The Andean chakra as a socioecological system of Buen Vivir for food sovereignty

A Chakra Andina como sistema socioecológico do Bem Viver para a soberania alimentar

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doi: 10.18472/SustDeb.v17n2.2026.61655

Received: 05/03/2026
Accepted: 27/07/2026

ARTICLE- VARIA

ABSTRACT

Agricultural production systems developed by Indigenous peoples in the Andes respond to mountain ecosystems characterised by high climatic, edaphic, biological and cultural diversity. This study analyses the agronomic and sociocultural practices of the Andean chakra in communities of the Ecuadorian highlands that produce food under the paradigm of *Sumak Kawsay* and the symbolism of the Chakana. The research adopted a mixed-methods approach across three phases: territorial characterisation through GIS georeferencing, fieldwork comprising 24 surveys, 16 semi-structured interviews and 3 focus groups in six provinces of the north-central highlands, and data analysis using NVivo 14 and SPSS 30. The results show that the chakra constitutes a family-based agricultural and livestock system underpinned by resilient ancestral knowledge and technologies, with an average of 25 cultivated species per productive unit. Among the main practices identified are crop association, conservation of native seeds, organic soil management, efficient water use and the application of phytomedicine. These practices strengthen biodiversity and reciprocity between society and nature through the communal work known as the minka. Likewise, the great majority of the chakras studied are managed mainly by women, who ensure food sovereignty, the transmission of knowledge and the conservation of agrobiodiversity. It is concluded that the Andean chakra is a current and adaptive strategy of sustainable agriculture, whose preservation requires intercultural public policies, recognition of women's work, and longitudinal and comparative lines of research across the Andes.

Keywords: Agrobiodiversity. Indigenous food systems. Ancestral knowledge. Community-based agriculture. Socioecological resilience. Andean cosmovision.

RESUMO

Os sistemas de produção agropecuária desenvolvidos pelos povos originários dos Andes respondem a ecossistemas montanhosos caracterizados por elevada diversidade climática, edáfica, biológica e cultural. Este estudo analisa as práticas agronômicas e socioculturais da "chakra" andina em comunidades da serra equatoriana que produzem alimentos sob o paradigma do "Sumak Kawsay" e sob o simbolismo da "Chakana". A pesquisa adotou uma abordagem mista em três fases: caracterização territorial por meio de georreferenciamento no SIG, trabalho de campo com 24 questionários, 16 entrevistas semiestruturadas e 3 grupos focais em seis províncias da serra centro-norte, e análise de dados com NVivo 14 e SPSS 30. Os resultados evidenciam que a "chakra" constitui um sistema agropecuário familiar sustentado em saberes e tecnologias ancestrais resilientes, com uma média de 25 espécies cultivadas por unidade produtiva. Entre as principais práticas identificam-se a associação de cultivos, a conservação de sementes nativas, o manejo orgânico do solo, o uso eficiente da água e a aplicação de fitomedicina. Essas práticas fortalecem a biodiversidade e a reciprocidade entre a sociedade e a natureza por meio do trabalho comunitário da "minka". Da mesma forma, a maioria das "chakras" estudadas é gerida principalmente por mulheres, que garantem a soberania alimentar, a transmissão de conhecimentos e a conservação da agrobiodiversidade. Conclui-se que a "chakra" andina é uma estratégia vigente e adaptativa de agricultura sustentável, cuja preservação requer políticas públicas interculturais, reconhecimento do trabalho feminino e linhas de pesquisa longitudinais e comparativas nos Andes.

Palavras-chave: *Agrobiodiversidade. Sistemas alimentares indígenas. Saberes ancestrais. Agricultura comunitária. Resiliência socioecológica. Cosmovisão andina.*

1 INTRODUCTION

The contemporary capitalist model of development has proven to be environmentally and socially unsustainable, as expressed in climate change, environmental pollution, water scarcity, food insecurity and the rise of global consumerism (Fernández; Gutiérrez, 2013; García, 2021; Whitmee *et al.*, 2015). In the agricultural sector, this crisis is expressed in the expansion of monocultures and the intensive use of agrochemicals and fossil fuels, practices that degrade soils, reduce biodiversity and deteriorate ecosystem services (Altieri; Nicholls, 2020; Brunet; Böcker, 2015), generating a growing debate about the need to move towards more resilient, diversified and socially just production models.

Conventional agriculture has been oriented towards maximising productivity through synthetic fertilisers, pesticides and modified seeds, with negative impacts on human health, ecosystems and food resilience (Ceccon, 2008; Fletcher, 2015). In response, international organisations promote sustainable systems based on the conservation of biodiversity and organic soil management (FAO, 2015; Rizo *et al.*, 2017). Agroecology proposes a break by conceiving the agricultural system as a social construction that integrates peasant knowledge (Altieri; Nicholls, 2020; Gliessman, 2015), while the Andean cosmovision incorporates reciprocity with the Pachamama (Escobar, 2014; Gudynas, 2011), which is absent from the conventional model. There remains a risk that technical solutions may render invisible the knowledge and practices of Indigenous peoples, with no consensus yet on how to reconcile productive efficiency with ancestral epistemologies.

In this context, agroecology integrates scientific knowledge and traditional knowledge to design sustainable agricultural systems, understanding traditional systems as reservoirs of ecological knowledge that enable environmental adaptation, conservation of agrobiodiversity and food sovereignty.

In Ecuador, these discussions gain relevance with the constitutional recognition of Buen Vivir or Sumak Kawsay, which proposes a harmonious relationship between human beings and nature and respect for the rights of the Pachamama (Cruz, 2018), based on reciprocity, complementarity and balance.

Among these practices, the Andean chakra stands out as an ancestral agricultural system that combines biological diversity, community organisation and Indigenous cosmovision in food production. Beyond its productive function, it reproduces the family unit and articulates ecological, community and spiritual knowledge in the management of agricultural biodiversity (Cachipuendo *et al.*, 2025; Confederación del Pueblo Kayambi, 2021; Herrán, 2017; Tamayo; Alegre, 2022).

Thus, in the face of the global socio-environmental crisis, studying the Andean chakra makes it possible to explore how the agronomic, cultural and spiritual practices of Indigenous communities contribute to the construction of more sustainable and resilient agricultural models (Altieri; Nicholls, 2020; Gliessman, 2015). This study analyses these practices in the production of healthy food, with the aim of understanding their contribution as a sustainable agriculture strategy for rural communities in the centre and north of the Ecuadorian Andes, considering the following theoretical framework.

Buen Vivir in food production

From the Andean cosmovision, producing food does not mean dominating the land, but rather being part of it in order to "nurture life" in reciprocity with the Pachamama (Acosta, 2015; Hidalgo *et al.*, 2014). Agriculture is conceived as a comprehensive practice that articulates political, spiritual, social and ecological dimensions oriented towards collective wellbeing. The Andean chakra expresses this paradigm by integrating biodiversity, family cooperation, organic soil management and gender equity (Confederación del Pueblo Kayambi, 2021; Herrán, 2017), revaluing the solidarity economy (Cachipuendo *et al.*, 2025).

Andean cosmovision and the alli mikuy

In the Andean cosmovision, the territory is a living system. The Chakana, or Andean cross, symbolises this structure of interrelationships and guides territorial organisation through ancestral knowledge (Campohermoso *et al.*, 2015; Confederación del Pueblo Kayambi, 2021). The chakra is configured as a biosystem oriented towards the nurturing of life, characterised by the diversified association of crops, the conservation of native seeds and the avoidance of agrochemicals (Herrán, 2017; Tamayo; Alegre, 2022), incorporating rituals linked to the alli mikuy, the collective right to healthy food. The family is the organisational core, driving practices such as the minka (Cachipuendo *et al.*, 2025).

Interculturality and the dialogue of knowledges

Contemporary Andean agriculture integrates ancestral and scientific knowledge in soil management, seed selection and agricultural calendars, without losing Indigenous cultural identity (De Sousa Santos, 2009; Escobar, 2014). In the chakra, knowledge is transmitted through communal experience, orality and spirituality (Churuchumbi, 2020), strengthening peasant autonomy and the decolonisation of agricultural knowledge (Salinas, 2019), in pursuit of complementarity between science and local wisdom (De Sousa Santos, 2009; Dubey *et al.*, 2026; Roos, 2025).

