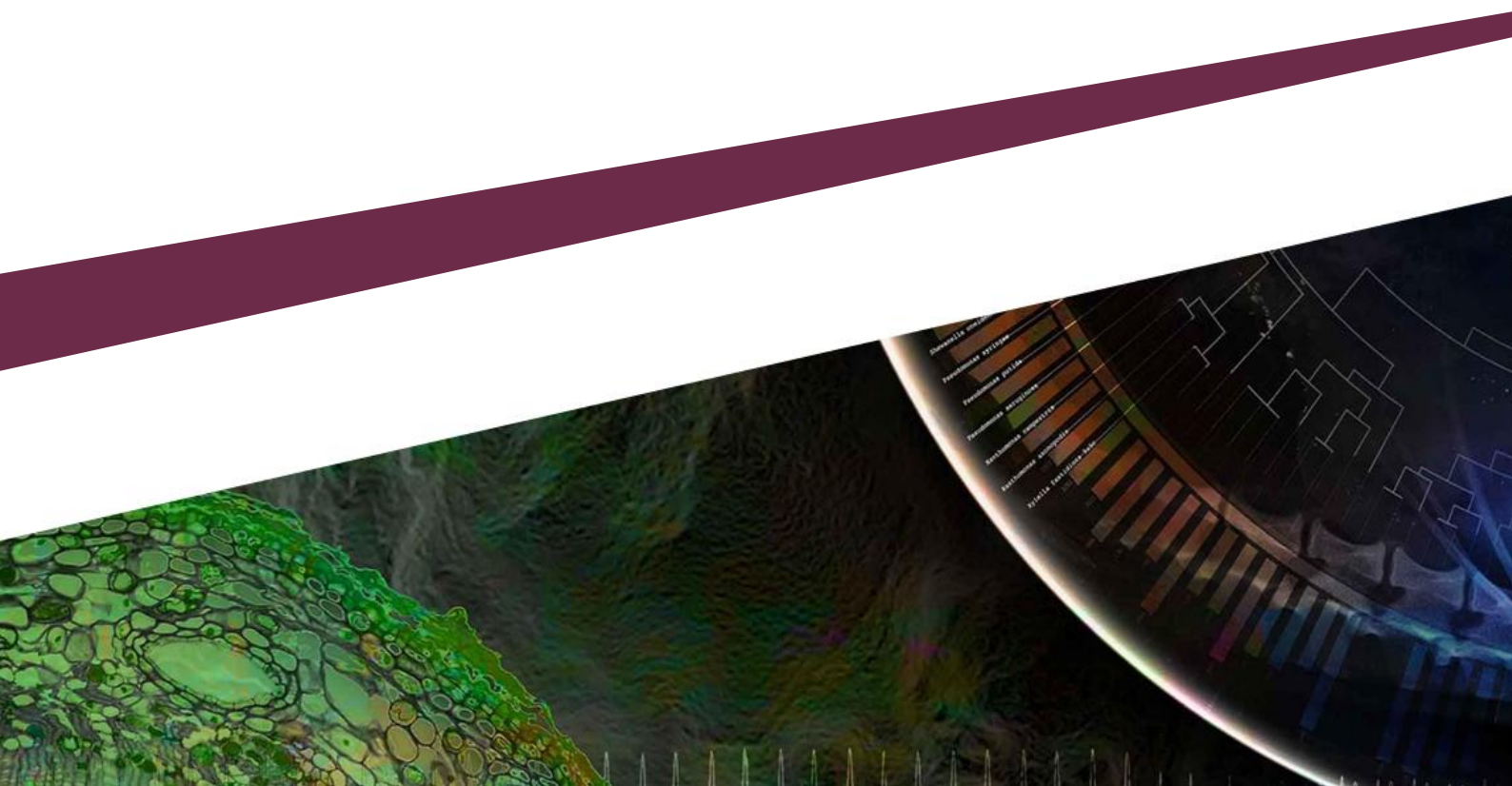




Testing TAPE

Assessing Agroecological Performance of
Biosuroeste and Exploring Applicability for Multi-
Stakeholder Agricultural Systems

Wilma Lagerman



Testing TAPE: Assessing Agroecological Performance of Biosuroeste and Exploring Applicability for Multi-Stakeholder Agricultural Systems

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Abstract

As global awareness of the roles and complexities of agriculture for sustainability challenges increases, emerging agricultural production-systems aim to model regenerative responses. These production-systems take on a wide diversity of organisational structures, including collaborative, participatory environments that bring together diverse stakeholders to co-create and test agroecological practices. This study explores the applicability of the Tool for Agroecological Performance Evaluation (TAPE), developed by the Food and Agriculture Organization (FAO), in assessing the agroecological transition of Biosuroeste, a multi-stakeholder Agropark located in the tropical Andes of Colombia. Biosuroeste integrates agroecology with the aim of fostering regenerative rural- and agricultural development. Results demonstrate that Biosuroeste scores highly in agroecological transition according to TAPE indicators. However, challenges in applying TAPE to non-household farming structures are highlighted, and suggested alterations brought forth. TAPE is concluded to enable communication and comparison of progress of the diverse initiatives of Biosuroeste on both an organisational and global scale. The study further concludes that while TAPE is valuable for agricultural sustainability assessment, its relevance is enhanced by its capacity to be tailored and adapted to specific purpose and localities, identifying potential trade-offs for stabilization of data for global comparison. TAPE developers are further encouraged to prioritize operational flexibility in future development of the tool, as an increasing diversity of agricultural initiatives look to TAPE for potential operative support.

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Expressing gratitude when gratitude is due – as in ripe – might just be essential to enjoyment of life. I would like to express gratitude for the countless lifeforms on and inside the mountain enclosing Tamesis (in Southwest Antioquia, Colombia), for providing the flow of movement which enabled this report: Absorbing and returning the evaporating river to the lowlands, exuding oxygen, balancing temperatures and providing swimming- as well as drinking water. It has been a joy to observe the waters journey during the writing of this material, and I have felt earnestly provided for. My further heartfelt thanks to Esteban Gil (Biosuroeste), for your time in the shaping of this report, as well as an overall generous distribution of kindness, including giving me Spanish lessons. Federico Botero (Biosuroeste), for aiding in countless practical tasks as well as a spirited overall commitment to instilling inspiration – both factors essential to an experience of flow. Teun Dekker (SLU Global) for envisioning and weaving together the collaboration. Raj Chongtham (SLU), for the encouraging supervision. Collaborators at FAO, working with the memorandum of understanding with SLU, for providing material and a methodology to move from, as well as supportive feedback.

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1.0 Introduction

As the potential of bioeconomies are gaining attention from policymakers and research communities, a diverse range of agroecological production-systems are at the forefront of modelling regenerative livelihoods tending to essential needs of life. Emerging agricultural production-systems make up a wide array of organisational structures, including that of collaborative, participatory environments that bring together diverse stakeholders to co-create and test innovative as well as traditional practices (Gamache et. al., 2020; McPhee et. al., 2021). With human creativity for developing business-structures marrying agroecological aspirations, tools for assessing the performance of these systems gain importance – in tandem with their need to remain flexible (Namirembe et. al., 2022). The Tool for Agroecological Performance Evaluation, TAPE, developed by the Food and Agricultural Organisation of the United Nations (FAO, 2019), is a broadly used and recognized tool for assessing agroecological performance and bringing awareness to benefits and challenges of agroecology (Mottet et. al., 2020). With increased global awareness of the role and complexities of agriculture for generating and facing sustainability challenges, TAPE aims to meet the need for multi-dimensional performance of agricultural systems, going beyond yield and profit.

With the acknowledgement that no one-size fits all for agricultural sustainability

assessments (Schader et. al., 2014), the objectives of TAPE might appear ambitious. The tool aims to provide a globally applicable scope through an operationally adaptable, yet evidentially robust survey-method, while generating evidence relevant for facing a global sustainability crisis (FAO, 2019; Mottet et. al., 2020). While the applicability of TAPE has been tested along a wide diversity of geographical locations (Hansdotter, 2022; Mottet, 2020; Namirembe, 2022), evaluations on the tool's performance on a variety of business structures, outside the family farm, are rarer. Namirembe et. al. (2022) suggest that TAPE can generally be used to inspire the design of performance-indicators, adapted to specific objectives and locality. Meanwhile, a core intention of TAPE is to obtain stabilized data on the performance of agroecology, collected within a global database (FAO, 2019) – an objective which might be disturbed if the community of users are routinely diverging from the tool.

Biosuroeste represents a multi-stakeholder agricultural production system, emerging within the tropical Andes of Colombia. Simultaneously developed as an agropark² for co-creation and transmission of agroecological practices, as well as a recreational space for the wider public, Biosuroeste aims to catalyse regenerative rural development within the southwest of Antioquia through modelling agroecological responses to challenges and openings within the bioregion³. This study

² An **agropark** generally represents an agribusiness structure which brings together researchers, producers and processors under a strategic vision to foster

agricultural development (Moratalla & Paül, 2022; Wubben & Isakhanyan, 2011).

³ A **bioregion** is a geographical area defined by biological and ecological

aims to provide operative support for further development of the agroecological emergence demonstrated by Biosuroeste, while simultaneously contributing to the FAO data collection on agroecology and its development of TAPE as a tool for supporting agroecological transitions.

This study represents a unique opportunity to evaluate the development of TAPE – currently undergoing changes to meet the needs of its community of users – while investigating the agroecological performance of an emerging multi-stakeholder corporation.

