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# Content



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# Agroecological Systems and Cotton Production In Northern Argentina

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## INTRODUCTION

Global climate change and the socio-environmental consequences of the industrial agriculture model are increasingly evident and threaten the well-being of society as a whole; land uses require practices and techniques that ensure the conservation of natural resources for ecosystem balance and social well-being. Agroecology has the conceptual and scientific foundations, practical applications and social legitimacy to support the transformation of food systems at all levels and to face the main planetary challenges such as climate change, food insecurity, biodiversity loss and ecosystem degradation, incorporating the political and socio-economic dimension such as the co-creation of knowledge, participatory processes, creating connections between producers and consumers and reducing existing social inequalities (Bezner Kerr et al., 2023). The agroecological paradigm is presented as a challenge and a current need that implies considering sustainability for the benefit of future generations, the ecological and sociocultural complexity of agroecosystems, the uncertainty that comes from this complexity and the plurality of values, understanding that there is no universal model (Sarandón, 2024). The development of agroecology should generate true transformative processes, autonomous collective struggles that result in a true emancipation from problems and structures created by industrial agriculture (Giraldo and Rosset, 2022).

Agroecology in Argentina has grown in recent years, not only in rural areas as an alternative to conventional agriculture but also with a strong presence in urban and peri-urban areas. In 2008, the National Institute of Agricultural Technology (INTA) created lines of action in agroecology with projects such as "Agroecology for social equity;" in 2013, the Agroecology Network (REDAE) was created as a programmatic instrument with the objective of managing the development of integrative knowledge for the design and management of agroecosystems based on agroecology, articulating with regional programs and projects with a territorial focus. The experiences of the REDAE are carried out in INTA's own sites (Experimental Agropecuary Stations, EEA in spanish) as well as in educational establishments and private productive fields. This mixed form of situated research provides complementarity in the generation of knowledge, given that in strictly experimental sites there is the advantage of testing disruptive questions, without necessarily expecting the success of the practice. This paper aims to review the technological and social proposal currently involved in producing cotton in agroecological systems in northern Argentina, in a context of climate change and loss of land devoted to family agricultural production, and to describe the latest significant activities on this topic developed in territory.

## THE PRODUCTIVE SYSTEMS OF NORTHERN ARGENTINA

Cotton crop is one of the most representative in northern Argentina and currently its production in conventional systems uses the technology called "No Tillage ", a technological package that uses heavy machinery, transgenic seeds, herbicides, insecticides, growth regulators and mechanical harvesters. Under this system, in the 2023/24 agricultural season, 337,829 ha were planted in the country, of which 94,025 ha corresponded to Chaco (SISA, 2024). The production of agroecological cotton (AAe) in food systems arises in northern Argentina as an alternative to the predominant model based on principles such as diversity, since it incorporates food species, wild plant edges and forest or fruit trees; it does not use synthetic pesticides but homemade preparations and bioinputs to control pests, always with the aim of promoting the presence of predators as a way of increasing functional diversity and avoiding input substitution. In addition, manual and mechanical weed control is used, ruling out the use of herbicides. Weeds are key in these systems because they can increase labor costs, delay agricultural work, host pests and reduce yields; but on the other hand, they can contribute to soil conservation, be a source of food, medicine, increase the genetic material present in the system and its stability by acting as a refuge for pollinators, predators and parasitoids (Blanco Valdes, 2016).

The network space for the promotion of AAe between Chaco and Santiago del Estero provinces emerged in 2019, from the meeting of the technical teams of INTA EEA Sáenz Peña (Chaco) and EEA Santiago del Estero, the Dr. Ramón Carrillo Chaco Foundation, the Association of Small Farmers of Chaco (APPCH in spanish, which since its creation in 1986 promotes and practices agroecological production) and the loom artisans of Santiago del Estero. It is currently made up of the “No'Oxonec - Border Cotton " Network (No' Oxonec means fabric in Qom language), and "Trama Viva" Santiagueño Agroecological Food and Cotton. This space has as its protagonists the families of AFCI (Family, Peasant and Indigenous Agriculture) and is integrated with all actors of the value-added process from ginning, spinning, weaving and clothing manufacturing, and consumers in Chaco and Santiago del Estero, to strengthen the regional economy, targeting short market circuits of a very traditional crop in northern Argentina, part of the history and idiosyncrasy of many rural and urban families (Rojas et al., 2021). Currently, the sowing area is approximately 22 hectares in both provinces and the aim is to reach the volume of spinning and weaving through small farms and the joint and supportive management of the value-added process between institutions, associations, organizations and groups. Table 1 describes the most important characteristics of the contrasting cotton production models in Argentina.

**Table 1. Comparison of contrasting models (adapted from Rojas et al., 2021).**

| System main features | Agroecological | Conventional |
|---|---|---|
| - Promotion of diversity | - Strong. Polycultures, covers, hedges and trees. | - Is not part of the productive approach. |
| - Local varieties use | - Yes. Guazuncho 3 INTA is used. | - Transgenic varieties are used, RR, Bt o Bt - RR. |
| - Soil management | - Conventional tillage. Hand tools, disc plow or chisel. Manure, enmiends. Rotations. | - No tillage. Low rotation level. |
| - Use of synthetic agrochemicals | - No. Bioinputs produced locally or national. | - Herbicides, insecticides and growth regulators. |
| - System costs and productivity | - Low. Requires manpower that is considered the generation of family labor itself. | - High. Seeds and inputs with dollar price. Little manpower requirement. |
| - Gender and intercultural approach | - Yes | - No |
| - Knowledge building | - Knowledge shared between organizations and institutions. Pluriculturality. | - Technological proposal is put forward by the State together with private companies. |
| - Differential price | - 50% on the value of the Argentine Cotton Chamber (CAA). | - Established by CAA. |
| - Ease for fiber processing | - Problems in disassembling, spinning and weaving low volumes and no contamination with transgenic fiber. | - High volumes are achieved without requiring non-contamination. |
| - Certification | - Participatory Guarantee System is chosen. | - Not required. |
| - Market opportunities | - High demand. In expansion (sustainable textile consumers and entrepreneurs). | - They depend on the national and international market. |
| - Value added process | - Artisanal and industrial. | - Without differential add value. |
| - Type of products for marketing | - Artisanal: thread, fabrics and clothing. Industrial: thread, wick, woven and knitted fabrics. Clothing. | - Industrial. |
| - Institutional and governmental support - | - Minimal and recent. | - High and for decades. |

The gender approach is fundamental in this work, as it seeks to break the typical power relations between people and nature imposed by patriarchy and gender-segregated activities, among others. This characteristic is reflected in the creation and management of the team built for this network; the majority of those who are part of the network, both organizations and institutions, are women with convictions in the gender perspective and the protection of nature, and the participation and role of peasant women, artisans and designers is prioritized. Interculturality also plays a fundamental role in this experience because it contributes to building culturally pluralized spaces, recognizing the identity and the value of the vision of indigenous populations.