The chakra and the production of healthy food

The chakra is a comprehensive system of annual provisioning and intergenerational transmission of knowledge, understood as a living school of communal learning (Almeida *et al.*, 2021). It contributes to the family economy through bartering or agroecological fairs (bioferias) (Conejo, 2020; Monteros, 2020;

Requelme *et al.*, 2019). Its crop diversity optimises the use of soil, water and solar energy (Zambrano *et al.*, 2018), integrating food, medicinal and ornamental plants that strengthen food sovereignty (Confederación del Pueblo Kayambi, 2021; Herrán, 2017).

Socioecological resilience and adaptation to climate change

The chakra is a socioecological system that is resilient to environmental, health and economic crises (Altieri; Nicholls, 2020; Cachipuendo *et al.*, 2025). Its structure is related to the levels of Hanan Pacha, Kay Pacha and Uku Pacha, an expression of Andean ecological complementarity (Tamayo; Alegre, 2022). At each level, species adapted to different climatic conditions are cultivated, conserving seeds and water essential for food sovereignty (Altieri; Nicholls, 2020; Koohafkan; Altieri, 2011), which strengthens climate resilience and soil fertility. The land is understood as a living subject in a relationship of reciprocity (Toledo; Barrera-Bassols, 2008), such that the chakra articulates ecological knowledge, community organisation and biocultural diversity in favour of the continuity of life (Escobar, 2014; Gliessman, 2015).

2 METHODOLOGY

2.1 STUDY AREA

The research was carried out in rural communities in the provinces of Chimborazo, Tungurahua, Cotopaxi, Pichincha, Imbabura and Carchi, in the Andean region of Ecuador (Figure 1). These provinces are home to Kichwa Indigenous peoples such as the Karanki, Otavalo, Kayambi, Chibuleo, Puruwá and Panzaleo, whose productive practices maintain traditional agricultural systems based on the Andean chakra.

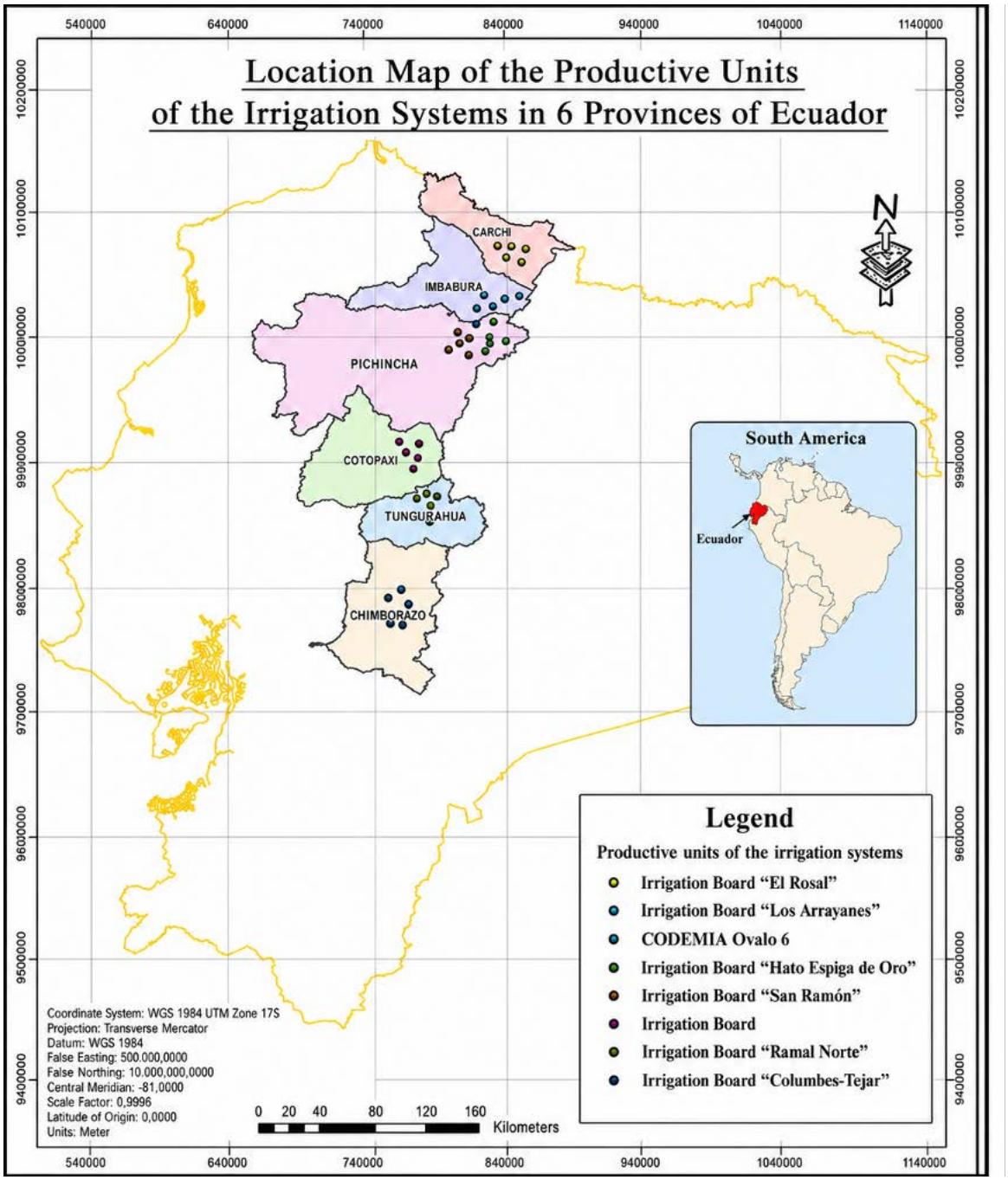


Figure 1 – Study area and location of the Andean chakras studied

Source: The authors (2026).

The study areas are located between 2,100 and 3,500 m.a.s.l., with a cool temperate climate (9°C to 16°C) and average annual rainfall of between 1,721 mm and 2,877 mm, giving rise to mountain ecosystems with high ecological diversity and agrobiodiversity (Climate, 2022). These conditions have favoured diversified agroecological systems based on ancestral knowledge of soil management, seed conservation and efficient water use.

2.2 METHODOLOGICAL DESIGN AND PROCEDURE

The research was carried out using an empirical, descriptive, analytical and participatory approach, combining qualitative and quantitative methods with leaders, producers and families who are guardians of chakras. Fieldwork was conducted between 2022 and 2024, in three phases.

First phase: contextual diagnosis

A documentary review was carried out of agroecological projects, rural development programmes and previous studies on Indigenous production systems in the north-central highlands. In addition, nine semi-structured interviews were conducted with key informants (NGO technicians, local government representatives, community leaders and academics), which made it possible to identify previous experiences and organisational processes related to chakra management.

Second phase: participatory fieldwork

24 surveys were administered to producers with active chakras, selected through purposive convenience sampling, and 16 semi-structured interviews were conducted with community leaders, women farmers and seed guardians, taking into account gender, generational and territorial diversity.

The questionnaire was organised into four sections: socioeconomic characteristics of the household; agronomic management of the chakra; cultural and spiritual practices; and marketing and food sovereignty. The instruments were validated through a pilot test with four producers not included in the sample and reviewed by a panel of three specialists in agroecology and Andean ethnobotany.

Fieldwork was complemented by three focus groups (northern highlands, central highlands and the transition zone), each with 8 to 12 members, with gender representation (at least 50% women), generational diversity and different community roles. The sessions were recorded with consent and transcribed for analysis. In addition, community discussions and participant observation were carried out during agricultural workdays, mingas and agroecological fairs, recorded in a structured field diary with predefined categories and free-form notes.

Third phase: systematisation and analysis

The chakras were georeferenced using GIS, employing QGIS 3.28 and ArcGIS 10.8, in order to identify their territorial distribution and the agroecological characteristics of the landscape. Qualitative data were processed through thematic content analysis using NVivo 14, and quantitative data using SPSS 30, by means of descriptive statistics, absolute frequencies and Spearman correlations between key ordinal variables (adoption of ancestral practices, crop diversity, use of compost and participation in exchange networks). Given the sample size, the results are presented as descriptive frequencies and trends, without statistical generalisation. Triangulation between sources, methods and analytical techniques strengthened the validity and reliability of the results.