1.1 Research questions

The study is guided by the following research questions to address the research aim:

1. How does Biosuroeste perform in terms of the 10 elements of agroecology and core criteria of performance as assessed by TAPE?
2. In what ways TAPE might support Biosuroeste in measuring their performance and bioregional impacts?
 - What alternative indicators and methodologies might be applied?
3. What are the relevant benefits and critiques of TAPE, noticeable from applying the method to Biosuroeste?
 - What are relevant differences for publicly available 2019 version of TAPE, and the 2025 version –

characteristics, including human land-use practices, rather than administrative boundaries (McGinnis, 1999). Within this

currently undergoing updates – of CAET?

1.2 Background

1.2.1 Background to study

Biosuroeste is currently in a process of developing indicators to measure their performance and impacts of their influence in the bioregion, including their technical assistance services provided to farmers. The potential use of TAPE for Biosuroeste, both as a method for tracking the agroecological performance within the corporation, as well as on associated farms, is there for evaluated.

Simultaneously, TAPE is undergoing changes to meet the needs of its community of users. In this study, an informal version of Characterization of Agroecological Transition (CAET – TAPE step 1), provided by the FAO to a few TAPE-affiliates at SLU and other organizations for feedback collection during February 2025, has been tested to collect further insight into the development of the tool as well as the agroecological performance of Biosuroeste. This study represents a unique opportunity to field-test the informal version of CAET 2025, and to provide reflections on the development of TAPE, before the release of the new pilot CAET-2025.

1.2.2 Background Biosuroeste

Biosuroeste is an initiative incorporating public, private and university sectors in the

study, the overall referenced bioregion indicates the southwest of Antioquia, the territory in which Biosuroeste operates.

deployment of scalable agroecological production systems adapted to the bioregional context. The project employs a holistic framework, incorporating economy as part of human ecology, and natural and cultural capital as distinguishable assets alongside financial capital.

Biosuroeste contains a recreational- as well as agropark⁴, stewarding 600 ha of land in between the municipalities of Támesis and Valparaíso in the southwestern part of Antioquia, Colombia. Nested within the tropical Andes, framed by the Cartama river, Biosuroeste was established to facilitate regenerative development and growth within the bioregion through connecting capacities of multiple stakeholders, providing a physical platform for agroecological collaboration and connecting to the wider public through recreational activities.

Biosuroeste was founded as a corporation by a collection of stakeholders with interests in promoting rural sustainable development⁵. The municipalities of Valparaíso and Támesis provided 600 ha of land under a 30-year contract, in what has been called “the first case of collective land restitution in Colombia” (Sierra & Ramirez, 2023, pg. 28). Upon request from the Biosuroeste corporation, Comfama assumed leadership of the project⁶.

Biosuroeste hosts two demonstrative agroecological production systems within

the park – a regenerative cattle operation, focused on rotational grazing and soil management, and an agroforestry system. Both demonstrative systems aim to illustrate market-appropriate agroecological transitions for the bioregion through focusing on both emerging and traditional sectors such as livestock, cacao and bio-tourism. Furthermore, the project connects researchers, public officials, market sectors, agroecological practitioners, farmers and the wider public through a wide array of activities such as events, technical assistance services, and through facilitating conversations between different constituents of the agricultural sector.

Through facilitating research, participating in regional development and providing services of technical agricultural assistance, Biosuroeste acts as a bridge or catalyst between the three pillars of agroecology – science, movement and practice.

2.0 Method

In concurring order of the described research-, and sub-research questions, the following methods have been applied and will be expanded upon in this section:

1. Semi-structured interview(s), shaped by TAPE questionnaires,

Corporación Interactuar, Universidad EAFIT, Fundación Nutresa.

⁶ **Comfama** is a non-profit organization operating as a *Family Compensation Fund* (or *Caja de Compensación Familiar*) – a public-private hybrid system operated through tax on formal employments.

⁵ **Stakeholders & Enablers:** Mayorships of Támesis & Valparaíso, Proantioquia, Comfama, Bancocolombia, Fundación Fomento a la Educación Julio C Hernández, Fundación Aurelio Llano, Fundación Berta Arias de Botero,

followed by assessment and analysis based on TAPE guidelines.

2. Participatory discussion(s) with core stakeholder(s) of Biosuroeste and literature review of sustainability indicators.
3. Trial of informal 2025 version of CAET, evaluation of TAPE 2019 and comparison of the two versions.

All steps for data collection have to some extent been performed interactively, mainly through conversations and semi-structured interview(s) with the strategy team and technical director of agroecology at Biosuroeste. Data collection also included a group discussion with the operational team of Biosuroeste – the employees working with farming the agroforestry and cattle systems – to further explore the impact and experience of working with agroecology, and as part of the corporation Biosuroeste.

The study commenced with gaining understanding of the context in which Biosuroeste operates (TAPE step 0). This was performed in a participatory manner via travels in the region, through conversations with farmers, the director-, and the technical director of agroecology at Biosuroeste and other locals within the bioregion. A meeting on agricultural policy with representatives from the Colombian government – including the Environmental Minister and the Governor of Antioquia – was hosted in Támesis at the time of data collection and provided additional information for the agricultural and political context of the study region. Furthermore, participation in a local meet organised by local agroecology- and social

movement activists around land-use legislation, contributed to immersion in the local context, enabling increased depth in analysis and raised data saturation for TAPE step 0. Discussions following the political meetings further contributed to participatory discussions around the agroecological element of governance, emerging as a significant factor for the agroecological performance of Biosuroeste within the TAPE analysis. Furthermore, scientific and governance publications relating to agriculture in the area have supplemented information on regional land-use.

A Characterization of the Agroecological Transition (CAET – TAPE step 1) of the agricultural production system at Biosuroeste was performed in several steps: Firstly, the agricultural production systems were observed and basic data collected on e.g. diversity of crops, design of production systems and soil management practices. Secondly, a semi-structured interview was hosted with the technical director of agroecology at Biosuroeste, Esteban Gil, based on the published and publicly available TAPE 2019 CAET questionnaire. After consultation with a member of the FAO team responsible for development of TAPE, an informal 2025-version of CAET (currently under development) was generously provided in an Excell-format. This version was tested and compared with the earlier, official, 2019 version. As this new version requires extensive and disaggregated data, a second interview was held to obtain the missing information. Both methods were, while being performed, discussed with the technical director of agroecology to enable a participatory evaluation of the process of

using TAPE. I.e., the interviews with Esteban Gil provided a base of data for research questions 1, 2 and 3.

Through participatory involvement in the operation of Biosuroeste for around two months during this study period, the accuracy of obtained data for the CAET may be considered relatively reliable. Nevertheless, reliability of qualitative data is inevitably affected by subjective interpretation of questionnaires (Bryman, 2018). The utilization of two different versions of CAET, containing different questionnaires, may be seen as complementary to each other, increasing reliability of results. The step-by-step assessment of Biosuroeste on the questionnaire of 2019 CAET is available as appendix to this report (see Appendix 1). The questionnaire of the 2025-trial version is not included due to the informal status of the scoring sheet.

An evaluation of the Core Criteria of Performance (TAPE step 2) of Biosuroeste proved challenging to perform within the existing TAPE framework. As TAPE is developed mainly for assessing the family-farms (FAO, 2019), several of the provided methods for calculation of performance proved poorly adapted to the unique format of Biosuroeste. The core criteria of performance are, however, highly relevant for measuring performance relevant to agroecology as well as for connecting agroecological performance to realizing Sustainable Development Goals (SDGs) (FAO, 2019). Therefore, all the criteria are covered in this study, with further explanation on which provided measurements proved relevant and not. Certain data for the core criteria of performance has been supplemented

through other methods than the ones provided in the annex to TAPE. These modifications are covered in results section of this report. These reflections on methods for assessing the core criteria might support in the further development of TAPE.

2.1 Delimitations

TAPE is primarily developed for assessing the agroecological transition of family-farms, with several aspects of the questionnaires pertaining to a household setting (FAO, 2019). This study represents a unique endeavour to apply TAPE to an alternative, agroecological production system emerging within a complex web of stakeholders. To perform a feasible TAPE analysis, Biosuroeste has been approached as agricultural production system, with the median response of staff both in the operational (farming) team and the strategy- and technical assistance teams corresponding to the scoring on social, behavioural- and working experiences. Technical assistance services, research facilitation and social initiatives/events from Biosuroeste have been included as operational activities and services from the production system. Biosuroestes involvement in the greater community through e.g. grassroots participation and facilitation is included from the level of the corporation as a whole, rather than as activities of any particular individual(s) or employee(s).

The agroecological production systems of Biosuroeste (i.e., the agroforestry system, and the regenerative cattle operation) started only 1,5 years prior to this study. As the intended outcome of the upstart of

Biosuroeste centres around research facilitation and knowledge sharing, market connections for produce are not yet established (see section 3.1.1 Step 0 – Context). Because of this, the element of *Circular and solidarity economy* has not been included in the CAET diagram in this study. Instead, information pertaining to market- and business strategies utilized and promoted by Biosuroeste is provided as a complimentary information.

3.0 Results

3.1 TAPE

3.1.1 Step 0 – Context

The land of Biosuroeste is multifunctional, acting as a space for agroecological and regenerative practices, simultaneously as being a recreational park for the wider public. The two demonstrative production systems – one agroforestry plot and a regenerative cattle operation – are accessible to park visitors while simultaneously functioning as research and experimental spaces. The demonstrative agricultural s production plots are, at the time of data collection, 1,5 years old. This entails a noticeably young production system.

Biosuroeste is placed at 700-900m above sea level, in a transition between two different biotopes – dry tropical forest and humid tropical forest. This entails unusually large contrasts in humidity, and a unique environment for plants to adapt to.

The agroforestry system consists of an area of 2000m² (0.2 ha), and the regenerative livestock operation occupies 12 ha. Remaining area of the 600 ha is dedicated to reforestation, recreation (with hike trails) and cropping of specific native trees with relevance to an emerging bioeconomy-market⁷, such as *Sapindus saponaria* (Cumbimbo/Soap nut tree). The sizes of the demonstrative production systems are intended to emulate the typical size for family-farming within the region.