## KNOWLEDGE GAINED ON THIS ISSUE IN RECENT YEARS

Regarding to agronomic aspects, the agroecological production system is oriented towards the so-called process technology, understanding this term as the promotion of ecological processes that ensure the balance and resilience of the productive systems, through the design of the agroecosystem, replacing the technology based on inputs, which generate greater dependence and costs (Fig. 1).

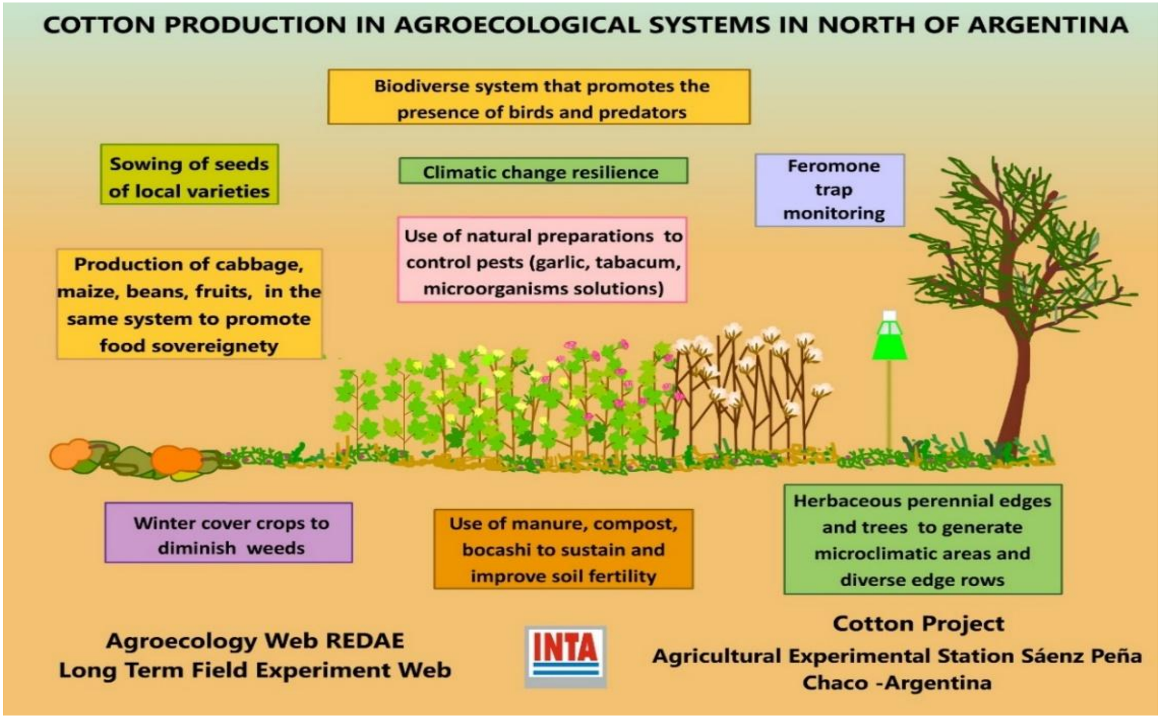


**Figure 1. Recommended practices for AAe production systems in north of Argentina.**

In this sense, various aspects of agroecosystems have been raised and evaluated in the agroecological production trial of the EEA Sáenz Peña: intra and interspecific diversity (García Hernández et al., 2021; Spoljaric et al., 2021), soil status and fertility replacement practices (Rojas et al., 2024), use of bioinputs, role of weevil traps, and effect of harvest date on fiber and seed quality (Spoljaric et al., 2024).

Conservative biological control promotes the use of native natural enemies and agroecological systems can be a tool that favors it. Recently, it was found that the AAe system presented greater diversity and richness of predators compared to the conventional system, even when natural preparations were used for pest control; while phytophagous arthropods showed greater diversity and richness in the conventional system even though pyrethroid insecticides had been applied for pest control and as a preventive measure. In AAe there was a lower abundance of predators and a higher abundance of phytophagous arthropods (Rojas et al., 2024).

However, the boll weevil is the most important pest of cotton crops in Argentina and to date, efficient control by predators has not been reported. A pheromone trap monitoring was carried out on the lot planted on 11/11/21 and whose stubble was destroyed on 04/28/22. The behavior of the pest was normal for the weevil, characteristic of a dry year and very few weevils were found in the traps throughout the crop cycle, but after the destruction of the stubble the number of weevils found in the traps increased considerably, therefore it is currently recommended to apply biopreparations every week as a preventive measure. Regarding weeds, a diversity survey was carried out in two contrasting system trials (Spoljaric et al., 2021). Although a greater number of weeds could be assumed in an AAe system due to the non-use of herbicides, 22 common species and 6 species exclusive to each system were found; that is to say, the weed population probably was an effect of management but there was no higher number of species in AAe.

Other important aspect is the soil organic carbon (SOC) stock, representative of organic matter, indicator of soil health and essential fuel for multiple ecosystem processes. The variation in soil organic carbon (SOC) and bulk density (Da) between 2020 and 2024 was analyzed in the Sáenz Peña EEA trial (Rojas et al., 2024) to study this variation and relate it to the practices used, with the aim of proposing strategies that allow production by strengthening agroecological principles since this system presents the challenge of achieving weed control while maintaining carbon reserves in the soil and low levels of compaction. The SOC stock up to 30 cm decreased significantly between 2020 and 2024, from 48.40 to 37.05 t/ha. The average in Chaco is 59.7 t/ha for Humid Chaco and 48 t/ha for Dry Chaco as determined by Gaitán et al. (2023). Regarding Da, the values decreased significantly compared to the initial year, from 1.25 (2022), 1.30 (2023) to 1.19 (2024), which is due to tillage and could favor infiltration but to the detriment of organic matter. It is therefore important to establish that a single practice is insufficient to maintain soil health in these systems. This could be achieved by applying multiple strategies (rotations, vertical tillage, long fallow periods of the plots, application of fertilizers such as cattle manure, and cover crops) instead of unidirectional proposals.

Another notable recent result is related to the impact of the harvest date on the fiber length, which is a very important piece of information for the destination of the production since the longest possible length is required for a good spinning process and seed germination. In an evaluation of these parameters by harvest date, it was found that the first dates presented the longest fiber and that the number of germinated seeds is also related to the time of harvest (Spoljaric et al., 2024). That farmers take this into account and separate the harvest, which is manual, by date, can measure the length of the fiber in situ with simple instruments, such as a caliper, can be a very low-cost technological improvement that requires simple training, speeding up and improving decision-making. Regarding seed quality, in a context with irregular rainfall distribution, high temperatures and low radiation, it would be important to carry out the harvest taking into account the destination of the production, especially in adverse weather conditions.