2.3 ETHICAL CONSIDERATIONS

The study followed the ethical principles of the Declaration of Helsinki and ILO Convention 169 on Indigenous and Tribal Peoples. The Universidad Politécnica Salesiana does not have an institutional Ethics Committee; however, the study was endorsed by the representative organisations of the participating peoples, including the Confederation of Pueblo Kayambi, within the framework of the Free, Prior and Informed Consent (FPIC) protocol. Participants were informed of the objectives, methods and scope, and gave voluntary consent. Data were anonymised using alphanumeric codes, and the results were

shared with the communities through assemblies prior to publication. The authors declare that the research involved no risk to participants and no clinical data, minors or sensitive information.

3 RESULTS AND DISCUSSION

This section presents the results on the Andean chakra as a system for the production of healthy food: agronomic practices and biodiversity management; community dynamics, highlighting the minka and the role of women; and its contribution to food sovereignty and Andean socioecological resilience.

Given the small sample size, the quantitative data are presented as descriptive frequencies and trends, without statistical representativeness. Qualitative data from 16 interviews and 3 focus groups complement the findings, cited with anonymised codes.

3.1 BUEN VIVIR AGRICULTURE AND THE CHAKRA AS A SOCIOECOLOGICAL SYSTEM

The results show that agricultural production in the Indigenous communities of the north-central highlands of Ecuador is organised around the paradigm of Buen Vivir (Sumak Kawsay), in which the chakra constitutes the central family productive unit. This system integrates crop diversity, organic soil management and relationships of reciprocity between the family, the community and nature.

In the territories studied, the coexistence of different agricultural approaches is observed. On the one hand, productive systems based on ancestral knowledge and the Andean cosmovision are maintained; on the other, contemporary approaches such as agroecology, biodynamic agriculture and regenerative agriculture are incorporated (Table 1).

Table 1 – Unit of study of Buen Vivir and sustainable agriculture approaches

Criteria/ Approaches	*Andean Chakra Agriculture*	*Agroecology*	*Biodynamic Agriculture*	*Regenerative Agriculture*
Knowledge base	Ancestral knowledge and Andean cosmovision (cosmovivencial)	Integration of local and scientific knowledge; systemic and ecological approach	Anthroposophy, agricultural spirituality and lunar cycles	Ecological science, adaptive management and innovative practices
System structure	Geo-biodiverse systems: chakras, ajás, terraces, gardens; integrated into the landscape	Diversified and integrated systems: gardens, farms, mixed holdings	Self-sufficient farms with cyclical, closed-loop design	Systems in ecological transition with a regenerative approach to soil and ecosystem
Relationship with the environment	Sacred territory: connection with family, community and the cosmos	Ecological approach at multiple scales: plot, farm, watershed	Astral rhythms, lunar calendars, respect for subtle energies	Restoration of degraded landscapes, ecological efficiency
Productive objectives	Family food, reciprocity, food sovereignty	Food security and sovereignty, resilience, fair trade	Energetic balance, health of the agricultural ecosystem	Soil regeneration, carbon sequestration, adaptation to climate change
Approach to soil	Soil as a living being linked to the Pacha Mama	Natural fertility, compost, green manures, ecological management	Dynamisation of the soil with biodynamic preparations and ritualised compost	Active soil regeneration: vegetation cover, soil biology, erosion control

Criteria/ Approaches	Andean Chakra Agriculture	Agroecology	Biodynamic Agriculture	Regenerative Agriculture
Scale and context	Local and communal, adapted to the territory and cosmovision	Local to regional, adaptable to multiple scales	Medium scale with specific technical and ritual requirements	Variable scale, adaptable to the ecological and economic context

Source: Altieri and Nicholls (2020), Herrera-Sánchez (2023) and Requelme et al. (2019).

The field analysis also made it possible to identify two main types of chakra: the traditional chakra, based on ancestral knowledge and oriented mainly towards subsistence production, and the modern chakra, which incorporates contemporary technologies and crops oriented towards the local or regional market (Table 2).

Table 2 – Characterisation and evolution of the Andean chakras

Criterion	Traditional Chakra	Modern Chakra
Knowledge base	Ancestral knowledge, orally transmitted across generations.	Integration of traditional knowledge with technology and contemporary agroecological approaches.
Crop diversity	High biodiversity with native and medicinal species.	Maintains diversity, but incorporates commercial species (e.g. roses, fruit trees, vegetables).
Destination of production	Mainly subsistence and communal bartering.	Mixed: subsistence and production for local markets or agro-export.
Use of technology	Manual tools and traditional techniques adapted to the environment.	Implementation of modern technologies: technified irrigation, solar energy, genetic improvement.
Relationship with nature	Based on reciprocity with the Pacha Mama and respect for natural cycles.	Focus on efficiency and optimisation of natural resources (soil, water, energy).
Organisation of space	Adaptation to the natural landscape following symbolic, spiritual and ecological logic.	Technical-productive design adapted to the space, with functional efficiency.
Climate resilience	Based on biological diversity and local ecological knowledge.	Strengthened through adaptation technologies and resource management.
Cosmovision	Strongly linked to Andean spirituality and Buen Vivir.	Still present but combined with market approaches and agricultural modernisation.

Source: The authors (2026).

Thus, the Andean chakra can be interpreted as a complex socioecological system, in which ecological, cultural and economic dimensions interact in food production. Unlike other contemporary agricultural approaches, its productive logic is not focused solely on productive efficiency, but on nurturing life in reciprocity with nature, a fundamental principle of Buen Vivir (Altieri; Nicholls, 2020; Cachipuendo; Pilataxi, 2025; Gudynas, 2011).

This finding is consistent with studies indicating that traditional agricultural systems constitute reservoirs of local ecological knowledge and can contribute significantly to territorial sustainability (Toledo; Barrera-Bassols, 2008).

The empirical data obtained in this study confirm and extend the propositions of Altieri and Nicholls (2020) on agroecological resilience: the average of 25 species per productive unit and the crop-livestock

integration observed in the chakras studied are consistent with the functional diversity attributes that these authors identify as determinants of resilience in Andean agroecosystems. However, the findings also reveal a dimension that conventional agroecology, as framed by Gliessman (2015), does not fully integrate: the chakra is not only an ecological management system, but a space for nurturing life articulated to the Andean cosmovision, in which the spiritual dimension —rituals, the agro-festive calendar, the relationship with the Pachamama— is not a cultural complement but a constitutive part of the productive system. This finding engages with the epistemology of the South proposed by De Sousa Santos (2009): the ancestral knowledge of the chakra is not a lesser form of knowledge to be validated by Western science, but a system of knowledge with its own logic that produces tangible agroecological results. The presence of these practices in every province studied, even under pressure from agricultural modernisation, suggests that the epistemological complementarity proposed by De Sousa Santos is not merely a normative horizon, but a reality already operating in Andean territories.

Recognising the chakra as a socioecological system can contribute to the design of rural development policies with an intercultural approach, capable of integrating ancestral knowledge and agroecological practices into strategies for food security, biodiversity conservation and adaptation to climate change in Andean territories.

The coexistence of traditional and modern chakras identified in this study (Table 2) nonetheless raises critical questions that go beyond typological description. The transition towards the modern chakra is not a neutral process: it involves trade-offs between productive efficiency and cultural continuity that deserve more in-depth discussion. The incorporation of roses, technified irrigation, and market crops—defining features of the modern chakra—generates monetary income, but may erode the logic of subsistence and reciprocity that underpin the system. The loss of the principle of alli mikuy (the collective right to healthy, culturally appropriate food) and the substitution of the minka by paid individual labour are dimensions of this transition that do not appear in the quantitative data, but which emerge as latent risks. In terms of Toledo and Barrera-Bassols (2008), the modernisation of the chakra may represent a form of extinction of biocultural memory, in which the loss is not only of species or varieties, but of the relationships, meanings and practices that articulate the system.

In this productive process, all family members participate actively: boys, girls, young people, women, men and older adults, who are regarded as living sources of ancestral wisdom (Figure 2).