The soil type of both production systems – the agroforestry plot and the regenerative cattle operation – is clay, which entails challenges mainly for the horticultural production. The soil tends to be highly compacted when dry and sticky when wet, with difficulties forming aggregates. For the rotationally grazed livestock, however, the soil structure provides benefits through cracking when dry, enabling water to run deeper and promote dense pasture growth after rainfall.

As a response to the soil conditions, agriculture within the bioregion (i.e. southwest Antioquia) at large is extensively focused on fruit trees and livestock farming (FOLU Antioquia, 2021; Toro et. al., 2020). Cattle holds a fundamental role for food production and food security within Colombia. The most common livestock systems in Antioquia operate under extensive permanent grazing or semi-extensive rotational grazing on variable topographies (Toro et. al., 2020). Cattle often graze on slopes greater than 25%, prone to erosion, on monocultures of pasture (Toro et. al., 2020). Within the

⁷ **Bioeconomy**, as applied by Biosuroeste, references existing and emerging markets which may be optimised to incentivise

forest conservation, while simultaneously stimulating local economies and rural development.

region, the erosion of pastureland paradoxically poses a significant threat to the very food security this agricultural activity offers.

Market- and industrial incentives for conventional production of fruit-trees have further resulted in significant replacement of tropical forests in the region with predominantly mono- or semi-monocultural production of coffee, hass avocado and citrus fruits, largely sustained by chemical fertilizers and pesticides (FOLU Antioquia, 2021). Consequences include loss of biodiversity, pollution, as well as sediment- and top-soil run off. Today, 40 % of Colombian soil faces erosion threats (IDEAM, 2019).

All the while there are evident environmental challenges relating to agriculture in the region, there are also strong socioecological movements looking to declare the southwest of Antioquia an agroecological District (Ortiz et al., 2024; personal information, technical director of agroecology at Biosuroeste). There is a strong presence of agroecological farms and social movements within the region. Furthermore, there is a strong agricultural identity overall in the territory, functioning as an enabler and foundation for the initiative of Biosuroeste. The corporation continuously receives feedback from surrounding communities on the relevance of their initiatives, and interest to participate in technical assistance programs is high.

As described in the introduction section, the operational- and strategy teams at Biosuroeste are employed by Comfama. The operational (farming) team is made up of seven staffs: four women and three men,

with three of all team members below 25 years of age.

As Biosuroeste does not operate their agricultural production under traditional entrepreneurial farming model – i.e., financing is not dependent on sold products establishing a market destination of output has not been a prioritized task in the upstart of the Biosuroeste. The work surrounding the demonstrative production systems so far has extensively focused on the establishment of agricultural systems and documenting the quality and quantity of production. As connecting producers to markets is essential to the intended objective of Biosuroeste, the strategy team is dedicating time and research to understanding market behaviours. The long-term plan includes connecting produce from Biosuroeste to markets, through e.g. Community Supported Agriculture (CSA) structure. The food produced is currently being consumed by families of the workers or sold to the restaurant inside the park. The restaurant has been established via Comfama together with a contractor, with the goal of providing agroecologically produced breakfast and lunches for workers and visitors.

3.1.2 Step 1 – Characterization of Agroecological Transition (CAET)

The CAET consists of a set of indicators aiming to illustrate the agroecological transition of a food-production system in relation to the 10 elements of

agroecology⁸. Within the publicly available 2019 version of TAPE (FAO, 2019), each element is followed by a subset of 3-4 indices (E.g. the element *Diversity* is made up of the 4 indices *Crops*, *Animals*, *Trees/Perennials* and *Diversity of activities, products and services*) with a scoring of 0-4 each according to set measurements. The average of the scoring is converted to a percentile and demonstrated within a polar diagram (see Figure 1).

Within the 2025 version of CAET, this process has evolved into disaggregating each index into further sub-criteria. The criteria were largely pre-existing, but mixed within each index, sometimes making it difficult to choose an appropriate scoring (personal information, FAO TAPE-team member). As an example, rather than the index of *Crops* under the element of *Diversity* offering a full score of 4 to the set measurement of *More than 3 crops of different varieties adapted to local conditions and spatially diversified with multi-, poly- or inter-cropping* – as in the 2019 version – the 2025 version divides the index into the sub-criteria: 1. *Number of plant species*, 2. *Presence of a dominant culture*, 3. *Temporal diversity* and 4. *Plant genetic diversity*. Each of the sub-criteria are scored from 0-4 – based on new set measurements – and the average of the sub-criteria amounts to the score of the index *Crops*. The process is repeated with the following indices under the element of *Diversity*, and the average of the indices amounts to the final scoring of the element.

In summary, the 37 indices from previous versions of TAPE remain, but are broken down into 100 sub-criteria. The new structure is intended to allow for more precise data collection to identify strengths and weaknesses within the production system, as well as for simplifying question formulation and responses (personal communication, FAO TAPE-team member). The 2025 version of CAET offers pre-formulated questions for each criterion, which makes up a significant difference to the 2019 version where the interviewer(s) themselves conduct an interview-guide to be able to accurately score the set measurement of each index. As can be seen in Figures 1 and 2, scores of the 10 elements are more evenly distributed in CAET 2025. Naturally, more even distribution is likely to occur when scoring on 100 variables (the 2025-versions sub-criteria) rather than 37 (the indices).

The following CAET diagrams (Figures 1 and 2), and their subsequent descriptions, aim to provide in-depth insight into the agroecological performance of Biosuroeste, as well as identify and analyse relevant differences between 2019 and informal 2025 version of CAET. The descriptions after the diagrams (Figures 1 and 2), are divided into each of the 10 elements. These will assume from the official 2019 version. The informal 2025 version may be considered as complementary to the performance assessment itself and will be included in descriptions where differences are

⁸ **The 10 Elements of Agroecology:** Diversity, Synergies, Efficiency, Recycling, Resilience, Culture and food

tradition, Co-creation and sharing of knowledge, Human and social values, Responsible governance & Circular and solidarity economy (FAO, 2018).

noticeable. The step-by-step scoring of Biosuroeste on the questionnaire of CAET 2019 are available as Appendix 1. The data obtained for the TAPE assessment comes from the latest, and first ever, production cycle (1,5 years) at Biosuroeste.