## FINAL INSIGHTS

The main difficulties that are considered to exist currently for the growth of this productive proposal are those related to the value-added process and the lack of public policies that favor agroecological production. The network contributes to generating and enhancing the forces and resources to travel the difficult path of accessing critical inputs, industrial textile services, without contamination, and achieving a fair price; with a differentiated final product achieving visibility in the market and a cost/price equation that allows all members of this cotton network to grow and reproduce in an expanded way. The agroecological cotton production network opened a space for agroecological theory and practice based on the production of cotton, food and local knowledge, in addition to working with other communities sharing knowledge, creating a network that did not exist before, part of the new paradigm. At the agroecosystem level, it is essential to find a way to close the nutrient cycles while maintaining the covers and incorporating animals or manure from nearby production and continuing to contribute and sustain intra and interspecific diversity; reduce dependence on diesel, which makes it less energy efficient, and conventional tillage, which affects the soil and therefore the balance of the entire system.

## REFERENCES

Bezner Kerr, R., Postigo, J.C., Smith, P., Cowie, A., Singh P.K., Rivera-Ferre, M., Tirado-von der Pahlen, M.C., Campbell, D. y H. Neufeldt. 2023. Agroecology as a transformative approach to tackle climatic, food and ecosystemic crises. Current Opinion in Environmental Sustainability. 62:101275.

Blanco Valdes, Y. 2016. The role of weeds as a component of biodiversity in agroecosystems. Cultivos Tropicales 37 (4), 34-56.

Gaitán J.J. et al. 2023. Mapa de almacenamiento de C en los suelos de la República Argentina. INTA, https://intamapacosargentina.users.earthengine.app/view/cos

García Hernández, LF; Rojas, JM; Spoljaric, MV. 2021. Dominancia, diversidad y abundancia de arañas en sistemas de producción agroecológico y convencional. II Congreso Argentino de Agroecología. 13 al 15 de octubre, Chaco.

Giraldo, O.F. y P.M. Rosset. 2022. Emancipatory agroecologies: social and political principles. The Journal of Peasant Studies, 50 (3), 820–850. https://doi.org/10.1080/03066150.2022.2120808

Rojas, JM, Spoljaric, MV, González, JR, Lacava, M y García Hernández, LF. 2024. Soil arthropod diversity, richness, abundance in agroecology and conventional cotton production systems in Chaco. Revista de la Sociedad Colombiana de Entomología. VOL. 50 NO. 2 (2024): VOL. 50 NÚM. 2 (JUL-DIC, 2024). https://doi.org/10.25100/socolen.v50i2.12867

Rojas, JM; Mansilla, NP; Kees, MA y MV Spoljaric. 2024. Estrategias para evitar degradación de suelos en sistemas agroecológicos con algodón. X Congreso Latinoamericano de Agroecología. 23 al 25 de octubre. Asunción, Paraguay.

Rojas, JM y MV Spoljaric. 2023. Producción de algodón en sistema agroecológico en Chaco. En: Experiencias agroecológicas del territorio: Red de Agroecología de INTA / Francisco Rodrigo Tizón; compilación de Tizón, Francisco Rodrigo. - 1a Ed - Bahía Blanca. Libro digital, PDF. Archivo Digital: descarga. ISBN 978-987-88-8823-1

Rojas, JM; Spoljaric, MV; Selva, MV y J Frías. 2022. Bioinsumos en la producción de algodón agroecológico. https://repositorio.inta.gob.ar/xmlui/handle/20.500.12123/12915

Rojas, JM; Spoljaric, M.V.; Paz, M.V. y M.A. Gómez. 2021. Algodón agroecológico: generando espacio en red frente a otros modelos. II Congreso Argentino de Agroecología. 13 al 15 de octubre, Chaco.

Sarandón, S.J. 2024. La introducción de la Agroecología en la educación agrícola en la Argentina. Revista Escenarios. Edición N° 20. En: https://www.unlc.edu.ar/wp-content/uploads/2024/07/REVISTA-ESCENARIOS-N%C2%B0-20.pdf

Sistema de Información Simplificado Agrícola, SISA. 2024. Algodón 2023-2024. En: https://www.argentina.gob.ar/sites/default/files/sisa_algodon_23_24.pdf

Spoljaric, MV; Goytía, SY; Bela, D; Levit González, C y J.M. Rojas. 2024. ¿Cómo orientar el destino de la producción de algodón en un contexto ambiental desfavorable? X Congreso Latinoamericano de Agroecología. 23 al 25 de octubre. Asunción, Paraguay.

Spoljaric, MV; Burdyn, B y J.M. Rojas. 2021. Estudio preliminar de malezas en sistema agroecológico y convencional. II Congreso Argentino de Agroecología. 13 al 15 de octubre, Chaco.

# Argentine Network of Women Cotton Producers: Crafts, Time, and Economy

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## ABSTRACT

The present experience consisted of the production of cotton (Gossypiun sp.) with an agroecological approach and was developed during the 2021/2022 campaign on the farm of family farmer Karina Billalba located in the "Las Tunas" area of the Reconquista district, north of the province of Santa Fe, Argentina. In 900 m2 of area planted with cotton (Gossypium sp.), 110 kg were harvested, of which 40% was made up of very good quality fiber. The most relevant results were the good yields obtained and the economic profitability of this crop. As lessons learned, we can mention the strength that family farmers have to integrate organizational spaces, as in this case the Argentine Network of Cotton Women, to promote the production of cotton fiber with an agroecological approach. In conclusion, it was possible to establish that incorporating cotton cultivation into this production system improved family income and allowed for further diversification of agricultural production.

**Keywords:** family farming; agro-ecology; local government.

## MATERIAL AND METHODS

The "El Hornero" farm, managed by agroecological family farmer Karina Billalba, is located in “Las Tunas” in Reconquista district, northeast Santa Fe, Argentina. It operates a mixed agricultural production system. In there take place fruit-horticultural activities, along with livestock and farm activities.

Additionally, Karina Billalba is part of the Argentine Network of Women Cotton Farmers, established in 2020, which aims to link all elements of the cotton chain nationally, promoting social, environmental, and economic sustainability. The network consists of 120 women, their families, and organizations in which they participate from Santa Fe, Chaco, Santiago del Estero, and Buenos

Aires. This network is supported technically by the SAFCI and INTA.

During the 2021/2022 season, cotton cultivation (Gossypium sp.) was incorporated to their biodiverse production system with the purpose of supplying the Network with agroecological cotton.

**Pictures 1 & 2. 1500m2 parcel cultivated by Billalba family.**

The experience took place on a 1500m2 plot, where "Guazuncho3" cotton variety (Gossypium sp.) was sowed along with corn (Zea mays), cowpea (Vigna unguicalata) and peanut (Arachis hypogaea). This family had never cultivated cotton in their field but they knew a little about its cultivation given that some years before they had worked as croppers in other productors fields. It is worth clarifying that at present, in this part of the country, cotton is sowed in great areas and it is harvested with mechanical harvesters.