Figure 2 – Distribution scheme of the Andean chakra

Source: Cachipuendo et al. (2025).

The **traditional chakra** is a system for producing healthy food, aligned with the paradigm of Buen Vivir and aimed at strengthening the socioecological resilience of Andean communities. This system maintains a high diversity of crops such as maize, beans, broad beans, potatoes, lupins (chochos), quinoa, squash (zambo), among others (Confederación del Pueblo Kayambi, 2021). Planting techniques are usually organised linearly in rows or in quadrants divided into sections that group different species in a diversified manner (see Figure 3), which ensures ecological balance by favouring crop rotation and association (Zambrano *et al.*, 2018).

Depending on the size of the land and the territorial context, this system is related to similar practices known in other regions of Latin America, such as the milpa in Mexico, which is likewise based on agricultural diversity and the rational use of soil (Gortaire, 2015).

In addition to crop production, the traditional chakra integrates the raising of small animals such as poultry, guinea pigs (cuyes), sheep and, in some cases, larger animals such as cattle, which reinforces food sovereignty and the peasant family economy (Figure 3).



Figure 3 – Traditional chakra with a polycultural arrangement in rows and quadrants, north-central highlands of Ecuador

Source: Cachipuendo et al. (2025.).

The **modern chakra** constitutes an agro-productive system that retains elements of traditional crop diversity while also integrating medicinal plant species and complementary subsystems such as milk, vegetable and fruit production. The latter are oriented mainly towards the local or regional market, albeit under an agroecological approach that respects certain principles of sustainability and ecological balance.

However, in response to new demands from the economic context, non-traditional species such as roses have been incorporated, along with contemporary technologies focused on optimising available natural resources, such as soil, water and solar energy. These innovations are adapted to the space, the landscape and the natural elements present in the environment (Figure 4), thereby strengthening the resilience of the productive system in the face of the effects of climate change.



Figure 4 – Modern chakra with diversified crops and irrigation technology and greenhouse construction in the Ecuadorian highlands

Source: Cachipuendo et al. (2025).

3.2 ANCESTRAL KNOWLEDGE AND INTERGENERATIONAL TRANSMISSION OF KNOWLEDGE

The study shows that more than 70% of producers in Chimborazo, Tungurahua, Cotopaxi, Pichincha and Imbabura maintain ancestral knowledge associated with the Andean chakra, transmitted mainly within the family.

Among the forms of knowledge identified are practices such as alli muyu (seed selection), alli tarpuy (appropriate planting times), communal work through the minka, solidarity exchange (ranti ranti), and the organisation of agricultural activities through the agro-festive calendar. These practices form part of the agricultural knowledge passed down between generations.

This intergenerational character was highlighted by the participants themselves. A farmer from Imbabura (EF-02) noted:

> For the Otavalo people, the chakra constitutes a space of family life, in which children, young people, parents and grandparents take part in production tasks. Here, we pass on values, principles and knowledge about the importance of producing in the chakra, mainly for family subsistence. However, in recent years, productive activities aimed at market sales have also developed, generating income for families (EF-02, farmer, Otavalo people, Imbabura, 2023).

Likewise, in the various focus groups, particularly with representatives of the Kayambi, Cotacachi, Otavalo and Panzaleo peoples, it was stated that:

> For us, the chakra is a space where we share knowledge, principles, communal practices and our way of seeing life. We also take the agro-festive calendars into account, because they guide us on the times for sowing, tending, harvesting and celebration, and they have cultural, spiritual and productive value for each people. Furthermore, the chakra strengthens the minka, first within the family, where we all

> take part in production, and then in the community, where neighbours and community members collaborate collectively in agricultural work. (FG-01, representatives of the Kayambi, Cotacachi, Otavalo and Panzaleo peoples, 2023)

In contrast, in the province of Carchi, a lower presence of this knowledge is observed: only 1 of the producers surveyed in that province reported having general knowledge of the chakra (Figure 5).

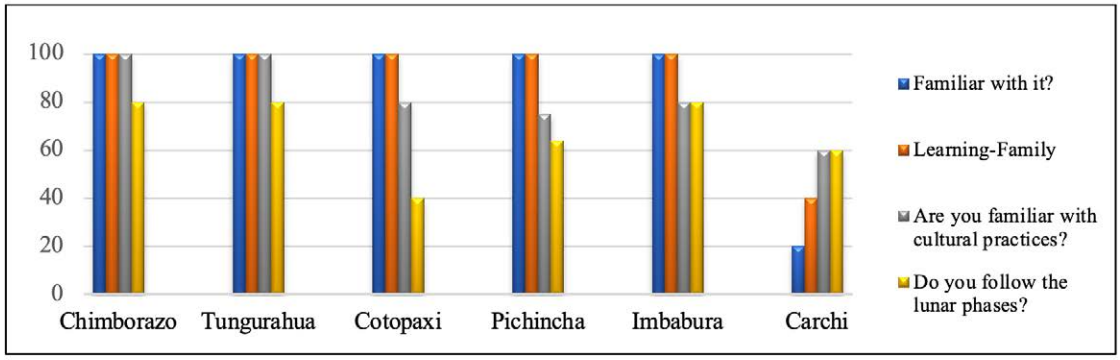


Figure 5 – Notion of knowledge and wisdom of the *chakra* by province

Source: The authors (2026).

The intergenerational transmission of knowledge is a fundamental element for the continuity of traditional agricultural systems. This knowledge not only guides agricultural practices, but also structures the relationship between communities and their territory, shaping systems of local ecological knowledge that have enabled rural peoples to adapt to different environmental conditions over time (Berkes, 2012; Toledo; Barrera-Bassols, 2008).

However, the decline of this knowledge in certain territories reflects processes of transformation associated with the expansion of agricultural models based on the Green Revolution, which have promoted production systems oriented towards maximising productivity through the intensive use of external inputs, mechanisation and the homogenisation of agricultural practices (Crespo; Vila, 2014). These processes have contributed to the devaluation of peasant knowledge and the progressive loss of traditional knowledge associated with the management of agricultural biodiversity and the sustainable management of the territory.

In the Ecuadorian case, this process has a specific history: the Green Revolution reached the highlands from the 1960s onwards, driven by state programmes for agrarian modernisation that promoted the use of improved seeds, synthetic fertilisers and pesticides as a condition for access to agricultural credit (Crespo; Vila, 2014). In provinces such as Carchi—where this study records the greatest loss of chakra knowledge and the exclusive use of tractors—the adoption of the conventional model was particularly early and intense, associated with the expansion of potato cultivation using improved varieties and agrochemicals (Crespo; Vila, 2014). This territorial contrast found in the study is no coincidence: it confirms that the erosion of chakra knowledge follows the historical geography of the Green Revolution's penetration into the country (Brassel *et al.*, 2008), and reinforces the urgency of differentiated policies to protect systems of ancestral knowledge where they still persist.

The preservation of this knowledge has important implications for the sustainability of rural food systems. Incorporating ancestral knowledge into agricultural education programmes, participatory research and rural extension could strengthen communities' resilience to climate change and to transformations in

food systems, favouring the development of more sustainable and culturally appropriate agricultural models (Altieri; Nicholls, 2017; FAO, 2022).

3.3 AGROECOLOGICAL MANAGEMENT OF THE ANDEAN CHAKRA

Agronomic management of the chakras varies between provinces. In Imbabura, most respondents (approximately 4 out of 5) use minimum tillage, while 1 uses a tractor. In Pichincha, around 3 out of 5 respondents apply minimum tillage, and 2 use a tractor. In Cotopaxi and Tungurahua, use is distributed similarly between both practices. In Carchi, respondents reported exclusive use of the tractor. Given that the n per province ranges between 3 and 5 cases, these figures reflect descriptive trends in the context studied and do not allow for statistical generalisation.

Regarding the use of compost, all respondents in Imbabura, Tungurahua and Chimborazo reported using it, while in Carchi only 1 respondent did so. With respect to seed origin, in Tungurahua, Cotopaxi and Imbabura almost all the farmers surveyed reuse their own seeds, whereas in Chimborazo the use of commercial seeds predominated among the cases recorded (Figure 6).

