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Good agricultural practices in horticultural production under cover in the LVRN, Patagonia, Argentina

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Abstract

The surface area of covered crops in the lower valley of the Negro River (Patagonia, Argentina) is significant, producing first fruits in summer and leafy vegetables in winter. Producers are interested in transitioning to agroecology, moving away from traditional management of horticultural crops. The objective of this work was to characterize vegetable production under cover in the Lower Valley of the Negro River. To achieve this, greenhouses of producers employing both management systems were surveyed. The methodology proposed by Sarandon was used, focusing on three dimensions of analysis: economic, social, and environmental. A survey was designed with indicators suggested by experts, and 16 establishments were visited to analyze the structure of the greenhouses, the crops present, and the quality of the soil and water. Most producers are beginning their activities with small modules, covering less than 2000 m2, with structures made of treated wood and covered with polyethylene. The technological level is low, requiring training and technical assistance to meet the local demand, with expectations of sustained growth over time. Around 10 different vegetables are grown in winter, and between 5 and 7 species in summer, with tomatoes being predominant. Since producers in agroecological transition have only recently started, they differ from traditional producers in crop diversity, soil physicochemical and biological conservation, and low dependence on external inputs.

Keywords: Crop diversity, Economic dimension, Environmental dimension, Greenhouse, Social dimension, Soil quality, Sustainability.

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Contents

Contribution of this paper to the literature
This research on the implementation of good agricultural practices in greenhouse crops demonstrates the benefits of agroecological management over traditional methods. Knowing the installed greenhouse capacity is vital for training producers, promoting crop diversification, improving soil quality, and reducing dependence on inputs, thereby ensuring growth that meets unmet local demand.

1. Introduction

The Lower Valley of the Negro River (LVRN) covers a total area of 80,000 hectares, of which 18,500 hectares are organized into farms with surface areas ranging from 30 to 120 hectares. These farms have a network of canals to facilitate surface irrigation, utilizing water from the Negro River, which is suspended during the winter months for system maintenance. Most farms are dedicated to agricultural production, including horticulture, fruit growing, and fodder, as well as livestock activities such as cattle and sheep fattening on irrigated pastures. Vegetable production is primarily carried out by small-scale producers who grow diversified crops to supply fresh food to the region. According to sworn crop declarations, 2,500 hectares are cultivated with vegetables, representing between 10% and 14% of the total irrigated area in the LVRN. Of these, approximately 1,500 hectares are dedicated to onion production, 300 hectares to squash, and 700 hectares to various other vegetables [1].

Most of the horticultural producers who settled in the region started as sharecroppers and now rent land on which they produce. They are compelled to lower costs by reducing labor expenses, and their production is generally family-based. Currently, horticultural production is conducted on a small scale, in an intensive and diversified manner, primarily for the domestic market and, to a lesser extent, for the regional markets such as Neuquén, Bariloche, and Comodoro Rivadavia. The population is estimated to consist of approximately 150 producing families, mostly tenants who sell around 70% of their produce on the domestic market. Although there is limited information on the productive capacity of these horticulturists, they supply fresh vegetables to consumers in the Viedma-Patagones region [2].

The increase in the surface area of covered crops observed in recent years, with the aim of producing early summer crops and leafy vegetables in winter, indicates the interest of producers in changing traditional management of horticultural crops. This activity intensifies the use of the soil, which means that greater contributions of nutrients, generally of chemical synthesis, must be made, or crops must be rotated by moving the structures to other plots, negatively impacting the sustainability of the system.

The greenhouse system is an enclosure delimited by a wooden or metal structure, covered by glass or any transparent plastic material, inside which vegetables and ornamental plants are usually grown during periods when external climatic conditions would not allow obtaining the desired products [3].

