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UNIVERSIDAD NACIONAL DE ROSARIO

UNR
Universidad Nacional de Rosario

Seminario científico franco-argentino sobre agroecología

22 Y 23 DE NOVIEMBRE

Rosario, Argentina

ORGANIZA

Programa Argentina Francia Agricultura
Programa de Movilidad Universitaria y Agroecología

ARFAGRI

22 Y 23 DE NOVIEMBRE DE 2022 | Rosario, Argentina

Seminario científico franco-argentino sobre agroecología

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AGROECOLOGY UNIVERSITY PROJECT OF MOBILITY – PUMA

2016-2022

Participating Institutions

- Agrocampus OUEST (currently l'Institut Agro Rennes-Angers) – Coordinator for the French side
- AgroParisTech
- Bordaux Sciences Agro
- LaSalle Beauvais Polytechnic Institute
- VetAgro Sup
- AgroSup Dijon (currently l'Institut Agro Dijon)
- University of Buenos Aires, School of Agriculture - Coordinator for the Argentine side
- National University of Rosario, Faculty of Agrarian Sciences
- National University of Cuyo, Faculty of Agrarian Sciences
- National University of the Northeast, Faculty of Agricultural Sciences

General objectives of the project

The “University Project for Mobility in Agroecology -PUMA” gather Argentine and French higher education and research institutions which desire to increase their internationalization degrees and to develop a fruitful cooperation.

The project involves a general dimension: the mobility of students and professors. On the other hand, a thematic dimension: the agroecology.

The participants assigned two objectives to the PUMA project:

1. To stimulate the mobility between institutions. The mobility will contribute to the training of young students who will be able to evolve in an increasingly international context and in a professional environment worldwide opened. Both, language learning and bicultural training, hold promise for academic enrichment and personal development. Secondly, the mobility of professors and/or researchers is also important, particularly for the realization of the second main objective.

2. To promote joint research, especially in the agroecology field. Build and strengthen the relationship between research teams. A better understanding of the associated institutions develops in the enrichment of the projects of each country, as well as in the implementation of common protocols to pursuit for international cooperation.

The PUMA project focuses specifically on agroecology and sustainable ways of production. This is the most important theme for all the actors involved.

3. To develop actions between both countries through the transference of knowledge and the implementation of cooperation tools to contribute to develop a productive innovation.

During the more than five years the project has been developed, the proposed objectives have become real and, in some cases, they have been expanded since the participants have worked to increase the connections between professors and researchers defining a common academic criteria for the students’ mobility of both countries.

Regarding the institutional impacts, the Coordination’ group has developed the promotion of a well-qualified knowledge in terms of content, complementarity of courses, academic structure and research.

From an academic point of view, the result was very positive: every student from France and Argentina who has participated was very satisfied with his/her mobility experience. The students were able to learn about an alternative agricultural system different to the one developed in their region, carry out field-work and interacting with local professors and students.

In this sense, the dossier of candidacies had a great impact. The visits of the delegations from both countries and the student mobility carried out have become in progress relating these aspects, linking not only the binational partners but also inter-institutional knowledge within the national consortium itself.

Firstly, visits were made by professors of related subjects/topics in both directions. This allowed to propose a second stage focused on Agroecology, taking into account the research lines of the 10 partners' programs.

With a big effort and a great interest, we developed several visits which developed into better relationships between us. Two general missions with all the partners on-site were organized, one in Argentina and the other one in France. This contributed to learn more about their academic proposals, to understand the functioning of the Social Schools and their training programs, and also promoted the bonds of friendship and trust between the general and local coordinators. The on-site experience had a great impact.

As a team, we participated in all the forums and proposals raised by the Ministry of Education of Argentina and the Ministry of Agriculture of France.

Regarding the theme of the project, agroecology has been at the heart of the French government's educational policy and agricultural policy for several years. It is also a priority issue in Argentina and the challenges around agroecology have become global.

The academic and institutional impacts were therefore very important and are supported by the ARFAGRI program. In fact, this has created a dynamic that allowed the French and Argentine partners to multiply cooperation agreements, which were few before the start of the project, and significantly increase the international projection of each one.
The PUMA project is the most important of the different ARFAGRI projects in terms of student mobilities, 54 mobilities from Argentina to France and 133 from France to Argentine partners in 5 years (we do not take into account, 2 pandemic years).

Other important result of this project is that, based on the in-depth knowledge of the consortium partner members, a Double Degree agreement has been signed between two of the participating schools; that is, between the UNR and the VetAgro Sup School. This agreement is being carried out with the mobility of a UNR student who is studying in France, facilitated by a scholarship from the French institution.

Therefore, we have proposed to organize a research seminar to bring together professors and researchers from all institutions and share the state of progress of their knowledge and work on the subject. It was carried out virtually in 2021 to establish a collaborative research dynamic, bring together people related to the subject and promote the emergence of joint projects that allow them to benefit from alternative financing for research mobility. During the year 2021, the protagonists of the PUMA project organized a cycle of monthly webinars for 10 months that allowed the teacher-researchers of the partner institutions to present their research work in agroecology. Around 100 participants (teachers, doctoral students, students...) were present. This seminar, now in Rosario, closes this cycle of webinars and seeks to establish common research projects in the future.

Any agricultural activity requires special agroecological attention, as we said above, it is a priority on the agenda of both countries. For this reason, we believe that it will exponentially enhance the cultural and social academic actions of the environment where our students develop, contributing sustainability and sustainability in each undertaking or act.

To finish the PUMA program and the cycle of webinars, was organized a **scientific seminar on November 22nd and 23rd, 2022 at the National University of Rosario (Argentina)**. In the context of climate change, the updated ambitions at COP26 in terms of reducing greenhouse gas emissions and the associated European Green Deal, teaching for produce differently is more important than ever.

Therefore, **this seminar's objectives are sharing the recent scientific results in the field of agroecology and developing joint research projects between French and Argentine teams.**

Agronomy

INDICATORS FRAMEWORKS FOR EVALUATING THE SUSTAINABILITY OF AGROECOSYSTEMS APPLICABLE AT THE FARM SCALE IN EXTENSIVE PRODUCTION. REVIEW.

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Numerous frameworks have been proposed to address socio-environmental problems in general and to assess sustainability in agroecosystems in particular. These frameworks differ from each other in multiple characteristics such as objectives, actors involved, fields of application, disciplinary origin, language, theoretical framework, spatial scale, temporal dynamics, conceptualization and approach to the social and ecological systems and their interactions. However, there are few that address these interactions. Some frameworks are oriented to analysis and others to action. In general, there is some trade-off between the scope of the framework and the precision of the indicators. Faced with this, there are frameworks aimed at deepening a dimension and/or scale of analysis and multi-criteria analysis frameworks aimed at visualizing the relationship between multiple dimensions, usually broken down into a series of indicators. Most of the sustainability assessments of agroecosystems correspond to this last group. There are top-down evaluations (scarce participation of producers and other stakeholders) and bottom-up (transdisciplinary approach with stakeholder participation throughout the process). Another classification criterion distinguishes between full evaluations (performed by experts) and rapid ones (can be carried out by producers) as opposite extremes within a continuum of possibilities. The latter are easier to implement, but less accurate and therefore less reliable for monitoring or certification processes. In addition, producers prefer the most complete tools, as they are more precise and offer quantitative information on specific contexts. The choice of tools to assess sustainability usually falls to institutional analysts, who rarely take into account the visions, needs or values of producers and other stakeholders involved in the initial phase of defining project objectives. This usually leads to the dissemination of tools that do not fit with the particular social-ecological-productive context to be improved, and consequently to frustrated objectives and inefficient use of resources. There is a need to bring the fields of knowledge production and implementation closer together. Currently there is a growing consensus on the need for indicators that simultaneously cover multiple dimensions, are adapted to each specific context and involve the interested parties, although their development is incipient worldwide and almost null in agroecosystems of the Argentine Humid Pampa.

The objective of this work was to review the frameworks of indicators for the evaluation of sustainability of agroecosystems applicable at the farm scale and to extensive productions, and to evaluate them according to criteria that we consider relevant from an agroecological perspective.

Regarding the methodology, a systematic bibliographic search was carried out using the "Scopus" database, with subsequent manual review using exclusion criteria. We used an equation including five topics: 1) spatial scale: “farm*” and “agroecosystem”, to include “farm”, “farming”, “farmers”, or “agroecosystem”; 2) type of evaluation: “assess*” and “eval*”, to include “assessment”, “assessing”, “evaluate”, “evaluation”, or “evaluating”; 3) evaluation tool: “framework”, “method”, “tool”, or “approach”; 4) analysis oriented towards sustainability: "sustainability"; 5) based on indicators: “indicator*”, including “indicator” or “indicators”. The analysis was performed within the fields "title", "abstract" and "keywords" (TAK). The search resulted in 1051 articles, of which a manual review was carried out using the following exclusion criteria: a) they did not imply the use of a tool: reviews (98), perspective articles (1), theoretical articles (6); b) did not include the farm scale (42); c) they evaluated few state variables (289); d) only analyze intensive (137) and small-scale (18) production systems; e) case studies (149); f) old versions of tools (1); g) they are not in Spanish or English (3); h) others (191). Resulting in 116 articles. To this list we added some tools (13) that did not appear in the search, but that we consider relevant for our study since they were studied in consulted reviews of great weight on the subject or because they were considered relevant at a regional level. In total we will use (129) tools for our analysis.

The selected frameworks were evaluated with various criteria that we consider relevant for evaluating the sustainability of an establishment in agroecological transition, such as: reductionist or holistic approach, weak or strong sustainability, dimensions of sustainability covered, emerging properties, actors involved and level of participation, types of indicators, indicators and measurement or estimation methodologies.

It is expected to identify frameworks that encompass multiple dimensions, allow their adaptation to different ecological contexts and consider the visions of the producers and other actors involved, as well as aspects of incipient development both worldwide and in the Argentine Humid Pampas.

Keywords: sustainability, evaluation frameworks, indicators, dimensions, agroecosystems, agroecology, evaluation tools

Bibliography:

-Binder, C. R., Feola, G., & Steinberger, J. K. (2010). Considering the normative, systemic and procedural dimensions in indicator-based sustainability assessments in agriculture. *Environmental impact assessment review*, 30(2), 71-81.

-Binder, C. R., J. Hinkel, P. W. G. Bots, and C. Pahl-Wostl. (2013). Comparison of frameworks for analyzing socialecological systems. *Ecology and Society* 18(4): 26.

-Bulkeley, H. and Mol, A.P., (2003). Participation and environmental governance: consensus, ambivalence and debate. *Environmental values*, pp.143-154.

-Constanza, R., & Daly, H. (1992). Natural and sustainable development. *Conservation Biology*, 6(1).

-Chopin, P., Mubaya, C. P., Descheemaeker, K., Öborn, I., & Bergkvist, G. (2021). Avenues for improving farming sustainability assessment with upgraded tools, sustainability framing and indicators. A review. *Agronomy for Sustainable Development*, 41(2), 1-20.

-De Olde, E. M., Oudshoorn, F. W., Sørensen, C. A., Bokkers, E. A., & De Boer, I. J. (2016). Assessing sustainability at farm-level: Lessons learned from a comparison of tools in practice. *Ecological Indicators*, 66, 391-404.

-De Ridder, W., Turnpenny, J., Nilsson, M., & Von Raggamby, A. (2007). A framework for tool selection and use in integrated assessment for sustainable development. J*ournal of environmental assessment policy and management*, 9(04), 423-441.

-Duru, M., & Therond, O. (2015). Designing agroecological transitions; A review. Agronomy for Sustainable Development, 35(4), 1237-1257.

-FAO. (2018). *El trabajo de la FAO sobre agroecología*. Recuperado de: http://www.fao.org/3/i9021es/i9021es.pdf

-Fernández RJ. (2016). How to be a more effective environmental scientist in management and policy contexts. *Environmental Science & Policy*, 64: 171–176

-García, M. L., & Vergara, J. M. R. (2000). La evolución del concepto de sostenibilidad y su introducción en la enseñanza. *Enseñanza de las ciencias: revista de investigación y experiencias didácticas*, 473-486.

-García, R. (2006). *Sistemas complejos*. Ed. Gedisa, Barcelona

-Gasparatos, A. (2010). Embedded value systems in sustainability assessment tools and their implications. *Journal of environmental management*, 91(8), 1613-1622.

-Gliessman, S. R. (1990). Agroecology: researching the ecological basis for sustainable agriculture. *Agroecology* (pp. 3-10). Springer, New York, NY.

-Gliessman, S. R. (2002). *Agroecología: procesos ecológicos en agricultura sostenible*. Turrialba, Costa Rica. Catie.

-Gutés, M. C. (1996). The concept of weak sustainability. *Ecological economics*, 17(3), 147-156.

-Harte, M. J. (1995). Ecology, sustainability, and environment as capital. *Ecological economics*, 15(2), 157-164.

-Iermanó, M. J., Sarandón, S. J. Tamagno, L.N. y A.D. Maggio. (2016). Evaluación de la agrobiodiversidad funcional como indicador del potencial de regulación biótica en agroecosistemas del sudeste bonaerense. *Revista de la Facultad de Agronomía de la Plata*.114:1-40.

-Jacobo, E., Cadaviz, N., Martínez Ortiz, U, Golluscio, R. y Rodríguez, A. (2019). "Uso de indicadores ambientales y económicos para evaluar la sustentabilidad de dos establecimientos ganaderos de la Cuenca del Salado, Argentina.", en "*Agroecologia em Foco – Volume 3*" (D.F. Andrade Editor), Capítulo 26: 173-177. Editora Poisson, Belo Horizonte, Brasil.

-López-Ridaura, S., Masera, O., & Astier, M. (2002). Evaluating the sustainability of complex socio-environmental systems. The MESMIS framework. *Ecological indicators*, 2(1-2), 135-148.

-Marchand, F., L. Debruyne, L. Triste, C. Gerrard, S. Padel, and L. Lauwers. (2014). Key characteristics for tool choice in indicatorbased sustainability assessment at farm level. *Ecology and Society* 19(3): 46.

-McGinnis, M. D., & Ostrom, E. (2014). Social-ecological system framework: initial changes and continuing challenges. *Ecology and society*, *19*(2).

-Munda, G. (2006). Social multi-criteria evaluation for urban sustainability policies. *Land use policy*, 23(1), 86-94

-Pearce, D. W., & Atkinson, G. D. (1993). Capital theory and the measurement of sustainable development: an indicator of "weak" sustainability. *Ecological economics*, 8(2), 103-108.

-Pérez, E., Casal, A. V., & Jacobo, E. J. (2019). Evaluación de la transición agroecológica de un establecimiento ganadero a base de pastizal de la cuenca del Salado, mediante indicadores. *Revista de la Facultad de Ciencias Agrarias UNCuyo*, 51(1), 295-307

-Sarandón, S. J. (2002). "El desarrollo y uso de indicadores para evaluar la sustentabilidad de los agroecosistemas", en "*Agroecología: El camino para una agricultura sustentable*", 20, 393-414.

-Sarandón, S. J., & Flores, C. C. (2009). Evaluación de la sustentabilidad en agroecosistemas: una propuesta metodológica. *Agroecología*, 4, 19-28.

-Schader, C., J. Grenz, M. S. Meier, and M. Stolze. (2014). Scope and precision of sustainability assessment approaches to food systems. *Ecology and Society* 19(3): 42.

-Schindler, J., Graef, F., &König, H. J. (2015). Methods to assess farming sustainability in developing countries. A review. *Agronomy for sustainable development*, 35(3), 1043-1057.

-Tonolli, A. J., & Ferrer Gonzalez, C. S. (2018). Comparación de marcos de evaluación de agroecosistemas. Universidad Autónoma de Yucatán. Facultad de Medicina Veterinaria y Zootecnia; *Tropical and Subtropical Agroecosystems*; 21; 3; 10-2018; 487-504

-Turnhout, E., Stuiver, M., Klostermann, J., Harms, B., Leeuwis, C. (2013). New roles of science in society: different repertoires of knowledge brokering. Sci. *Public Policy* 40, 354–365.

-van der Hel, S. (2016). New science for global sustainability? The institutionalisation of knowledge co-production in Future Earth. *Environmental science & policy*, 61, 165-175.

SERVICE CROPS IN GRAPEVINE AGROECOSYSTEMS. CHARACTERIZATION OF AGROBIODIVERSITY, ECOSYSTEM SERVICES, SOIL QUALITY AND THE ECOPHYSIOLOGICAL RESPONSE OF GRAPEVINES TO THESE ENVIRONMENTS.

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The increase in agricultural production can lead to a reduction in biodiversity and, therefore, to a decrease in the capacity of ecosystems to provide ecosystem services (Martín-López and Montes, 2011). Agroecology, as an alternative, has contributed to point out the negative environmental impacts of the conventional agricultural management, but it still needs to develop practices that can properly accomplish its bases: improvement and conservation of biodiversity, soil quality and water care (Tonolli *et al.*, 2019) and thereby ensure the provision of ecosystem services.
One of the main tools to promote agrobiodiversity in perennial crops consists of developing a permanent or temporary vegetation cover, on the field surface (Uliarte *et al.*, 2009). This practice increases soil structure, reduces soil compaction, improves water infiltration and maintains biodiversity, among other qualities (Figure 1).

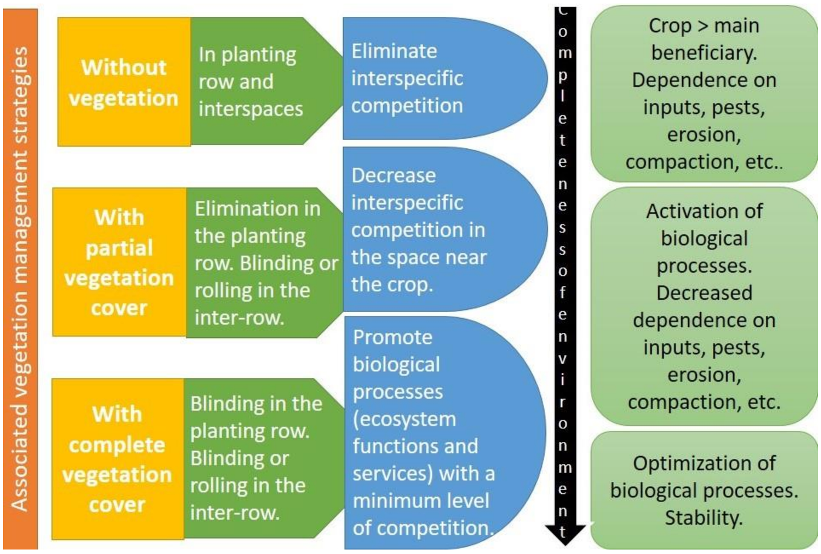

Figure 1. Management strategies for vegetation associated with perennial crops (A.Tonolli)

The dominant vineyard production model in Argentina corresponds to the conventional management but since a time ago, there have been concerns about the environmental

sustainability of these agroecosystems. In this sense, many winegrowers have advanced in strategies for managing accompanying vegetation. Thus, it is common to observe green cover in the vine inter-rows. However, this practice still shows imprecise effects on the accompanying plant community, on the soil and on the ecophysiology of the grapevine crop.
This project aims to contribute to understand the characteristics of soil, agrobiodiversity, ecosystem services and grapevine ecophysiology in a vine agroecosystem with sowing rye.
The research will be carried out in a grapevine agroecosystem in Mendoza, Argentina, during three vegetative cycles. The cultivar is Malbec, conducted on high vertical shoot position trellis system, with drip irrigation. Four treatments will be applied:

1) Without row and inter-row vegetation
2) Total cover with spontaneous vegetation
3) Partial cover of rye *Secale cereale* (inter-row).
4) Total cover of rye *Secale cereale* (inter-row + row)

Each treatment with three replications and two sampling plots of 80 m2 in each replication. Observations of plant cover, plant characteristics, plant and insect diversity, soil quality will be made.

Bibliography

Martín-López B. y Montes, C. (2011). Biodiversidad y servicios de los ecosistemas. *Observatorio de la Sostenibilidad en España (OSE)*: 444-465.

Tonolli, A.; Greco, S. y Sarandón, S. (2019). Algunos aspectos emergentes y de importancia para la construcción del enfoque agroecológico *Rev. Fac. Cs. Agrarias, UNCuyo*, 51(1):205-212.

Uliarte, E.; del Monte, R.; Ambrogetti, A.; Montoya, M. (2009). Evaluación y elección de diferentes especies de coberturas vegetales en viñedos bajo riego de Mendoza. *Revista 13°*, 2(15): 18-34.

DESIGN AND FARM ORDERING. A FACILITATING TOOL FOR THE AGROECOLOGICAL TRANSITION IN EXTENSIVE SYSTEM IN THE SANTA FE PROVINCE CENTER.