The harvested agroecological cotton fiber was comercialized within the network so that other women could do the spinning and the subsequent weaving.

## RESULTS

Cotton (Gossypium sp.) cultivation occupied 900 m², planted in mid-October 2021, and then harvested. The distribution among other crops was made in an intercalated way to promote synergism among species (see Figure 1). As predecessor, during 2021's autumn-winter, oat (Avena sativa) was sowed as a cover crop. Oat (Avena sativa) was grazed by sheep and goats before preparing the ground for the sowing of spring-summer crops.

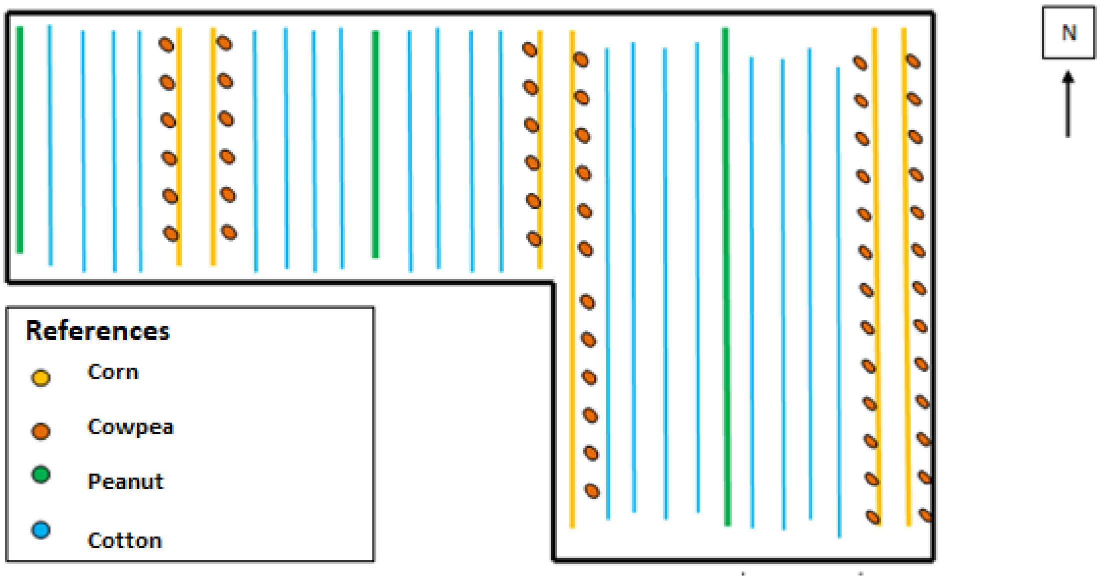


**Figure 1. Crops design.**

**Pictures 3 y 4. Parcels with intercrops.**

During the crop cycle, various management practices were implemented. Cotton was sown manually in rows spaced 0.7 m apart. After seedling emergence, thinning was conducted along the planting line, leaving 5 plants per linear meter. During crop growth, hoeing was performed along the planting line, allowing spontaneous vegetation to grow between rows to maintain soil cover and prevent moisture loss. Pheromone traps were set to attract the cotton boll weevil (Anthonomus grandis), along with color traps for aphids and thrips. To enhance crop nutrition, foliar applications of a liquid biostimulant, prepared through a fermentation process of nettle (Urtica urens), were applied. In January 2022, cotton plants were affected by a boll weevil infestation, which was controlled with a bioinsecticide made from paradise tree (Melia azedarach) and rue (Ruta graveolens). Despite climatic adversities, including a prolonged drought and high temperatures, the crop reached harvest in good development condition. The harvest begun February 18th, 2022, and was carried out manually. The members of the family were in charge. 110 kg were yield from the 900m2 sowed. The fiber yield was 40%. The final fiber price was $600/kg, six times that of conventional cotton.

**Pictures 5 & 6. Cotton crop harvest.**

The technical follow-up was conducted by technicians from SAFCI's General Obligado Territorial Team and from EEA INTA Reconquista, who accompanied the family farmer with training and socio-productive assistance along the entire productive cycle.

The Argentine Network of Women Cotton Farmers counts with a rotational funding mechanism facilitates the purchase of fiber from family farmers, which is then distributed to female spinners. The yarn is subsequently supplied to weavers, who settle the yarn costs upon sale of the textiles. The spinners then replenish the rotational fund with the proceeds from the fiber initially received.

The experience underscored the value of diversified production systems combining food and fiber crops, incorporating an industrial crop like cotton. Furthermore, this diversification improved the family's income, securing a premium price for the fiber sold as agroecological cotton.

The fiber obtained from the production provided raw material to cover the first link in the Argentine Network of Women Cotton Farmers chain.

## CONCLUSIONS

This experience achieved good cotton fiber (Gossypium sp.) yields in a diversified agroecological system with other crops.

Sales income from agroecological cotton fiber was notably higher than conventional production, thanks to the added value this model provides and the direct marketing through the Network. That allowed to enhance the prices, the logistic and the strengthening of local and regional networks.

This model embodies the genuine idea of "sustainability" in a concrete product like agroecological cotton (Gossypium sp.). It showcases a collective approach in which diversity is a strength, guiding toward achievable horizons where human, technical, and ecological aspects converge and mutually reinforce.

# Development of a Mini Cotton Gin: Bridging Technology Gaps and Enhancing Accessibility

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## ABSTRACT

The generation of tools and machinery adapted to the different production realities is important for promoting productive development and integrating diverse actors in the production chain in socioeconomical terms. In this sense, this article presents the development process of a mini cotton ginner, adapted to the low scale agroecological cotton production conditions of families and communities belonging to the 'Red Argentina de Mujeres Algodoneras' association (which means, Argentine Network of Cotton Women), leading to increased efficiency in the process and improving life quality for these individuals.

## THE PROJECT

In a new productive context, where modern agroecosystems require change, agroecology emerges as an environmentally friendly practice with a significant socioeconomic component. The Argentine Network of Cotton Women fully links the cotton chain, from agroecological family-scale production to spinning and the artisanal making of garments. It is made up of various organizations, with technical support from science and technology agencies, encompassing families and producers from rural areas in the provinces of Santa Fe, Santiago del Estero, Tucumán, Buenos Aires and Chaco.

Agroecological cotton production at a small scale generates volumes of raw fiber that are not accepted by the large industrial ginners in the market. In this context, the initiative arose to develop a ginner with the capacity and functional characteristics suited to the needs of the Network. To carry this out, a project proposal was submitted to a call for Social Inclusion Technology Projects from the Ministry of Science, Technology, and Innovation of Argentina, which provided funding for the construction of the machine. The project considered the surveying, design, construction, and commissioning of the Mini Ginner, aiming to improve the life quality of the farming and artisan families of the Network through technology that allows mechanization of the ginning, which was a limitation in the production process.