Already in García and Quaranta [4], emphasized the importance of having information on the horticultural sector and the territory that enables informed decision-making by different actors (such as the public sector, producer and consumer organizations, etc.) in the green belt of the town of La Plata, capital of the province with the largest number of inhabitants in Argentina. In the province of Río Negro, which is among the 10 least populated in the country, there is no systematized information on horticultural production, much less under cover. In this sense, Tellería et al. [5] highlighted the social aspect of vegetable production, highlighting the work of women and the precariousness of the production system. Zalazar [2] reported on the diversity of horticultural foods offered and quantified the economic impact of LVRN producers in the region.

In order to have updated information related to the increase in the surface area of greenhouses, this work proposes updating the information on under-cover production systems, the quality of their soils, and the crops grown, differentiating between producers with conventional management and those in agroecological transition.

2. Materials and Methods

2.1. Study Site

The Lower Valley of Río Negro (LVRN) is located in the SE of the province of Río Negro, Argentina (40° south latitude and 63° west longitude), on the southern bank of the homonymous river. The climate in the region is mesothermal semiarid, with an average annual rainfall of 394 mm and an average annual temperature of 14.2 °C. It is a fertile area with fine to medium textured soils.

Figure 1 illustrates the geographic location of the LVRN in Patagonia, Argentina.

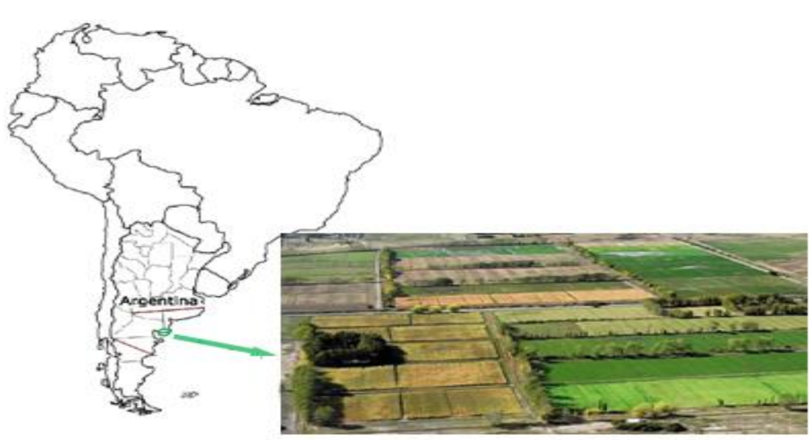

Figure 1. Geographic location of the LVRN.

To characterize the crops under cover, the production systems were studied in three categories:

1. Survey of greenhouses: dimensions, construction materials, and crops.
2. Analysis of soil and water quality: Physical and chemical aspects.
3. Survey of producers: Environmental, economic, and social dimensions.

2.2. Survey of Greenhouses

Based on geographic information and using Google Earth®, a total of 31 producers with varying amounts of covered surface area were identified. For the study, representative producers of each type were selected: conventional and agroecological, based on the suggestions of qualified informants. In June and September 2022, 16 establishments of entrepreneurs who produce vegetables in greenhouses were visited: 12 producers who use conventional management with chemical synthesis inputs and 4 who manage production with low dependence on external inputs (agroecological transition).

During each visit, in addition to the semi-structured interviews conducted with producers, the dimensions of the production modules (each of the buildings), the materials and construction design, orientation, and protection of the greenhouses and crops present were recorded.

2.3. Soil and Drilling Water Analysis

For soil characterization, a sample was taken consisting of five subsamples from the first 10 cm of soil in three conventional production greenhouses and three in agroecological transition. A water sample was also collected from the boreholes of four establishments to assess the quality of irrigation water during winter.

In soil samples, clay content was determined by the Bouyoucos method, pH in a 1:2.5 water solution, electrical conductivity in saturation paste, Sodium Absorption Ratio (SAR), total nitrogen by Kjeldahl, phosphorus by the Olsen method, organic matter by Bray-Curtis, and potassium by flame spectrophotometry.