D'Angelo, C.; Grosso, S; Bortoluzzi, A.; Canesini, M.C; Benzi, P.; Lauxmann, S.; Regis, Anselmo; Scotta, R.; Grenón, D.; Sanchez Deicas, L.; Risso, M. J.; Ceballos, L. y Aiello, F.

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As a strategy, the agroecology seeks to develop a ecosystemic processes management linked to environmental services considering the need to generate knowledge and local technologies. At the farm scale, the agroecological transition process includes not only the substitution of synthetic inputs (pesticides, fertilizers, etc.) for bioinputs with lower environmental impact, but also the development of cultural practices that promote ecosystem services and the redesign of the farm in accordance with these transformations (Gliessman *et al*, 2007).

OBJETIVE

This paper presents the advances in the development of a methodology to contribute to the design and spatial farm ordering in a agroecological transition process, applicable to extensive systems characteristic of central Santa Fe, to be subsequently validated in real cases.

METHODOLOGY DEVELOPMENT

The conceptual model applied is that of Complex Adaptive Systems (CAS) (Holland, 2006; Gunderson & Crawford 2002). The analysis is carried out at three integrated levels: the farm (N - focal level), socio-environmental context (N + 1) and farm subsystems (N - 1).

The methodology is based on five primary postulates corresponding to the agro-productive, economic, social and environmental dimensions:

i.) The farm is a heterogeneous agro-environmentally managed space.

ii.) All uses have spatially significant requirements.

iii.) The spatial receptivity of the farm for such requirements is heterogeneous.

iv.) The farmer is the one who perceives the signs of the farm problems and decides the priority of the interventions to be carried out in the farm design, based on the diagnosis made.

v.) Designing and ordering a farm spatially implies articulating the agro-productive, environmental and social requirements of the agroecological transition with the receptivity of the farm system, considering the restrictions and opportunities of the environment, and the farmer priorities.

The rearrangement of a farm in agroecological transition begins with an interview with the producer aimed at identifying, systematizing and dimensioning the problems that he perceives and prioritizes. This is structured from the application of the dimensions and problems defined in the Sustainability Assessment Method -MEA- (Adaptation of the IDEA method, Zahm et al, 2019) (Table 1).

Dimension	Problem/Variable
Economic	Financial economic viability
	Economic independence
	Socioeconomic transmissibility
Socio-Territorial	Feeding
	Local development and circular economy
	Employment and job quality
	Ethics and human development
Agroecological	Biodiversity
	Autonomy
	Productive sustainability
	Rational use of water
	Environmental impact management

Table 1. Dimensions and problem/variable considered in the Sustainability Assessment Method -SAM.

For the assessment of the variables, *ad hoc* performance indicators are applied and, if any, the spatial design indicators associated with them are identified.

This first part of the analysis allows a particular diagnosis (Dpart) of the current spatial-functional ordering of the farm focused on the problems perceived by the farmer.

At the same time, an evaluation and diagnosis of the state of the general ordering of the farm (Dgral) is carried out, considering 7 agro-productive, social and environmental requirements typical of the agroecological transition, the farm spatial receptivity and the restrictions and opportunities of the farm environment. Table 2 shows the requirements and associated sub-requirements. For each of these, the appropriate design indicators have been defined for mapping and subsequent spatial analysis.

Requirements	Sub-requirement
Farm-context congruence	Security (theft, rustling, vandalism)
	Mitigation of exogenous risks (e.g. drifts)
	Attenuation of off-farm impacts
	Access to consumer centers and services
	Remote signal
Habitability	Mitigation of impacts on the place of residence
Economic performance	Sufficiency of the operating result per management unit
	Possibility of business withdrawal per management unit
Functional integration of farm subsystems	Entries to store
	Outputs to assimilate
	Outputs to dissipate
Congruence management unit-site	Correspondence between usability and usage
	Correspondence between site status and management unit
Biodiversity	Productive biodiversity (time and space)
	Associated biodiversity (patches and corridors)
	Adverse biodiversity
Infrastructure associated with productive use	Location on the farm
	Condition
	Dimension/magnitude

Table 2. Requirements and sub-requirements considered in the General Diagnosis of the current state of spatial adequacy of a farm in agroecological transition.

Figure 1 shows the sequence of steps of the methodology for the spatial ordering of a farm in agroecological transition, which concludes with the identification of the priorities to be considered in the reordering, and the spatial guidelines to be applied.

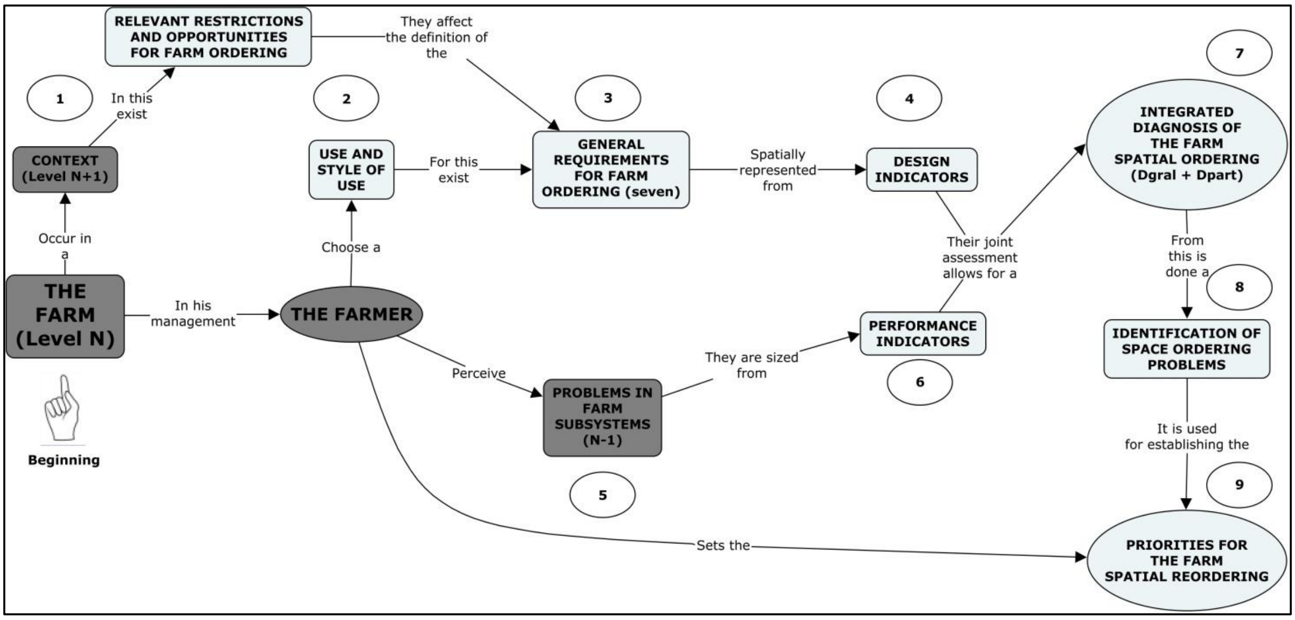

Fig. 1 Methodological steps.

The farm is the focal level of the analysis. This occurs in a context with relevant restrictions and opportunities for farm planning (1). The farmer chooses a use (agricultural, livestock, mixed, etc.) and a style of use (agroecological transition, in this case) (2). A farm in agroecological transition must satisfy 7 general requirements and 19 sub-requirements (Table 2) (3). The state of the requirements and sub-requirements observed in the farm is spatially represented using design indicators and give rise to the General Diagnosis of the current farm spatial state (4). In parallel, the farmer may perceive one or more particular problems in one of the three dimensions considered in the analysis (Table 1) (5). The magnitude of the observed problems is defined through the application of specific performance indicators and gives rise to the Particular Diagnosis of the farm management based on the perceived problems (6). The combination of the General Diagnosis of the spatial state of the farm focused on the requirements and the Particular Diagnosis focused on the problems gives rise to an Integrated Diagnosis of the current state of spatial ordering of the farm (7). From the integrated diagnosis, it is possible to represent the problems of farm arrangement in spatial terms (8), allowing the farmer to establish the priorities to be considered for the rearrangement of the farm (9).

The process continues with the economic-financial planning of the interventions to be carried out for the rearrangement of the farm and the programming of the monitoring of the performance indicators to be applied to follow up on the changes introduced.

CONCLUSIONS

The methodology developed conceives the farm as a complex system integrated by three dimensions: agroecological, socio-territorial and economic, considers the interactions with the context, values the importance of biodiversity as the main component of the system's memory and adaptive flexibility, considers to the farmer as the articulating axis of the ordering of the system. It is expected that this tool, intended for agronomic advisors, will contribute to decision-making on farm design and management of the multiple dimensions involved in agroecological transitions.

BIBLIOGRAPHY

Gliessman S, F Rosado-May, C Guadarrama-Zugasti, J Jedlicka, A Cohn, V Mendez, R Cohen, L Trujillo, C Bacon & R Jaffe (2007) Agroecología: promoviendo una transición hacia la sostenibilidad. Ecosistemas 16 (1): 13-23.

Gunderson, L. & Crawford S. (2002). Resilience and adaptive cycles. En: Gunderson, L. y Holling, C. (ed.) (2002). Panarchy: Understanding Transformations in Human and Natural Systems. Washington, DC: Island Press.

Holland, J. (2006). Studying Complex Adaptive Systems. Journal of Systems Science and Complexity, vol. 19, n°1, 1–8.

Zahm F. et al., 2019. Évaluer la durabilité des exploitations agricoles. La méthode IDEA v4, un cadre conceptuel mobilisant dimensions et propriétés de la durabilité. *Cah. Agric.*, 28, 5.

AGRI-ENVIRONMENTAL ASSESSMENT OF CONVENTIONAL AND ALTERNATIVE BIOENERGY CROPPING SYSTEMS PROMOTING BIOMASS PRODUCTIVITY

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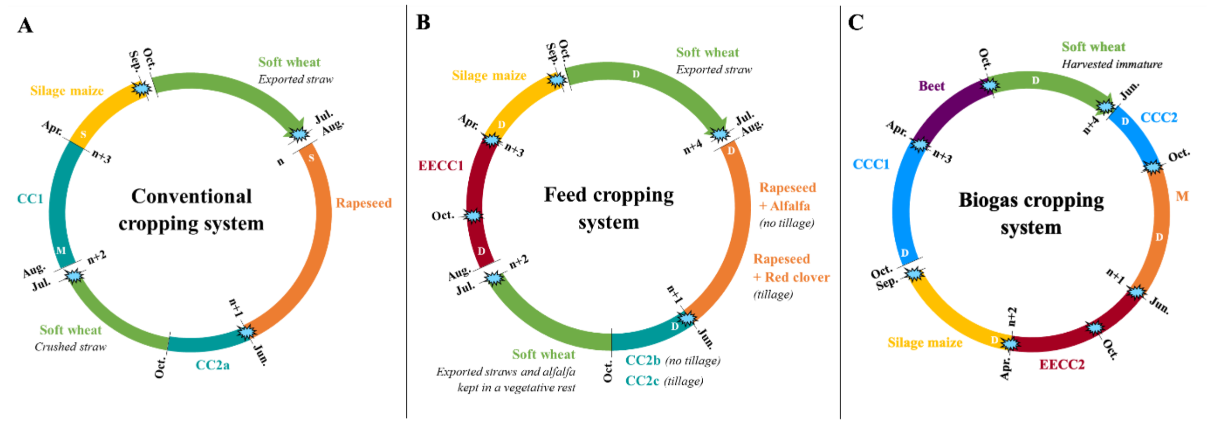
Bioenergy, currently the largest renewable energy source in the EU (64% of the total renewable energy consumption), has sparked great interest to meet the 32% renewable resources for the 2030 bioeconomy goal. In this context, energy-efficient crops are increasingly integrated into food and feed cropping systems with a high biomass productivity, where agroecological practices are associated with biogas production. Compromises between the different uses of biomass (food, feed and biogas) and the impacts of these cropping systems on climate change mitigation and natural resources need a deeper understanding. The design of innovative cropping systems informed by bioeconomy imperatives requires the evaluation of the effects of introducing crops for bioenergy into conventional crop rotations. With the expansion of cropping systems maximizing biomass productivity, number of studies have focused on the effects of these systems on ecosystem processes (e.g., nitrogen cycling dynamics and greenhouse gas emissions) in order to identify the ecosystem services but also the disservices associated with those systems. However, studies have investigated the effects of bioenergy crops on ecosystems processes at the crop scale, disregarding the overall effects at the system scale and integrating the entire crop rotation in their analysis. Deepening understanding of the long-term effects of high biomass productivity cropping systems using a system-scale approach is pivotal to warrant the successful integration of annual crops in diversified crop rotations. This study examined the effects of high biomass productivity cropping systems on environmental and agronomic services to assess their sustainability at the system scale. The tillage and no-till conditions were investigated in this experiment to assess the potential effects of tillage practices on system performances. The agri-environmental services studied were: (1) biomass productivity and soil returned biomass; (2) N fertilization autonomy; (3) methanogenic potential; and (4) greenhouse gas emissions.

The study was conducted over four years from 2016 to 2020 at the UniLaSalle Polytechnic Institute farm (49°27′59″ N, 2°4′21″ E) in Beauvais, France. The field was divided into 26 individual plots, each measuring 24 m × 85 m, grouped into four blocks representing a different year in the crop rotation. The experimental design comprised three cropping systems (Figure 1) conducted under two tillage practices (i.e., with and without tillage). The first system was referred as "conventional cropping system" (Conv) (Figure 1.A), representing a typical crop rotation (mixing food and feed crops) from a dairy cattle farming system in northern France. The second system, called "feed cropping system" (Feed), was a transitory system that promotes food and feed productions and includes cover crops that can be exported for feed or biogas production (Figure 1.B). The third system, “biogas cropping system” (Biom), was a high biomass productivity system, with the biomass exported for feed and biogas production (Figure 1.C). Sampling methods were adapted to the type of vegetation (Figure 2). The weighted dry-mass was used to determine the biomass productivity of each crop, which were then added for a same crop rotation to calculate the biomass productivity at the system scale. To evaluate the N fertilization autonomy, the total N input, including the amendments and the N in the returned biomass, was divided by the total N exported from the biomass. The methanogenic potential of each cropping system was calculated using the weighted methanogenic potential by the biomass productivity of each crop, which were then summed to obtain the methanogenic potential at the system scale. The greenhouse emissions were modeled using the ABC’Terre tool.

Irrespective of the cropping system, tillage practice did not affect any of the tested biomass categories, variables linked to the N fertilization autonomy and the soil residual N, the methanogenic potential and the tested greenhouse gas emissions (Figure 3). In contrast, biomass productivity was significantly affected by the cropping system type, with a higher total biomass productivity in Biom than in the other two systems. Exported N was significantly affected by the cropping system type, with Biom and Feed showing higher amounts of exported N than Conv, which can be explained by their higher exported biomass. Biom showed a higher returned N quantity than the other cropping systems. Even if fertilization autonomy was not reached, the system with maximal biomass production including crops for biogas (Biom) was more efficient in nitrogen economy. In the present study, the biogas cropping system was equivalent to Conv when considering at the ratio of returned to exported N, highlighting that even if most of the biomass is exported in this system, there is no negative impact on the returned quantity, which could allow for a better autonomy potential. The analysis on the methanogenic potential showed significant differences between each cropping systems, with a highest methanogenic potential for Biom; three and two times higher than Conv and Feed, respectively. Total greenhouse gas emissions were significantly lower in Conv than in the other two cropping systems. When focusing on the greenhouse gas emissions per unit mass of dried biomass produced, significantly lower emissions were observed in Biom than in Conv and Feed.

This first investigation to assess cropping systems integrating food, feed and/or biogas crops has allowed quantify of their agronomic and environmental services and characterize their sustainability at a system scale. The biogas cropping system offered most production services (biomass productivity, methanogenic potential and N fertilization autonomy) but had higher greenhouse gas emissions that were not mitigated under the no tillage condition, which is in contrast what was originally hypothesized. Although, when emissions were related to biomass yield, the biogas cropping system gave lower greenhouse gas emissions than the other systems. This system-scale approach showed the sustainability of the biogas cropping system which also depends on the objectives of the farming system. The multiple crop valorizations in the food, feed and bioenergy sectors could avoid competition between the food
and the non-food sectors provided that supply thresholds for each bioeconomy sectors are established. Consequently, it would be appropriate would be to undertake a multicriteria assessment of innovative bioenergy cropping systems using agri-environmental, economic and social performances.



Cover Crops (CC)		Energy-Efficient Cover Crops (EECC)		Catch Cover Crops (CCC)		Meslin (M)
CC1	CC2	EECC1	EECC2	CCC1	CCC2	
Spring vetch Phacelia Oat	Regrowth of: (a) Rapeseed (b) Rapeseed and alfalfa (c) Rapeseed and red clover	Rye Phacelia Italian ray-grass Red clover* Spring vetch* Winter horse bean*	Maize Rye Italian ray-grass Winter horse bean* Winter vetch* Red clover*	Rye Winter fodder pea Winter horse bean	Rapeseed Ryegrass	Winter barley Winter fodder pea Winter vetch

*Harvested in April

Figure 1. Detailed crop rotations of each tested cropping systems, integrating the harvested time and the amendment type for each crop.

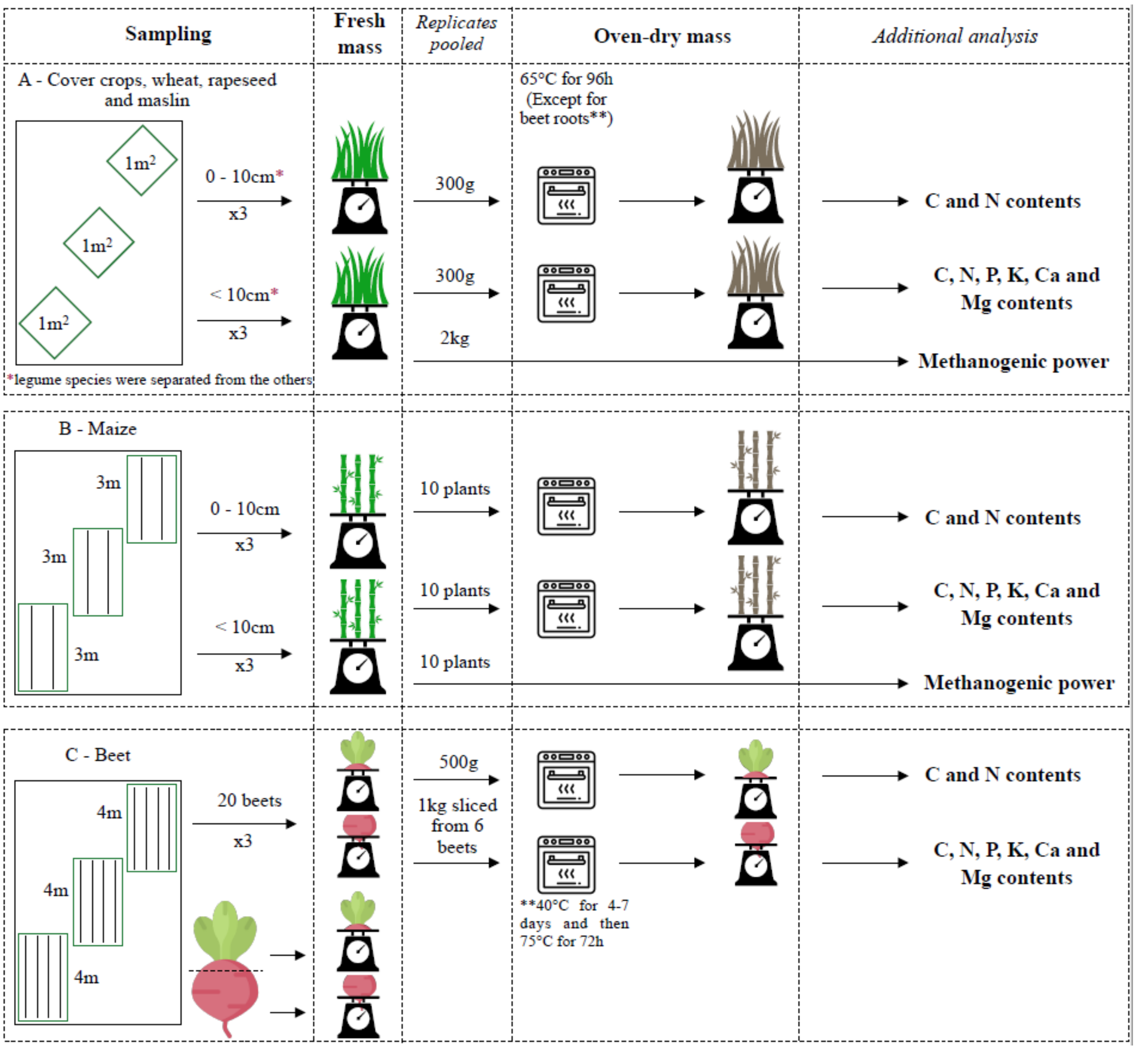


Figure 2. Sampling protocols for each vegetation type.