## THE DESIGN MACHINE

Figure 1 shows views of the three-dimensional (3D) models of the main parts and subsystems of the machine designed in this project.

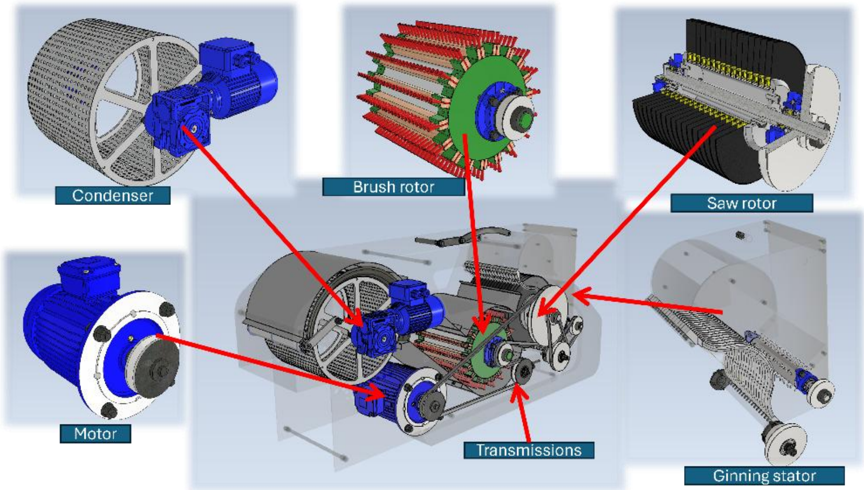


**Figure 1.** Main components of the designed machine. It shows the ridimensional (3D) design made by computer, indicating it main parts.

The overall dimensions of the designed machine are 1500 x 600 x 1200 mm (length x width x height, respectively). Its nominal power is 3.5 HP, requiring a three-phase electrical connection of 220/380 V. Regarding the ginning process, it consists of 17 twelve-inch saws (Lummus technology), with 19 ribs mounted on a retractable stator. The main drive motor is 3 HP, three-phase with a direct start system. It features a classic double B-type V-belt main transmission and combined secondary transmissions using single A-type belts. All belts and pulleys are of commonly used dimensions and are readily available on the market.

The condenser system and automatic feeder are powered by independent gear motors with an installed power of around 0.25 HP. The feeding system operates intermittently and allows for the regulation of the cotton loading rate through electrical timing of the running and stopping periods.

Additionally, it features illuminated viewing windows that allow for observation of the internal ginning process, providing the machine with an extra educational functionality. Figure 2 shows photos of the constructed machine and the viewing windows mentioned.

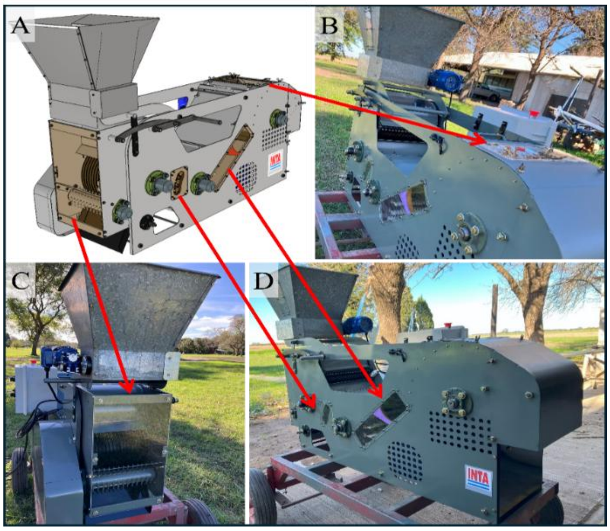


**Figure 2.** Image of the 3D design (A) and photos of the constructed machine from a top-side view (B), rear view (C), and side view (D). The arrows indicate the viewer system present in different parts of the machine, which allows observation of the fiber ginning process.

## DESIGN, CONTRUCTION AND FUNCTIONING

As a starting point, the concept of an old mini cotton ginner with conventional ginning technology, existing in the industry, was used. The initially surveyed machine, shown in Figure 3, has 15 twelve-inch saws, a rotary condenser system, and electric drive with an installed power of 5.5 HP.

Using computer-aided design (CAD) tools, a three-dimensional survey of the machine's geometry was conducted, while simultaneously operating it to measure various mechanical functional parameters (rotational speeds, transmissions, power consumption, among others). Thus, based on the functional concepts of the existing machine, the conceptual foundations for the design of the new model were established.

**Figure 3.** Old ginner surveyed to initiate the design and adaptation process of the machine proposed in the project, viewed from both sides.

In parallel to this process, the functional objectives required to meet the new design were defined, from the perspective of need or demand. In this sense, the design began based on the following premises:

- Achieve a machine with safety conditions for working in a non-industrial environment, which is compact and portable.
- Use standard saws, ribs, and other ginning elements compatible with modern ginners available in our geographic region, to ensure access to spare parts.
- Modernize the design to allow construction with current manufacturing technologies available in the region, while also improving functionality and aesthetics.
- Optimize the use of materials, the number of parts, and transmissions.
- Improve access for cleaning and adjustment tasks, enabling independent work with different batches of cotton, considering a future fiber traceability system.
- Enhance visibility of the internal ginning process.
- Optimize the installed electrical power of the machine and modernize the electrical system.

Using computer-aided mechanical design tools, 3D models and virtual prototypes of the different systems of the machine were constructed. These prototypes were computationally built with the logic of assemblies and sub-assemblies that connected to form a three-dimensional representation that could be visualized in detail before the construction of the physical models. Figure 4 shows some views of the 3D model during its development process.