Comparisons between conventional systems and agroecological transition systems were made using ANOVA and LSD mean comparison test ($p < 0.05$).

In June, when producers used drilling water because the irrigation system supplied by the Negro River was suspended to clean the canals, the pH was analyzed in water samples, as well as the electrical conductivity, soluble salt content, and sodium content determined by flame spectrophotometry.

2.4. Producer Surveys

Semi-structured interviews were conducted with producers, who were grouped according to the production system: conventional and in agroecological transition. The categories, descriptors, and indicators suggested by the experts and collected in the interviews are presented in Tables 1, 2 and 3. As a first step, the values of each variable were standardized on the scale recommended by Cieza and Sarandón [6]. In this work, the scale ranged from 0 to 4, with 0 representing the least sustainable category and 4 the most sustainable, regardless of the original units of each indicator. They were thus converted and expressed in scale values. Level 2 was adopted as acceptable for all variables. For example, cultural biodiversity was evaluated with a scale of 5 values (from 0 to 4): 4 indicating six crops; 3 indicating five crops; 2 indicating four crops; 1 indicating three crops; and 0 indicating 1-2 crops. This facilitated comparison between different systems.

With the systematized information, the values of the indicators were averaged to determine the value of the corresponding descriptor. The average of the final values was represented in spider web diagrams, as suggested by Sarandón et al. [7], to identify strengths and critical points of each system.

Table 1. Categories of analysis for the environmental dimension suggested by local experts.

Category	Descriptor	Indicators
Soil	Conservation of physicochemical fertility	Risk of salinization
		Fertilization management
	Conservation of physical properties	Management of organic matter
		Tillage practices
	Conservation of biological conditions	Use of pesticides
		Tillage practices
		Rotations
Biodiversity	Conservation of biodiversity	Use of pesticides
	Crop variability	Rotations
		Crop diversity
Water	Irrigation Water Quality	Risk of salinization

Table 2. Categories of analysis for the economic dimension suggested by local experts.

Category	Descriptor	Indicators
Economic stability	Productive diversity	Number of cultivated species
		Land ownership
Economic benefits	Economic growth	Economic growth
	Degree of technical development	Hybrid seeds
		Type of heating
		Use of Venturi
		Use of manometer
		Temperature and humidity recording
	Dependence on external inputs	Use of synthetic fertilizers
		Use of pesticides

Table 3. Categories of analysis for the social dimension suggested by local experts.

Category	Descriptor	Indicators
Quality of life	Basic needs	Access to health
		Access to education
	Producer satisfaction	Degree of satisfaction
	Land ownership	Land ownership
	Line of succession	Children and family

3. Results

3.1. Greenhouse Survey

Greenhouse crops constitute a small part of the productive structure of the LVRN in terms of surface area occupied. With a total of 20 ha out of 2,500 ha dedicated to horticultural production, they practically represent all the vegetables consumed in the region. Currently, 31 producers have greenhouses on their farms, totaling 94 modules. Forty-one percent of the producers have a single module, 29% have expanded to two or three modules, and the remaining have more than four. Notably, two producers have 12 modules on their farms (Figure 2A). The increase in the number of modules per producer is due to the experience gained in managing this productive system, which encourages investment in infrastructure. Regarding the surface area of the modules, most producers build them 50 or 100 meters long to optimize the use of polyethylene rolls and align with the capacity of pressurized irrigation water pumping systems. Greenhouses used for agroecological production tend to be shorter, ranging from 25 to 30 meters, likely due to higher labor demands and the need for improved ventilation to control pests and diseases. Concerning width, there is no consistent pattern; modules vary between 9 and 45 meters, with a predominance of 30 meters. The chosen width correlates with the machinery used in the field. All greenhouses feature a gable roof design, with more than half measuring 5 meters at the center and 2.20 meters at the sides, incorporating zenith ventilation to enhance air circulation. Additionally, 41% have a central height of 3 meters, which may compromise air exchange due to construction costs and the absence of adequate windbreak curtains. Of the 94 covered production modules in the LVRN, 37% have an average surface area of 2000 m^2 and 25% have an average surface area of 1000 m^2 (Figure 2B). In other words, most of the modules are small; however, the number of modules in the establishments differentiates two categories of producers: those who are starting with this activity and have less than 1500 m^2 of greenhouse space, and those who have already mastered the system with more than 1 hectare under cover in production (Figure 2C). According to Hidalgo [8], having very small production units limits access to technology, training, and technical assistance. That is, the costs required to implement new technologies cannot be amortized by small-scale production.