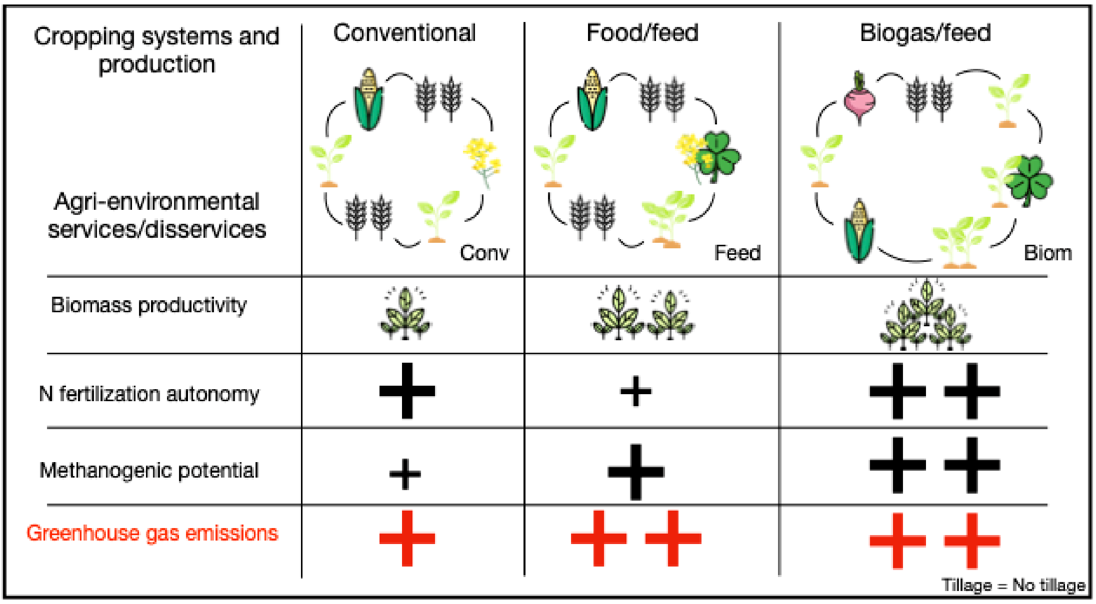


Figure 3. Graphical abstract summarizing all the results obtained in this study.

BIBLIOGRAPHY

Kervroëdan, L.; Houben, D.; Guidet, J.; Denier, J.; Dulaurent, A.M.; Marraccini, E.; Deligey, A.; Journel, C.; Lamerre, J.; Faucon, M.P. (2022) Agri-environmental assessment of conventional and alternative bioenergy cropping systems promoting biomass productivity. *Frontiers of Agricultural Science and Engineering*, 9(2): 284–294.

STUDY OF AGROECOLOGICAL TRANSITIONS IN SPECIALISED AND MIXED CROP-LIVESTOCK SYSTEMS BY COMBINING SOCIOLOGICAL AND BIOTECHNICAL APPROACHES

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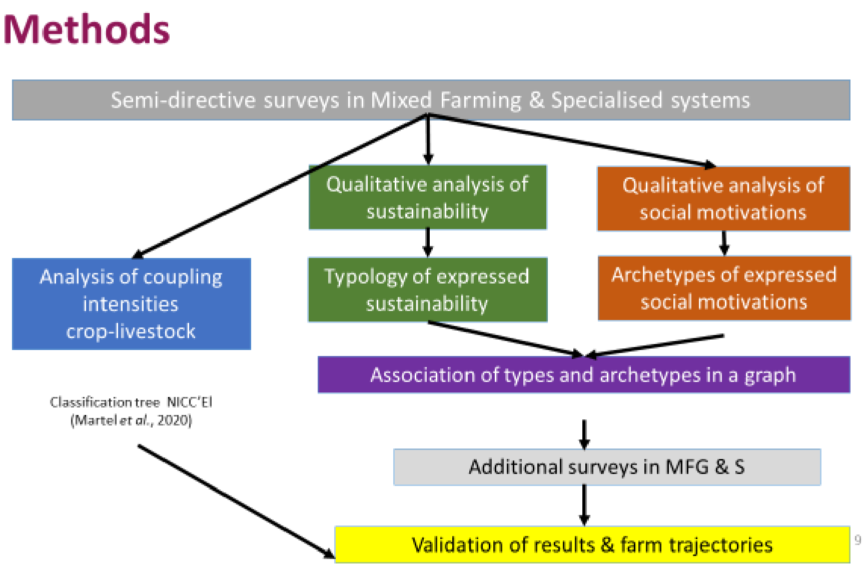
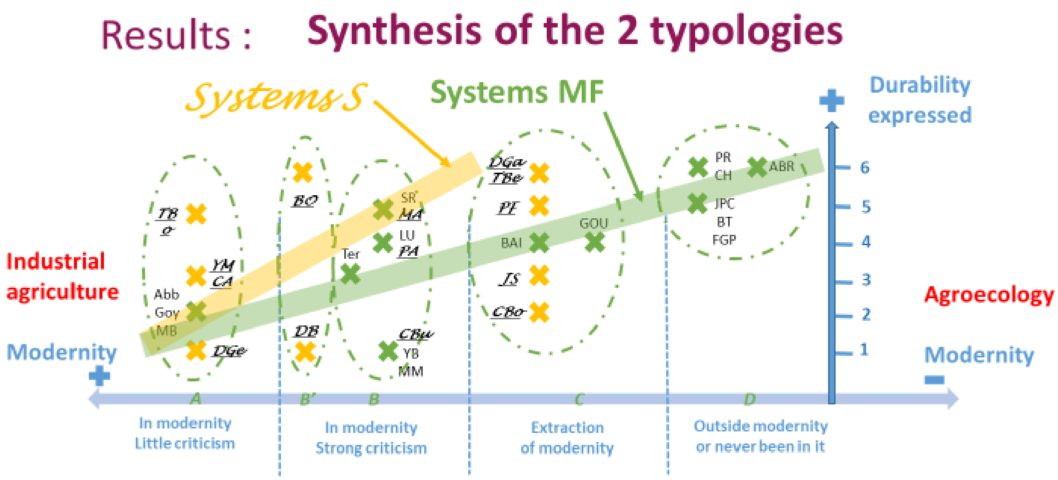
Objectives: Current societal and environmental issues require the re-adaptation of agricultural systems by favouring more sustainable forms to move towards an agro-ecological transition (AET) of agriculture. A model capable of responding to these challenges and formerly traditional is the mixed farming systems (MF). Thanks to the complementarity of crops and livestock, and subject to interactions between these two activities, MF farms are more autonomous, better integrated into the social fabric of their territory and more respectful of the environment (Ryschawy, 2014; Coquil, 2009). However, the disadvantages most often deplored in MF systems, such as the heavy workload associated with crop and animal activities and the lower level of production requiring a move towards quality production (Perrot et al., 2012), lead in practice to the marginalisation of these systems in favour of farm specialisation.
This observation led us to question the motivations of farmers to choose MF, how they see the sustainability of their farms and why some preferred to stop and specialise in one production. It also led us to question in a more general way the relationship of farmers to AET as actors and first concerned by this transition: how do they perceive it? How do they participate in it? Do they finally see the same need for AET and for greater social and environmental sustainability as the rest of society? Do they place economic sustainability on the same criteria?
In order to answer these questions, our study mixes human and social sciences and biotechnical sciences in order to question the production models chosen by farmers and to link them to their implementation in mixed farming systems.

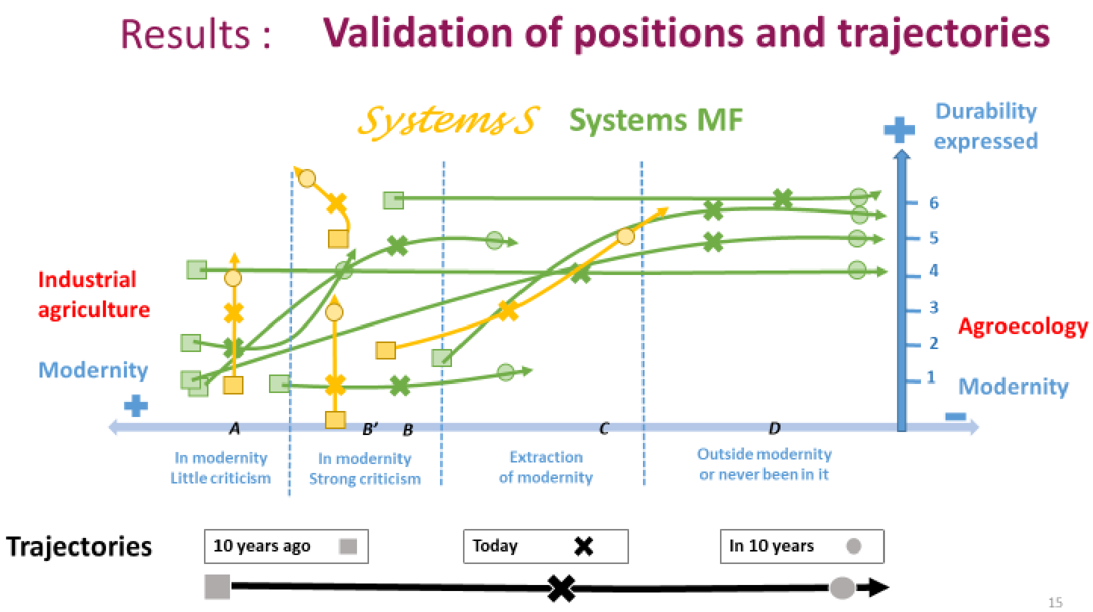
Methods: We conducted a semi-directive survey in the plains of Isère and Ain (France), among 16 diversified mixed farming systems (MF) farms (cattle / sheep, dairy / suckling cows, conventional / organic) with large workshops *vs* 14 specialised (S) farms (crops / dairy cows / with suckling cows). The farmers' discourses were analysed in parallel according to 2 qualitative analyses (Jarousse et al., 2018; Brunschwig et al., 2019a, 2019b, 2020). A first analysis focused on the pillars of sustainability expressed in their discourse in order to create a typology. A second analysis used sociological notions of 'modernity' expressed in farmers' motivations to define archetypes. In this study we considered 'modernity' from a sociological point of view, i.e. as seen at the end of the 20th century (commercial world + industrial world + relationship to the control of nature) (Latour, 1991). We then studied the organisation of these farms by measuring the intensity of coupling between their crop and livestock workshops. We then developed a synthesis of types and archetypes using a graphic analysis (Bertin, 1971). Finally, additional interviews conducted on 11 farms (7 MF and 4 S) were used to validate the results and to study their evolutionary trajectories over a 20-year period in order to visualise the farms' trajectory.
This first part of the research highlights the obstacles and motivations related to the adoption and maintenance of mixed crop-livestock systems at the farm and territorial levels. The series of interviews highlights some of the reasons for abandoning mixed farming. The main reasons

mentioned were: an excessive workload, too much investment to bring livestock buildings and equipment up to standard. In addition, according to the farmers, cereal production is more profitable than dairy production in terms of the time spent on each workshop.



Results: This study also allowed to highlight the perception of the sustainability of the farms according to the farmers' statements. Several visions of this sustainability were identified and gave rise to the construction of a typology based on the speeches of each farmer (see economic, social and environmental pillars). The analysis of the discourses allowed us to obtain 6 types linked to sustainability (from - expressed to +) and 5 archetypes linked to modernity (from + expressed to -). The analysis of the link between the pillars of sustainability and the social reference values highlights two trends. Some farmers remain anchored in "modernity" with a priority economic pillar, but tend to take better account of the social and environmental pillars. Conversely, some farmers change their view of "nature" and question the modern system and talk about the three pillars of sustainability simultaneously. Moreover, the analysis of the trajectories shows for the MF and S systems, an overall movement towards a greater consideration of the 3 pillars of sustainability, but with however 2 main tendencies towards modernity: either the trajectory remains anchored in modernity, by adapting the existing system, or it shows an extraction of modernity, with a strong questioning of the modern values, a redesign of the system and often conversions to organic farming. This extraction is all the more marked as the links between the workshops are strong within the farms. Thus, the S farms correspond mainly to the first trend of system adaptation, while the MF farms are more part of the second trend aimed rather at system redesign.





Discussion: In this study, the characterisation of the diversity of mixed farming systems at the farm and territorial levels, via the schematisation of the couplings between the crop, livestock and grassland workshops of each farm, made it possible to visualise the synergies implemented. The results obtained show that mixed crop-livestock is not necessarily associated with strong linkages and that there is a diversity of situations. But overall, the farms with the highest levels of coupling are also those whose discourse takes the 3 pillars of sustainability into consideration the most.

From a methodological point of view, the originality of this study lies in the combined use of social and biotechnical approaches obtained during a single interview, but analysed in a disjointed manner before being recombined, thus making it possible to shed light on the links between the farmers' values underlying their systems and the coupling and sustainability methods implemented.

Bibliography

Bertin J., 1977. La graphique et le traitement graphique de l'information. Paris : Flammarion 288p

Brunschwig G, Mondière A, Jarousse A, Cayre P, Goron JP, 2019a. A method combining sociological and biotechnological approaches to study agroecological transitions. In: Book of abstracts of the 70th annual meeting of the European Federation of Animal Science. (NLD): Wageningen Academic Publishers 2019. 655

Brunschwig G., Mondière M., Jarousse A., Cayre P., Goron JP. 2019b. « Une méthode combinant des approches sociologiques et biotechnologiques pour étudier les transitions agroécologiques » OPDE Clermont-Ferrand, 15 octobre 2019

Brunschwig G., Jarousse A., Mondière A., Cayre P., Goron JP., 2020. Une méthode combinant des approches sociologiques et biotechnologiques pour étudier les transitions agroécologiques. Symposium PSDR4, Transitions pour le développement des territoires, 28-30 octobre 2020, Webinaire, http://www.psdr.fr/PSDRfinal.php?categ=197&lg=fr

Coquil X. Blouet A., Fiorelli JL., Bazard C., Trommenschlager JM. Conception de systèmes laitiers en agriculture bilogique: une entrée agronomique [Article] // Inra Production animale. - 2009.

Jarousse A, Cayre P., Goron J.P., Brunschwig G., 2018, Une méthode combinant approches sociologique et biotechnique pour étudier la transition agroécologique de systèmes de polyculture élevage. Renc. Rech. Ruminants, 24, pp. 21-25

Latour B., 1991. Nous n'avons jamais été modernes. Essai d'anthropologie symétrique. Paris : La Découverte, 210p

Perrot C., Caillaud D., Chambaut H., 2012. Économies D'échelle et Économies de Gamme En Production Laitière Analyse Technico-Économique et Environnementale Des Exploitations de Polyculture-Élevage. Alim'agri, http://agriculture.gouv.fr/economies-dechelle-et-economies-de-gamme-en-production-laitiere-analyse-technico-economique-et

Ryschawy, J., Choisis N., Choisis JP., Joanon A., Gbon A., 2012. "Mixed crop-livestock systems: an economic and environmental-friendly way of farming?" Animal 6 (10): 1722-1730.

Biodiversity

CHARACTERIZATION OF AGROBIODIVERSITY IN VITICULTURAL AGROECOSYSTEMS OF THE UCO VALLEY, MENDOZA, ARGENTINA.

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Abstract

The sustainability of viticultural agroecosystems has been a matter of concern since the last decades for science and for decision makers and for producers themselves as well (BA, 2013). As a result, different forms of technological management (precision agriculture, good agricultural practices, biodynamic agriculture and organic production, among others) have been applied to address this concern. Figure 1 shows the emerging properties of viticultural agroecosystems that can be modified according to technological management. The expected responses for each of these properties in have been described for conventional management (Garibaldi et al., 2017) but they have not been described for organic viticulture so far.

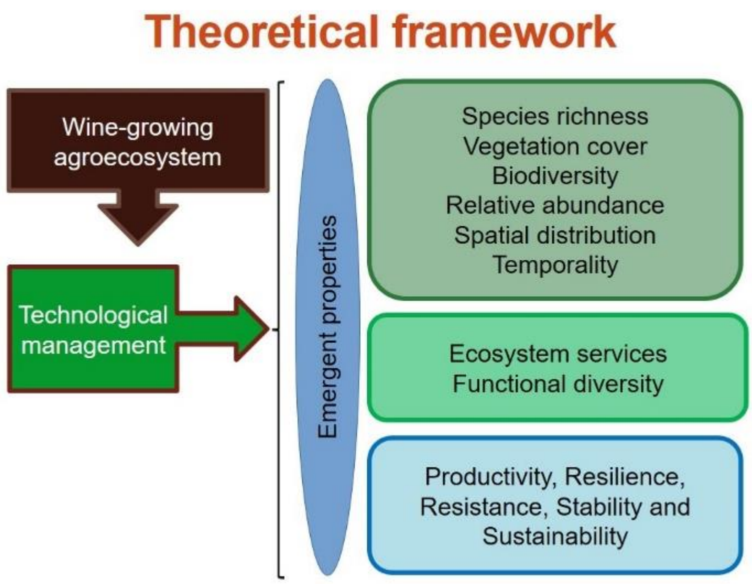

Figure 1: Emerging properties in viticultural agroecosystems

On the other hand, some winegrowing entrepreneurship have turned to implement sustainability, diversity and, in general terms, nature conservation protocols in productive ecosystems built by humans (Van den Bosh, et al., 2015). These protocols require, among other aspects, the determination of biodiversity as an element of analysis and as a tool for their management, but it is not specified which elements of diversity are of importance for the agroecosystem, nor how to implement it in their management.
Considering this background, the present work contributes to understand the characteristics of biodiversity in viticultural agroecosystems according to different technological/agronomic

management (conventional vs. organic) and provides methodological and analytical elements for plant diversity studies.

Methodologically, we worked with five agroecosystems (three conventional and two organic) located in the same region and close to each other. The agroecosystems chosen for each management have consolidated agronomic practices (more than 5 years of continuous implementation) and with cultivar Malbec grapevines (Figure 2).

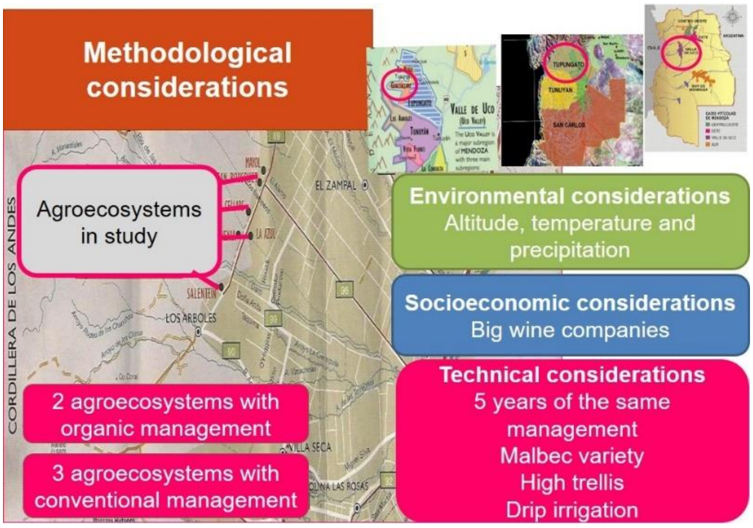

Figure 2. Methodological approach

The data were collected during two productive cycles (2020 and 2021) during winter, spring and summer seasons using the phytosociological method in three plots of 10 m² per agroecosystem. The plots were located in the same barracks at points away from alleys, perimeters and other management, in order to avoid the edge effect.

Figure 3 shows the comparison of the variables: vegetation cover, richness, diversity, number of frequent species, number of abundant species and the relationships between the number of frequent species and abundant species with respect to richness. The values presented are averages for the year and for the winter, spring and summer seasons.
Results for all the variables are similar for both management systems, with a slight superiority for conventional management in all parameters.