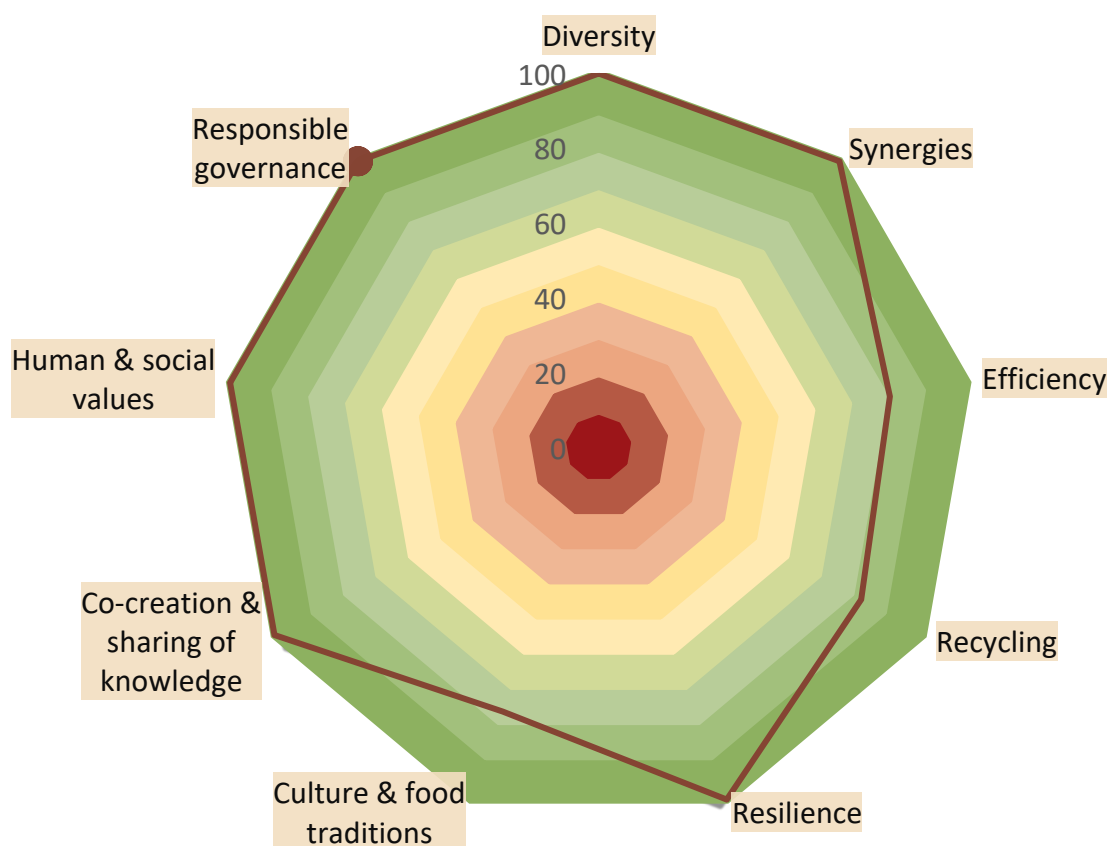


Figure 1: CAET diagram (2019-version) – Agroecological transition of Biosuroeste

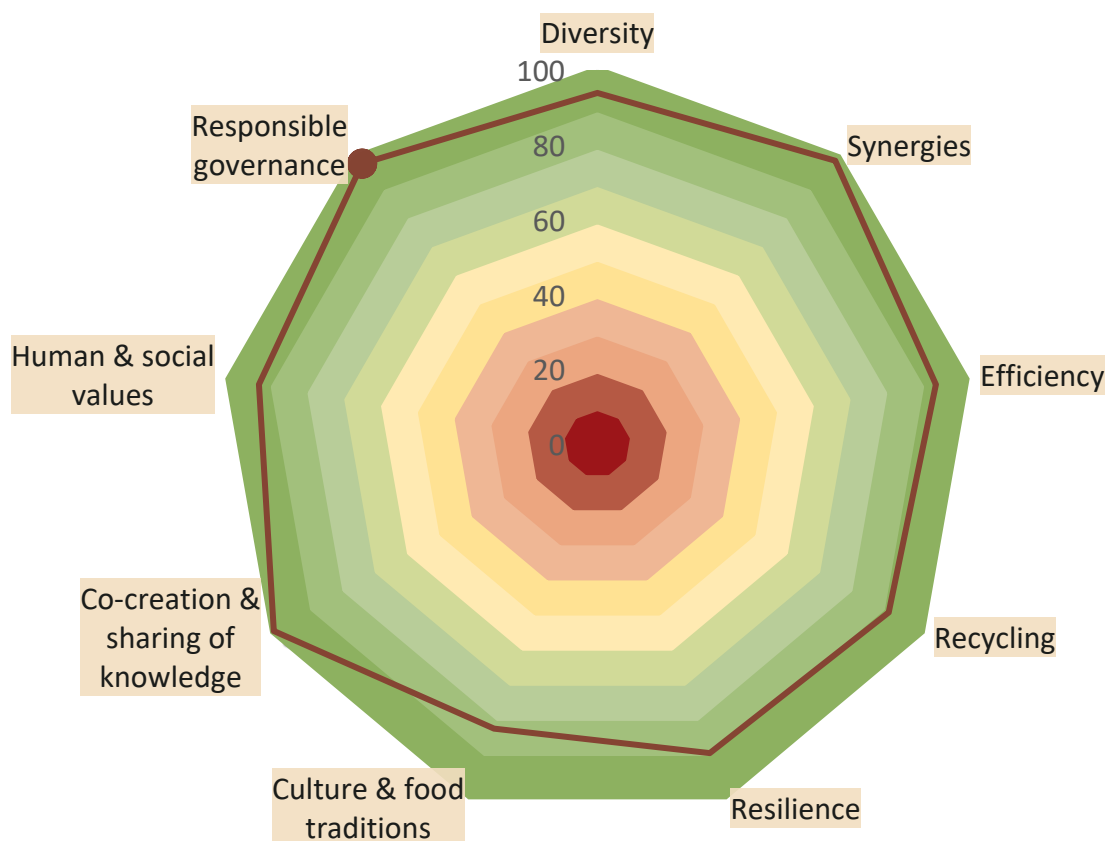


Figure 2: CAET diagram (informal 2025 trial-version) – Agroecological transition of Biosuroeste

Element *Diversity*

2019 CAET:

Score: 100%

Indices: *Crops, Animals, Trees/Perennials & Diversity of activities*

The following main crops have been cultivated at Biosuroeste in the latest production cycle:

Basil
Lettuce
Cucumber
Chilli
Tomato
Radish

Arugula
Lemongrass
Rice
Curanetano bean
Vitabosa
Yuca
Banana
Plantain
Papaya
Cacao

Apart from cultivated food-crops, Biosuroeste grows cover crops and service crops for mulching. Intercropping is intrinsic to the agroforestry system, as are perennials, and rotation of annuals is systematically practiced.

Biosuroeste cultivates native honeybees, solitary bees and earthworms. The cattle raised is of native breed, *Blanco oreginegro*, and the production system includes mules for purposes of transportation in the mountainous terrain.

Several activities and services are part of the project, including research facilitation, training programs, technical assistance programs and hosting of networking-events, representing a high diversity in all the indices of diversity within TAPE.

Within the 2025 CAET that was tested, score of the element *Diversity* is slightly lowered due to a newly added sub-criteria on diversity of breeds in animals. While the cattle at Biosuroeste are of native breed, screened for genetic diversity and intentionally bred for the climate, there is clear dominance of one breed. Currently, Biosuroeste is in contact with a native breeder in the region with the intention of incorporating further breeds into the operation.

Element Synergies

2019 CAET:

Score: 100%

Indices: *Crop-livestock-aquaculture integration; Soil-plants system management; Integration with trees; & Connectivity between elements of the agroecosystem and the landscape*

The cattle operation at Biosuroeste is practiced according to regenerative rotational grazing practices. Pasture density is tracked, along with weight-gain for the animals, and grazing is planned in accordance with maximizing fertility of soil. Animals are exclusively fed from grazing. Manure is partially harvested for

the bio-factory established in the heart of the agricultural production systems. The bio-factory aims to cultivate a diversity of microbes to facilitate and accelerate soil succession.

All soil is covered with residues or cover crops, soil disturbance is minimized and microorganisms are produced on Biosuroeste through various methods to increase soil fertility. The ecosystem, simultaneously designed as agricultural production system and a recreational park, makes up a mosaic with high connectivity to the natural landscape and many non-cultivated elements are left and related to as habitat for biodiversity. These components jointly account to a high score within the element of synergies.

Element Efficiency

2019 CAET:

Score: 79%

Indices: *Use of external inputs; Management of soil fertility; Management of pests and diseases*
Not applicable (N/A): *Productivity and household needs*

The element of efficiency partially seeks to account for the self-sufficiency of inputs used within the agricultural system. At Biosuroeste, inputs purchased from outside the production system include seeds, mineral supplementation for the cattle and mineral amendments for the soil which are utilized in the bio-factory to increase bonding-capacity of molecules. These mineral amendments are sourced from mining though classified as organic. The young animals are a contribution from an ally within the community – Agrosavia, a

technical arm from the agriculture ministry.

Seeds are retrieved from local farmers as well as commercial enterprises. Seeds are also being saved within the system. As the production cycle referenced in this report is the first for Biosuroeste, naturally most seeds have been brought in from outside the production system, altering the score of the index *Use of external inputs*. Overall, most inputs (feed, fertilizer, water etc.) used are produced or obtained within the system, and networks for trade within the community are in place.

On animals, obligatory vaccines are given. Once in the production cycle, de-worming medicine and medicine for parasite control was given to the young bovines. This proceeded an analysis of manure, as weight drops had been registered.

Within the 2019 version of CAET, under the index of *Management of pests and diseases*, both higher scores of 3 & 4 require zero use of drugs on animals. Furthermore, within this index, drugs and chemical pesticides are clustered together. For Biosuroeste, the scoring on this index is lowered due to their medicinal treatment of cattle. Within the CAET 2025, this set measurement has been altered, allowing for a score of 4 for use of drugs in animals in precise measurements when needed, and there are further criteria to demonstrate if preventative measures are utilized. Hence, this updated version offers a more nuanced and detailed scoring system for the treatment of diseases in animals and modifies a previous assessment that any drug- treatment of animals results in negative effect on agroecological performance.

The index of *Productivity and household needs* has been deemed N/A for this production system, as the set measurements are written in ways which mainly applies to a family-farm system. Modifications in the CAET that could enable this index to suit alternative agricultural production systems could read as follows, e.g. for score 4: *Workers needs are met in terms of income and free-time to enable a good diet, regular savings and fulfilling recuperation.*

Element Recycling

2019 CAET:

Score: 81%

Indices: *Recycling of biomass and nutrients; Water saving; Management of seeds and breeds; & Renewable energy use and production*

All biomass and nutrients produced within the agricultural production at Biosuroeste is used as mulch or compost. Water harvesting is done through keyline hydraulic design, and no irrigation is currently needed. The strategy team are looking into other methods and equipment for harvesting water, as they notice dry periods are becoming more persistent than previously in the bioregion.

Biosuroeste utilizes solar power to maintain the cattle operation and gasoline is used in small amounts for a rototiller, woodchipper and a grass chopper a few times a year. Mainly, transportation within the park is done with mules. The park – with offices and a restaurant – uses electricity from the municipal grid, effecting the score of the index of *Renewable energy use and production*. Biosuroeste are currently looking into

pathways for transitioning to self-produced electricity, a factor which is specifically included in the 2025 version, slightly raising the score on the element of recycling in this version.

Element Resilience

2019 CAET:

Score: 100%

Indices: *Stability of income/production and capacity to recover from perturbations; Mechanisms to reduce vulnerability; Indebtedness; & Diversity of activities, products and services*

Within the evaluated production cycle, both production of crops/meat and the average income of employees have increased throughout the year. Within 2024, Comfama increased salaries for employees with lower income. The reasons were two-fold: 1 to even out wage-gaps between employees, and 2. the government of Colombia raised the over-all minimum wage, signalling requested developments for many formal employments. The operational (farming) team earn substantially (one third) more than minimum wage and above the average farmer in the region. Income and employments are experienced as stable.

The surrounding community is experienced as highly supportive. An example provided within the interview was the occurrence of a forest fire affecting the land of Biosuroeste in 2024, when several communities in the area showed up to aid with practical support in putting out the fires. Furthermore, there is a high diversity in stakeholders and investors in the project, indicating increased resilience in cases of perturbations. Land-tenancy and financial

support for the project is experienced as secure. The project is not indebted.

Within the 2025 version tested in this study, the index of *use of seeds and breeds* has moved from recycling into the element of resilience. As described under the rubric recycling, majority of seeds have not been self-produced due to the studied production-cycle being the upstart of the agroforestry system. This slightly lowers the score of resilience in the 2025 version.