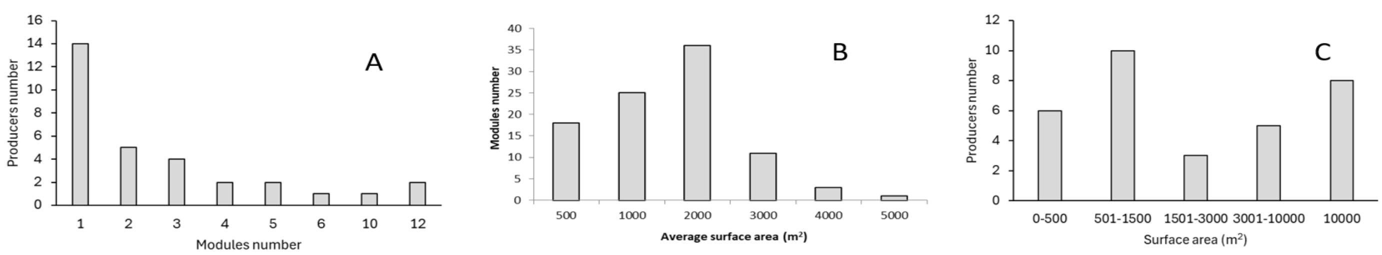

Figure 2. Structural characterization of the LVRN greenhouses. A) Number of modules per producer, B) Surface area of the modules built, and C) Total surface area per producer. The survey was conducted using Google Earth® for the 31 producers.

The structures of the LVRN greenhouses are made of eucalyptus or palm poles that have been treated with sulphate; without this treatment, their lifespan is very short. Additionally, to extend the poles' useful life, they are painted with tar on the part that is buried. Generally, the thickness of the lateral poles and roof braces causes shading inside, which negatively impacts the crop during periods of high photoluminescent requirements [3]. For this reason, poles with a smaller diameter but made of resistant wood are selected in the region.

The covering material used is 150-micron LLDPE (linear low-density polyethylene). The incorporation of "long-lasting" additives, which protect it from ultraviolet radiation, and "long-lasting thermal" additives, which make it more opaque to long-wave radiation (thermal PE 0.2 mm = 15-18%), makes it a suitable material for production, especially in the winter months. Although the useful life of these polyethylenes is around four years, their low weight, the fact that they are sold in variable widths, and their good light diffusion facilitate their construction without the need for specialized labor (Figure 3). The orientation of the modules is mainly parallel to the prevailing winds of the WNW region. To protect the structures from the effects of cold winds, they are built close to windbreaks made of established poplars. Since the LVRN has irrigation channels, the modules are built close to the drains (drainage channels) to allow the percolation of irrigation water, thereby preventing waterlogging inside and salinization of the soil. Investment in technological equipment is low: they do not have a heating system, automated irrigation, automatic window opening, or high-temperature control that would help the plants develop better and avoid losses due to extreme temperatures. They do not evaluate or control the quality of the soil or irrigation water, which is detrimental to the sustainability of the system.

Figure 3. Internal structure of greenhouses.