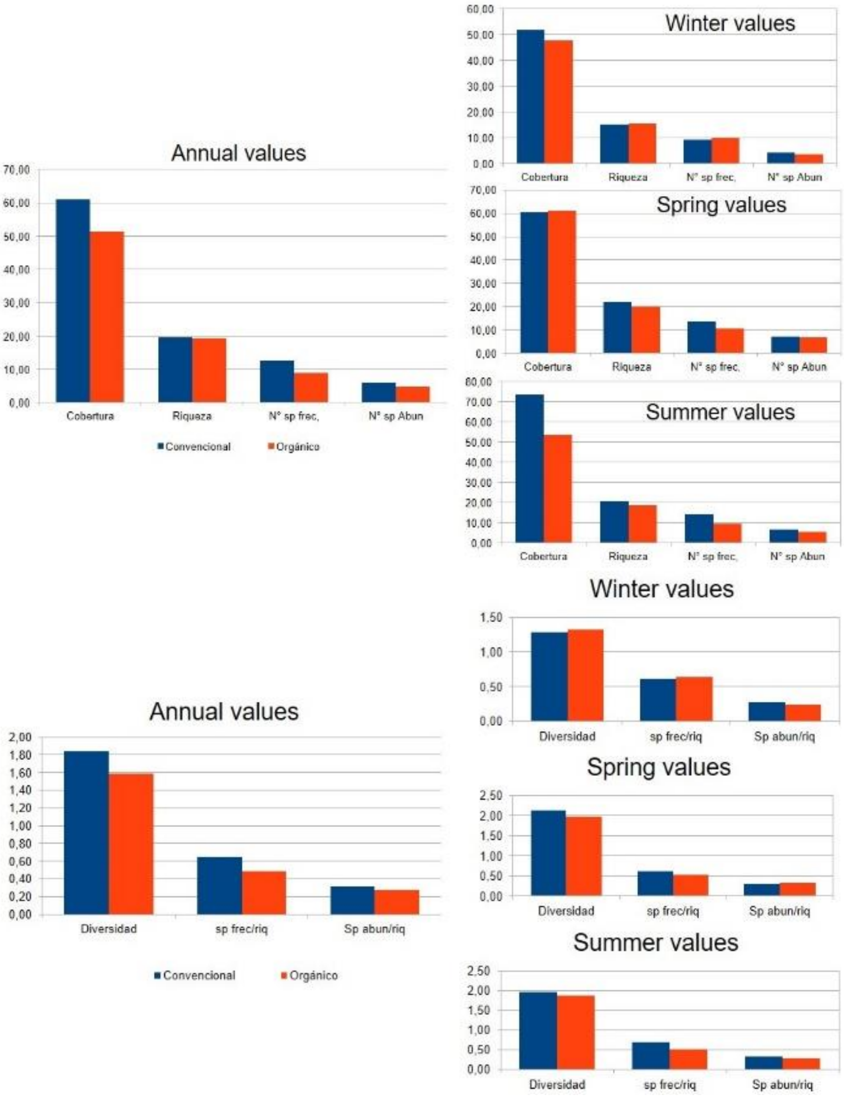

Figure 3. Values of accompanying vegetation parameters in conventional and organic management.

In conclusion, it can be said that the parameters observed to characterize conventional and organic vineyard management at the agroecosystem level do not show significant differences. It is understood that mechanical (organic) and chemical (conventional) vegetation management responded in a similar way at the agroecosystem level for the parameters studied. It should be investigated the vegetation respons s to the frequency of these disturbances and the vegetation at the inter-row and row levels.

Bibliography

Bodegas Argentinas (BA). 2013. *Protocolo de autoevaluación de sustentabilidad vitivinícola.* http://www.bodegasdeargentina.org/comisiones

Garibaldi, L.A.; Gemmill-Herren, B.; D'Annolfo, R.; Graeub, B.; Cunningham, S. y Breeze, T. (2017). Farming approaches for greater biodiversity, livelihoods, and food security. *Trends Ecol. Evol.* 32: 68-80

Van den Bosh, M; Abraham,L y Alturria, L. 2015. Viticultura agroecológica en la provincia de Mendoza. Razones de su adopción y consecuencias de la experiencia. *Memorias del V Congreso Latinoamericano de Agroecología*. La Plata

Education Knowledge transfer

A COLLABORATIVE INTER-INSTITUTIONAL PROJECT BASED ON AN ON-FARM RESEARCH EXPERIMENT IN AGROECOLOGICAL TRANSITION

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Agroecological (AE) innovations are based on the co-creation of knowledge by exchange between research institutions and farmers. This experience describes the process that it took to establish and consolidate an inter-institutional team focused on pursuing on-farm research and demonstration (MID) in AE transition in Entre Ríos province (Figure 1). Farmers, AG companies and agricultural research and development institutions started to work together in 2016. Meetings have been held periodically to exchange ideas and proposals, and to organize activities to address a technological reconversion of extensive rural and peri-urban agricultural production systems with reduced environmental impact. The outcome of the team was the redesign of the agricultural system through an AE approach, which is periodically enriched and strengthened with stakeholder´s and researcher´s participation. Two agreements, Technological Association and Research Collaboration, were signed between the participants. The on-farm experiment, MID, is located on a 27ha field of the "San Sebastián" Farm. Four technological approaches representing a gradient between the current input-based production systems existing in the region and process-based AE production systems characterize the transition. Even so MID constituted a challenge for all the participant parties from the beginning, it advanced in several aspects: decision-making, common management agreement, logistics of supplies, internal communication, and transfer of results and solutions for agricultural producers. It is expected to continue collecting valuable scientific information, promote the training of human resources, strengthen research groups, address problems from a holistic and systemic point of view, and involve resources and engage the participation of different actors in the agricultural sector.

Key words: sustainability, experimental plot, collaborative work, environmental impact, livestock farming systems.

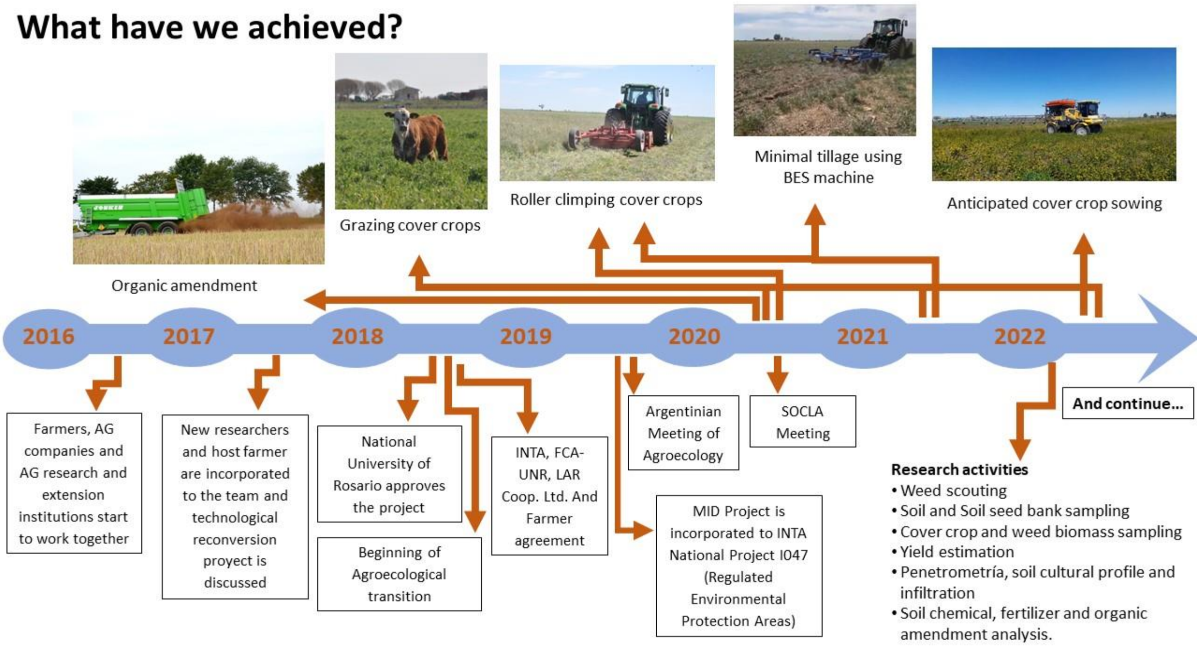

Figure 1. Step and milestone time line to achieve on the research and demonstrative on-farm experiment, MID, in agroecological transition located in Seguí rural area, Entre Ríos Province, Argentina.

Figure 2. Researcher, agronomist and farmer meeting on the on-farm research experiment.

PRE-PROFESSIONAL PRACTICES FOR AGRICULTURAL ENGINEERING´S STUDENTS AT THE INTEGRATED SYSTEM OF AGROECOLOGICAL PRODUCTIONS (SIPA)

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Pre-Professional Practices (PPP) are curricular requirements of the FCA-UNR Agronomy Study Plan aimed to strengthen professional training and insert graduate students in the agricultural environment. The introduction of research as a pedagogical teaching strategy in PPPs constitutes a tool that helps to reinforce previously acquired concepts and incorporate new ones, while stimulating learning skills as experimental design, problem approach, analysis of results and conclusions, writing and presentation; as well as an opportunity to learn by curiosity, typical of elective activities. Greater importance and interest are gained when PPPs are carried out in challenging work environments, like where relevant socio-productive problems associated with changes in production paradigms are discussed. Such is the case of SIPA. In the present work, a set of student experiences at FCA-UNR, coordinated by professors-researchers of the Institution, is reported. The dynamic and continuous participation and intervention of the involved actors (students, teachers, collaborators and others) allowed reaching the proposed objectives. In different scenarios (field, laboratory and classroom), and even in informal talks, it was possible to integrate knowledge, wisdom and experiences associated with crop and weed management, among other disciplines. Through a pandemic, communication and exchange of information/knowledge was widely promoted through different channels. The teaching-learning process was not exempt from difficulties that provided the possibility of taking corrective actions and providing feedback to the process. In general, "research as a learning tool" was effectively introduced. It is necessary to repeat and reinforce those positive aspects. Likewise, it will be imperative to overcome the aforementioned difficulties and those new ones that may appear.

Key words: Agronomy career, agroecological transition, meaningful learning, agricultural education.

Figure 1. Preprofessional Practice Students and coordinators carrying out different activities in the field, in the greenhouse, face to face and virtual classes, and presenting activities in meetings and technical scientific events.

BUILDING, APPROPRIATION, AND TRANSFER OF KNOWLEDGE IN THE INTEGRATED AGROECOLOGICAL PRODUCTION SYSTEM IN THE COLLEGE OF AGRICULTURAL SCIENCES, NATIONAL UNIVERSITY OF ROSARIO, ARGENTINA

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The Integrated Agroecological Production System (SIPA, from the Spanish name) of the College of Agricultural Sciences, National University of Rosario, was set up in 2017 by an interdisciplinary team of teachers with the aim of transforming agricultural practices into sustainable agrifood systems. Most SIPA activities are carried out in a 12-ha area at the College Experimental Field, located in the outskirts of Zavalla town. Every year, the SIPA team offers pre-professional practices to students of the two degrees awarded by the College (Agricultural Engineering and Baccalaureate in Natural Resources), with the aim of broadening and improving students' training in agroecosystems design, management and assessment (Fig.1). The practices are part of research projects, and the results are reported through scientific articles and meetings (Muñoz & Montico, 2021). The SIPA invites people and organizations linked to the agricultural sector, such as advisors, technicians, professionals, schools and municipalities, to exchange knowledge on agroecological practices and strategies (e.g., cover crops, hedgerows for biodiversity, crop associations and rotations, silvopastoral systems). Also, the SIPA teachers team participates in activities organized by the National Society of Agroecology, the National Network of Municipalities and Communities that promote Agroecology (RENAMA), and the National Agroecology Directorate (Fig. 2).

Figure 1. Teaching and research activities in the SIPA

Figure 2. Extension activities in the SIPA

The objective of this research was to evaluate, along a two-year study period (2017-19), the training design created in the SIPA by the processes of knowledge building, appropriation and transfer, in conjunction with complex thinking and the principles of agroecology, as well as the influence of this training design on the SIPA itself, the college, the professional profile, and the regional agricultural context. Our aim was to develop a useful theoretical contribution to improve student training in the field of the agricultural sciences in relation to the negative environmental impacts of a simplified production model heavily reliant on chemical inputs. Another important aim was to make a contribution to the curriculum changes currently underway in order to comply with the activities reserved to the professional degree in Agricultural Engineering, one of the university degrees declared of public interest by Higher Education Act N° 24,541 (Muñoz 2022). The theoretical framework was developed interdependently with empirical work, following a zigzag path between theory and practice. It was organized around four core topics: I- Building, appropriation and transfer of knowledge; II- Configuration of a training design; III- Agroecology and complex thinking; IV- Agricultural production model and environmental problems. The main authors followed were Motta (2015, 2016), Sarandón (2018, 2019), Pengue (2017, 2020), Sanjurjo (2017, 2020), and Camilloni (2010, 2017).

The research followed a qualitative methodological design framed in the hermeneutical, reflexive and critical paradigms of education, along with contributions from the Paradigm of Complexity. Given the objectives of the thesis work, and the requirements of an empirical approach, we selected the Case Study method, specifically the single case study with a sociological perspective. Data collection design drew upon elements of ethnographic research, and data processing followed contributions of Grounded Theory (GT). Also, the Complex Systems Theory (CST) was used to identify the natural-social transformations of SIPA within the study period.

Data were collected by a combination of different techniques, applied in compliance with the Ethics Committee procedures. The techniques included:

- ethnographic participant observation of teaching, research, and extension activities;
- in-depth interviews to teachers and key informants;
- opinion polls to students;
- analysis of documents: Governing Board decisions related to the creation and functioning of SIPA, reports of Preprofessional Practices, scientific articles and communications, among others

The results obtained allowed characterizing the evolution of SIPA as a complex system on the basis of six dimensions: epistemological, scientific, academic, technical-productive, sociopolitical, and spiritual, all traversed and strongly influenced by communication trans-dimension. The application of the Complex Systems Theory showed that the driving forces behind the creation of SIPA were a spiritual component (‘non-rational’ beliefs, both religious and non-religious), and a sociopolitical component emerging from the institution to question the agro-export model. A negative aspect identified was the opposition of both the predominant scientific-technological model marked by disciplinary hyperspecialization, and the conventional production model associated with a professional training either lacking critical judgment and/or indifferent to environmental degradation. Still another negative impact identified was the technocratic rationality underlying institutional communication, which hampered the recognition of SIPA as an intersubjective sociocultural network (Fig. 3).

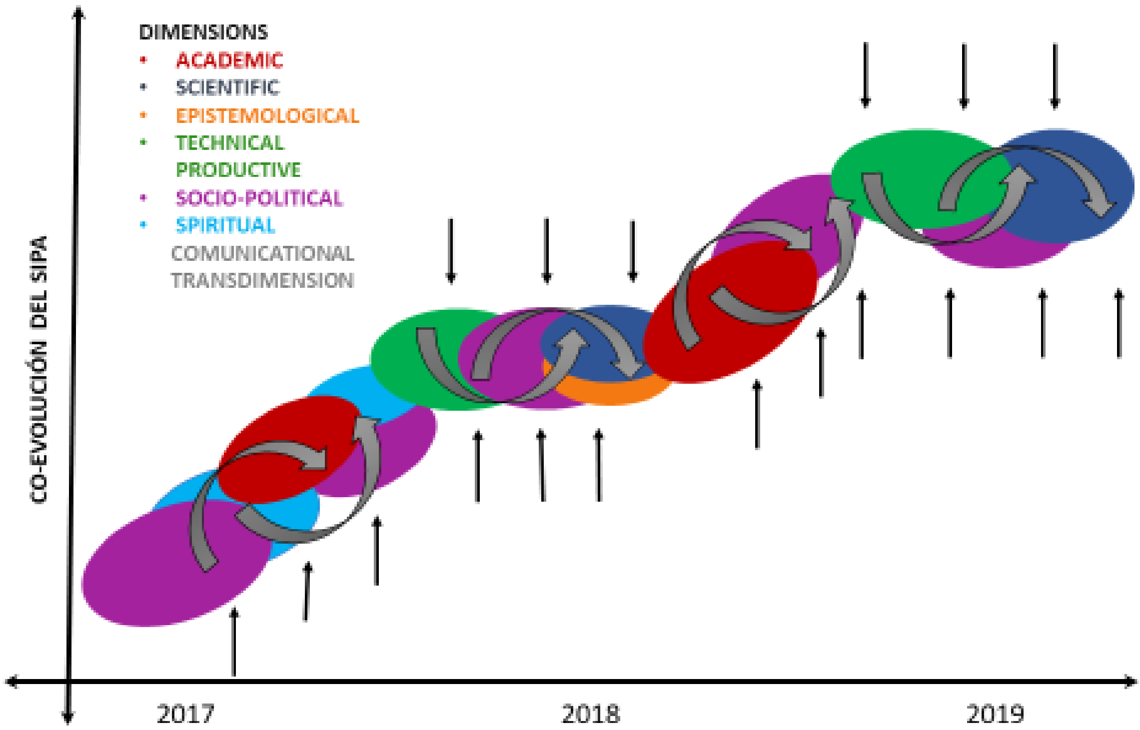

Figure 3. Simplified diagram of the evolution of the SIPA dimensions analyzed

Analytic interpretation of data based on the Grounded Theory showed that processes of building, appropriation and transfer of knowledge were imbued with contributions from agroecology and complex thinking through the incorporation of concepts, procedures, approaches to environmental problems linked to the practice of agricultural professionals, the cultural, social, political, and economic contextualization, and the ethical-political reflection on the consequences of the different production models. It was also observed that the interaction between those processes gave rise to a learning network more suited to achieve sustainable food production systems which respect both the environment and the health of communities. GT also allowed identifying the components which hampered the evolution of the SIPA: the predominance of a classical communication model, at the expense of a strategic one, which impacted negatively on the SIPA development both within the institution and into the region, and the strong influence of the traditional paradigm on the training of researchers and on the scientific-technological system adopted by national institutions. Our results highlight the strengths of SIPA towards the development of a professional profile suited to the new activities reserved to the professional degree, by incorporating the ultimate responsibilities of agricultural professionals for hygiene, safety, and environmental impacts.

Bibliografía

Camilloni, A. (2010). La formación de profesionales en la universidad. Revista Gestión Universitaria. 2(2). http://www.gestuniv.com.ar/gu_05/v2n2a3.htm

Camilloni, A. (2017). La movilización de procesos metacognitivos en la formación de los conocimientos de los profesores. En Revista Entramados – Educación y Sociedad, 4, (4), 17-32. https://fh.mdp.edu.ar/revistas/index.php/entramados/article/view/2038

Motta, R.D. (2015). El pilotaje de la Complejidad en la Era Planetaria. En el contexto del cambio climático global. Dossier. Cátedra Itinerante UNESCO "Edgar Morin" para el Pensamiento Complejo. https://www.ciuem.info/publicaciones/dossiers/

Motta, R.D. (2016). El desafío institucional en la evaluación de las instituciones de educación superior en América Latina y el Caribe. En: *Transitando en presente la universidad compleja*. Comp. Josefa Julia García de Ceretto y Carlos Enrique Arcocha. https://unr.edu.ar/noticia/10700/programa-de-pensamiento-complejo-cei-libro-electronico

Muñoz, G. (2022) Evaluación de la trama formativa configurada por los procesos de construcción, apropiación y transferencia de conocimientos articulados con los principios de la agroecología y el pensamiento complejo. El caso del sistema integrado de producciones agroecológicas de la facultad de Ciencias Agrarias de la Universidad Nacional del Rosario. Tesis doctoral. Facultad de Ciencias Veterinarias. Universidad Nacional de Rosario. Argentina. https://www.fao.org/family-farming/detail/en/c/1604929/

Muñoz, G.& Montico, S. (Comp.) (2021) Sistema Integrado de Producciones Agroecológicas. Aportes para el manejo de la transición en agroecosistemas extensivos. Libro digital, PDF. Facultad de Ciencias Agrarias (UNR) https://fcagr.unr.edu.ar/wp-content/uploads/2021/04/SIPA%202020.pdf

Pengue, W. (2017). Hacia el pensamiento ambiental del Sur. Recursos naturales, desarrollo y reflexiones sobre una región estratégica. En: *El pensamiento ambiental del Sur Complejidad, recursos y ecología política latinoamericana*. Walter Pengue comp. Buenos Aires. FP Compañía Impresora. https://ediciones.ungs.edu.ar/wp-content/uploads/2017/11/9789876303194-resumen.pdf

Pengue, W. A. (2020). Las bases y principios de la agroecología: una perspectiva desde América Latina. *Revista Fronteras*. Publicación Anual del Grupo de Ecología del Paisaje y Medio Ambiente. Facultad de Arquitectura, Diseño y Urbanismo Universidad de Buenos Aires, 18 (18), Pp.1-18. http://gepama.com.ar/wp-content/uploads/2020/06/Compilado-Revista-Fronteras-N%C2%BA-18-2020-Junio-10-final.pdf

Sanjurjo, L. (2017). La formación en las prácticas profesionales en debate. *Revista del Cisen Tramas/Maepova*, 5 (2), 119-130. http://oaji.net/articles/2020/7304-1588104789.pdf

Sanjurjo, L. (2020). The corruption of theories in practices: the case of the field of professional training. REDU. Revista de Docencia Universitaria, 18(1), 91-104. https://doi.org/10.4995/redu.2020.13044

Sarandón, S. (2018). Potencialidades, limitaciones y desafíos para la introducción de la agroecología en la educación agrícola superior en la Argentina. El caso de la cátedra de agroecología en la Universidad Nacional de la Plata: Una experiencia de 16 años. Agroecología, 11(1), 47-61. https://revistas.um.es/agroecologia/article/view/329631

Sarandón, S. (2019). Potencialidades, desafíos y limitaciones de la investigación agroecológica como un nuevo paradigma en las ciencias agrarias. *Revista De La Facultad De Ciencias Agrarias UNCuyo*, 51(1), 383-394. http://revistas.uncu.edu.ar/ojs3/index.php/RFCA/article/view/2458

Farming

THE PLACE OF ANIMAL HEALTH IN SUSTAINABLE FARM SYSTEMS

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It is the need of the hour to bring about a change in our food system and the way we produce. But what does it mean at the ground level, i.e., at the farm's scale? It translates to a more integrated and value-based system where our livestock gets more respect, preservation of soil and our natural resources, taking the farmer's knowledge and expertise into consideration all of which consequently impacts the quality of food produced. Sustainability in our animal farming systems needs to build upon the three concrete fundamental pillars of social viability, economic performance, and environmental sustainability.
Agroecology is a science, a movement, and a set of practices that farmers and scientists try to use to reduce the environmental footprint of farming. This is achieved by using natural processes that not only improve efficiency but minimize inputs and pollution. The application of agroecology to livestock farming is based on five principles: P1 managing animal health in an integrated way, P2 reducing inputs by using ecological processes, P3 reducing pollution by closing cycles, P4 using diversity to increase resilience, P5 preserving biodiversity by adapting practices. (Dumont et al, 2013). However, it must be taken into consideration that this transition requires a change of habits and practices and poses a significant load on the farmers in terms of economic viability, mental strain, workload, the knowledge gap, and uncertainty of the consequences on the produce.