Element Culture & food traditions

2019 CAET:

Score: 75%

Indices: *Appropriate diet and nutrition awareness; Local or traditional (peasant/indigenous) identity and awareness; & Use of local varieties/breeds and traditional (peasant/indigenous) knowledge for food preparation*

Within the group discussion held with the operational team at Biosuroeste, topics surrounding food utilization and preparation were discussed. Access to food within the area of residence is sufficient, diverse and financially accessible for the employees of Biosuroeste. Nutritional practices are known to some extent, but not fully implemented in day-to-day life of employees, with little consumption of deep-coloured vegetables and leafy greens. Through the harvesting at Biosuroeste employees are gifted vegetables, herbs and fruits, but there is an identified lack of knowledge for food preparation of several of the harvested crops.

This challenge has been identified prior to this study, and both the director of Biosuroeste and its technical director of

agroecology strategize on pathways for increasing knowledge of food preparation and dietary diversity within the community. The restaurant contracted to serve breakfast and lunch to employees and visitors was explicitly requested to use local produce, to minimize use of e.g., sugar and deep-fry vegetal oils, and to culinarily engage with the diversity of crops harvested at Biosuroeste. To promote traditional knowledge about food preparation, Biosuroeste organized a gastronomic event in December 2024 with the aim to promote different cuts of beef and techniques for their preparation.

A strong local and agricultural identity is expressed within the region and present within Biosuroeste as well. Generally, this is pointed to by the strategy team as an enabler for agroecology in the region, whereas lack of knowledge of diverse-food preparation is viewed as a challenge.

Within 2019 version of CAET, the index of *Use of local varieties/breeds and traditional (peasant/indigenous) knowledge for food preparation* presents an example of diverse criteria clustered into one, as *use of local breeds* and *knowledge for food preparation* are clustered into one scoring. Within the 2025 version, the criteria are further disaggregated, enabling the possibility to identify and score for a diverse use of traditional breeds cultivated at Biosuroeste. These include plantain, cacao, banana and papaya, as well as traditional animal breeds, such as *Blanco orejinegro*, and honeybees, cultivated on the farm. Nevertheless, the technical director of agroecology at Biosuroeste points to a difficulty in assessing crops as “traditional” in a country where agriculture

has been shaped by colonisation, and requests further clarification on this criterion.

Element *Co-creation & sharing of knowledge*

2019 CAET:

Score: 100%

Indices: *Platforms for the horizontal creation and transfer of knowledge and good practices; Access to agroecological knowledge and interest of producers in agroecology; & Participation of producers in networks and grassroots organizations*

Co-creation and sharing of agroecological knowledge are essential to the expressed mission of Biosuroeste, and many platforms are established for this purpose. The allyship with Agrosavia is a main channel for expanding awareness of agroecology in use by Biosuroeste. Agrosavia is a technical arm of the ministry of agriculture, legislated to provide agricultural information and technical support to farmers. Agrosavia interacts with associations of farmers with representatives from both large- and small-scale producers in the region. The allyship with Biosuroeste entails that Agrosavia has access to their platform of agroecological knowledge and statistics. This can further be incorporated it into strategic development of agriculture in the region, in dialogue with farmers associations.

Within the region, there are strong social and environmental movements present, promoting the values of healthy ecosystems in opposition to forces of extractivism and large-scale copper mining present within the region. Biosuroeste exchanges support and engages in

collaboration with such movements. In 2024, for example, an event was co-organized by Biosuroeste, called *Diálogos por el Buen Vivir* (Dialogues for good living). Participation was diverse, with majority women, and representation from children and elderly.

When it comes to agroecological knowledge among the producers themselves at Biosuroeste, the operational (farming) team went through a course on agroecology – developed in collaboration with Agrosavia – together with participants from local communities, of more than 100 hours. This course formed the basis for the establishment of the agroforestry system at Biosuroeste. In the group discussion held with the operational team, there was noticeable interest in agroecology, with discussions around crop-rotation and agroecological solutions to pest-management.

Further platforms in use and in development for co-creation and sharing of agroecological knowledge include OSESA (Observatorio de Suelos y Ecosistemas del Suroeste de Antioquia), a database providing i.a. soil and weather data, intended to accelerate research processes and to be used by farmers in establishments of agricultural production systems.

Element Human & social values

2019 CAET:

Score: 100%

Indices: *Youth employment and emigration; Animal welfare*

Not applicable (N/A): *Women's empowerment; Labour/productive conditions, social inequalities*

The reliability of the 2019 CAET scoring for Biosuroeste is affected by the inapplicability of 2 indexes, leaving the average of only 2 indexes to provide the total score.

The set measurements to *Women's empowerment* pose difficulty in assessing the structure of Biosuroeste, as they regard decision making and access to resources for women – indicating the free choice to plan and organize the production system. At Biosuroeste, there is a hierarchical company structure, where directors ultimately make decisions for the progression of the corporation. Mechanisms are in place to include strategy and operational teams, as well as allies such as Agrosavia, in decision making. These mechanisms include strategy and consultation meetings with all staff. Within the operational team, women are leading voices. The strategy team is made up of men. Directors of Biosuroeste are male. Looking to Comfama as the employer, the directive council is made up of women and men. There are also strategies in place within Comfama to increase LGBTQ+ awareness in the region, through e.g., free movie-screenings of queer film productions.

The index of *Labour/productive conditions, social inequalities* place agriculture on a spectrum where scores 2-4 require family farming, wherefor it is herein deemed N/A to the agricultural production structure of Biosuroeste. The 2025 version of CAET, with disaggregated criteria, enable for other applicable criteria of working conditions within the agricultural system. However, the criteria *Farmers empowerment* again draws a spectrum of farming which on one end is

agribusiness with unjust working conditions (score 0-1), and on the other end is agriculture based on family farming (scores 2-4). This spectrum leaves out alternative agricultural systems, such as the model of Biosuroeste, community/co-operative agriculture or different types of living labs operating under a research- & commercial food production combination structure.

Youth engagement is evident within the work of Biosuroeste. Within the operational team, there are 3 women aged below 25, and the workers testify to an interest in working in agriculture. The strategy team observes participation of youth in events hosted by Biosuroeste as well as technical assistance programs. Youth engagement is viewed as essential to the development of agroecology in the region, and strategies to involve youth include discerning and strengthening premium markets and interweaving agriculture with bio-tourism.

Animals at Biosuroeste are slaughtered according to national regulations, which are described as strict and well-regulated. Animals are kept well – with shade offered by the forest they take part in regenerating, rich pastures increasing in quality by soil management-oriented grazing practices and plentiful room to express natural behaviours – and there is overall good knowledge about their health state. Interestingly, the technical director of agroecology at Biosuroeste is a veterinary and used to work at university, teaching animal welfare to veterinary students.

Within the informal 2025 version of CAET herein tested, a sub-criterion of *Physical strain of farming activities* has been included, with highest score of the set

measurement reading as *Farming tasks do not involve any heavy manual labour*.

Farming tasks at Biosuroeste are balanced and aided from mechanizations such as rototillers, but nevertheless physically straining, slightly altering the score of this element.

Element *Circular & solidarity economy*

2019 CAET:

Score: N/A

Not applicable (N/A): *Products and services marketed locally; Networks of producers, relationship with consumers and presence of intermediaries; Local food system*

As noticeable in the CAET diagrams (Figures 1 & 2), the element of Circular and solidarity economy is not included for the assessment of Biosuroeste. As produce is not connected to market (see Results, Step 0 – Context) assessments of the locality of products, relationship with consumers, and marketing processes are not possible.

Financial viability and market connections are, however, at the core of Biosuroestes' strategy plan for agroecological expansion in the bioregion. One point where Biosuroeste differs in opinion from the value-system evident within TAPE is around market behaviours. Within the 2019 version of CAET, the index of *Products and services marketed locally* requests all products and services to be sold on local markets for a high-scoring agroecological transition. Biosuroeste does not, in their bioregional strategy, promote focus on only the local market context.

Values are inherent to transdisciplinary research, and awareness of them is important for conscious utilization of research output. The practices scoring high within TAPE are inevitably promoted by the tool. The assembly of indices has been participatory, involving many discussions, with representation from diverse organizations as well as research communities (FAO, 2019). Their development is also under continuous revision, as evidenced by the development of a 2025 version of CAET, where the highest scoring of this criterion differs to *80 % of products and services marketed locally*.

The evident difference in view on promotable market behaviours – although largely levelled out in the updated version of CAET – for achieving financial viability within agroecological production presents an interesting conversation around agroecology and scalability. At the core of the business strategy at Biosuroeste is the concept of emerging sectors, with the potential to access so called premium markets world-wide. Premium markets are identified as markets with access to conscious consumers who are willing to pay higher price for added value and quality of products. Since products with added value typically require more skilled labour than those without – e.g., added value within cacao and coffee sectors require skills of drying, roasting, fermentation and tasting – this market focus is intended to attract younger populations to the countryside, create more formal employments, encourage local training- and knowledge enhancing initiatives to liberate more skilled labour, and catalyse overall rural development. Biosuroeste promotes an integrative (both-

and rather than either/or) thinking-approach, where the production system is developed around a produce suitable to premium market-demand (e.g., cacao as main crop in an agroforestry system), and surrounding produce are intended to promote self-sufficiency and the local food-supply (e.g., the surrounding agroforest). Furthermore, premium markets can be local as well as international. An example includes the local coffee market in the studied region. The technical director of agroecology at Biosuroeste highlights the work of OMCE (Organización Multisectoral Campesina Emprendedora), claiming that the organisation has, during the last decade, led a local culturalization of coffee and set the standard within the territory for how a “good coffee” is produced, and what it tastes like.

As part of their business strategy around emerging sectors, Biosuroeste works with what they call Developmental driving organizations. These are businesses and farmers organisations within the region who are connected to premium markets, with an evident interest or focus on agroecological practices. The intended outcome is that small-scale producers, through collaboration with these businesses, might get access to the markets and aforementioned benefits.