3.2. Soil Quality

Plant growth is strongly influenced by soil salinity conditions, and vegetables are no exception [3]. In laboratory studies, no differences were observed between the variables analyzed in the soils of greenhouses where conventional production is carried out compared to those in agroecological transition. The plots where the greenhouses have been installed have a clayey loam texture with high pH values typical of the region. A high salinity (EC) with a high sodium content (SAR) is notable, probably associated with the quality of the water used for winter irrigation (Table 4). These salinity values are associated with yield losses of around 50%, according to Iglesias [3]. The yield is reduced by half in spinach, tomato, and lettuce with EC values of 9, 8, and 5 mS/cm, respectively.

Regarding fertility parameters, soils in greenhouses undergoing agroecological transition tend to be higher, although they are not yet statistically different from soils under conventional production (Table 4). However, the values observed under both greenhouse production systems are higher than those observed by Avilés et al. [9] in open-air soils where the nitrogen, organic matter and phosphorus content was 0.20 ± 0.01 g N / 100 g, 2.90 ± 0.11 g OM/ 100 g and 27.7 ± 5.9 mg P/kg respectively, evidencing good fertility management within the greenhouse. The potassium contribution should be improved since the content is higher in the field than in greenhouses (632 ± 75 mg K/kg). This deficiency in potassium content and increase in phosphorus content was also observed by Silveira and Barbazán [10] in greenhouses in Uruguay, who suggest that producers review fertilization practices.

Table 4. Physicochemical characterization of greenhouse soils under conventional management and during agroecological transition.

Soil quality	Conventional management			Agroecological management		
Clay (g/100 g)	32.83	±	9.58	38.73	±	4.69
pH	8.01	±	0.15	8.00	±	0.23
EC (mS/cm)	11.41	±	3.09	9.99	±	2.26
SAR	14.5	±	2.1	11.7	±	0.6
N (g/100g)	0.22	±	0.00	0.27	±	0.05
P (mg/kg)	135	±	33	142	±	21
K (mg/kg)	254	±	49	365	±	67
OM (g/100g)	4.30	±	0.55	5.36	±	0.49

3.3. Irrigation Water Quality

Regarding irrigation water, both in conventional production systems and those undergoing agroecological transition, during the summer season (August to April), farms have a water supply from the Negro River through a system of high-quality canals (EC 0.4 mS/cm and SAR < 1). The irrigation system employs drip hoses with a pressurizing pump and Venturi for fertilizer incorporation into the soil, although the smaller systems use a precarious bypass-type fertilization system that involves sucking fertilizer directly with the irrigation pump. During the winter months (May to July), the river water supply is suspended for canal system maintenance, prompting producers with greenhouses to perforate their farms to supply water to crops. Studies on some of these boreholes have detected high salt content (EC 6.1 mS/cm and SAR 18), which qualifies the water as unsuitable for crop irrigation according to the Riverside standard (C6, S3). This issue is exacerbated by the localized irrigation system and its repeated use over time. According to Castellón Gómez et al. [11], EC values higher than 3 mS/cm and SAR higher than 9 in irrigation water are associated with a severe degree of restriction for agricultural production.

Due to the low annual rainfall in the area (392.2 mm), and particularly during months when irrigation water supply is cut off, where the average rainfall over the last 57 years was 92.2 mm [12], it is not feasible to accumulate rainwater for use during the winter season as proposed by Lobos Rodríguez, et al. [13] for the O'Higgins region in Chile. Producers should compare yield losses in summer crops due to soil salinization with the gains obtained from winter production and consider the possibility of suspending winter production under cover. They could also evaluate the feasibility of incorporating technology such as reverse osmosis equipment for the winter months.

3.4. Survey of Producers

The results of the interviews were grouped into three dimensions: environmental, economic, and social, according to the indicators suggested by the experts (Table 1, 2 and 3),comparing producers who carry out conventional management with those who are in agroecological transition (Figure 4).