Objectives: To date, the scope of research has majorly ignored herd health in agroecological systems. However, as a central part of the production cycle, livestock health deserves a spotlight at a global level. Therefore, this study intends to bolster the value of livestock health, and develop a better understanding of health management in agroecosystems. We first explore the needs and expectations of farmers regarding the support of health currently provided. This step was necessary to propose a new perspective on health monitoring by veterinarians that correspond to theses agroecological farmer's needs.

Methods A sociological study was conducted, based on observations and semi-structured interviews in sixteen farms. The choice of the farms was based on the selection of mixed farming systems with a large animal species diversity in various regions of France and Switzerland, in order to explore a diversity of situations, without claiming to be representative. Every farm was visited and considerable time was spent together with the farmers to have a deeper and complete understanding of each of their systems as well as to build a trusted relationship to allow for an open and honest dialogue.
All the information gathered from the interviews has been recorded. These interviews dealt with four main subjects: Farm presentation, Sustainability in the agrosystems, Health practices used by the farmer, and Expectations for veterinary medicine. The data gathered allows the establishment of profiles of sustainable farms and the required moral values to start an agroecological transition. This has also enabled us to identify the existing practices of health management which are involved in sustainable farms.

Results: The interviews with the farmers allowed the collection of a large volume of verbatims. In this document, we will limit ourselves to the presentation of what corresponds to the health elements and relations with veterinarians. The healthcare practices used by the farmers interviewed were classified into eight categories:

1. Choose animals adapted to the production system: breeds resilient in harsh environments, ability to maximize the forage resource
2. Develop herd immunity and balance: resistance to parasites and pathologies
3. Feeding practices: systems based on local and natural feeding resources, as pastoralism
4. Agronomic practices: soil and forage management involved in feed quality
5. Husbandry practices: reproduction and milk practices, rearing of the young
6. Medical practices: minimize chemical drugs, using of alternatives medicines
7. Managing parasitism: a result of a plurality of practices
8. Take time, observe, and learn: farmers' knowledge is based on observation of animals in their context and way of life, to prevent and understand their needs.

With regard to relations with veterinarians, all the interviewed farmers believe that the current veterinary approach, mainly based on curative treatments, is not enough to support their evolution and that a holistic perspective is crucial and would be of extremely valuable assistance to them.

Discussion: We can suggest reconsidering health monitoring by creating a space for discussion and a relationship of trust with farmers, aiming to think together at the system level. In addition, it is important to carry out a real health monitoring, capable of developing a preventive approach, which will have to be based on several economic models in order to make it possible. Furthermore, it is important to propose a multidisciplinary approach to rethink the systems by combining eclectic knowledge. Finally, it is imperative to put in place collective initiatives that will create a space for exchange and innovation based on a respectful human connection. This space will strengthen the risk-taking capacity of those involved and will bridge the gap between farmers and veterinarians and bring them closer to a common goal. As livestock partners and health specialists, veterinarians have a role to play in supporting sustainability, rethinking systems in cooperation with farmers and other agricultural advisors.

Bibliography

Dumont B., Fortun-Lamothe L., Jouven M., Thomas M., Tichit M., 2013. Prospects from agroecology and industrial ecology for animal production in the 21st century. Animal, 7, 1028-1043.

Scholly Schoeller A., 2022. Santé animale dans la transition agroécologique : quelles attentes des élevages durables pour la médecine vétérinaire ? Thèse de docteur vétérinaire, VetAgro Sup, Lyon, 145p.

PARTICIPATORY EVALUATION OF SUSTAINABILITY IN EXTENSIVE SYSTEMS IN AGROECOLOGICAL TRANSITION AT THE SOUTHEAST OF BUENOS AIRES, ARGENTINA.

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In last decades, the extensive agricultural production in Argentina has been based on a set of inputs technologies that increased the production, although with serious environmental and social impacts. In response to these problems, is taking place a slowly but surely process about producers who decide to reconvert their establishments into diversified systems in order to reduce until leave aside the use of chemical synthesis inputs, reduce costs and promote multiple ecosystem services. In the southeast of the Buenos Aires province and helped by the permanence of mixed farming systems, some producers have begun the agroecological transition process. Currently there are some works that assess sustainability of extensive agroecosystems in the region applying indicators. However, most of these works don't include the multiple dimensions of sustainability and no one have involved interests' parts in their elaboration, which is a kay requirement for the success of a sustainability evaluation process.This project proposes to assess in a participatory way (with producers, professional advisers of producers' groups, stakeholders of public institutions, service providers and other actors involved) the sustainability of extensive agroecosystems of this region that are at different levels of the agroecological transition to recognize some barriers that lag and strategies that encourage the process. This work will articulate with preliminary results of another doctoral thesis of the same investigation group (Paloma Berón) specifically focused on the elaboration of indicators. The calculation of indicators will be conducted with information collected through interviews, secondary information and field data, as appropriate. Finally, the evaluations will beanalyzed and discussed in two workshop instances with the actors involved inquiring about: a) the factors and processes of different dimensions and scales that directly or indirectly affect the agroecological transition and b) those key processes that emerge as the main strategies that dynamize or barriers that delay the transition process. The results will be an input to develop public policies that promote the necessary scaling up of agroecological production in the region.

Keywords: Inter-mountainPampas, diversified systems, producer groups, participatory diagnosis, transition processes.

Bibliography

Aizen, M. A., Garibaldi, L. A., &Dondo, M. (2009). Expansión de la soja y diversidad de la agricultura argentina. Ecología austral, 19(1), 045-054. Altieri, M., & Nicholls, C. (2004). *Biodiversity and pestmanagement in agroecosystems*. CRC Press.

Arizpe, N., &Locatelli, F. (2009). La expansión de los agrotóxicos y los impactos en la salud humana. *Ecología política*, (37), 84- 89

Campbell, B. M., Beare, D. J., Bennett, E. M., Hall-Spencer, J. M., Ingram, J. S., Jaramillo, F.,&Shindell, D. (2017). Agricultureproduction as a majordriveroftheEarthsystemexceedingplanetaryboundaries. *Ecology and Society*, 22(4).

Correia, F. V., & Moreira, J. C. (2010). Effectsofglyphosate and 2, 4-D onearthworms (Eiseniafoetida) in laboratorytests. *Bulletinofenvironmentalcontamination and toxicology*, 85(3), 264-268

Duru, M., &Therond, O. (2015). Designingagroecologicaltransitions; A review. *AgronomyforSustainable Development*, 35(4), 1237-1257.

IAASTD (2009). Agriculture at a Crossroads. *International AssessmentofAgriculturalKnowledge, Science and Technologyfor Development* (IAASTD). Johannesburg, South Africa.

Iermanó, M. J., Sarandón, S. J., Tamagno, L. N., &Maggio, A. D. (2015). Evaluación de la agrobiodiversidad funcional como indicador del “potencial de regulación biótica” en agroecosistemas del sudeste bonaerense. *Revista de la Facultad de Agronomía, La Plata*, 114(3), 1-14

Jacobo, E., Cadaviz, N., Martínez Ortiz, U., Golluscio, R. & Rodríguez, A. (2019). Uso de indicadoresambientales y económicos para evaluar la sustentabilidad de dos establecimientos ganaderos de la Cuencadel Salado, Argentina. *Agroecologia em Foco*, Editora Poisson, Belo Horizonte, Brasil, 3(26), 173-177.

Lajmanovich, R.C., Attademo, A.M., Simoniello, M.F., Poletta, G.L., Junges, C.M., Peltzer, P.M., Grenón, P., Cabagna-Zenklusen, M.C. (2015). Harmfuleffectsof dermal intakeofchlorpyrifos, 2,4-D and glyphosate in commontoadRhinellaarenarum (Anura: Bufonidae). *Water, Air, and SoilPollution* 226,427.

Marchand, F., L. Debruyne, L. Triste, C. Gerrard, S. Padel, & L. Lauwers. (2014). Key characteristicsfortoolchoice in indicatorbasedsustainabilityassessment at farmlevel. *Ecology and Society* 19(3), 46

Pérez, E., Casal, A. V., & Jacobo, E. J. (2019). Evaluación de la transición agroecológica de un establecimiento ganadero a base de pastizal de la cuenca del Salado, mediante indicadores. *Revista de la Facultad de Ciencias Agrarias UNCuyo*, 51(1), 295-307.

Sainz Rozas, H. S., Echeverria, H. E., &Angelini, H. P. (2011). Niveles de carbono orgánico y pH en suelos agrícolas de las regiones pampeana y extrapampeana argentina. *Ciencia del suelo*, 29(1), 29-37.

Sainz Rozas, H. S., Echeverria, H., &Angelini, H. (2012). Fósforo disponible en suelos agrícolas de la regiónPampeana y ExtraPampeanaargentina. *RIA. Revista de Investigaciones Agropecuarias*, 38(1), 33-39

Schindler, J., Graef, F., &König, H. J. (2015). Methodstoassessfarmingsustainability in developingcountries. A review. *Agronomyforsustainabledevelopment*, 35(3), 1043-1057

Román, M. E., & González, M. C.(Coords.). (2016). Transformaciones agrarias argentinas durante lasúltimas décadas: Una visión desde Santiago del Estero y Buenos Aires. (1° ed.).Buenos Aires*: EditorialFacultad de Agronomía*, Universidad de Buenos Aires.

Viglizzo, E.F.; F. Frank, J. Bernardos, D.E. Buschiazzo and S. Cabo. (2006). A rapidmethodforassessingtheenvironmental performance ofcommercialfarms in the Pampas of Argentina. *EnvironmentalMonitoring and Assessment* 117(1), 109-134.

Zulaica, L., Bocero, S., Tribó, J., Cabral, V. N., Di Bona, A., Paz, M., &Tomadoni, M. (2015). Agroquímicos en áreas de transición urbano-rural: problemas y ambientes en el partido de General Pueyrredón, Universidad Nacional de Mar del Plata, *Estudios Sociodemográficos*, 5.

MANAGEMENT LIVESTOCK AND RESTORATION OF FOREST IN THE SEMI-ARID ARGENTINE CHACO

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In the Santiago forest, the socioenvironmental changes caused by agricultural expansion and livestock intensification were drastic and extremely rapid. Nowadays, the dry forest of Santiago del Estero represent the largest extension in the Americas, and one of the most important in the world. Typically, the native forest are managed for uses multiples on peasant (82%), livestock production has been a traditional source of income in this region. Our objective is to describe a sustainable silvopastoral management practice in small systems, have developed with communities, technicians and other researchers during more than a decade of joint work. Closures, where grazing is excluded during the rainy season, are used in the restoration of forests degraded by continuous grazing. This practice allows to restore vegetation herbaceous of forests and to defer fodder to the dry season (winter dry season). Nevertheless, the rehabilitation in shrubs requires permanent closures of several years with seedbeds of key tree species. Most of the peasant of the forest with better forest condition and livestock receptivity have several closures delimiting patches of relatively homogeneous native vegetation, which are used at the most appropriate time according to the predominant species. In addition, areas of extreme degradation can be used for the planting of exotic grasses tolerant to drought and salinity, to be used the beginning of the wet season (key moment for slow growing native pastures). Finally, some closures have a fraction without trees dedicated to grain and horticultural crops for consumption and marketing, contributing to productive diversification for peasant.

KEY WORDS: Dry forests, grazing rest, degradation, vegetation

GRASSLAND MANAGEMENT AND ECONOMIC RESULTS IN THE LOWER BASIN OF THE SALADO RIVER, BUENOS AIRES PROVINCE, ARGENTINA

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The lower basin of the Salado River is the main cattle breeding area in Argentina.The increase in animal stocking rates under continuous grazing enhanced the deterioration of natural grassland and its replacement by pastures or forage crops. Alternatively, controlled grazing appears as a process technology for the rehabilitation and conservation of natural vegetation that remains the main forage base of these systems. The aim of the work was to analyze the gross margin (direct income - costs) and its sensitivity to different price scenarios, of different productive approaches: high inputs and low proportion of grassland under continuous grazing vs. low inputs and high proportion of grassland under controlled grazing. The direct costs of livestock production on establishments that manage natural grassland reached only between 30% and 50% of the direct costs of more intensified managements respect the use of external inputs (seeds, fertilizersand pesticides). For the intensified proposals, the coefficient of variation of the gross margin was almost three times higher than those who manage the natural grassland under controlled grazing. When the ratio of input/product prices is favorable for livestock, the intensified managements have similar economic result or higher than those who manage the pasture. However, when this same relationship is unfavorable, for the proposals that manage the pasture the gross margin reduced much less (almost three times) than the most intensified. This reduction in the gross margin could lead to give up the activity. The greater stability respect to economic variations could extended to the typical climatic variations of the region since the grassland is more resilient than pastures and annual forage crops.

Keywords: livestock, Flooding Pampa, economic stability, productive models.

Bibliography

Martínez Ortiz, U., Jacobo, E., Cañada, P., Sobredo, M. (2017). Análisis económico del manejo de pastizales de la Depresión del Salado, en *Boletín técnico de la Fundación Vida Silvestre*. Buenos Aires: Editorial Fundación Vida Silvestre Argentina.

EFFECT OF GRAZING ON UNDERSTORY COVER AND REGENERATION OF TREE SPECIES IN FORESTS OF THE ARGENTINE HUMID CHACO

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Most of the native forests area used extensive livestock since the early nineteenth century. Cattle consume the vegetation of the understory reducing its coverage and generating changes in the availability of light and tree regeneration. The most methodology widespread is the continuous grazing, however, there are less studied grazing alternatives. The objective of the study was to determine the effects of different grazing methodology on understory cover and tree regeneration in shade-tolerant species and shade-intolerant species of forests of the humid Chaco. We compare three livestock establishments and reserve areas of 80 years (control) in areas adjacent to the Plaza Forest Station of INTA, province of Chaco. The grazing methodology include continuous and adaptative grazing of different times of occupation and rest: continuous without rest, seasonal rotation and voissin. In each experimental unit were surveyed understory cover, forest density and quality of regeneration, and differences between grazing methodology and forest types were analysed using mixed general and generalized linear models. The results show significant effects of the methodology of grazing for the three variables. The coverage of non-grazing forests is higher with respect to situations of continuous and seasonal grazing. In forests whit shade-tolerant species the density of regeneration increases in seasonal grazing and in forests whit shade-intolerant species it decreases in continuous grazing. The plant quality is higher in adaptative grazing with respect to grazing continuous. These results provided in this work indication of grazing methodology with rest, an alternative to conventional continuous grazing, for sustainable silvopastoral management in Chaco forests.

KEY WORDS: Wet chaco, grazing methodology, cover, understory, tree regeneration

USING MACHINE-LEARNING TECHNIQUES TO DETERMINE CHANGING POINTS IN ANIMAL REQUIREMENTS DURING THE FATTENING PERIOD TO IMPROVE FEED EFFICIENCY OF BEEF BULLS

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Feed efficiency (FE) should be improved in animal production, especially in cattle, where FE is naturally lower than in other species (Tolkamp, 2010). Nutrition precision strategies (NP) improved FE in pigs and chickens, (Andretta et al., 2014). However, NP has not been developed in cattle, thus, the objective of this work is to model individual animal requirements to determine main changing points during the whole fattening period to recommend different dietary formulations more adapted to animals. For this, we utilized animal performances recorded from 4 different experiments conducted with 342 growing crossbred cattle (269±70.9kg BW). Animals were fed a high-dense diet, weighed every 14 days, and dry matter intake (DMI) was measured through electronic feeders (GEA Surge, Westfalia). We conducted a retrospective analysis to estimate both net energy for gain (NEg, Mcal/d) and metabolizable protein (MP, g/d) requirements of animals following the NRC (2016). We utilized segmentation point techniques in R to determine the main points where animal requirements significantly change from other points during the whole fattening period (126d). Animal requirements showed positive linear regressions both for NEg (2.49+0.0131*BW, R^2=0.46) and MP (575+0.334*BW, R^2=0.06) (Figure 1). Results of segmentation point techniques of energy (Mcal NE/kg DMI) showed no significantly different ($P>0.05$) change points during the whole fattening period while results of protein (gMP/kg DMI) showed 3 change points ($P<0.01$); at 288kg BW, 323kg BW and 381kg BW. These results show how dietary energy concentration could remain similar (0.96Mcal NEg/kg DMI) from the beginning until the end of the fattening period while dietary protein concentration could change from 123gMP/kg DMI at the beginning to 93gMP/kg DMI at 288kg, to 85gMP/kg DMI at 323kg and to 80gMP/kg DMI at 381kg in order to decrease protein waste. Therefore, the utilization of a multiphase diet (3 phases) could improve the protein utilization, which will influence both a lower environmental impact and a higher feed efficiency and economic profitability in beef cattle production. However, this preliminary work has been conducted as a retrospective study, thus, further in-vivo works should confirm this feed efficiency improvement and also, validate the change points (kg BW) here identified where dietary energy or protein concentration were modified.

Keywords: Nutrition precision strategies, machine-learning techniques, beef cattle production

Bibliography

Tolkamp, B. J. (2010). Efficiency of energy utilisation and voluntary feed intake in ruminants. *animal*, 4(7), 1084-1092.

Andretta, I.; Pomar, C.; Rivest, J.; Pomar, J.; Lovatto, P. A.; and Radünz Neto, J. (2014). The impact of feeding growing–finishing pigs with daily tailored diets using precision feeding techniques on animal performance, nutrient utilization, and body and carcass composition. *Journal of Animal science*, 92(9), 3925-3936.