This orientation towards organic practices was confirmed qualitatively: a producer from Tungurahua (EF-07) stated:

> In our chakra we try to avoid the use of external products, such as agrochemicals and synthetic fertilisers. That is why we keep our own seeds for the next planting, we use crop stubble to nourish the soil, and we use manure from our animals, together with kitchen waste, to make compost. Some of us also produce vermicompost (worm humus). With these practices, we look after the soil, strengthen our autonomy and keep agroecological and ancestral production alive. (EF-07, producer, Tungurahua, 2023).

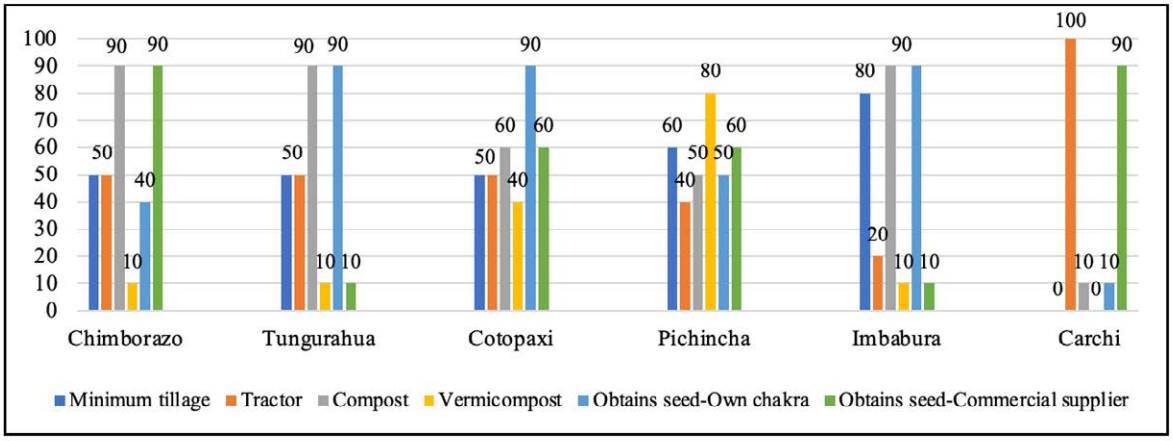


Figure 6 – Agroecological management practices in the Andean chakra, Ecuadorian highlands

Source: The authors (2026).

The practices observed reflect different levels of integration between traditional knowledge and modern agricultural technologies. The use of compost, minimum tillage and the conservation of local seeds contribute to improving soil fertility, favouring biological activity and strengthening the resilience of agroecosystems in the face of environmental and climatic disturbances (Gliessman, 2015; Pretty, 2008). Likewise, the conservation of local seeds is a key element in maintaining the genetic diversity of crops and the productive autonomy of peasant communities, by preserving varieties adapted to the

ecological conditions of the territory and to environmental change (Jarvis *et al.*, 2011; Toledo; Barrera-Bassols, 2008).

Promoting these agroecological practices through family farming support programmes, community seed banks and farmer-to-farmer training processes could help to reduce dependence on external inputs and strengthen the sustainability of rural production systems. Various studies have shown that participatory approaches to agricultural innovation and horizontal knowledge exchange between farmers favour the adoption of sustainable practices and strengthen the resilience of local agricultural systems (FAO, 2023; Rosset; Martínez-Torres, 2012).

3.4 AGRICULTURAL PRODUCTION AND CROP DIVERSITY

The chakras display significant productive diversity. In Chimborazo, Tungurahua and Cotopaxi, most of the cases recorded correspond to vegetables as the predominant crop, followed by roots and tubers, cereals and legumes. In Pichincha and Imbabura, a more balanced distribution is observed among different crop groups, while in Carchi production is concentrated mainly on vegetables and fruit trees (Figure 7). This crop diversity reflects the capacity of the chakras to adapt to different agroecological conditions and to integrate traditional food species with introduced crops, giving rise to multifunctional agricultural systems adapted to the territory.

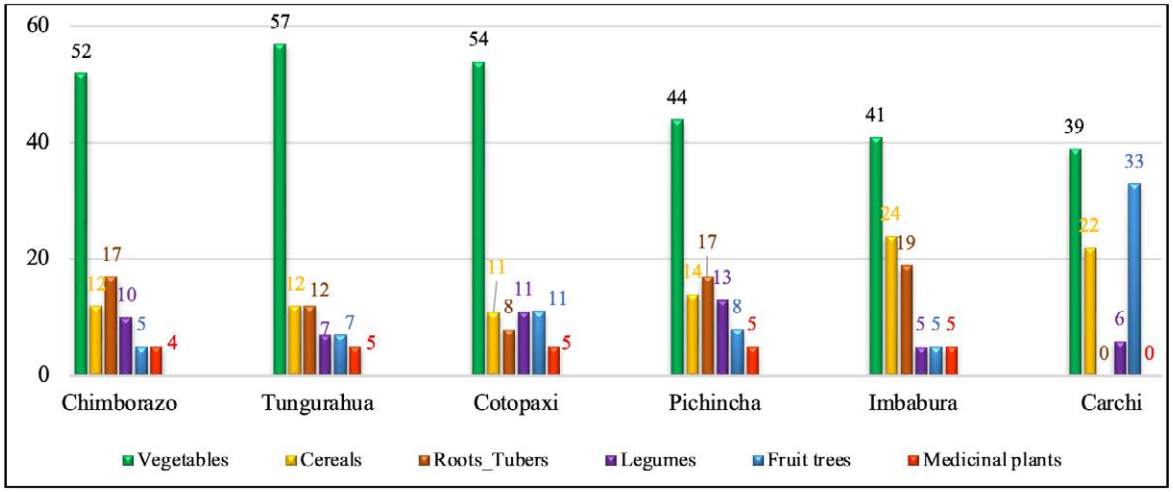


Figure 7 – Crop diversity in Andean chakras by province, north-central highlands of Ecuador

Source: The authors (2026).

The agricultural diversification observed in the chakras confirms their multifunctional character as agricultural systems oriented towards both family subsistence and local marketing. Various studies have shown that diversified agricultural systems help improve the resilience of agroecosystems by reducing production risks, increasing yield stability and strengthening food security in rural communities (Gliessman, 2015; Perfecto; Vandermeer, 2010; Pretty, 2008). Likewise, crop diversity is a key element for the conservation of agrobiodiversity and the maintenance of agricultural varieties adapted to local ecological conditions, which favours the adaptation of production systems to climatic and environmental variability (Jarvis *et al.*, 2011; Toledo; Barrera-Bassols, 2008; Zimmerer, 2014).

Strengthening diversified agricultural systems based on the chakra could help improve food security in rural Andean territories and promote short marketing circuits that strengthen the peasant economy. In this regard, traditional agricultural systems have been recognised as relevant strategies for addressing the current challenges facing food systems, including biodiversity loss, ecosystem degradation and the

effects of climate change on agricultural production (Altieri; Nicholls, 2020; FAO, 2023; Koohafkan; Altieri, 2011).

3.5 LIVESTOCK PRODUCTION AND ECOLOGICAL CYCLES IN THE CHAKRA

Livestock production is an integral part of the chakra. In absolute terms, 14 of the 24 households surveyed raise guinea pigs (cuyes), while between 3 and 6 raise laying hens, depending on the province. Organic waste from animal rearing is reused as natural fertiliser for crops (Figure 8). This practice makes it possible to recycle nutrients within the production system and maintain soil fertility through the use of organic manures generated within the productive unit itself. This integration between agriculture and animal rearing was clearly described by one of the focus group participants:

> For us, the chakra is an integral productive unit, where we combine plants that serve for family food with the raising of animals such as guinea pigs, sheep, chickens, rabbits, pigs, cows and horses. These animals complement our diet and, when there is a surplus, they also help generate income through sale at market. In addition, their waste serves as manure for the crops, while plant residues feed the animals. In this way, we maintain a supportive relationship between plants and animals, strengthening biodiversity and the care of the chakra. (FG-02, producer, north-central highlands of Ecuador, 2023).