Regarding the environmental dimension, it is observed that both production systems manage irrigation similarly, reaching an acceptable level, aided by the contribution of river water during the summer season (Figure 4A). A similar pattern occurs with fertilization management: conventional producers supply external nutrients through the fertigation system, optimizing the doses of these compounds with Venturi in the drip system during the crop cycle, while those in the agroecological transition stage provide manure and compost during seedbed preparation. Producers in the agroecological transition are distinguished by their low use of pesticides (including biopreparations), crop rotations, more conservative tillage practices, and the addition of organic matter. Crop diversity, in terms of species and varieties, is enhanced through seed exchanges with agroecological producers from other regions, preserving native germplasm and incorporating aromatic plants to control pests [1].

The analysis of the economic dimension indicates that land ownership and economic growth are adequate and similar in both production systems (Figure 4b), because the enterprises in agroecological transition consist of families of conventional producers adopting the new production system based on the capital they already possess. This enables them to gradually enter a niche of specific consumers. They do not depend on external inputs, which enhances their qualifications, and due to consumer demand (market), they have been expanding the diversity and variety of crops. However, both types of producers, possibly due to their low educational level [2] and limited experience in covered systems, present a critical point in terms of the degree of technicalization, as observed by Mundo Coxca et al. [14]. In the crops under cover of the town of Puebla in Mexico, they suggest strengthening the link between research and government centers at their different levels with tomato producers through continuous advice and training. In this sense, Hernández Suárez [15] observed that the federal programs, which were crucial for the establishment of greenhouses and the growth of their number in Zacatecas (Mexico), were granted to low-income producers with insufficient capacities to face all the vicissitudes of this type of activity, which is highly uncertain and risky.

Since producers in agroecological transition are members of the same families that produce conventionally, the social dimension is similar in most of the evaluated indicators (Figure 4C). They live on the same property, in the same home, belong to the same family, have access to the same health system, but are more satisfied with their production due to the response of consumers and because they perceive an improvement in their living conditions.