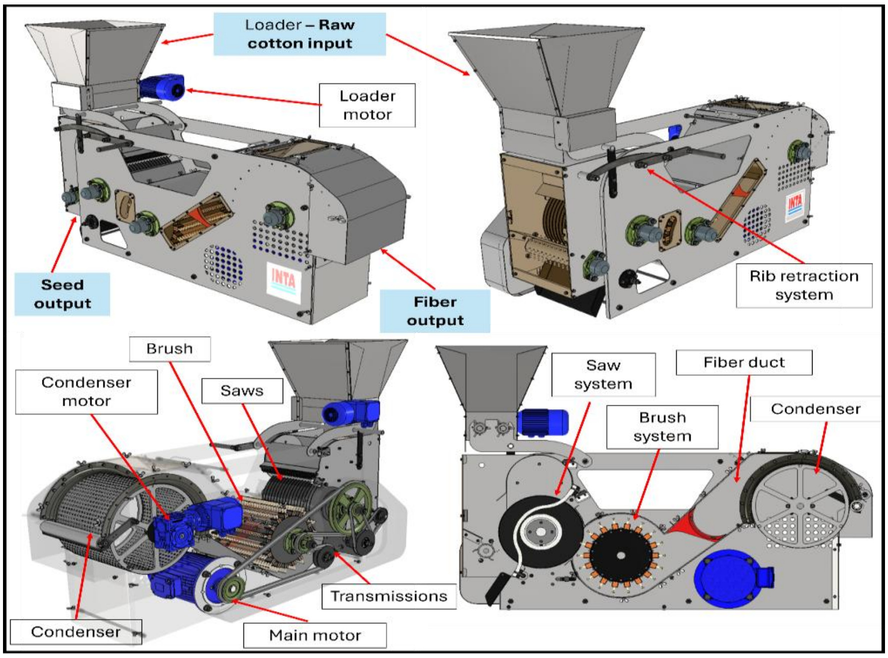


**Figure 4.** Different views of the 3D design of the Mini Ginner developed in this project. The external and internal systems of the machine are shown, highlighting the main components designed based on the previous survey and adapted to the identified needs. The entry points for raw cotton into the process, as well as the exit for ginner fiber and seeds, are outlined in color.

The design proposed a main structure with side plates intended for laser-cut manufacturing, positioning the condenser in order to achieve a compact machine, and incorporating a fiber duct system that is easy to disassemble to keep the machine completely clear for cleaning tasks (Figure 4). Standard ginning elements corresponding to a model from the Lummus brand (saws, ribs, and separators) were adopted as technology. Based on power measurement data taken from the existing machine, a 3 HP electric motor was selected, and a drive system was designed with direct starting from a main control panel. The drive mechanisms for the condenser rotor and the feeder system were planned with independent gear motors to simplify mechanisms and transmissions, replacing mechanical components with electromechanical systems controlled by contactors and electrical timers.

The construction and commissioning took place at the Agricultural Experimental Sation of INTA Reconquista. For this, based on the virtual prototype constructed (3D model), complete drawings and a materials list were generated. The assembly process was developed in two stages. Initially, assembly and commissioning were carried out to perform what is colloquially known as ‘making the machine work’. During these tests, feedback processes and modifications improved performance and functionality. Some adjustments were made, related to changes in rotational speeds to harmonize operation, improve the design and construction of mechanical transmissions, and modifications to the fiber duct geometry in order to prevent blockages.

After commissioning and initial evaluations, the final assembly of the device was completed, with all parts properly painted and conditioned. Additionally, all elements related to the protection and safety system were adjusted and finalized. Figure 5 shows some images from the construction and commissioning process.


**Figure 5.** Images of the construction process and commissioning of the mini ginner. Treatment and painting process of individual parts (A), initial ginning tests (B), rear viewer of the machine where raw cotton is loaded (C), top viewer showing the saws in the ginning process (D), clean fiber output area (E), and top view of the internal duct system for fiber passage (F).

## MACHINE EVALUATION

Once the Mini Ginner was built, the necessary evaluations were conducted to verify not only its ginning capacity but also that the fiber quality parameters were not affected after the process. For this, two batches of raw cotton fiber, produced agroecologically and harvested manually, were taken, determining that the machine has a ginning capacity of 1 kg of raw cotton per minute, operating continuously and without issues. Additionally, a small sample fraction from each batch was ginned using the laboratory ginner at INTA Reconquista (ecophysiology laboratory). The quality of the fiber samples obtained from each ginner was analyzed comparatively, with the main parameters shown in Figure 6. As observed, the samples showed no differences in length (UHML), percentage of short fibers (SF), strength (Str), or elongation (Elg), regardless of whether they were ginned in the laboratory ginner or in the mini ginner constructed in this project. These results indicate that this new ginner operates correctly, with a good processing flow and providing fiber of adequate quality.

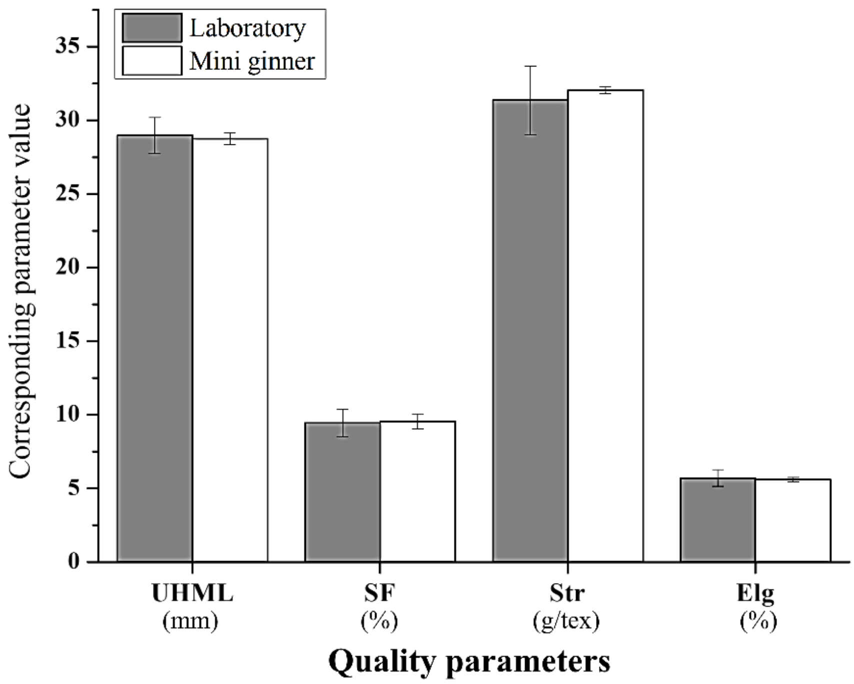


**Figure 6.** Main quality parameters obtained for the fiber using the gin from the research (Laboratory) compared to the gin built in this project (Mini ginner). The parameters of length (UHML), short fibers (SF), strength (Str), and elongation (Elg) are shown. Y axis show the corresponding parameter value, which units are indicated under each quality parameter in the X axis.

Subsequently, larger quantities of fiber were processed, ginning batches of 54 kg in a real operational time of 66 minutes, with a net loss calculated at 4.5% accounted for in fiber and seed. Some photos of the machine in operation can be seen in Figure 7.