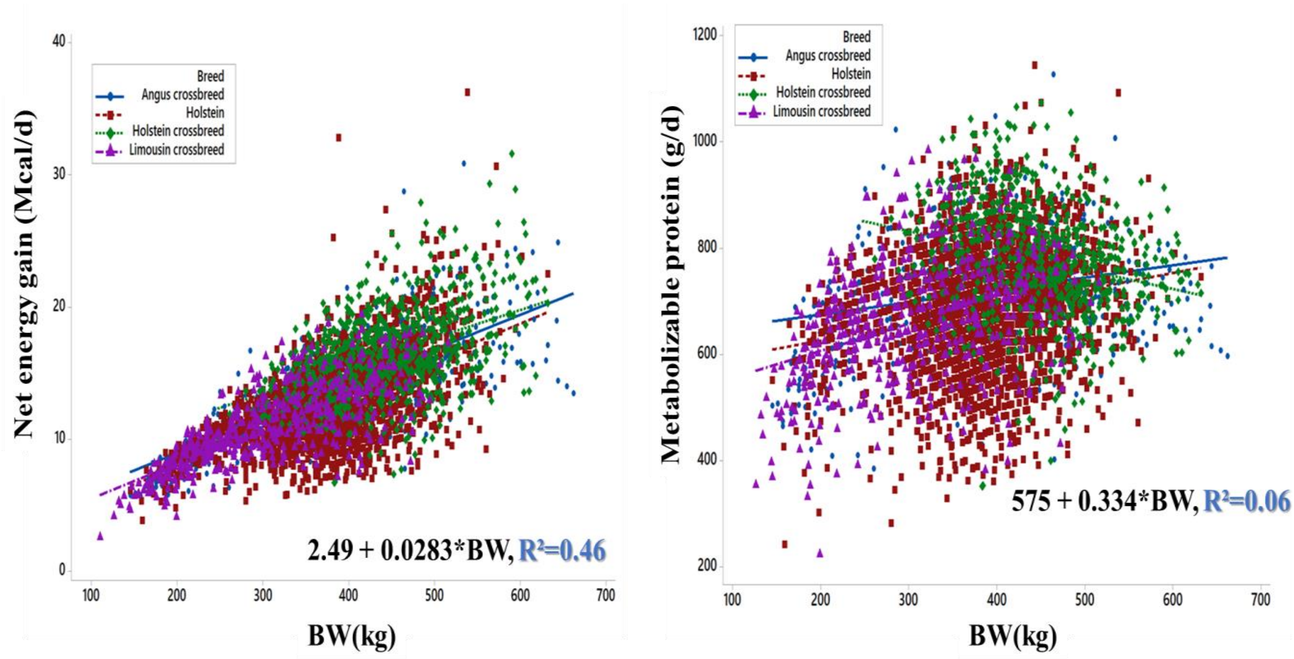

Figure 1: Linear modelling of Net energy and Metabolizable protein requirements of animals by breed

PHENOTYPIC PLASTICITY OF SOYBEAN ABOVE AND BELOW GROUND FUNCTIONAL TRAITS IN RELAY-CROPPING CONDITIONS: HOW CULTIVARS WITHSTANDCOMPETITION FOR LIGHT AND WATER.

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Grain/soybean relay-cropping (RC) has been proved to be feasible and efficient from a land and resource perspective. However, when relay-cropped into standing winter crops, yield loss ranges from 15 to more than 30% which is mainly due to early water and light competition with the first crop. To improve RC productivity the technical route must be adapted, especially by selecting the variety. In order to understand the response of soybean spectrum on plants interactions in RC systems, more research is needed.

A field experiment was conducted from October 2021 to September 2022 in the north of France on barley-soybean interactions and soybean cultivars phenotype plasticity. The main purpose of this study was to evaluate the competitiveness of different soybean genotype compared to their pure crops. We assumed that cultivars do not have the same ability to withstand competition for light, water and nutrients. Four different cultivars of soybean were relay-cropped with barley and compared to their respective soybean-pure crops treatments. The Senator cultivar of maturity group (MG) 000 is considered as the control cultivar as it is the MG used in this area. The other cultivars (Altona, Stumpa and Adelfia) of MG 00 were chosen to be from different genetic branches. The growth and development stages were assessed between pure crops and RC. At barley harvest and RC flowering, root traits, leaf traits and biomasses were measured. Yield and yield components were evaluated at soybean harvest.

RC significantly impacted soybean growth, roots and shoot traits compared to soybean-pure crops. Root biomass was drastically reduced compared to pure crops but the RC roots have a higher number of nodules. The three late cultivars yielded more than Senator as they could continue their vegetative development after barley harvest. Still RC soybeans suffered from a major water stress and produced less than pure crops. Relatively late maturity cultivars showed better potential for grain/soybean RC. More research is needed to improve this cropping system.

Bibliography

Caviglia, Octavio P., Victor O. Sadras, and Fernando H. Andrade. 2011. '*Yield and QualityofWheat and Soybean in Sole- and Double-Cropping*'. AgronomyJournal 103 (4): 1081–89. https://doi.org/10.2134/agronj2011.0019.

Li, Long, JianhaoSun, Fusuo Zhang, TianwenGuo, XingguoBao, F. Andrew Smith, and Sally E. Smith. 2006. '*RootDistribution and InteractionsbetweenIntercroppedSpecies*'. Oecologia 147 (2): 280–90. https://doi.org/10.1007/s00442-005-0256-4.

Nelson, Kelly A., Clinton G. Meinhardt, and Randall L. Smoot. 2010. '*Wheat (Triticum Aestivum L.) Cultivar SelectionAffectsDouble-Crop and Relay-IntercropSoybean (Glycine Max L.) Response onClaypanSoils*'. International JournalofAgronomy 2010 (July):.https://doi.org/10.1155/2010/543261.

Vandermeer, John H. 1989. *TheEcologyof Intercropping*. Cambridge: Cambridge UniversityPress. https://doi.org/10.1017/CBO9780511623523.

Plant Science

ARE COVER CROPS ALWAYS EFFECTIVE FOR WEED CONTROL IN AGRICULTURAL SYSTEMS UNDER AGROECOLOGICAL TRANSITION?

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Cover crops (CC) planted between two summer crops provide multiple ecosystem services. When CC are used as a weed control tactic, several factors can affect their performance. In agricultural systems under agroecological (AE) transition, the combined use of CC and herbicides for weed management may be an admissible practice until herbicide use is excluded and system stability is achieved. In this study, we aim to determine the effectiveness of vetch and triticale alone as weed suppressor CC in a productive approach under AE transition, and to characterize some of the key factors that can influence such effectiveness. Between 2018 and 2021 weed scouting (species identification and counting of individuals) was carried out, and CC (vetch and triticale alone) and weed biomass were sampled out on two AE transition scenarios located in Zavalla, Santa Fe province (33°1'55.461"S; 60°53'1.305"W) (Figure 1 and 2). These scenarios were compared against a winter cash crop (wheat) under AE transition and a conventional winter chemical fallow (BQ) (Figure 1). All treatments had soybean or maize as summer cash crops. Biomass of vetch and triticale alone was large (6±0.4 and 7.4±0.7 $tn.ha^{-1}$, respectively). Both CC were equally effective as wheat (9.5±0.8 $tn.ha^{-1}$) and BQ to suppress weeds. Weed biomass ranged between 0.76±0.12 and 1.15±0.44 $tn.ha^{-1}$ for BQ and wheat, respectively, and did not differ from CC treatments. Timing and the soil/crop conditions of CC sowing and termination, as well as climatic factors, were identified as the main conditioning factors of the effectiveness in the suppression of weeds. The opportunity for the strategic use of herbicides in the AE transition is also a factor in favor of the effectiveness of CCs and is not always properly considered and applied.

Key words: weed management, resistant weeds, herbicides, soil cover, agroecology.

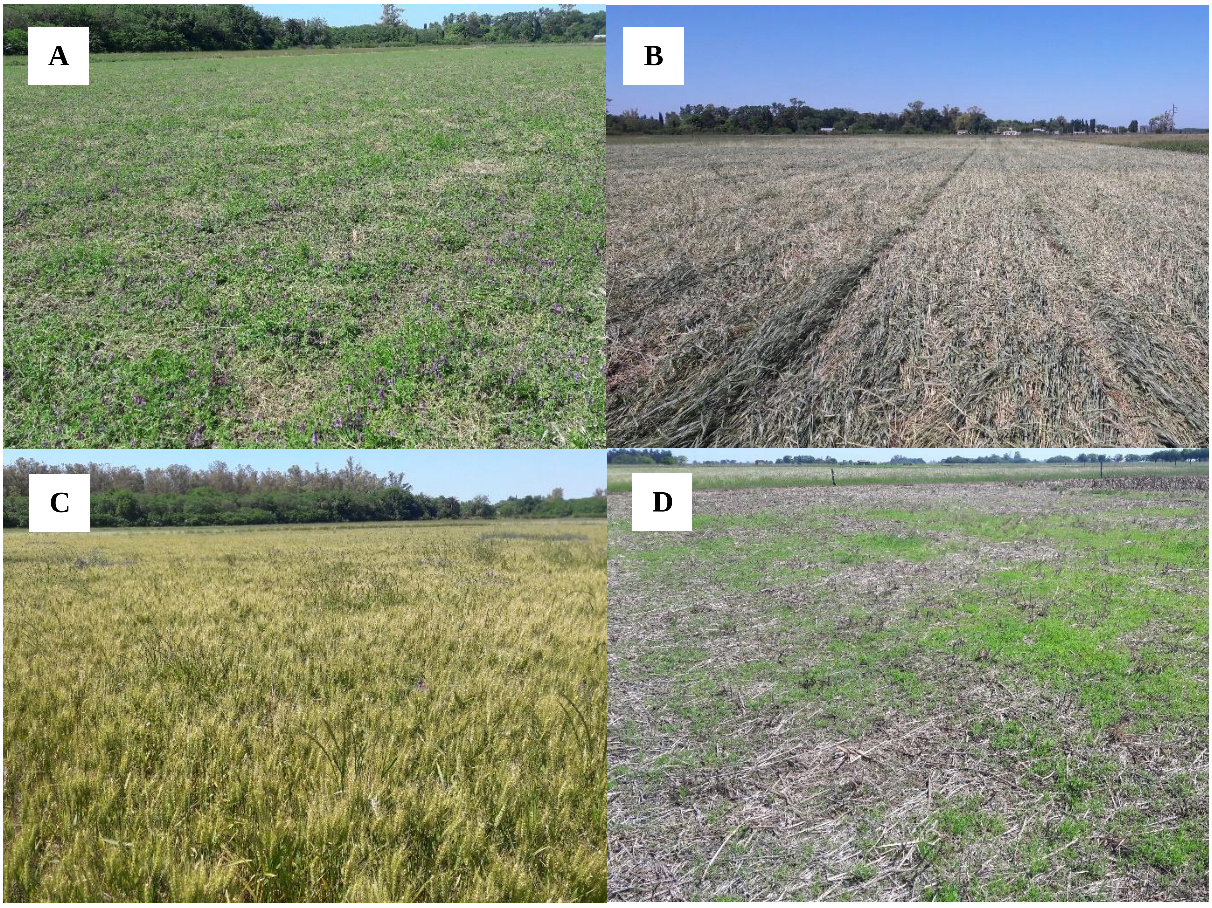

Figure 1. Regrowing rolled vetch, rolled triticale, wheat crops before maturity and chemical fallow before soybean planting (A, B, C and D, respectively) in November 2018 on agroecological transition research plots located in Zavalla, Santa Fe province.

Figure 2. Rolled triticale (left) and vetch (middle), and wheat (right) with high biomass and few weeds growing on the cover on November 2020.

SURVEY OF PHYTOPHAGOUS ARTHROPODS AND NATURAL ENEMIES IN SOYBEAN CROPS UNDER AGROECOLOGICAL TRANSITION IN THE TOWN OF ZAVALLA, SANTA FE.

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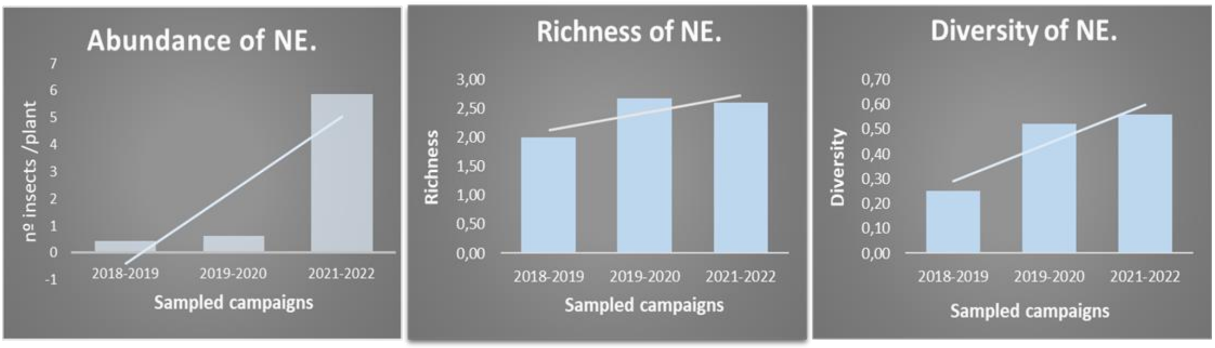
The modality with which extensive agriculture is carried out in the south of Santa Fe is characterized by the homogeneity of the landscape: few crops, with high levels of yield, but with low genetic variability, very susceptible to diseases and pests and poorly adapted to marginal areas. Non-arable areas, such as routes and crops borders and rural roadsides, are systematically treated with broad-spectrum herbicides, eliminating the remaining plant diversity of a very impoverished system. An important attributes of agroecological management of insect pests is the use of functional vegetal diversity. Since its inception, in the SIPA module (Integrated System of Agroecological Productions), of the Faculty of Agrarian Sciences-UNR, techniques aimed at increasing vegetal diversity were implemented, in order to promote the population growth of Natural Enemies of pests (NE). For this, a biodiversity border (BB) was implanted in the surroundings of the plots, with certain plant species that provide nectar, pollen and alternative food for the EN, the chosen species were: *Coriandrum sativum; Vicia villosa; Brassica napus, Sinapis al*ba, as commercial species, in addition to spontaneous species such as: *Foeniculum vulgare, Ammi majus, Ammi, visnaga and Conium maculatum*. In addition, cover crops were incorporated in the winter months and the plots were not treated with insecticides, in order to allow the development and establishment of NE populations, with the aim that the arthropod communities reach their equilibrium levels. During the 2018-19, 2019-20 and 2021-22 campaigns, phytophagous insects (PHY) and NE were monitored in soybean plots belonging to SIPA. The crops were monitored with the vertical cloth method. For each campaign, the abundance, richness, equitability and diversity of FIT and NE were determined, with the aim of seeing their evolution throughout the agroecological transition. From the beginning of the crop until physiological maturity, 6 sampling stations of 1 linear meter were observed weekly. To calculate the variables, the multivariate statistical package Pc-ord was used. Throughout the campaigns, the abundance of PHY decreased by 45%, the same decreasing trend was seen in the values of richness, equitability and diversity. During 2018-19, the only pest population peak recorded to date was due to *Anticarsia gemmatalis*, a mayor soybean pest in Argentina, which would have required a chemical intervention. Regarding the NE, their abundance increased by more than 100%, this growing trend was also expressed in the values of richness, evenness and diversity throughout the evaluated campaigns (Figure 1). In conclusion, it can be mentioned that, although the studies on the evolution of the PHY and NE populations must continue over time, even after the transition period has ended, the preliminary results obtained show a clear tendency to reach levels of pests that can coexist with crop production. On the one hand, incorporating and managing the appropriate functional vegetal diversity outside the crops on the BB, and on the other hand, adding temporal vegetal diversity within the plots through winter cover crops, food resources and shelter are provided and for NE, leading to decreased pest populations, without the need to use chemicals.

Figure 1. Ecological variables, abundance, richness and diversity of Natural Enemies



Bibliography

Gamundi, J. C., Andrian, M., Bacigaluppo, D., Lago, M., Lenzi, L., Randazzo, P., & Bodrero, M. (2003). Incidencia del complejo de chinches en el cultivo de soja con diferentes espaciamientos entre líneas. Soja. Para mejorar la producción, Eds. INTA, 142p.

Karp, D. S., Chaplin-Kramer, R., Meehan, T. D., Martin, E. A., DeClerck, F., Grab, H., ... y Wickens, J. B. (2018). Crop pests and predators exhibit inconsistent responses to surrounding landscape composition. Proceedings of the National Academy of Sciences, 115(33), E7863-E7870.

Landis, D.; Wratten, S.D. y Gurr, G. (2000). Habitat management to conserve natural enemies of arthropod pests in agriculture. Annual reviews of entomology, 45, 175-201.

Montero, G.A. y Lietti. M.M. (1998). Hibernación de Calosoma argentinense Csiki (Coleoptera: Carabidae). Revista Sociedad Entomológica Argentina, 57 (1-4), 13-16.

Muñoz y Montico, (2021). Sistema integrado de producciones agroecológicas en agroecosistemas extensivos: aportes para el manejo de la transición. Fundación Ciencias Agrarias. Libro digital, PDF. ISBN: 978-987-46406-9-7.

Paleologos, M.F.; Flores, C.C.; Sarandon, S.J.; Stupino, S.A. y Bonicatto, M. M. (2008). Abundancia y diversidad de la entomofauna asociada a ambientes seminaturales en fincas hortícolas de La Plata, Buenos Aires, Argentina. Revista Brasileira de Agroecologia, 3(1), 28-40.

Polack, L. A., Lecuona, R. E., & Lopez, S. N. (2020). Control biológico de plagas en horticultura. Experiencias argentinas de las últimas tres décadas. Ediciones INTA

EXTENSIVE AGRICULTURE UNDER REGULATED ENVIRONMENTAL PROTECTION AREAS AT INTA PARANÁ

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The INTA Paraná Agricultural Experimental Station (EEA Paraná), in the province of Entre Ríos, seeks to promote agronomic management strategies for new production challenges: greater selection pressure from resistant weeds, social pressure regarding the use of pesticides, and greater climate variability. This framework gave rise to the setup of extensive agriculture production experiments in the Environmental Protection Area within the EEA Paraná where spraying with pesticides products is banned. The experience began in July 2018 on a 5 ha field with sowing of cover crops for seed production. Currently, the experimental area has 80 ha of extensive agricultural production for grains and hay. The objectives of the research that guide the experiment are agro-environmental monitoring and innovation regarding the mechanical control of weeds, increase in diversity and improvement in soil and water properties. The effect of a modified flat wing chisel harrow for total weed control with minimal removal of soil cover was evaluated, both in terms of its efficacy and in terms of possible implications on soil structure through the Profile Cultural method. Important progress and management recommendations were obtained and are already being disseminated, related to environmental, soil conditions, and depth for the chisel harrow usage. Atmospheric deposition samples of pesticides were also taken out in the fields and compared to a traditional production area. Those results are consolidated as a baseline that continues to be surveyed and which contribute to the analysis of the functionality of protection areas close to the traditional production systems. The results include both, achievements and controversial ones, and are extremely valuable to develop the co-innovation strategy with stakeholders.

Key words: environmental protection area, agroenvironmental monitoring, weed mechanical handling, pesticides.

Figure 1. Environmental Protection Area (B) where no till crops area planted: maize (E), fodder turnip (F) and oat for forage (A). A modified flat wing chisel harrow for total (C and D) and for between maize line weed control with minimal removal of soil cover are being evaluated. Team meetings in the field or in the meeting room are regular to discuss the project progress (G).

HOST MIXTURES FOR PLANT DISEASE CONTROL: BENEFITS FROM PATHOGEN SELECTION AND IMMUNE PRIMING

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In a previous article (Clin et al., 2021), we showed the importance of an induced resistance mechanism (named "priming") in mixtures composed of 2 varieties, susceptible and resistant. To go further in the study on the benefits linked to priming, we considered a greater number of varieties in the mixture. The interactions leading to priming increase with the number of varieties and will further reduce the prevalence of the disease. Our new model only considers resistant varieties.

We have developed an epidemiological model to explore the effect of varietal mixtures composed of a variable number of cultivars, each possessing a unique resistance gene, on the equilibrium prevalence of the disease caused by a polymorphic pathogen population. Within this pathogen population, the pathogen genotypes have a number of virulence genes varying between 1 and the number of varieties present in the mixture, n. The avirulent genotype (no virulence gene) is not considered because it cannot infect this type of mixture. The total number of virulence genes of a genotype is defined as its virulence complexity, k. For the same complexity of virulence, there may be several genotypes because the number of combinations varies. Carrying a virulence gene implies a cost c for the pathogen. Its transmission rate is reduced by a factor of $0 < 1-c < 1$, compared to an avirulent genotype on a variety without a resistance gene. These virulence costs are multiplicative in the case where the pathogenic genotypes possess more than one virulence gene. When a pathogenic genotype does not have the right virulence gene(s) to infect the host, it acts as an avirulent genotype and triggers priming in the host with which it is in contact. For example, if a genotype has a single virulence gene among 3 possible in the case of a mixture of 3 varieties, then it can prime 2 varieties out of 3. Once the priming has been established, the effectiveness of the priming, ρ, reduces the probability of infection of virulent pathogen genotypes for the variety in question.

This model can quickly become complex due to the possible virulence gene combinations. To analyze it in the case of a mixture with n varieties, the following assumptions were made: the varieties of the mixture are present in the same proportions, all the diversity of pathogenic genotypes is initially present, the virulence costs, c, are the same for each virulence gene, and the basic reproductive rate (R) is the same for all varieties. All of these hypotheses make the model symmetric and make it possible to follow the epidemiological dynamics by focusing on a single variety of the mixture. The differential equation model obtained is then in dimension n+1 and composed of n variables measuring the density of hosts of the focal variety infected by a pathogen genotype of a given virulence complexity, plus a variable measuring the density of primed hosts of the focal variety. We carry out a relatively complete analysis of the model at equilibrium.