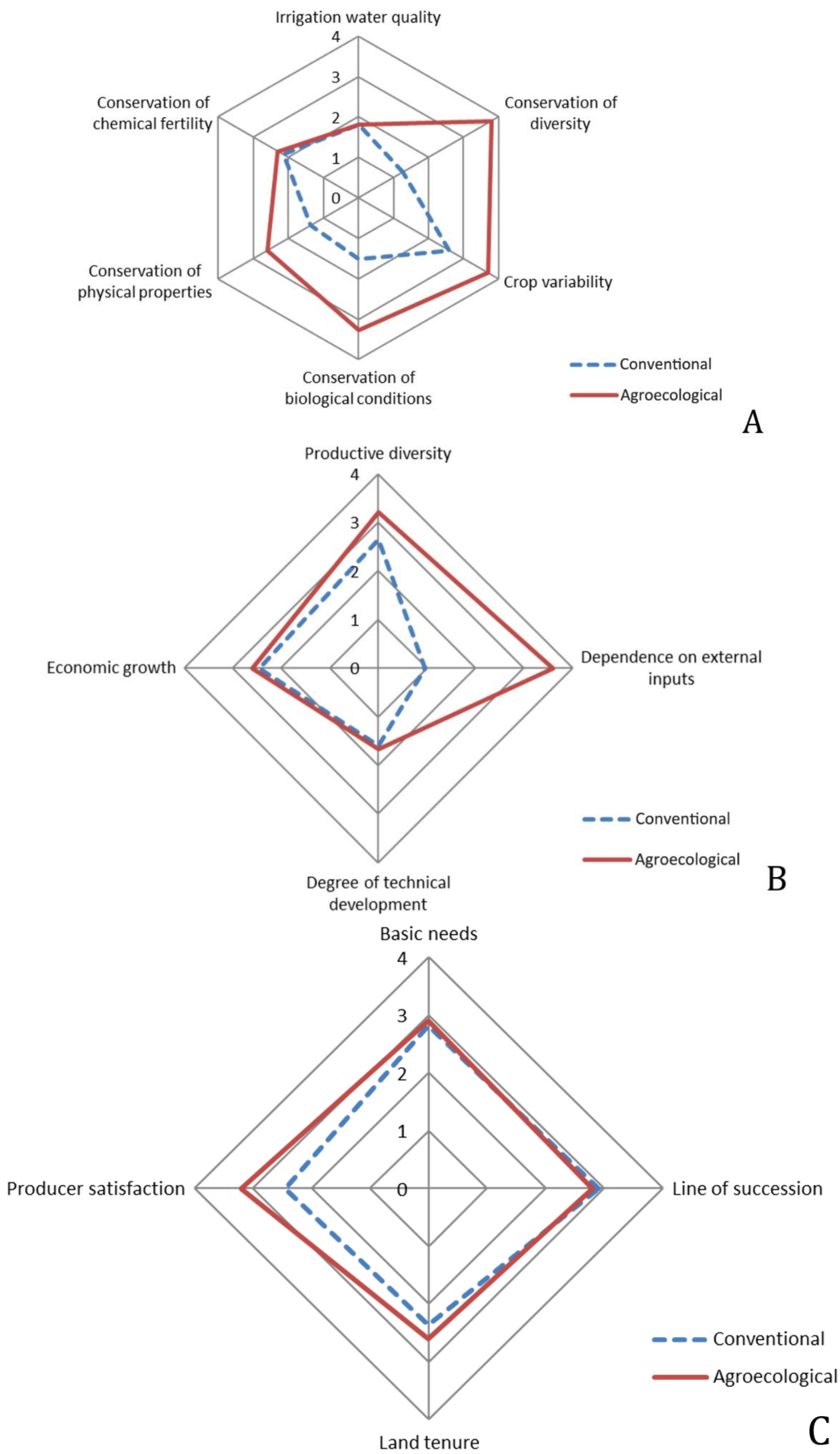

Figure 4. Comparison of covered production systems in the LVRN: conventional vs. agroecological transition. A) environmental dimension; B) economic dimension; and C) social dimension.

3.5. Winter and Summer Crops

Although production is traditionally divided into two seasons: winter, for green leafy crops, and summer, for fruit crops, these criteria are becoming less distinct. At the farm level, practices involve cultivating different crops throughout the year. Protected cropping is a practice aimed at extending the productive season, which allows for early and late harvests.

In the area, the main winter crops are planted in a staggered manner to supply the town with lettuce in its different varieties (curly, head, and butter lettuce), spinach, chard, celery, broccoli, parsley, beetroot, among other minor crops. Particularly, producers in agroecological transition add aromatic species that fulfill the double purpose as a crop and pest regulator, such as mint, lavender, marigold, certal, citronella, rosemary, etc. In each module, between 7 and 10 different crops were observed, which implies a complex management by having to regulate the irrigation and fertilization regime by sectors, although this allows them to offer greater diversity of products to local consumers and expand commercial sales.

Summer crops are generally less diversified and are sown on a single date to facilitate logistics and management of irrigation and fertilization, compensating for the supply to consumers with field crops. Among the crops grown on larger areas in greenhouses, the tomato stands out in its different varieties: pear, platense, red cherry, yellow cherry, and chocolate cherry. Bell peppers, peppers, eggplant, green beans, strawberries, broad beans, and cucumbers are also produced, and some farmers even add melon to obtain early fruits.

4. Conclusion

The surface area of covered crops in the LVRN is significant and responds mainly to the local demand for food. As producers gain experience, they risk adding modules and diversifying production. However, the technological level is still low and requires training and qualified technical assistance to fulfill the still unsatisfied local demand, predicting sustained growth over time.

Producers in agroecological transition in the LVRN replaced the cultivation system, convinced of the improvement in family health and the social recognition acquired, which encourages other producers who see in this system a healthy, sustainable, and economically viable alternative.