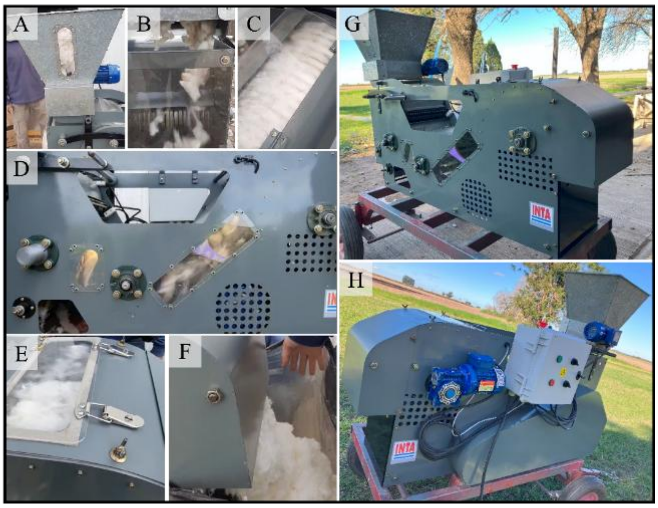

**Figure 7.** Images of the final machine in operation. Entry of raw cotton into the loader (A), rear viewer where the fiber falls into the saw system (B), ginning process (C), side viewers showing the passage of fiber (D), viewer from the top of the condenser (E), and exit of clean fiber from the front (F). Side views of the completed mini ginner (G-H).

## CONCLUSIONS

The developed machine will be part of the Argentine Network of Cotton Women, and its design was specifically intended to be transportable to different high-fiber production locations, allowing ginning to take place on-site, thus streamlining processes for the producers belonging to the Network.

The present work represents a significant advancement in bringing technologies adapted to different socio-productive realities through the design, construction, and commissioning of a continuous low-scale ginner. Furthermore, machinery of this nature enables these families and communities to have some of the necessary tools to establish future traceability in their products. This technology will improve work efficiency, reduce the time and effort required to transform raw fiber into high-quality cotton thread, creating a direct impact on the growth of the various socioeconomic factors involved and, consequently, on their quality of life.

# Agroecological Cotton: A Socioeconomic and Environmentally Friendly Alternative

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## BACKGROUND

Agroecology in known as the practice, science and movement that involves the socioeconomical, ecological and ethical complexity of production systems. It has emerged as a methodological approach for sustainable development in some specific areas as an enhancement proposal to the conventional agricultural production. There are many countries from different continents around the world that employed, to a greater or lesser extent, the agroecology. According to Sustainable Food Trust Organization, the international range of 'agroecology' is leaded by Western Europe and The Americas, followed by Africa and Australia, while in Asia fewer groups embrace the term agroecology. It is based on returning unbalanced systems to stable ecological conditions, but it also has a deep social component. Argentina, together with other Latin America countries, is not the exception, presenting different agroecology production experiences. A local example, called 'Red Argentina de Mujeres Algodoneras (RAMA)' (which means, Argentine Network of Cotton Women), link together family farmers, minority and native communities from different provinces of Argentina with technicians from public institutions to encourage agroecological cotton production. These families carry out their cotton production on a small scale intercropped with food crops, such as peanut, pumpkin, onion, corn, pepper, beans and others. Intercropping is the practice that increases crop diversity to strengthen agroecosystem functions while decreasing chemical inputs and minimizing negative environmental effects of crop production. Families within RAMA not only grow their own cotton using agroecological methods but also add value through in-network handmade spinning and garment making. Furthermore, these groups cultivate their own food in a healthy manner, involving entire families and individuals of diverse ages in the productive chain, from product development to commercialization. Argentina, Brazil and Colombia are playing a leading role in promoting the development and use of biological inputs such as insect repellents, insecticides and/or nutritional purposes. The families of RAMA are provided with different bioinputs produced in a biofactory located in 'Instituto Nacional de Tecnología Agropecuaria' (INTA) Reconquista and advised with recipes to produce their own bioinputs.

The aim of this work was to share an experience on cotton production within an intercropping system with two food crops, peanut and corn, evaluating different biological inputs produced by the biofactory, thus generating an agroecological model to being incorporated into the RAMA producers.

## METHODS

The research was conducted at INTA Reconquista located in Santa Fe province, Argentina. The experimental design involved plots containing an intercrop of cotton – 2 lines per treatment - (the primary crop under evaluation, cultivar Guazuncho 3), along with peanut and corn – 1 line each per treatment. Corn was sown on October 3rd, cotton and peanut on October 19th for the 2023/24 season. Four treatments containing bioinputs were sprayed to all crops (cotton, peanut, and corn) every 7 days. These treatments (detailed below) were compared against a control group that did not receive any bioinputs.

**Control (C): water**

T1: Equisetum arvense ('horsetail') 10% v/v

T2: Urtica ('ortiga') slurry 10% v/v

T3: Sapindales and Ruta ('paradise and rue') 10% v/v

T4: Combination of T1, T2 and T3

The bioinputs were weekly produced at the biofactory following the protocols described in Barchuk et al., (2018). Given that the bioinputs assessed were linked to insects and diseases, the focus during data collection was on several key aspects: cotton yield, biodiversity, pests, pathogens, and the advantages or disadvantages of the chosen crops for establishing the intercropping system.

## RESULTS AND DISCUSSION

Cotton production in Argentina has a significant socioeconomic impact, particularly in Santa Fe province, where it undergoes complete industrial processing: 'from field to garment'. The main cotton production is under conventional tillage system, using genetically modified (GM) Gossypium hirsutum cotton cultivars, containing bollworms and glyphosate resistance technologies. However, in recent years, alternative cotton productions systems have emerged. These systems involve agroecology as a socioeconomic and environmentally friendly options. Groups and families that are economically excluded have found on cotton agroecology production an opportunity of progress and advancement. In this context, we performed the study over an agroecological model for cotton production, to contribute with data to emerging producers in this field, such as those belonging to the RAMA.

### Organisms in agroecological cotton production

The dominant stress factors that commit cotton comprise pathogens and insect pests that are mainly responsible for reduction of cotton yield. Crop productivity largely depends on successful field pest management, which is often achieved by using chemical control methods.

Biological control is an important aspect of integrated pest management. A great shift from the use of pesticides to biological pest control is being noted in many countries' farming systems. The agroecological systems combine the use of bioinputs with biological control for pest management. In this study, an exhaustive analysis of pathogens, pests, beneficial insects, and the biodiversity in the different crops was performed.

**Pathogens**

Different fungi, bacteria and viruses are the major pathogens in the cotton system. Bacterial blight and cotton blue disease are two notorious diseases of cotton crop that are under surveillance in Argentina. Both are present in almost all cotton production areas and up to now the diseases were controlled by using genotype-resistant cultivars. Along cotton cultivars available in our country, the non-genetic modified (non-GM) cotton genotype chosen for agroecological production, Guazuncho 3, is genetically resistant to both diseases.

On the other hand, fungal diseases of cotton crops are also much more dynamic, caused by various fungal pathogens. Among them, Alternaria leaf blight is one of the major foliar diseases, prevalent in all cotton growing regions worldwide. Although no commercial cotton cultivars grown are known to be immune to Alternaria, different levels of Alternaria leaf blight resistance may exist in current commercial cotton cultivars and breeding lines. Cotton plants are more susceptible late in the season where favorable environmental conditions play a vital role in the occurrence of the disease. During late flowering of Guazuncho 3 plants, a disease incidence of 100% with a 10-25% infected leaf area was recorded on five leaves evaluated from middle and lower part on five plants randomly selected from each treatment (Figure 1A-B). No significant differences between the different bioinputs treatments and control were obtained. Alternaria spp. spores were detected on leaf sample and isolated to determine the diversity of Alternaria species (Figure 1C).