An example of an identified developmental driving organization is EcoHome, buyers of the harvest from *Sapindus saponaria* (Cumbimbo/Soap nut tree) for production of detergents. In collaboration with Biosuroeste, livestock-farming communities were invited in 2024 to learn about cropping of the native tree. This initiative promoted silvopasture systems contributing to forest regeneration, as well

as economic diversification for cattle farmers.

Element *Responsible governance*

2019 CAET:

Score: 100%

Indices: *Producers' empowerment; Producers' organizations and associations; & Participation of producers in governance of land and natural resources*

Within the CAET 2019, the element of *Responsible governance* is largely focused on the territory/community, as well as national, level. Within CAET 2025, focus has somewhat shifted to participation of producers in governance processes and their experienced sense of access to resources.

Biosuroeste is collaborating with several farmers associations in the bioregion, such as OMCE, Association de Cacao, Association de Ganaderos (Asogans) and Red de Protectores del Chumbimbo. Through providing and promoting formal employments, producers' rights are legally recognized.

On territory level, there are mechanisms in place which allow producers to participate in governance. The *Reunión de Campesinos* – meeting of farmers – hosted in Támesis during the time of data collection for this study provides an example of national and regional government representatives coming to the territory to engage with producers. While there is concern about increased political polarisation in the region, the technical director of agroecology at Biosuroeste testifies that the social movements of the

region continue to have a significant influence: “If it were not for the social movements, this territory would be covered mining and companies doing whatever to the land. When the mining came [...] the people became united.”

3.1.3 Step 2 – Core criteria of Performance

The Core criteria of performance within TAPE has been developed to generate evidence on the integrative performance of agroecology, to be used on policy-level (FAO, 2019). Therefore, each criterion has been linked to one or several SDG indicators, and TAPE results are collected to contribute to a global database by the FAO.

The criteria are divided into 10, together covering the policy-informing sustainability dimensions of Governance, Economy, Health & nutrition, Society & culture and Environment⁹. The results are calculated via questionnaires and provided methods of assessment, and communicated via a traffic-light approach, with green indicating desirable, yellow acceptable and red unsustainable.

As expanded upon in the methods chapter, several of these methods for assessment proved incompatible with the structure of Biosuroeste. The criteria of *Productivity*, *Income* and *Added value* necessitated a calculation of sold produce to utilize the provided method for assessment, and the provided questionnaires for criteria of *Women's empowerment* and *Youth employment opportunity* required a

⁹ **Core criteria of performance:** Secure land tenure, Productivity, Income, Added value,

Exposure to pesticides, Dietary diversity, Women's empowerment, Youth employment opportunity, Agricultural biodiversity and Soil health

household structure, or a farm-system where the community is living on sight, to be utilized. Nevertheless, each criterion communicates an important dimension of sustainability. In the following sub-chapter, the performance of Biosuroeste in relation to the criteria (see table 1) will be disclosed, together with how data could/not be supplemented by other methods.

Criterion *Secure land tenure*

Traffic light: Desirable

Method used for assessment: TAPE questionnaire

The land appointed to Biosuroeste is legally held by mayorships of Valparaíso and Tamesis. The municipal government assigned the land to the Biosuroeste corporation under a 30-year contract, and the perception on land rights from the project is that it is secure.

Table 1: Biosuroestes performance on the Core criteria

Dimension of sustainability & SDG(s)	Core criteria of performance	Results	Description
Governance 1; 2; 5	Secure land tenure	Desirable	Formal lease and perception of secure access to land
Economy 1; 2; 10	Productivity	Desirable	Output is equal to or above conventional regional farms
	Income	Desirable	Workers income above median income in similar agroecosystem
	Added value	N/A	
Health & nutrition 2; 3	Exposure to pesticides	Desirable	No pesticides used
	Dietary diversity	N/A	
Society & culture 2; 5	Women's empowerment	N/A	
	Youth employment	N/A	
Environment 2; 15	Agricultural biodiversity	Desirable	Gini Simpson score of 74%
	Soil health	Desirable	SCOLA Average score of 4,3

Criterion *Productivity*

Traffic light: Desirable

Method used for assessment:

Data provided by Biosuroeste – measuring productivity value per plant/live weight of cattle – compared to conventional production in a proximate area

The method for assessment of productivity provided in TAPE include calculations of sold produce, in relation to production and inputs. Ultimately, TAPE aims to find out if productivity per ha is above, similar or below average productivity value per ha in the country/region. Since sold produce is not measurable within Biosuroeste, alternative data to measure productivity has been obtained.

Biosuroeste has weighed and tracked all produce harvested from their agricultural production systems in the first production cycle and are in the process of comparing the data to statistics from conventional farms in the region.

Since the productive spaces are grown in intercropping systems, measuring productivity has been done through calculating the harvest per plant rather than ha. For the fruit trees which have already started providing harvests, i.e., banana, papaya and plantain, the harvest per tree was equal to that of conventionally grown trees in the region – but without any use of external inputs such as chemical fertilizers or pesticides.

Just the same, the bovine growth showed a productive output. Towards the end of the production cycle, the bovines were gaining 450 g per animal per day, entailing a live weight of 312 kg per ha. The average live weight per ha in cattle production in Colombia is 200 kg (Personal information, agroecological director of Biosuroeste). Important to note is that the studied production cycle was used to *establish* the cattle operation from scratch, solely through regenerative grazing practices. I.e., no tractors or other inputs were used, and the operation initiated with relatively bad forage quality from old, lignified grasses. This points to great potential for growth in productivity per ha for the cattle operation at Biosuroeste.

An important difference between the method used for assessment and that of TAPE is that the provided calculation-sheet of TAPE measures costs for inputs, which is missing for the alternative method utilized in this study.

Criterion *Income*

Traffic light: Desirable

Method used for assessment: Median income of workers in comparison to median income in region

Important to note is that the original purpose of the criterion of income is to report on whether agroecological production systems are offering a stable return based on their production. Hence, reporting on salaries being paid by Comfama, not based on sold produce/services, differs from the original purpose of this criterion. Nevertheless, workers at Biosuroeste perceive their income as stable and satisfactory.

Criterion *Added value*

Traffic light: N/A

The method of assessment provided in TAPE questionnaire for Added value requires calculation of sold produce. No alternative method of assessment was used.

Criterion *Exposure to pesticides*

Traffic light: Desirable

Method used for assessment: No calculation of exposure needed; no chemical pesticides in use

Methods for ecological management of pests in use at Biosuroeste include cultural control, plantation of naturally repelling plants such as moringa (trap-crop for leafcutter ants), use of cover crops such as vitabosa, favouring of reproduction of beneficial organisms within the bio-factory, as well as favouring of biodiversity within the agroecosystem.

Criterion *Dietary diversity*

Traffic light: N/A

Herein, the dietary diversity index is interpreted as intending to describe if dietary diversity within a household-type farm is met through their production. Hence, the criterion was deemed N/A in this study. For further information on Biosuroestes work to promote dietary diversity and nutrition awareness, see rubric *Culture & food traditions* (results, TAPE step 1 – CAET) and sub-chapter TAPE Step 3 - Participatory review of performance.

Criterion *Women's empowerment*

Traffic light: N/A

The questionnaire provided in the TAPE annex for women's empowerment is developed for a household structure. No alternative method of assessment was used.

Criterion *Youth employment opportunity*

Traffic light: N/A

The questionnaire provided in the TAPE annex for youth employment opportunity and emigration is developed for a household structure, looking at i.e., how many young persons have emigrated from the household. No alternative method of assessment was used. For further descriptions on youth in the production system of Biosuroeste, see rubric *Human & social values* under results (TAPE Step 1 – CAET).

Criterion *Agricultural biodiversity*

Traffic light: Desirable

Method used for assessment: TAPE

questionnaire – *Gini-Simpson index of diversity* Scoring 74%

For this study, the Gini-Simpson index provided in the TAPE guidelines proved poorly adapted to measure the studied intercropping systems, as the calculation requests areal per crop calculated in ha. Within intercropping systems, such as the agroforest, crops are typically unevenly distributed throughout the plots, making it challenging to estimate the area they cover. Hence, an estimation was made on area covered by which crop, which results in uncertain accuracy. An alternative method for calculating agricultural biodiversity in intercropping systems might benefit further development of TAPE.

Furthermore, Colombian livestock unit equivalents could not be obtained. Herein, bovine animals were calculated to 1 livestock equivalent, and mules to 0,8, as this corresponds to a European equivalent of horses and/or donkeys.

With further inclusion of more species of animals, the diversity index would raise significantly. Nevertheless, the diversity within the production system of Biosuroeste is evident and scores as desirable.

Criterion *Soil health*

Traffic light: Desirable

Method used for assessment: TAPE questionnaire – *SOCLA 10 indicators*, assessment from technical director of Agroecology at Biosuroeste

Table 2: SOCLA assessment of the two production systems of Biosuroeste

Indicators (scored 1-5, with 1 lowest and 5 highest)	Demonstrative Agroforestry system	Demonstrative regenerative cattle system
Structure	3	3
Compaction	3	3
Soil depth	5	5
Status of residues	5	5
Colour, odour and organic matter	5	3
Water retention	5	5
Soil cover	5	5
Erosion	3	3
Presence of invertebrates	5	5
Microbial activity	5	5
Average score	4,4	4,2

3.1.4 Step 3 – Participatory review of performance

The CAET diagrams and subsequent descriptions were examined together with the technical director of agroecology at Biosuroeste. The main challenge identified through the analysis concerned food preparation, nutritional- and conservation practices, as well as developing culinary habits within the community for utilizing the diversity of crops provided from the agroforestry system. As described under the element *Culture & food traditions*, mechanisms are already in place to meet this challenge. Further interventions planned include organizing an event in Tamesis in collaboration with a local

farmer and social movement activist, teaching preparation techniques of different horticultural crops. This workshop is intended to later be recreated with the working team of Biosuroeste.

