain. This is especially important if the finished products are earmarked for export to countries where there are more stringent entry standards and regulatory requirements, recognizing that these quality-oriented interventions result in a higher product standard and consequent appreciation for the final consumer.

For Problems, in Group2, the dispersion or non-coincidence of the highest frequencies of Target Positions in relation to the most cited CA and/or E point to the condition of a greater number of institutions and/or actors involved in the Problems detected in this group (Figure 2).

For Opportunities, it was pointed out/recognized in the Target Position (CA3, E4) that the initiative to expand the definition of standards in trade channels, along with the support and interest of public and private institutions, favors the dissemination of these products in Public Health (Figure 1).

Group 3

The diagram in Figure 1 points out, in Group 3, in the Target Positions (CA1, E2) in Problems and (CA2, E2) in Opportunities, the highest demand for actions. Identifying the main Problem in producer institutions in the Field Production Stage. The main Opportunity can be found in the access to credit and to training and research, also in the field production stage. This behavior indicates the worker's lack of conditions, primarily at the beginning of the value creation process, in this CdV group. Singh and Chatterjee[35], based on the analysis of the value chain of a non-timber forest product, also detected the need for training and qualifications to improve workers' knowledge in adopting sustainable practices in the production stage in order to maintain the overall vitality and health of India's forested areas with high anthropogenic pressures.

Group 4

In Group 4, more than 80% of Problems are related to CA2 and CA3, and more than 70% of the Opportunities to CA1. In addition, for both Problems and Opportunities, it was noted that 75% of the Target Positions have an absolute frequency equal to zero, indicating the non-citing of occurrences in these points, which reinforces the incipience and lack of recognition in the management and organization of this group's chains (Figure 2).

It was observed that, in groups with a higher performance, it is possible to observe a greater number of Target Positions marked in their Action Diagrams (Figure 2). The identification of more Target Positions in the CdV group points to a greater understanding or perception, on the part of actors and institutions, in recognizing Problems and Opportunities in the value creation process. This whole scenario reflects the historical structural inequalities that make this sector vulnerable.

There is a greater number of Problems than number of Opportunities (Figure 2), a frequent situation at the beginning of the promotion of productive chains that intend to transform into CdVs. This is due, among other things, to the lack of investment in time and effort in cooperation and articulation between the actors, in each link of the chain, between the Stages (production, processing, and commercialization) and between their CAs (operators, support services, and regulatory bodies). These weaknesses have a negative impact on the competitiveness of these products, in a market that increasingly requires compliance with fair and sustainable trade standards.

Thus, it reiterates the urgency of promoting actions aimed at promoting the CdV of sociobiodiversity as a catalyst for productive inclusion and promotion of collective health, in an intersectoral and policy articulation perspective, as well as the proper allocation of resources as a strategy in government plans.

Conclusion

The combination of the two DEA approaches and the Pareto Diagram carried out in this study proved to be relevant in order to prioritize the reinforcement of actions, and may contribute to the definition of strategies in the management of these resources, among the four groups, involving the 26 CdV analyzed in this study. The results point to integrated solutions to support, guide, and catalyze the necessary collective actions in public health, to face the global challenges involving collective and environmental health, in a new global paradigm[36]. In this way, they allow the manager to adapt actions throughout the implementation process, through result indicators, as well as the optimization of invested resources and the formulation of intersectoral public policies.

Based on the diagrams, it was possible to identify the priority strategic actions to be implemented in each CdV group. The citation frequencies of

the CAs indicate the institutions to be activated, individually or jointly, to promote the desired institutional arrangements. The frequency of the citation of Process Stages aids in the identification of the actors who are to be attended to. With this, what is precisely identified is the Target Position, or the point on the map, or the address to be prioritized, for both the Problems and the Opportunities envisioned and detected in the workshops held in each group of CdVs. Among the groups with the best performance, the CdVs stand out in the Cosmetics sector, followed by the Herbal Medicines and Foods sectors. All of the CAs experienced demands in all CdV groups. As for the Stages of the process, stage E5, which deals with Consumption, was the least demanded in the occurrence of Problems, in the four groups of CdVs.

In this sense, this study can establish strategies to strengthen and develop these CdV products of Brazilian sociobiodiversity so that users and consumers can gain access to products with high quality, efficacy, safety, and sustainability. In this way, together with the PCTAFs, this study seeks to to stimulate community development, solidarity, and social participation that serve to integrate and stimulate actions to promote collective health, with the sustainable production of wealth, which contributes to environmental conservation, in addition to fairer productive relationships, overcoming the social determinants of health, in turn structuring healthy and sustainable territories.

Collaborations

E Oliveira: conceptualization, data curation, formal analysis, investigation, methodology, software, validation, visualization, writing – original draft, writing – review, editing and approval of the version to be published. NLA Nunes: conceptualization, data curation, formal analysis, investigation, methodology, validation, visualization, writing – original draft, writing – review, editing and approval of the version to be published. JC Costa: conceptualization, data curation, formal analysis, investigation, methodology, technical and executive project coordinator, supervision, validation, visualization, writing – review, editing and approval of the version to be published.

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