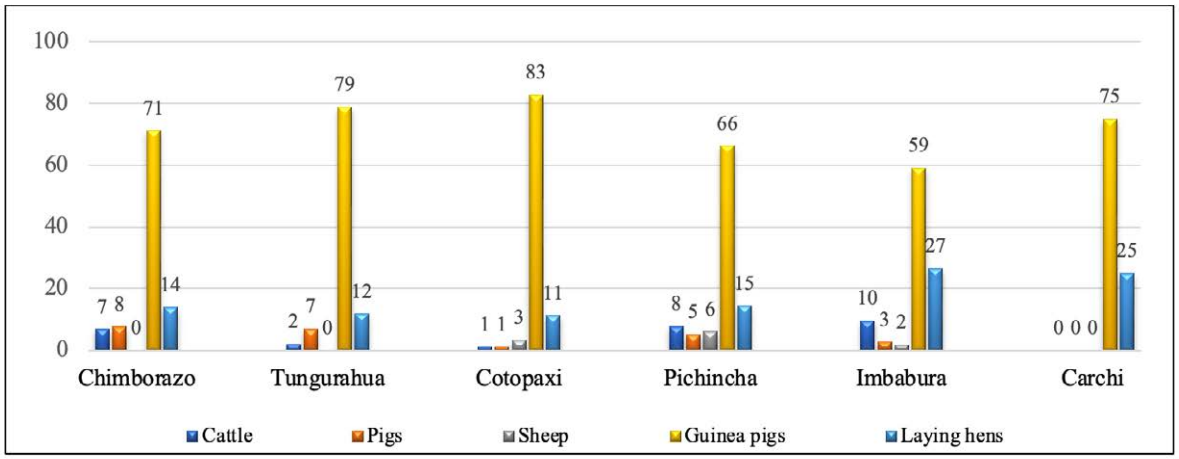


Figure 8 – Animal species in Andean chakras by province, north-central highlands of Ecuador

Source: The authors (2026).

The integration of agriculture and livestock farming makes it possible to close nutrient cycles within the production system and reduce dependence on chemical fertilisers. These integrated systems have been recognised as effective strategies for improving the sustainability of agroecosystems by favouring nutrient recycling, resource-use efficiency and the ecological balance of production systems (Gliessman, 2015; Herrero *et al.*, 2010; Pretty, 2008). Likewise, diversified agricultural systems that integrate crops and animals help strengthen the resilience of productive units in the face of environmental and economic disturbances by increasing nutrient-use efficiency, diversifying sources of income and reducing the risks associated with climate variability (Dumont *et al.*, 2013; FAO, 2023; Thornton; Herrero, 2015).

In this context, promoting integrated crop-livestock production systems could strengthen the sustainability of family farming and generate complementary sources of income for rural communities. In addition, these practices help to improve soil fertility, optimise the use of local resources and

strengthen the productive autonomy of peasant families, fundamental aspects for the development of more resilient and sustainable agricultural systems (Altieri; Nicholls, 2020; Wezel *et al.*, 2020).

3.6 AGROBIODIVERSITY AND FAMILY MANAGEMENT OF THE CHAKRA

The chakras analysed have an average of 25 cultivated species per productive unit, evidencing a high level of agrobiodiversity (Figure 9). This agricultural diversity includes food, medicinal and ornamental species adapted to different ecological conditions. The simultaneous presence of multiple crops within the same productive space constitutes a traditional strategy of territorial management that optimises the use of natural resources such as soil, water and solar energy, in addition to reducing production risks associated with climate variability (Altieri; Nicholls, 2020; Toledo; Barrera-Bassols, 2008).

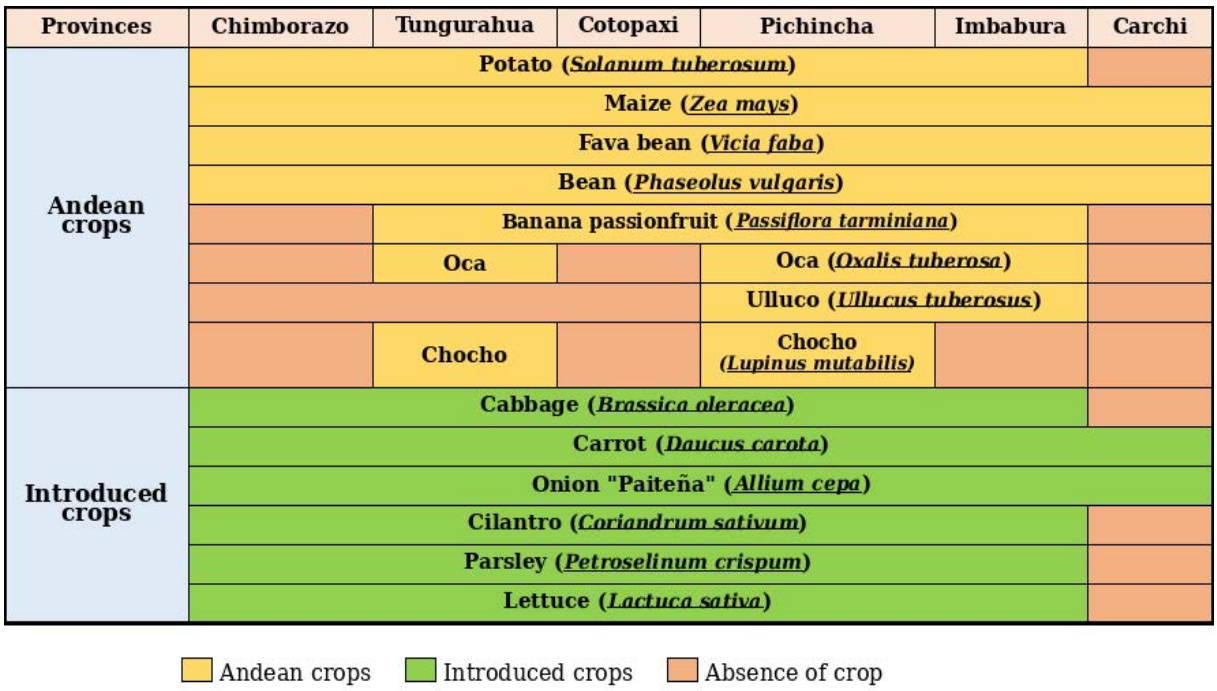


Figure 9 – Species cultivated in Andean chakras in the north-central highlands of Ecuador

Source: The authors (2026).

The crop diversity present in the chakras confirms their importance as reservoirs of agrobiodiversity and as agricultural systems fundamental to the food security of rural communities. Various studies have noted that traditional agricultural systems maintain a wide genetic diversity of crops adapted to local ecological conditions, which contributes to the productive stability and food sovereignty of peasant communities (FAO, 2013; Koohafkan; Altieri, 2011).

Likewise, the conservation of these traditional agricultural systems could help preserve agricultural genetic resources and strengthen the resilience of food systems to climate change, since species and varietal diversity allows for greater adaptive capacity in the face of environmental change and extreme climatic events (Altieri, 2017; FAO, 2022). In this respect, Andean chakras can be considered key spaces for the in situ conservation of agrobiodiversity and for the maintenance of the biocultural heritage of the Indigenous peoples of the Andes.

3.7 THE ROLE OF WOMEN IN CHAKRA MANAGEMENT

The study shows that in the great majority of the chakras visited (between 18 and 19 of the 24 units surveyed), management falls mainly to rural women. These women play a central role in seed selection, soil management, the organisation of agricultural production and the intergenerational transmission of knowledge. Through these practices, women contribute to maintaining crop diversity, caring for the territory and reproducing family food systems based on ancestral knowledge. Various studies on family farming indicate that women tend to be the main custodians of seed conservation, the management of diversified gardens and the transmission of agricultural knowledge within the domestic and community sphere (Agarwal, 2018; Howard, 2003). This central role was expressed by the women themselves during the interviews. A seed guardian from Pichincha (EF-11) stated*:*

> Since ancient times, we women have been responsible for caring for the family's food and for the chakra as a source of life. One of our main roles has been to look after the seed, because the next harvests are born from it; for us, the seed is like our wawas [children]: we care for it, protect it and watch it grow. We are also the ones who encourage the family to take part in the chakra, especially at weekends, when we gather to work, share knowledge and keep our ancestral practices alive. (EF-11, seed guardian, Kayambi people, Pichincha, 2023)

The prominent role of women in chakra management confirms their key part in the sustainability of peasant food systems and in the conservation of agrobiodiversity. Research on traditional agricultural systems has highlighted that rural women play a fundamental role in the management of agricultural biodiversity, particularly in the conservation of native seeds, the management of family gardens and the transmission of agricultural and food-related knowledge (FAO, 2023; Zimmerer, 2014). Likewise, agroecological approaches recognise the importance of women's work in producing food for subsistence and in organising communal exchange networks, which helps strengthen food sovereignty and the resilience of local agricultural systems (Altieri; Nicholls, 2020; Bezner Kerr *et al.*, 2021).