References

[1] N. Seba *et al.*, *Diversified horticultural production in the Lower Río Negro Valley: Current socio-productive models and their potential for ecological intensification*. Buenos Aires, Argentina: Ediciones INTA, 2017.

[2] J. Zalazar, "Horticultural production and the producer community at the Viedma municipal fair," Bachelor's Thesis, National University of Comahue. National University of Comahue Repository. Viedma, Argentina, 2022.

[3] N. Iglesias, "Vegetable production under cover. Crop structure and management for Northern Patagonia," Technical Dissemination Bulletin No. 49, pp. 89. INTA Editions, 2006.

[4] M. García and G. Quaranta, "Analysis of horticultural statistics in Buenos Aires. A contribution to the quantification of horticultural establishments in La Plata," *Geograficando*, vol. 18, no. 1, p. e108, 2022. https://doi.org/10.24215/2346898Xe108

[5] A. Tellería, C. Román, and L. Avilés, "The role of women in the horticultural sector and their participation in productive decision-making in Viedma," *Negocios Agroalimentarios*, vol. 5, no. 1, pp. 14–18, 2020.

[6] R. Cieza and S. J. Sarandón, "Sustainability assessment of family and business production systems in the Salado River Basin," *Revista de la Facultad de Agronomía*, vol. 122, no. 1, p. 121, 2023. https://doi.org/10.24215/16699513e121

[7] S. J. Sarandón, M. S. Zuluaga, R. Cieza, L. Janjetic, and E. Negrete, "Sustainability assessment of agricultural systems in Misiones, Argentina, using indicators," *Agroecology*, vol. 1, pp. 19–28, 2008.

[8] M. Hidalgo, "Impact of production scale on technology adoption in greenhouse farming," *Journal of Agricultural Development*, vol. 12, no. 1, pp. 45–60, 2019.

[9] L. Avilés, O. Gajardo, A. Mamani, and S. Cañón, "Weed community in onion crops after pre-emergence control associated with soil adsorptive capacity and growers' perceptions," *Revista Malezas*, vol. 1, pp. 4–17, 2018.

[10] D. Silveira and M. Barbazán, "Soil characterization of horticultural greenhouses in Northern Uruguay," *Agrociencia Uruguay*, vol. 24, no. 2, p. 51, 2020.

[11] J. J. Castellón Gómez, R. Bernal Muñoz, and M. D. L. Hernández Rodríguez, "Water quality for irrigation in protected agriculture in Tlaxcala," *Ingeniería*, vol. 19, no. 1, pp. 39–50, 2015.

[12] C. Mussi Saluj, *Agroclimatic data for the lower valley 1965–2021*. Viedma, Argentina: Ediciones INTA, 2022.

[13] P. Lobos Rodríguez, B. Vega Candia, and J. Carrasco Jiménez, *Greenhouse vegetable production: Use of a rainwater collection, storage and harvesting unit. En J. Carrasco, R. Abarca & C. Aguirre (Eds.), Manual de buenas prácticas y lecciones aprendidas para adaptación al cambio climático: Para la agricultura de secano de la Región de O'Higgins*. Santiago, Chile: Instituto de Investigaciones Agropecuarias (INIA). Manual INIA, 2022.

[14] M. Mundo Coxca, J. L. Jaramillo Villanueva, J. M. Jimenez, A. Macias López, and J. Ocampo Mendoza, "Technological characterization of greenhouse tomato production units in Puebla," *Revista Mexicana de Ciencias Agrícolas*, vol. 11, no. 5, pp. 979-992, 2020. https://doi.org/10.29312/remexca.v11i5.2010

[15] J. L. Hernández Suárez, "The development of greenhouses in Zacatecas. Between boom and abandonment," *Entreciencias: Diálogos en la Sociedad del Conocimiento*, vol. 8, no. 22, 2020. https://doi.org/10.22201/enesl.20078064e.2020.22.70248