Plans for improvement of performance were identified as already in place for all elements of the CAET where scoring showed less-than-ideal results. Examples are written out under section 3.1.2 (Step 1 – CAET) and include introduction of new breeds to the cattle operation, development of seed-saving practices and transition to self-produced electricity.

The enabling environment was identified as crucial to the performance observed in the CAET diagrams concerning especially the elements of governance and co-creation and sharing of knowledge. The prevalence of local people’s political engagement, the engagement of public-private initiatives in agroecology (i.e. Agrosavia, Comfama), the presence of active social movements and the diversity of farmers associations were particularly highlighted. An example provided was the occurrence of a regional mass-death of bees witnessed in the region a few years prior to this study, mobilizing locals and resulting in a prohibition of a commonly used neonicotinoid on avocado, citrus- and coffee trees. The agroecological director pointed to a relative uniqueness of this enabling environment stating “People here feel that their voices are important, that they can speak up. Even with the history we have [of political turbulence] in Colombia.”

The evidence generated at Biosuroeste may be used to inform regional development of several SDGs and may prove highly relevant for regional and national policymakers. Table 1 provides

connections of SDGs to each criterion of performance as they have been identified by the FAO. Looking beyond these, Biosuroeste can be stated to be generating particularly intriguing evidence on regional development of goals 8 (decent work and growth) and 11 (sustainable communities).

3.2 Potential uses and limitations of TAPE for Biosuroeste

For Biosuroeste, the results of this report can be useful to provide a descriptive summary of their agroecological approach to allies and other relevant actors. Through utilization of a globally applicable tool, this report provides results which can be compared on global scale. It may also be utilized to demonstrate multi-faceted performances of agroecology and the potential of the initiative of Biosuroeste to policymakers within their reach. Seeing as the project is – according to the assessment herein brought forth – bridging on ideal scoring, the TAPE survey might be considered too rudimentary for utilization aiming to measure the progress of Biosuroeste itself. Nevertheless, TAPE might serve as a useful tool for many other interests of Biosuroeste. The following text will suggest uses of TAPE, as well as reflect on relevant strengths and limitations of the method identified through a participatory discussion and literature review.

During the participatory reflection for this study, the technical director of agroecology at Biosuroeste expressed an interest from the project in understanding how the unique environment surrounding the southwest provides the enabling

opportunities for agroecology identified in steps 0-3. “Why is this happening here, in the southwest? Why are people having these conversations here?” To fully answer this question, different research methodologies would need to be applied, focusing on the role of social movements and governance within the region. TAPE could, however, be used to further verify the proposal of the southwest of Antioquia as an agroecological district, through mapping its different agricultural initiatives. As the tool was developed to require minimum training for data-collection (Mottet, 2020), Biosuroeste could – through their established connections with different universities globally – help attract students to the region to perform this type of mapping. This type of collaboration would further contribute to the FAO database on TAPE and the performance of agroecology.

TAPE was initially developed to collect data on the prevalence and performance of agroecological production systems (FAO, 2019; Mottet, 2020), though it is currently broadly being used to monitor and evaluate agricultural projects over time (personal communication, FAO TAPE-team member). Upon participatory discussion with the technical director of agroecology at Biosuroeste, there was agreement on the potential of TAPE to help assess progress of producers in technical assistance programs offered by Biosuroeste. The technical director expressed interest in adapting the 10 elements to the local context and developing a survey stemming from TAPE which incorporates particularly relevant technical aspects, such as live weight per ha of bovine livestock. There was also a request to simplify the tool, making it easier to use and less clustered

than in the 2019 version of CAET, and to implement it through digital surveys sent directly to farmers.

With the revisions TAPE is currently undergoing, as evident in the 2025 trial CAET version, some main intentions are to meet these very requests (personal communication, FAO TAPE-team member). The 2025 CAET version of TAPE includes more refined sub-criteria to reduce clustering and will also be tested in a yes/no format for feasibility and ease of use (personal communication, FAO TAPE-team member). The TAPE surveys are also intended to be made available via KoBoToolbox, a platform developed for humanitarian data collection, which integrates directly with the FAO database (Mottet, 2020). Looking to these developments, Biosuroeste could benefit from collaboration and co-creation with FAO, rather than diverging from the development of TAPE. Seeing as a core aim of TAPE is to provide an operationally flexible framework (FAO, 2019), co-created modifications might prove feasible while maintaining integrity of data for global comparison. Stemming from the collaborations underlying this study, a meeting is being planned between the technical director of agroecology at Biosuroeste and a developer of TAPE at the FAO, to explore possible convergences of interests and future collaboration between the organisations.

Within the participatory discussion, the interview-process of TAPE was remarked as time-demanding, resulting in the idea of a digital-survey form for farmers to fill out themselves. There was, however, acknowledged benefits of the interview format in terms of quality of information,

influencing the appropriateness of potential interventions. Some of the main strengths identified for TAPE include its ability to foster transformative discussions among and between farmers, researchers and policymakers (Hansdotter, 2022; Mottet, 2020). With a simplified survey form, trade-offs might include the participatory aspects of the method which foster relationships between data collectors and farming communities. Therefore, the purpose of the evaluation should be considered carefully before choice of method for data collection.

Further limitations of TAPE remarked through discussions with the strategy team of Biosuroeste include the constraint of the circular economy, as it is presented in CAET 2019, to the local market. As presented under the element *Circular & solidarity economy* (see 3.1.2 Step 1 – CAET), Biosuroeste utilizes and promotes a business strategy which focus on both local and export markets. It would be out of strategy for them to measure impact of their projects with indicators they are not in agreement with. Within the informal CAET 2025 utilized herein, the measurement has been altered from 2019, giving a full score of 4 to a ratio of 80 % of products and services marketed and sold locally, rather than requesting *all* sales to be sold and marketed locally. Biosuroeste would need to consider whether the practices promoted in TAPE are in alignment with their own business strategy and agroecological approaches.

3.2.1 Measuring impact – Alternative indicators

A challenge of intercropping systems, shared by Biosuroeste, is that of measuring productivity of produce. Within the evaluation of their first production cycle, Biosuroeste have calculated productivity per plant in comparison to an estimated productivity per plant in a neighbouring, monocultural farm (see results, Step 2 – Core criteria of performance, rubric *Productivity*). An alternative metric for measuring productivity of harvest per area is utilizing the land equivalent ratio, or LER, developed in the 1980's for evaluation of biological efficiency of intercropping systems (Leihner, 1983). This method is useful to 1. Compare and pedagogically express advantages in terms of biological production (produce per area) of intercropping as compared to monoculture/sole cropping systems and 2. Discern advantages or disadvantages of one intercropping-combination of crops in comparison to another one, in terms of biological production (Leihner, 1983). LER technically offers the calculation of productivity of an unlimited number of crops in combination, making it appropriate to agroforestry systems. The metrics required for calculation are 1. Weighed harvest of each individual crop in an intercropping system, delimited by a chosen area (e.g. 1 ha) and 2. Output per equal area of the same crops in a comparable monoculture system. The table below (see table 3) provides a description of the calculation through figurative data. The table indicates that a total of 1,83 ha of monoculture/sole cropping area would be needed to produce the same yields as 1 ha of the imagined intercropped system.

Table 3: Example of application of LER to an intercropping system

Crop	Intercropped Yield IY (kg/ha)	Sole Yield SY (kg/ha)
Grain	4000	5000
Fruit	9000	15000
Vegetable	3000	7000
Land equivalent ratio (LER):	$(IY_{grain}/SY_{grain}) + (IY_{fruit}/SY_{fruit}) + (IY_{vegetable}/SY_{vegetable})$	= 1,83

A limitation of the above method is the lack of measured productivity in terms of the input-output ratio. The calculation sheets provided in the annex to TAPE (FAO, 2019) aim to account for costs of input in the calculation of productivity, with the downside that productivity results will fluctuate in accordance with market behaviours. Furthermore, neither method accounts for invaluable assets, such as increased soil quality, stored carbon or nutritional increases in plant.

LER might be utilized to measure productivity over time in farm-systems connected to Biosuroeste, through e.g. technical assistance programs, and could be utilized to demonstrate if implemented strategies have increased productivity of the assessed farms.

For measuring multi-dimensional progress of Biosuroeste as an organization, the Sustainability Assessment in Food and Agriculture Systems (SAFA) guidelines – also developed by the FAO (FAO, 2012) – may be tested. For some agricultural researchers, such as Schader et. al. (2014), SAFA provides an encompassing baseline for what sub-themes/sustainability

dimensions can be included for a holistic sustainability assessment. Few comparisons have been found in the literature review to this study between SAFA and TAPE, and a trial comparison utilizing Biosuroeste as a case study may prove of high research relevance. Nevertheless, scope-differences are that SAFA aims its focus on a broad spectrum of sustainability dimensions and organisational forms within the whole food-production chain, whereas TAPE emphasises agroecological transitions on the farm-scale. As Biosuroeste aims its scope of collaboration and sharing of agroecological practices towards small-scale farmers as well as agribusiness, SAFA might prove useful to measure impact of initiatives directed at the latter group.

Furthermore, many areas where Biosuroeste express an interest for generating impact might require multiple methods for evaluation. As Biosuroeste are adopting a holistic and integrative-thinking perspective, understanding and incorporating mixed-methodology frameworks will likely prove important. Measuring changes in overall health of a complex ecosystem of humans- and non-humans is likely to require approaches which value subjective experience alongside quantitative data.

4.0 Discussion & conclusions

The following section aims to conclude the remarks brought forth, embed results in their research context and further reflect upon the reliability of this study.