Furthermore, the knowledge of rural women has been recognised as a fundamental component of climate change adaptation strategies in peasant and Indigenous territories, owing to their knowledge of crop diversity, water management and agroecological practices adapted to local conditions (FAO, 2023; Nelson; Stathers; Martin, 2016). In this regard, their participation in chakra management has implications that are not only productive but also cultural, ecological and territorial, as it contributes to the conservation of biocultural heritage and to strengthening the socioecological resilience of rural communities.

Thus, the role of women in production, leadership, marketing and feeding their families is fundamental, as expressed in the focus groups:

> Those of us who work in the production of healthy food from the chakra recognise that women carry a large part of the organisation and leadership. For this reason, we play a fundamental role in keeping this form of production alive. For us, the chakra is not only a place to sow and harvest, but also a place where we share knowledge, values, respect for the land and love for nature. We experience all this work as a minka, in which we all collaborate with our labour, knowledge, exchange of produce and sales at agroecological fairs (bioferias). In this way, we strengthen the chakra through family unity, community organisation and spiritual respect for life, the land and the community. (FG-03, women participants, Kayambi, Cotacachi, Otavalo and Panzaleo peoples, 2023)

Recognising the role of women in chakra management has important implications for the design of rural development policies with a gender approach. Strengthening their participation in training

programmes, agricultural financing and territorial decision-making could help improve the sustainability of production systems, the conservation of agrobiodiversity and resilience to climate change in Andean rural communities.

However, women's prominent role in the chakra involves a tension: women are the main guardians of the system, but this role is frequently exercised without economic recognition, without equitable access to land or credit, and under conditions of a double workday. Research among Ecuadorian Kichwa communities has documented that women's empowerment in agroecological systems can coexist with structures that restrict women's autonomy in territorial decision-making (Churuchumbi, 2020; Conejo, 2020). The chakra can simultaneously be a space of agency and identity and a space of unpaid work overload, a tension that future studies will need to address with specific instruments.

3.8 STUDY LIMITATIONS

The results should be interpreted taking into account four limitations. First, the sample size (n=24 across six provinces, ~4 cases per province) limits inter-provincial statistical generalisation. Second, purposive sampling of families who are guardians of active chakras under-represents those who have abandoned the system, whose trajectories are equally relevant. Third, the cross-sectional design (2022-2024) captures a single moment in the system without accounting for its historical evolution; longitudinal studies would be necessary to understand its long-term trajectory. Consequently, the findings are specific to the Ecuadorian north-central highlands, and their transposition to other Andean contexts—Bolivia, Peru, Colombia—requires caution, as each territory expresses a particular configuration of cosmovision, agrarian history, and ecological conditions.

4 CONCLUSIONS

In the communities studied in the north-central highlands of Ecuador, the chakra retains its relevance as a production system based on crop association, the conservation of native seeds and the raising of small animals, sustained by the intergenerational transmission of knowledge —alli muyu, alli tarpuy, minka— and by the prominent role of women as the main guardians of the system. The coexistence of traditional and modern chakras shows that this relevance is not static but adaptive.

However, the expansion of conventional agricultural models is eroding knowledge in some territories, and women's prominent role coexists with structures that limit women's access to land, credit and territorial decision-making. These tensions indicate that the resilience of the chakra is not guaranteed and depends on institutional, cultural and economic conditions that this study cannot resolve on its own.

The findings support the incorporation of the chakra into intercultural territorial planning instruments, the strengthening of community banks for native seeds, and the economic recognition of the women's work that sustains the system. These measures require the involvement of local governments, research institutions and Indigenous organisations.

The Andean chakra represents an active response to present-day socio-environmental challenges under the paradigm of Sumak Kawsay. Preserving it means preserving a way of relating to the territory that the global crisis makes increasingly necessary, and a longitudinal and comparative research agenda across the Andes is essential to consolidate the evidence needed to guide this task.

DECLARATION ON THE USE OF ARTIFICIAL INTELLIGENCE

The authors used ChatGPT, developed by OpenAI, exclusively for linguistic revision and stylistic refinement. All scientific content, analysis and intellectual contribution were developed and verified by the authors, who assume full responsibility for the accuracy and integrity of the manuscript.

REFERENCES

ACOSTA, A. El Buen Vivir como alternativa al desarrollo: algunas reflexiones económicas y no tan económicas. **Política y Sociedad**, v. 52, n. 2, p. 299–330, 2015. Available at: https://doi.org/10.5209/rev_POSO.2015.v52.n2.45203

AGARWAL, B. Gender equality, food security and the sustainable development goals. **Current Opinion in Environmental Sustainability**, n. 34, p. 26–32. 2018. Available at: https://doi.org/10.1016/j.cosust.2018.07.002

ALMEIDA, E.; CAJAS, D.; AMARU CHIMBA, J. Aspectos relevantes de la cosmovisión andina mediante narrativas para el fortalecimiento de la identidad y el orgullo cultural de las comunidades kichwa del norte del Ecuador. **Revista Estudios del Desarrollo Social:** Cuba y América Latina, v. 9, n. 2, 2021.

ALTIERI, M. A.; NICHOLLS, C. I. The adaptation and mitigation potential of traditional agriculture in a changing climate. **Climatic Change**, v. 140, n. 1, p. 33–45, 2017. Available at: https://doi.org/10.1007/s10584-013-0909

ALTIERI, M. A.; NICHOLLS, C. I. **La agroecología en tiempos del Covid-19**. Berkeley: Centro Latinoamericano de Investigaciones Agroecológicas. 2020.

BERKES, F. **Sacred ecology**. 4.ed. New York: Routledge. 2018. Available at: https://doi.org/10.4324/9781315114644

BEZNER KERR, R. et al. Agroecology, food sovereignty and nutrition. **Global Food Security**, n. 29, 100533, 2021. Available at: https://doi.org/10.1016/j.gfs.2021.100533

BRASSEL, F.; HERRERA, S.; LAFORGE, M. (Eds.) **¿Reforma agraria en el Ecuador? Viejos temas, nuevos argumentos**. Quito: SIPAE. 2008.

BRUNET, I.; BÖCKER, R. Desarrollo sostenible, humano y endógeno. Estudios Sociológicos, v. 33, n. 98, p. 311–333, 2015. Available at: https://doi.org/10.24201/es.2015v33n98.1299

CACHIPUENDO, C. et al. **Alli Mikuy y alimentos saludables del pueblo Kayambi**. Quito. 2025.

CACHIPUENDO, C. J.; PILATAXI, S. The Chakana: a symbol of the Andean worldview in community water management, and a form of governance of life. **Ecology and Society**, v. 30, n. 3, p. 24, 2025. Available at: https://doi.org/10.5751/ES-16388-300324

CAMPOHERMOSO, F.; SOLIZ, R.; CAMPOHERMOSO, O. Lógica aimara trivalente y cosmovisión andina. **Cuadernos Hospital de Clínicas**, v. 56, n. 2, 2015.

CECCON, E. La revolución verde: tragedia en dos actos. **Ciencias**, n. 91, p. 21–29, 2008.

CHURUCHUMBI, G. **Usos cotidianos del término Sumak Kawsay en el territorio Kayambi.** Quito: Universidad Andina Simón Bolívar. 2020.

CLIMATE-DATA.ORG. **Datos climáticos:** Ecuador. 2022. Available at: https://es.climate-data.org/america-del-sur/ecuador/. Accessed on: 6 Mar. 2026.

CONEJO, M. **Los saberes agrotradicionales de la chakra andina y su influencia en el tejido social de las comunidades rurales kichwas del cantón Cotacachi – provincia de Imbabura.** Quito: Universidad Andina Simón Bolívar. 2020.