Our model presents two major results. The first result shows that a relatively large amount of resistance genes must be deployed to achieve a low disease prevalence. This result is due to intraspecific competition in the pathogen population and the presence of virulence costs which tends to select an intermediate virulence complexity. There is a competitive exclusion between virulence complexities resulting in a pathogen population consisting of a set of pathogen genotypes with the same virulence complexity. It is therefore possible to prevent the emergence of a pathogenic genotype capable of circumventing all the resistance deployed when the genetic diversity of the varieties is high. Moreover, if the number of varieties in the mixture is high enough, it is possible to eliminate the disease. This critical number of varieties can be expressed from the analysis of the model. Second, priming significantly reduces the number of plant genotypes needed to bring disease prevalence down below a disease acceptability threshold. This large reduction is possible when the transmission rate, R, and the virulence cost, c, are high enough. Indeed, a high virulence cost selects for a low virulence complexity, which maximizes the host-pathogen interactions that trigger priming. For certain sets of parameters, when the priming efficiency is total, it is possible to halve the number of varieties to be used to reach the acceptability threshold (Figure 1).

From an agroecological point of view, it seems relevant to consider a disease acceptability threshold (meaning that the objective is not to eliminate the disease), especially since the availability of resistance genes in cultivars is limited. This article shows once again the benefits of mixtures and the importance of priming to protect crops from plant diseases. In some cases, it may be preferable to exploit the benefits of priming and preserve genetic resources while reducing the prevalence of the disease rather than to design mixtures with a large number of resistance genes. Currently, few experiments have attempted to quantify priming while we show with this model that it would be interesting to evaluate it when designing host mixtures.

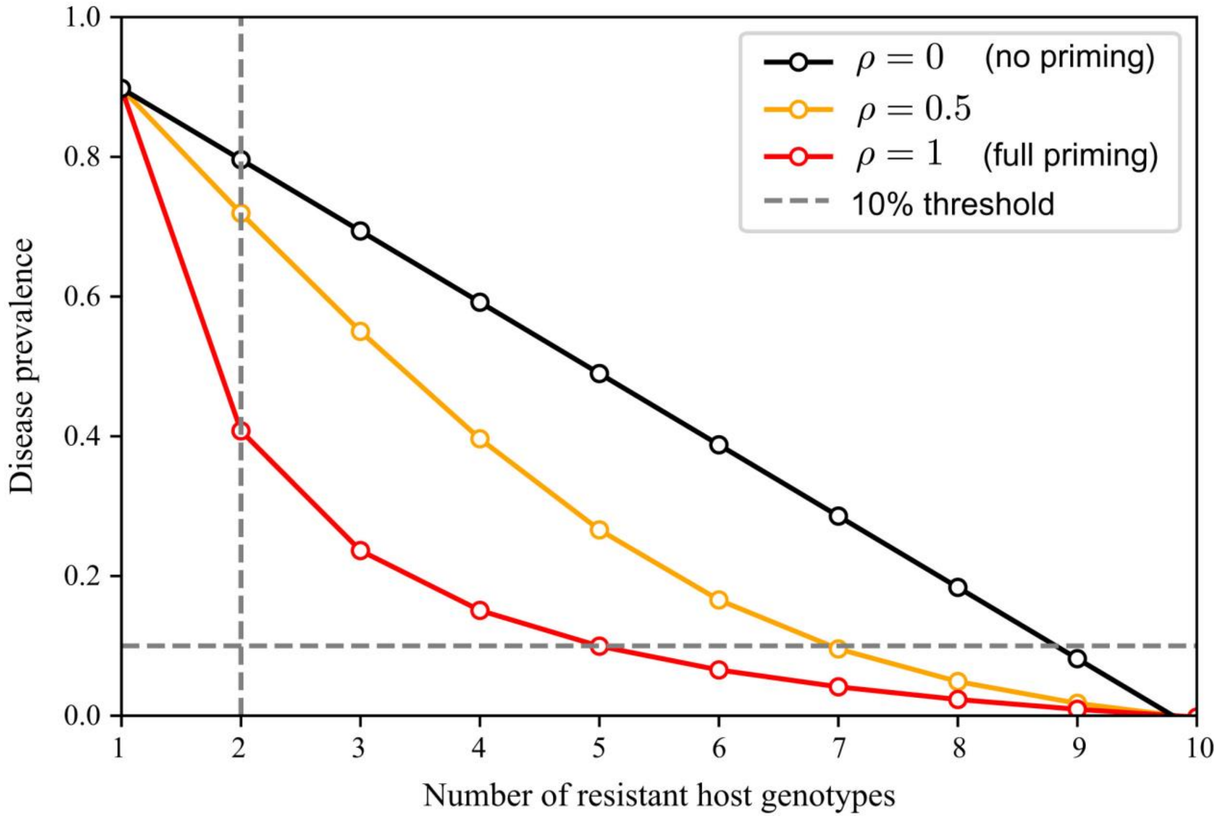

Figure 1. Total equilibrium prevalence of the disease, as a function of the number of varieties in the mixture n. The 10% prevalence threshold corresponds to a possible acceptable threshold in an agroecological context. Parameters values: R = 20 (transmission rate), c = 0.5 (virulence cost) and ν = 1 (re-scaled removal rate). In this case, the number of varieties needed to bring

the prevalence below the 10% threshold can be reduced from 9 to 5 through priming. The n = 2 line corresponds to a possible situation in which the genetic resource is limited to n = 2. The prevalence can be reduced from 0.8 to 0.4 through priming

Bibliography

Clin, P., Grognard, F., Mailleret, L., Val, F., Andrivon, D., & Hamelin, F. M. (2021). Taking advantage of pathogen diversity and immune priming to minimize disease prevalence in host mixtures: a model. *Phytopathology*, 111(7), 1219-1227.

Clin, P., Grognard, F., Andrivon, D., Mailleret, L., & Hamelin, F. M. (2022). Host mixtures for plant disease control: Benefits from pathogen selection and immune priming. *Evolutionary Applications*, 15, 967– 975. https://doi.org/10.1111/eva.13386

*ARACHIS PINTOI*KRAPOVICKASET GREGORYAS A COVER CROP ON YERBA MATE (*ILEX PARAGUARIENSIS* A. ST.HIL.)

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Yerba mate is a perennial species native to southern Brazil, southern Paraguay and northeastern Argentina, where it iscultivated.

The conventional management of plantations and the inadequate use of herbicides for many years led to soil depletionanderosion.

In this work we evaluateda cover crop assay using *Arachis pintoi*(Sec. *Caulorrhizae*), native of Bahia (Brazil), which roots easily on branches and is used as a fodder crop.
Weed censuses were carried out in two yerba cultivation plots under the following treatments: 1) with *A. pintoi* planted cover, and 2) without cover (control). Weed presence and dominance were recorded, the latter computed as the average relative cover of each species.
To evaluate the effects of the cover crop, weed dominance, organic matter (OM) content and soil temperature at 10 cm depth were compared between the two treatments.
Under *A. pintoi* cover crop, weed dominance was very low (0.1% in all species) compared to control (5% in 6 species). Another remarkable effect was the higher OM content (3.58%) and the lower soil temperature (between 28.4 and 31.4 °C) withcover than without cover (2.77% and 43 °C).
The cover crop of *A. pintoi* can contribute to the sustainable management of yerba mate plantations, reducing the use of herbicides and fertilizers, preserving and improving the physical, chemical and biological conditions of the soil.

Key words: legume, agriculture, sustainability, perennial crops.

Fig. 1. Cover crop*A. pintoi*, 12 months after implantation

Fig. 2. Soil temperature. A.without cover. B. with cover of 15 cm height and C. with coverage of 40 cm height

Bibliography

Krapovickas, A.and Gregory,W. (1994). Taxonomía del género *Arachis (Leguminosae)*. *Bonplandia*,8 (1-4), 81-82.

Puertas, F., Arévalo, E., Zúñiga, L., Alegre, J., Loli, O., Soplin, H., andBaligar, V. (2008). Establecimiento de cultivos de cobertura y extracción total de nutrientes en un suelo de trópico húmedo en la amazonia Peruana. *Ecología aplicada*, 7(1-2), 23-28.

POTENTIAL OF VISIBLE (RGB) IMAGERY FOR DYNAMIC MONITORING OF NITROGEN REQUIREMENTS IN WINTER WHEAT USING THE INNOVATIVE APPI-N METHOD.

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The balance-sheet method has been widely used for decades as a reference method to calculate the amount of nitrogen (N) fertilizer to supply to winter wheat. With this method, the amount of N fertilizer is calculated at the end of the winter to support the N requirement for an estimated yield level. This method is now being questioned because it has become difficult to predict yields, given climate change and the increased presence of pests in agroecological cropping systems, resulting in greater uncertainty about the yield achieved compared to conventional systems of the past. Alternative methods, such as the innovative approach of nitrogen fertilization (APPI-N; Ravier et al., 2018), are proposed for dynamic fertilization management: the amount of nitrogen fertilizer is adjusted to the real nitrogen status of the plant using the N nutrition index (NNI). Lemaire et al. (1989) define the NNI as the ratio of the measured nitrogen concentration (%N) to the critical nitrogen concentration (%Nc; Justes et al., 1994); it can be indirectly determined by measuring the leaf chlorophyll content using hand-held non-destructive contact devices (i.e. N-Tester, SPAD). However, their use is time-consuming and not suitable for routine use by farmers or advisors. Different optical measurements by proxi- or remote sensing using leaf color charts or vegetation indices combining visible and infrared wavebands at leaf or canopy level seem promising for estimating the nitrogen status of winter wheat. In the literature, a dark green color index (DGCI), was specifically created for the purposes of leaf nitrogen concentration analysis using visible images (Fig.1). The range of DGCI values is between 0 (very yellow; low N rate) and 1 (dark green; high N rate). Indeed, nitrogen is directly related to leaf color because it is a key component of the chlorophyll molecule (Tracy et al., 1992). First studied on grass (Karcher and Richardson, 2003), it was then successfully tested on maize crops (Rorie et al., 2011), provided that the images were normalized to correct for differences in lighting conditions during and between experiments and differences between cameras. In order to better understand the relationships between DGCI measurement methodology and nitrogen fertilization, different experiments were conducted at a canopy level. The objectives of this work were to explore the potential of the DGCI in winter wheat crop at canopy level for estimating NNI deduced from conventional methods (N-Tester). The trial zone represented 24 microplots: half of them were seeded with a winter wheat (*Triticum aestivum* L.) cv. LG Absalon and the other half with a mixture of cultivars (LG Absalon, Lipari, Rubisko, Tenor). To create a nitrogen gradient, the plots were fertilized according to five modalities (with two replicates) corresponding to different nitrogen doses ranging from 0 to 300 kgN.ha^{-1}, with a nitrogen index ranging from 0.4 (minimal N status) to 1.2 (supra optimal N nutrition). A series of non-destructive measurements was performed on this N gradient during two growth stages, 2 nodes and heading. A chlorophyll-meter (N-tester) and three different optical systems (a digital camera and two smartphones) were used to estimate indirectly the leaf chlorophyll concentration from NNI.

To validate protocol for image acquisition, three factors were tested: 1) DGCI *vs.* relative DGCI to evaluate the impact of standardization of image data 2) different optical systems to evaluate their impact and that of the white balance (manual or automatic) on the quality of the results 3) a pure wheat cultivar *vs.* mixture of cultivar to evaluate the capacity of the DGCI face to different cultivars. Statistical analyses were conducted to investigate the correlations between the N-Tester measurements and those deduced from images (DGCI and relative DGCI) using R software and RStudio, an integrated development environment for R.
First results demonstrated that the relative DGCI values were highly correlated with NNI measurements with a significant degree of association. Best results were observed considering only one cultivar (LG Absalon). The "manual" option of white balance improved the results. Furthermore, there seemed to be a varietal effect depending on whether a mixture or a single cultivar is studied. As the results were only obtained in one year and at one location, further measurements are needed to validate this new methodology, which is easy to use and can be carried by any type of mobile platform (smartphone, drone, robot, etc.).
From the results, the DGCI method developed on a large scale could be used as a nitrogen nutrition indicator on arable crops for dynamic monitoring of nitrogen fertilization.

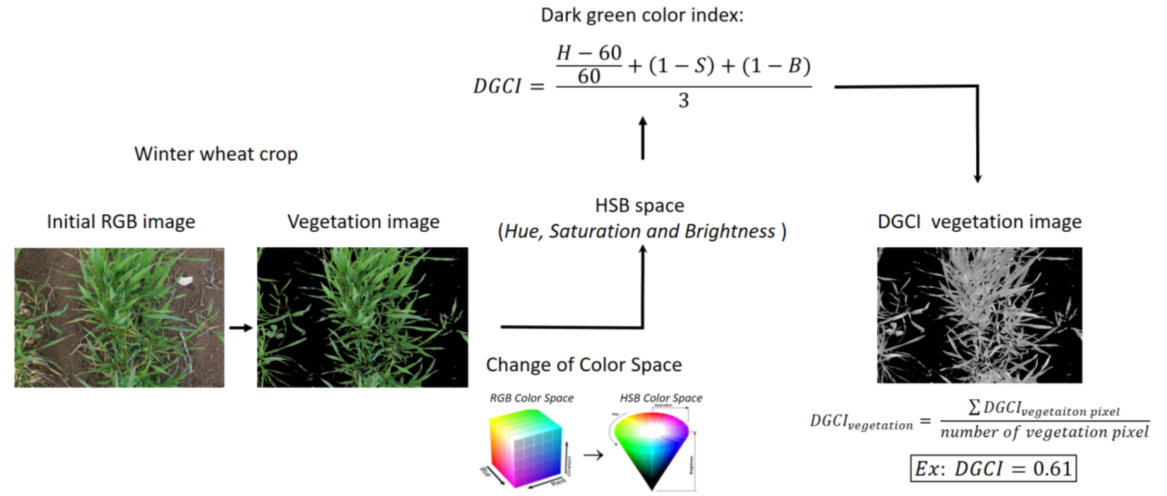

Fig. 1: Description of visible image processing for the DGCI the calculation

Bibliography

Justes, E.; Mary, B.; Meynard, J.M.; Machet, J.M. and Thelier-Huché, L. (1994). Determination of a critical nitrogen dilution curve for winter wheat crops. *Annals of Botany*, 74(4), 397-407.
Karcher, D.E. and Richardson, M.D. (2003). Quantifying turfgrass color using digital image analysis. *Crop Science*. 43, 943-951
Lemaire, G.; Gastal, F. and Salette, J. (1989). Analysis of the effect of N nutrition on dry matter yield of a sward by reference to potential yield and optimum N content. In: *Proceedings of the 16th International Grassland Congress*, Nice, France, 179-180.
Ravier, C.; Jeuffroy, M.H.; Gate, P.; Cohan, J.P. and Meynard, J.M. (2018). Combining user involvement with innovative design to develop a radical new method for managing N fertilization. *Nutrient Cycling in Agroecosystems*, 110, 117-134
Rorie, R.L.; Purcell, L.C.; Mozaffari, M.; Karcher, D.E.; King C.A.; Marsh M.C. and Longer, D.E. (2011). Associaton of "greenness" in corn with yield and leaf nitrogen concentration. *Agronomic Journal* 103, 529-535.
Tracy, P.W.; Hefner, S.G.; Wood, C.W. and Edmisten, K.L. (1992). Theory behind the use of instantaneous leaf chlorophyll measurements for determining mid-season cotton nitrogen

recommendations. p. 1099–1100. In: *Proceeding of Beltwide Cotton Conference*, National Cotton Council of America, Memphis, TN, USA.

WEEDS OF MELLIFEROUS IMPORTANCE IN CROPS OF THE NORTHEAST ARGENTINA REGION

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Agriculture intensification has led to the decline of pollinators. For this reason, there has been increased interest in attracting pollinator populations, providing alternative non-crop resources to obtain higher food production. Weeds can be useful for this purpose, as they provide resources that attract and maintain active pollinator populations.
We analyzed ecological relationships between weeds occurring in cotton, yerba mate and flooded rice crops and social bees *Apis mellifera* L. and *Tetragonisca fiebrigi* Schwarz, in the Northeast Argentina Region (NEA region). The evaluation was carried out by meta-analysis of the accumulated evidence related to i) Evidence for floral resource use by *A. mellifera* and *T. fiebrigi* bees, and ii) composition and structure of weed communities associated with cotton, yerba mate and flooded rice crops in the NEA region. Evidence for floral resources (nectar and pollen) use by bees was obtained by pollen analysis of honey and pollen loads in previous regional-scale studies. The frequency of weeds species present in crops was calculated from presence/absence data. A *species* x *crop* Correspondence Analysis (CA) was carried out. Weeds were classified into functional groups according to a) status, into native and adventitious species, b) habitat, into terrestrial and marsh species, and c) bee species with evidence of use as a foraging resource, *A. mellifera* and *T. fiebrigi*.
Within the list of weeds forming the communities studied in this research, 66 species were foraging resources with evidence of use by the social bees. The *A. mellifera* bee showed a wider foraging range, with a greater species number than *T. fiebrigi*, including all species exploitable by this bee species (Figure 1). This result is related to the fact that *A. mellifera* is a highly generalist species. For *T. fiebrigi*, preference for native weeds was observed, and for two adventitious species only (*Echium plantagineum* L. and *Chenopodium album* L.) (Figure 1). Among the weeds used by bees, species groups differentiated by type of crop habitat were identified. One group was strongly associated to flooded rice, with mainly marsh and aquatic species (Figure 2). This result allows us to explore assumptions about the trophic and ecological importance that bees may have in natural and artificial wetland habitats. Other groups were associated with weed communities of rainfed crops (cotton and yerba mate) (Figure 2). The highest proportion of species was native flora (85%) (Figure 3). Melliferous floral supply in terms of species richness was highest in yerba mate.
In conclusion, there is a need to increase knowledge about the interactions between weeds and social bees to understand the roles of weeds and pollinators in agroecosystems, and to promote the beneficial ecosystem services they provide.

Key words: agricultural sustainability, beekeeping, food security.

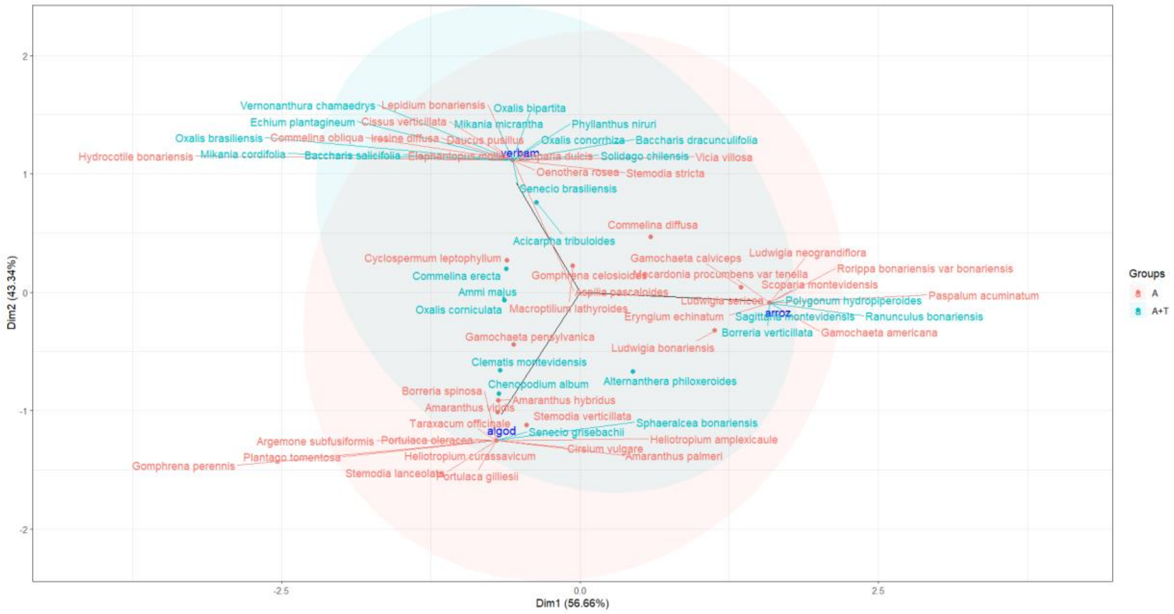

Figure 1. *Species x crop* Correspondence Analysis. In blue: yerbam (yerba mate crop), algod (cotton crop), arroz (flooded rice crop). In turquoise: weeds species whit use evidence of *Apis melifera* (A). In orange: weeds species whit use evidence of *Tetragonisca fiebrigi* and *A. melifera* (A+T).