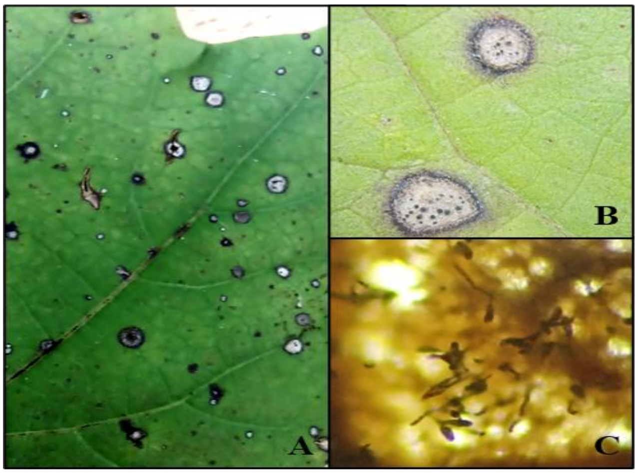


**Figure 1.** Alternaria spp. symptoms in cotton leaves. A-B. Small, brown, circular lesions on the leaves surrounded by distinct purple or dark brown margins. C. Microscopic sporulation pattern of Alternaria colonies on leaves.

**Insect pests**

In Argentina, the main biotic factor that could reduce up to 100% yield production is the boll weevil (Anthonomus grandis Boheman). To date, different management strategies have been established to minimize pest populations.

The principal and fundamental tool to evaluate the presence and dispersal of boll weevil are the pheromone traps that are typically placed next to cotton fields one month before sowing date and monitored weekly until crop harvest (Figure 2A). However, the effectiveness of traps in detecting weevil populations decline rapidly once cotton is actively fruiting. In fact, cotton field may be heavily infested with boll weevils, yet adjacent traps may not capture any weevils.

Nowadays, sustainable agriculture is presented as a good alternative to reduce or avoid the use of harmful products to the environment. Thereby, the utilization of bioinputs in combination with intercropping production resembles a good strategy among small- and medium-sized rural producers in several developed countries to mitigate biotic stress. In this study, the efficacy of different bioinputs were analyzed regarding boll weevil control. The evaluation was performed through the observation of cotton reproductive structures damage due to boll weevil feeding, oviposition or both punctures (Figure 2B). Results indicate no significant differences among the bioinputs treatments, since insect population remained active causing damage, mainly due to feeding. However, significant differences in the damage produced by boll weevil to reproductive cotton structures were observed depending on the different moment of observation during cotton development cycle. The results also indicate variations in the number of healthy reproductive structures depending on the sampling time. This effect could be related to the perennial nature of cotton plants, since cotton grows indefinitely, it continuously generates new reproductive structures unless some chemical growth regulators are applied. In an agroecological system, such as the one evaluated in this study, no growth regulators were applied, so the cotton crop exhibits indefinite growth, continuously generating new reproductive structures, which are attractive for boll weevil.


**Figure 2.** Cotton boll weevil evaluation on agroecological system production. A. Pheromone traps placed next to the assay before sowing date and maintained during crop development. B. Images representing reproductive structures damage due to boll weevil feeding (black arrows) and oviposition punctures (white arrows). The observation was initiated at the end of the reproductive phenological stage and monitored every 10-15 days.

## Diversity of arthropods

Successful control of arthropod pests is achieved using chemical control methods, which are effective when pesticides are applied correctly. However, they also harm non-targeted beneficial arthropod species, such as lady beetles (Coccinella ancoralis), which primarily feed on aphids. Reductions in beneficial arthropods can have negative effects on biological control systems, which are inherently one of the key benefits of more diversified agricultural systems.

Agroecological production encourages beneficial insects and predator pests in cotton crops. A wide diversity of beneficial species has been recorded in the present study (Figure 3). The ability to identify these beneficial species in strip crops is essential for understanding the diversity and for developing more effective control measures conducive to preserving biodiversity through the adoption of agroecological practices in cotton cultivation. The functional groups of the arthropod community associated with cotton were analyzed, with predatory and decomposer functional groups, as well as pollinators, being the most representative. Among them, we can recognize mainly spiders, bugs, lady beetles, dipteran and bees (Figure 3).

Together with the boll weevil, another insect pest of cotton crop is the fall armyworm (Spodoptera frugiperda). The biodiversity observed on agroecological system also include the presence of entomopathogens, as was evidenced by dead larvae infected by Nomuraea sp., an entomopathogenic fungus known to naturally infect various Lepidoptera species, including S. frugiperda (Figure 3K). Although infection assessments were not conducted, the high incidence of S. frugiperda larvae infected by Nomuraea sp. suggest that there were favorable conditions that promote fungus's growth and development.


**Figure 3**. Biodiversity in agroecological cotton production. Beneficial arthropods and predators: A. Cycloneda sanguínea. B. Coleomegilia quadrifasciata. C. Harmonia axydiris. D. Podisus sp. E. Geocoris sp. F. Crisopa sp. G. Argiope trisfasciata. Decomposers: H. Larv sirphidae. I. Diplopodos. Pollinators: J. Bee. K. Entomopathogenic fungus: Nomuraea sp. growing on S. frugiperda.

**Intercropping peanut as a trap of Spodoptera sp.**

Spodoptera frugiperda is the main pest in maize (Figure 4A), but it also attacks the vegetative and reproductive stages of the cotton crop (Figure 4B). According to the insect monitoring conducted during this study, the fall armyworm was present during the early stages of maize development but in cotton, it was found but in very low proportions. These results were related with planting peanuts as a 'buffer crop' alongside maize and cotton. Peanuts have acted as a 'trap crop', attracting pests and keeping them away from the main crops (cotton and corn). During severe fall armyworm infestations in this study, up to 100 larvae per linear meter of peanut have been recorded, showing that this crop served as a food source base that prevented damage to both maize and cotton by this pest (Figure 4C). This result shows the importance of using this intercrop system when producing agroecological cotton in areas with high fall armyworm infestations.


**Figure 4.** Fall armyworm Spodoptera frugiperda on intercropping system. A. Corn. B. Cotton. C. Peanut. Black arrows indicate S. frugiperda insect colonization.

## CONCLUSIONS

The present study shows the importance of technical research concerning agroecology cotton crop production, with a holistic approach as considering intercropping food crop and bioinputs as alternatives for disease and insect management. Regarding on this, the evaluation of biotic stress associated with the biodiversity set in this study are essential to contribute to the development of agroecological cotton production adapted to the regional economies of Argentina, and specifically to family producers comprising RAMA.