Through utilization of a globally applicable tool, this report provides results on the agroecological performance of Biosuroeste which may be used for comparison and communication on a global scale. Within the TAPE surveys, Biosuroeste scores overall explicitly high on agroecological performance. This indicates that TAPE might be rudimentary to evaluate further development of Biosuroeste, and tools such as SAFA may be explored to measure further development of Biosuroeste in ways which include a diversity of sustainability dimensions. As expressed by Schader et. al. (2014), there are however trade-offs to utilizing assessment methodologies which aim to cover a broad scope, as a broad scope likely compromises depth of analysis.

TAPE aims to cover particularly broad scopes, both in terms of sustainability dimensions but also through the aim of global applicability. There is broad support stating TAPE as a valuable tool for assessing agroecological performances (e.g., Mottet et. al., 2021) but also statements that it is one which requires adaptation to the local context on-site for ultimate effectiveness (Namirembe et. al., 2022). Co-design, with particular attention to specific objectives, together with relevant stakeholders for Biosuroeste – and through a possible collaboration with FAO TAPE-developers – is recommended for implementation of TAPE to assess impacts of technical assistance programs provided by Biosuroeste. Attention to possible trade-offs, in terms of quality of information, is of importance if the methodology for data collection is shifted to a digital survey form, directly filled out by producers.

If TAPE aims to move towards broader inclusiveness of alternative agricultural production systems, revision of the core criteria of performance and formulations of certain set measurements within the CAET could be beneficial. Table 4 represents a summary of indices and criteria herein found not applicable to the non-household farming system.

Table 4: Summary of indices and criteria deemed N/A to non-household food-production systems

CAET Indices	Core criteria of performance
Productivity and household needs	Women's empowerment
Women's empowerment	Youth employment
Labour/productive conditions, social inequalities	Dietary diversity

Furthermore, subsequent table 5 demonstrates which indexes and criteria proved not/poorly applicable for assessment of a production system outside of market structures, such as different types of farm-scale research projects.

Table 5: Summary of indices and criteria N/A to food-production system outside the market

CAET Indices	Core criteria of performance
Products and services marketed locally	Productivity
Networks of producers, relationship with consumers and presence of intermediaries	Income

Local food system	Added value
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While the indices and criteria displayed in tables 4 and 5 are currently not, or poorly, adapted to the agricultural system herein studied, their importance is valid. Minor to grander adjustments in formulations (in CAET) and additional, alternative methods provided for data collection (in the core criteria of performance) would radically alter their applicability to alternative, non-household farm structures. Several suggestions have been brought forth in the results chapter of this report.

Changes from the official 2019 to the pre-pilot version of CAET 2025 tested within this study include greater discernment of agricultural practices within each index, allowing for increased quality of data and reliability of assessment. The pre-formulated questions provided to score the studied production-system marks an improvement in reliability and replicability from the 2019 version, where the conductor of the evaluation designs an interview guide to obtain the needed information to score on the indicators. Hansdotter (2022) has pointed to the vulnerability of a method with such space for interpretation on how to conduct the assessment, as evident in CAET 2019.

While the vulnerability of subjectivity is improved through the pre-formulated questions – which will be launched and tested in a yes/no format among TAPE affiliates in 2025 (personal communication, FAO TAPE-team member) – subjectivity of assessment may be considered an inevitable element of qualitative data collection, coloured both by the interviewers and the interviewees formulations and interpretations (Bryman,

2018). Within this study, the utilization of two different CAET questionnaires may be viewed as a reinforcement of results, increasing reliability. Nevertheless, subjectivity of interpretations remains, and a replicated assessment by another evaluator would enhance further credibility of this study.

TAPE has been tested for appropriateness of utilization in a wide diversity of geographical locations (Mottet, 2020; Hansdotter, 2022), but assessments of the tool's performance on a variety of business-structures, outside of the family farm, are rarer. This study has represented a unique opportunity to explore the development of TAPE and its applicability to alternative emerging agricultural initiatives. Within this study, conclusions coincide with that of Namirembe et. al. (2022) and Shader et. al. (2014), concluding that the relevance of a tool for sustainability assessment aiming to cover a broad scope is enhanced by its capacity to be tailored to its specific purpose and coverage. At the same time, routine divergence from TAPE surveys might ultimately result in less robust comparative data on the global scale. The FAO TAPE-team is there for herein encouraged to maintain, and prioritize, operational flexibility in further development of TAPE. Furthermore, co-creation with potential communities of users, such as Biosuroeste, tailoring the survey to specific bioregions might result in increased inflow of stabilized data on global agroecological prevalence and performance.

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Appendix 1 – Scoring of Biosuroeste on 2019 CAET

Element	Index	Score
Diversity	Crops	➤ 4 – More than 3 crops of different varieties adapted to local conditions and spatially diversified farm with multi-, poly- or inter-cropping
	Animals (including fish and insects)	➤ 4 – More than three species with different breeds well adapted to local and changing climatic conditions
	Trees (and other perennials)	➤ 4 – High number of trees (and/or other perennials) of different species integrated within the farm land
	Diversity of activities, products and services	➤ 4 - More than 3 productive activities, and several services
	Crop-livestock-aquaculture integration	➤ 4 - Complete integration: animals are exclusively fed with feed produced on the farm, crop residues and by-products and/or grazing, all their manure is recycled as fertilizer and they provide more than one service (food, products, traction, etc.)
Synergies	Soil-plants system management	➤ 4 - All the soil is covered with residues or cover crops. Crops are rotated regularly and intercropping is common (or rotational grazing is systematic). Little or no soil disturbance.
	Integration with trees (Agroforestry, silvopastoralism, agrosilvopastoralism)	➤ 4 - Complete integration: many trees (and other perennials) provide several products and services
	Connectivity between elements of the landscape	➤ 4 - High connectivity: the agroecosystem presents a mosaic and diversified landscape, many elements such as trees, shrubs, fences or ponds can be found in between each plot of cropland or pasture, or several zones of ecological compensation
	Use of external inputs	➤ 3 - The majority of the inputs is produced on farm/within the

Efficiency		agroecosystem or exchanged with other members of the community
	Management of soil fertility	➤ 4 - No synthetic fertilisers are used, soil fertility is managed only through a variety of organic practices
	Management of pests and diseases	➤ 2.5 (due to use of drugs to treat animals once in the production cycle, Biosuroeste falls in between the rankings even if preventative measures and organic practices are the norm. The formulations have been modified 2025) 2 – Pests and diseases are managed through organic practices but chemicals are used only in specific and very limited cases 3 – No chemical pesticides and drugs are used. Biological substances are the norm
	Productivity and household's needs	N/A
Recycling	Recycling of biomass and nutrients	➤ 4 – All of the residues and by-products are recycled. No waste is discharged or burnt
	Water saving	➤ 3 – One type of equipment for water harvesting or saving and various practices to limit water use
	Management of seeds and breeds	➤ 3 – The majority of seeds/animal genetic resources are self-produced or exchanged. Some specific seeds are purchased from the market
	Renewable energy use and production	➤ 3 – Significant production of renewable energy, negligible use of fuel and other non-renewable sources
Resilience	Stability of income/production and capacity to recover from perturbations	➤ 4 – Income and production are stable and increasing over time. They fully and quickly recover after shocks/perturbations
	Mechanisms to reduce vulnerability	➤ 4 – Community is highly supportive for both men and women and can significantly help after shocks. And/or access to credit is almost systematic and insurance covers most of production

	Indebtedness	➤ 4 – No debt
	Diversity of activities, products and services	➤ 4 – The average score for the element of diversity
Culture & food tradition	Appropriate diet and nutrition awareness	➤ 3 – Food is sufficient and diverse. Good nutritional practices are known but not always enforced
	Local or traditional (peasant/indigenous) identity and awareness	➤ 4 – Local or traditional identity strongly felt and protected, high respect for traditions and/ or rituals
	Use of local varieties/breeds and traditional (peasant/indigenous) knowledge for food preparation	➤ 2 – Both local and exotic/introduced varieties/breeds are produced and consumed. Local or traditional knowledge and practices for food preparation are identified but not always applied
Co-creation & sharing of knowledge	Platforms for the horizontal creation and transfer of knowledge and good practices	➤ 4 – Several well established and functioning platforms for the co-creation and transfer of knowledge are available and widespread within the community, including women
	Access to agroecological knowledge and interest of producers in agroecology	➤ 4 – Widespread access to agroecological knowledge of both men and women: producers are well aware of the principles of agroecology and eager to apply them, facilitating knowledge sharing within and between communities and involving younger generations
	Participation of producers in networks and grassroots organizations	➤ 4 – Producers (with equal participation of men and women) are highly interconnected and supportive and show a very high engagement and participation in all the events of their local community and grass-root organisations
Human & Social values	Women's empowerment	N/A
	Labour (productive conditions, social inequalities)	N/A
	Youth employment and emigration	➤ 4 – Young people (both boys and girls) see their future in agriculture
	Animal welfare	➤ 4 – Animals do not suffer from stress, hunger, thirst, pain, or diseases, and are slaughtered in a way to avoid unnecessary pain

Circular & solidarity economy	Products and services marketed locally	N/A
	Networks of producers, relationship with consumers and presence of intermediaries	N/A
	Local food system	N/A
Responsible governance	Producers' empowerment	➤ 4 – Producers' rights are recognised and respected for both men and women. They have the capacity and the means to improve their livelihoods and to develop their skills.
	Producers' organizations and associations	➤ 4 – More than one organisation exist. They provide market access and other services, with equal access to men and women
	Participation of producers in governance of land and natural resources	➤ 4 - Mechanisms allowing producers to participate in the governance of land and natural resources exist and are fully operational. Both women and men can influence decisions