CONFEDERACIÓN DEL PUEBLO KAYAMBI. **Sistema de desarrollo integral y de crianza sabia para la vida comunitaria:** wawakunapak kintiku yachay. Quito. 2021.

CRESPO, J.; VILA, D. **Saberes y conocimientos ancestrales, tradicionales y populares:** el buen conocer y el diálogo de saberes dentro del proyecto del buen conocer. Quito: FLOK Society. 2014.

CRUZ, M. Cosmovisión andina e interculturalidad: una mirada al desarrollo sostenible desde el Sumak Kawsay. **Chakiñan. Revista de Ciencias Sociales y Humanidades. 2018.**

DE SOUSA SANTOS, B. **Una epistemología del sur:** la reinvención del conocimiento y la emancipación social. México: Siglo XXI. 2009.

DUBEY, P. K.; MAJUMDAR, A.; SARKAR, D.; UPADHYAY, M. K.; JHA, P. K. Editorial: Indigenous and local knowledge as a catalyst for sustainable agriculture and food security. **Frontiers in Sustainable Food Systems**, n. 10, 1855120, 2026. Available at: https://doi.org/10.3389/fsufs.2026.1855120

DUMONT, B. et al. Prospects from agroecology and industrial ecology for animal production in the 21st century. **Animal**, v. 7, n. 6, p. 1028–1043, 2013. Available at: https://doi.org/10.1017/S1751731112002418

ESCOBAR, A. S**entipensar con la tierra:** nuevas lecturas sobre desarrollo, territorio y diferencia. Medellín: Ediciones Unaula. 2014.

FAO. **Objetivos de desarrollo sostenible:** agricultura sostenible. Roma: FAO. 2015.

FAO. **El estado de la seguridad alimentaria y la nutrición en el mundo 2022**. Roma: FAO. 2022.

FAO. **The status of women in agrifood systems.** Roma: FAO. 2023.

FERNÁNDEZ, L.; GUTIÉRREZ, M. Bienestar social, económico y ambiental para las presentes y futuras generaciones. **Información Tecnológica**, v. 24, n. 2, p. 121–130, 2013. Available at: https://doi.org/10.4067/S0718-07642013000200013

FLETCHER, S. Understanding the contribution of environmental factors in the spread of antimicrobial resistance. **Environmental Health and Preventive Medicine**, n. 20, p. 243, 2015. Available at: https://doi.org/10.1007/s12199-015-0468-0

GARCÍA, D. Salud sostenible. **Eidon**, n. 56, p. 1–2, 2021. Available at: https://doi.org/10.13184/eidon.56.2021.1-2

GLIESSMAN, S. R. Roots of resistance to industrialized food systems. In: GLIESSMAN, S. R. **Agroecology:** a transdisciplinary, participatory and action-oriented approach. Boca Raton: CRC Press, p. 23–34, 2015.

GORTAIRE, R. **Agricultura campesina y prácticas tradicionales:** agroecología. Roma: FAO. 2015.

GUDYNAS, E. Buen vivir: germinando alternativas al desarrollo. **América Latina en Movimiento**, n. 462, p. 1–20, 2011.

HERRÁN, J. **Trabajando con la gente:** comunicación-acción-participación en comunidades indígenas de los Andes ecuatorianos. Quito: Universidad Politécnica Salesiana. 2017.

HERRERA SÁNCHEZ, D. J.; GAVILÁNEZ BUÑAY, T. C. Estrategias de agricultura regenerativa para mejorar la salud del suelo. **Revista Científica Ciencia y Método**, v. 1, n. 2, p. 15–28, 2023.

HERRERO, M. et al. Smart investments in sustainable food production: revisiting mixed crop-livestock systems. **Science**, v. 327, n. 5967, p. 822–825, 2010. Available at: https://doi.org/10.1126/science.1183725

HIDALGO-CAPITÁN, A. L.; GUILLÉN GARCÍA, A.; DELEG GUAZHA, N. (Eds.) **Sumak Kawsay Yuyay:** antología del pensamiento indigenista ecuatoriano sobre Sumak Kawsay. Huelva / Cuenca: CIM / PYDLOS / FIUCUHU. ISBN: 978-84-616-8167-9, 2014.

HOWARD, P. L. (ed.). **Women and plants:** gender relations in biodiversity management and conservation. London: Zed Books. 2003.

JARVIS, D. I. et al. An heuristic framework for identifying multiple ways of supporting the conservation and use of traditional crop varieties within the agricultural production system. **Critical Reviews in Plant Sciences**, v. 30, n. 1–2, p. 125–176, 2011. Available at: https://doi.org/10.1080/07352689.2011.554358

KOOHAFKAN, P.; ALTIERI, M. A. **Globally important agricultural heritage systems:** a legacy for the future. Rome: FAO. 2011.

MONTEROS, E. **Ferias agroecológicas y su relación con el consumo responsable de alimentos en la parroquia Tabacundo del cantón Pedro Moncayo.** Quito: Universidad Andina Simón Bolívar. 2020.

NELSON, V.; STATHERS, T.; MARTIN, A. **Climate change and gender:** what role for agricultural research among smallholder farmers in Africa? Brighton: Institute of Development Studies. 2016.

PERFECTO, I.; VANDERMEER, J. The agroecological matrix as alternative to the land-sparing/agriculture intensification model. **Proceedings of the National Academy of Sciences**, v. 107, n. 13, p. 5786–5791, 2010. Available at: https://doi.org/10.1073/pnas.0905455107

PRETTY, J. Agricultural sustainability: concepts, principles and evidence. **Philosophical Transactions of the Royal Society B**, v. 363, n. 1491, p. 447–465, 2008. Available at: https://doi.org/10.1098/rstb.2007.2163

REQUELME, N.; TAPIA, N.; USHIÑA, T. **Mujeres en resistencia y territorios agroecológicos**. Quito: Abya Yala. 2019.

RIZO, M.; VUELTA, D.; LORENZO, A. Agricultura, desarrollo sostenible, medioambiente, saber campesino y universidad. **Ciencia en su PC**, v. 2, p. 106–120, 2017.

ROOS, R.; VAN DER SLUIJS, J. Bridging different ways of knowing in climate change adaptation requires solution-oriented cross-cultural dialogue. **Frontiers in Climate**, n. 7, 1544029, 2025. Available at: https://doi.org/10.3389/fclim.2025.1544029

ROSSET, P. M.; MARTÍNEZ-TORRES, M. E. Rural social movements and agroecology: context, theory, and process. **Ecology and Society**, v. 17, n. 3, p. 17, 2012. Available at: https://doi.org/10.5751/ES-05000-170317

SALINAS, S. C.; NÚÑEZ, J. M. J. Las interculturalidades, identidades y el diálogo de saberes. **Reencuentro. Análisis de Problemas Universitarios**, n. 66, p. 10–23, 2019.

TAMAYO, C.; ALEGRE, J. C. Asociación de cultivos: alternativa para el desarrollo de una agricultura sustentable. **Siembra**. 2022.

THORNTON, P. K.; HERRERO, M. Adapting to climate change in mixed crop-livestock systems. **Nature Climate Change**, v. 5, n. 9, p. 830–836, 2015. Available at: https://doi.org/10.1038/nclimate2754

TOLEDO, V. M.; BARRERA-BASSOLS, N. **La memoria biocultural:** la importancia ecológica de las sabidurías tradicionales. Barcelona: Icaria. 2008.

WEZEL, A. et al. Agroecological principles and elements and their implications for transitioning to sustainable food systems. **Agronomy for Sustainable Development**, n. 40, p. 40, 2020. Available at: https://doi.org/10.1007/s13593-020-00646-z

WHITMEE, S. et al. Safeguarding human health in the Anthropocene epoch. **The Lancet**, v. 386, p. 1973–2028, 2015. Available at: https://doi.org/10.1016/S0140-6736(15)60901-1

ZAMBRANO, G. S. J. et al. Saberes ancestrales y agroecología: contribuciones para el desarrollo sostenible. **Revista Caribeña de Ciencias Sociales**, n. 6, p. 1–5, 2018.

ZIMMERER, K. S. Conserving agrobiodiversity amid global change. **Ecology and Society**, v. 19, n. 2, p. 1, 2014. Available at: https://doi.org/10.5751/ES-06316-190201