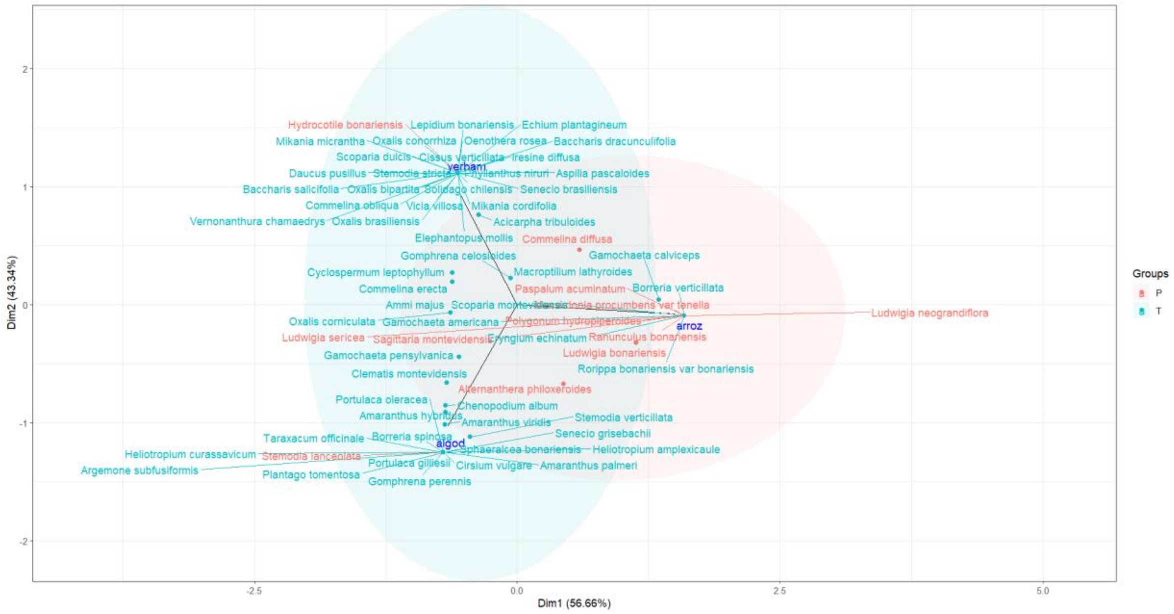

Figure 2. *Species x crop* Correspondence Analysis. In blue: yerbam (yerba mate crop), algod (cotton crop), arroz (flooded rice crop). In turquoise: terrestrial weeds species (T). In orange: marsh or aquatic weeds species (P).

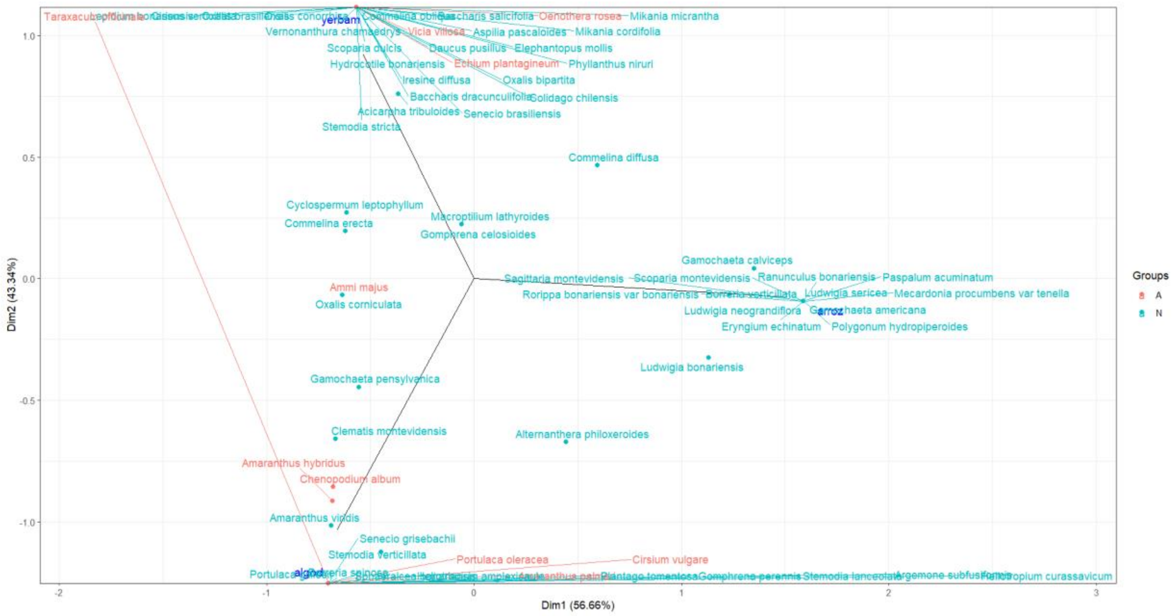

Figure 3. *Species x crop* Correspondence Analysis. In blue: yerbam (yerba mate crop), algod (cotton crop), arroz (flooded rice crop). In turquoise: native weeds species (N). In orange: adventitious weeds species (A).

Bibliography

Grimau, L.; Gomez Unjidos, M. C.; Figueroa Espinoza, R.; Pizarro, R.; Núñez, G. and Montenegro Rizzardini, G. (2014). The importance of weeds as melliferous flora in central Chile. Cien. Inv. Agr. 41(3), 387-394.

Jachuła, J.; Denisow, B.; Wrzesień, M. and Ziółkowska, E. (2022). The need for weeds: Man-made, non-cropped habitats complement crops and natural habitats in providing honey bees and bumble bees with pollen resources. Science of The Total Environment, 840, 156551.

Lovato Echeverría, R. A.; Giménez, L. I. y López, M. G. (2022). Ecología de comunidades de malezas de arroz (Oryza sativa L.) como aporte hacia una agricultura sustentable. RIA. Revista de investigaciones agropecuarias, 48(2), 148-154.

Salgado, C.R. y Pire S.M. (1998). Análisis polínico de mieles del Noroeste de la provincia de Corrientes (Argentina). *Darwiniana* 36 (1-4), 87-93.

Salgado, C.R. y Pire S.M. (1999). Contribución al conocimiento del contenido polínico de mieles de Corrientes, Argentina. *Asociación Paleontológica Argentina Publicación Especial* 6, 95-99.

Salgado, C.R. (2006). Flora melífera en la provincia del Chaco. Gobierno de la Provincia de Chaco. Ministerio de la Producción, PROSAP (Programa de Servicios Agrícolas Provinciales), Préstamo BIRF- 4150/AR. 60pp.

Salgado, C.R; Pieszko, G. y Tellería, M.C. (2014). Aporte de la Melisopalinología al conocimiento de la flora melífera de un sector de la provincia fitogeográfica Chaqueña, Argentina. Bol. Soc. Argent. Bot. 49(4), 513-524.

Salgado, C.R; Tellería, M.C y Coronel, J.M. (2017). Botanical and geographical origin of honey from the dry and humid Chaco ecoregions (Argentina). Grana 56, 1-12.

Salgado C.R., Tellería M.C., Coronel J.M. & S.V. Sobrado. 2022. An overview of the palynology and physicochemistry of monofloral honeys from the Dry and Humid Chaco of Argentina. Palynology. (ID: 2103748 DOI:10.1080/01916122.2022.2103748).

EVALUATION OF BIOFERTILIZERS IN LETTUCE CROP IN EASTERN CHACO

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Key words: Bokashi-Native Microorganisms -Colonia Benítez-Agroecology-Intensive Crops-Leafy Vegetables

The objective of agroecological agroecosystem management is to provide, with diversified design, a balanced environment, biologically mediated soil fertility with sustainable yields, and natural pest regulation, a more efficient system for local food producers. Improving soil fertility is important to optimize the agroecosystem; this is achieved by increasing and conserving soil organic matter and soil biodiversity. The objective of this work was to evaluate the use of Bokashi type biofertilizers and native microorganisms (MN) on lettuce crop yield in eastern Chaco. A field trial was conducted at the EEA INTA Colonia Benitez, transplanting the Brissa variety on 23/05/22, with a randomized complete block design, in a treatment plot of 5 m long and 0.6 m wide. The treatments were T1: 80 $g.plant^{-1}$ of Bokashi; T2: 80 $g.plant^{-1}$ of Bokashi + 10 $ml.m^{-2}$ of MN; T3: 80 $g.plant^{-1}$ of Bokashi + 40 $ml.l^{-1}$ foliar and T4: 80 $g.plant^{-1}$ of Bokashi + 10 $ml.m^{-2}$ of MN + 40 ml.l-1 foliar. Bokashi was applied at transplanting, MN to the soil at transplanting and after 21 days, and MN foliar application at transplanting and every 15 days. At harvest, aerial fresh weight, commercial fresh weight, aerial dry weight, stem length, number of total and commercial leaves were measured. T2 showed lower values in total fresh weight, commercial fresh weight and dry weight with significant differences to the other treatments. The use of Bokashi plus MN is an alternative when used as foliar and combined soil-foliar; for later evaluations of MN to the soil, the time of MN activation can interfere in the type of microorganisms present.

Bibliography

Alberto, J. A., Mignone, A., Arce, G. A.; López, S. (2018). Dinámica y desarrollo urbano del área metropolitana del Gran Resistencia: organización espacial en las primeras décadas del S. XX. *Contribuciones Científicas GAEA 30, 30-35.*

Camacho, J. A.; Recharte Pineda, D. C.; Díaz, F. Y; Moreno LLacza, S. M. and Buendía Molina, M. A. (2020). Fertilizing with native efficient microorganisms has a positive effect on the phenology, biomass and production of tomato *(Lycopersicum esculentum* Mill). *Journal Scientia Agropecuaria 11(1): 67-73.*

Gliessman, S.; Tittonell, P. (2015). Agroecology for food security and nutrition. Agroecology and Sustainable Food Systems. 39, 131-133.

González R. L.; Pérez Ramos, J.; Pérez Hernández, Y. and Espinosa, I. (2019). *Journal Fac. Nac. Agron. Medellín 72(3): 8937-8943.*

Lassevich Esperanza, D. D. (2021). Caracterización de tres biopreprados: Bokashi, MIcroorganismos Eficientes Nativos y Supermagro, y evaluación de sus efectos en el rendimiento de los cultivos y en la comunidad micorbiana del suelo. *Tesis Instituto de Investigaciones Biologicas Clemente Estable, Monteviseo Uruguay.*

Sarco, P. C.; Avico, E.; Monteros, D.; Vagabculow, J.; Vagabculow, R.; Francescutti, F.; Lestani, M. Y Shindoi, M. (2020). Diagnóstico de la actividad hortícola en la zona de influencia de la EEA INTA Colonia Benítez, Chaco.

Olivera, D.; Leiva, L.; Calero, A.; Meléndrez, J. F. (2015). Empleo de microorganismos nativos multipropósitos (MNM) en el comportamiento agro-productivo de cultivos hortícolas. *Journal Agrotecnia the Cuba 39 (7), 34-42.*

Olivera, D.; Ayala, J.F.; Calero, A.; Santana, M.; Hernández, A. (2014). Prácticas Agroecológicas en la provincia de Sancti Spíritus, Cuba. Ciencia tecnología y Sociedad (CTS) para la construcción de la Agroecología. UnB, Brasilia, Brasil. 77-84.

Peñafiel, B; Y Donoso, M. (2004). "Evaluación de diferentes dosis de microorganismos eficientes (EM) en el cultivo de pepino (Cucumis sativus) híbrido atar ha-435" Tesis, facultad de ingeniera en mecánica y ciencias de la producción, escuela superior politécnica del litoral.

Monicault, L.; Pellerano, L.; Saez, R.; Sarco, P. (2013). Aspectos de la producción y comercialización de productores familiares del Cinturón Verde de Resistencia.

Peralta-Antonio, N.; De Freitas, G. B.; Watthier, M. y Silva Santos, R. H. (2019). Compost, bokashi y microorganismos eficientes: sus beneficios en cultivos sucesivos de brócolis. IDESIA 37 (2), 59-66.

Rodríguez Montoya, M. O. (2017). Evaluación de cuatro dosis de microorganismos benéficos con aplicación materia orgánica (pollaza) en el cultivo de lechuga (*Lactuca sativa* L.) Variedad Grand Rapids Waldeman S Strain, bajo condiciones agroecológicas en la provincia de Lamas. *Tesis Universidad Nacional de San Martín-Arapoto Facultad de Ciencias Agrarias Escuela Profesional de Agronomía*

POTENTIAL OF VISIBLE (RGB) IMAGERY FOR DYNAMIC MONITORING OF NITROGEN REQUIREMENTS IN WINTER WHEAT USING THE INNOVATIVE APPI-N METHOD.

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The balance-sheet method has been widely used for decades as a reference method to calculate the amount of nitrogen (N) fertilizer to supply to winter wheat. With this method, the amount of N fertilizer is calculated at the end of the winter to support the N requirement for an estimated yield level. This method is now being questioned because it has become difficult to predict yields, given climate change and the increased presence of pests in agroecological cropping systems, resulting in greater uncertainty about the yield achieved compared to conventional systems of the past. Alternative methods, such as the innovative approach of nitrogen fertilization (APPI-N; Ravier et al., 2018), are proposed for dynamic fertilization management: the amount of nitrogen fertilizer is adjusted to the real nitrogen status of the plant using the N nutrition index (NNI). Lemaire et al. (1989) define the NNI as the ratio of the measured nitrogen concentration (%N) to the critical nitrogen concentration (%Nc; Justes et al., 1994); it can be indirectly determined by measuring the leaf chlorophyll content using hand-held non-destructive contact devices (i.e. N-Tester, SPAD). However, their use is time-consuming and not suitable for routine use by farmers or advisors. Different optical measurements by proxi- or remote sensing using leaf color charts or vegetation indices combining visible and infrared wavebands at leaf or canopy level seem promising for estimating the nitrogen status of winter wheat. In the literature, a dark green color index (DGCI), was specifically created for the purposes of leaf nitrogen concentration analysis using visible images (Fig.1). The range of DGCI values is between 0 (very yellow; low N rate) and 1 (dark green; high N rate). Indeed, nitrogen is directly related to leaf color because it is a key component of the chlorophyll molecule (Tracy et al., 1992). First studied on grass (Karcher and Richardson, 2003), it was then successfully tested on maize crops (Rorie et al., 2011), provided that the images were normalized to correct for differences in lighting conditions during and between experiments and differences between cameras. In order to better understand the relationships between DGCI measurement methodology and nitrogen fertilization, different experiments were conducted at a canopy level. The objectives of this work were to explore the potential of the DGCI in winter wheat crop at canopy level for estimating NNI deduced from conventional methods (N-Tester). The trial zone represented 24 microplots: half of them were seeded with a winter wheat (*Triticum aestivum* L.) cv. LG Absalon and the other half with a mixture of cultivars (LG Absalon, Lipari, Rubisko, Tenor). To create a nitrogen gradient, the plots were fertilized according to five modalities (with two replicates) corresponding to different nitrogen doses ranging from 0 to 300 $kgN.ha^{-1}$, with a nitrogen index ranging from 0.4 (minimal N status) to 1.2 (supra optimal N nutrition). A series of non-destructive measurements was performed on this N gradient during two growth stages, 2 nodes and heading. A chlorophyll-meter (N-tester) and three different optical systems (a digital camera and two smartphones) were used to estimate indirectly the leaf chlorophyll concentration from NNI.

To validate protocol for image acquisition, three factors were tested: 1) DGCI *vs.* relative DGCI to evaluate the impact of standardization of image data 2) different optical systems to evaluate their impact and that of the white balance (manual or automatic) on the quality of the results 3) a pure wheat cultivar *vs.* mixture of cultivar to evaluate the capacity of the DGCI face to different cultivars. Statistical analyses were conducted to investigate the correlations between the N-Tester measurements and those deduced from images (DGCI and relative DGCI) using R software and RStudio, an integrated development environment for R.
First results demonstrated that the relative DGCI values were highly correlated with NNI measurements with a significant degree of association. Best results were observed considering only one cultivar (LG Absalon). The "manual" option of white balance improved the results. Furthermore, there seemed to be a varietal effect depending on whether a mixture or a single cultivar is studied. As the results were only obtained in one year and at one location, further measurements are needed to validate this new methodology, which is easy to use and can be carried by any type of mobile platform (smartphone, drone, robot, etc.).
From the results, the DGCI method developed on a large scale could be used as a nitrogen nutrition indicator on arable crops for dynamic monitoring of nitrogen fertilization.

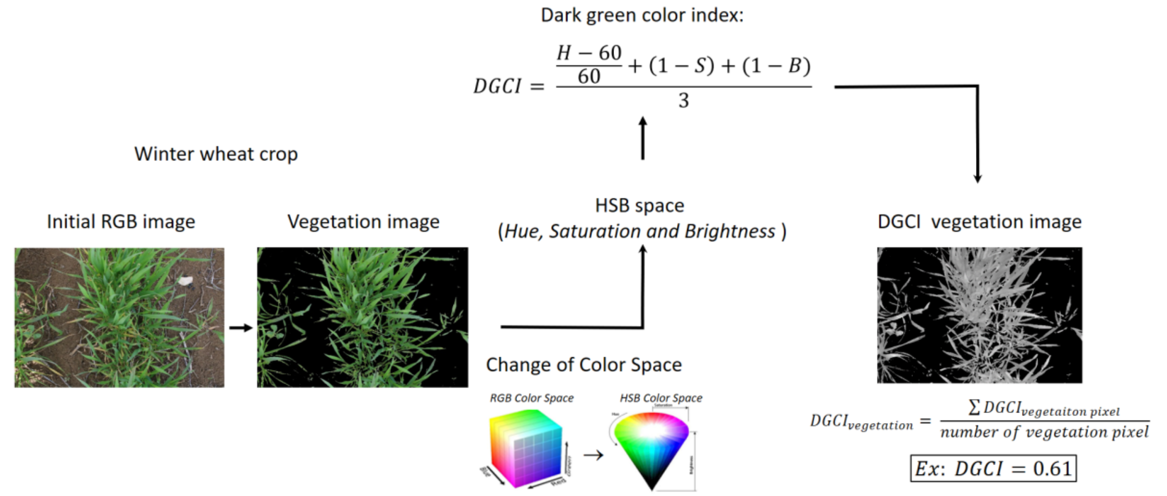

Fig. 1: Description of visible image processing for the DGCI the calculation

Bibliography

Justes, E.; Mary, B.; Meynard, J.M.; Machet, J.M. and Thelier-Huché, L. (1994). Determination of a critical nitrogen dilution curve for winter wheat crops. *Annals of Botany*, 74(4), 397-407.
Karcher, D.E. and Richardson, M.D. (2003). Quantifying turfgrass color using digital image analysis. *Crop Science*. 43, 943-951
Lemaire, G.; Gastal, F. and Salette, J. (1989). Analysis of the effect of N nutrition on dry matter yield of a sward by reference to potential yield and optimum N content. In: *Proceedings of the 16th International Grassland Congress*, Nice, France, 179-180.
Ravier, C.; Jeuffroy, M.H.; Gate, P.; Cohan, J.P. and Meynard, J.M. (2018). Combining user involvement with innovative design to develop a radical new method for managing N fertilization. *Nutrient Cycling in Agroecosystems*, 110, 117-134
Rorie, R.L.; Purcell, L.C.; Mozaffari, M.; Karcher, D.E.; King C.A.; Marsh M.C. and Longer, D.E. (2011). Associaton of "greenness" in corn with yield and leaf nitrogen concentration. *Agronomic Journal* 103, 529-535.
Tracy, P.W.; Hefner, S.G.; Wood, C.W. and Edmisten, K.L. (1992). Theory behind the use of instantaneous leaf chlorophyll measurements for determining mid-season cotton nitrogen

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REGIONAL PROJECTION OF WINTER FROST RISK ON A LEGUME CROP DUE TO WARMING IN A TEMPERATE CLIMATE

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Pea (*Pisum sativum* L.) is an important annual legume crop grown in temperate regions for its high seed nitrogen concentration and environmental benefits. In the recent climate warming, a subtle evolution of the winter crop frost risk was observed: a paradoxical increase of frost stress events and a frost stress intensity decrease (Castel *et al.* 2017). Such results are questioning the future winter frost risk for peas. We assessed the winter frost damage evolution along 2006 to 2100 in Burgundy-Franche-Comté (a French region - western part of Europe). The approach is based on the combination of i) a dynamical downscaled climate data of two RCP trajectories (4.5 and 8.5) (Boulard *et al.* 2016) and ii) a winter frost stress model calibrated and validated for pea (using varieties with different frost resistance levels and acclimation rates) (Lecomte *et al.* 2003; Castel *et al.* 2017). Our results show that frost risk will not disappear with warming climate (Fig. 1). Compared to the historical period (1980-2005), the frost risk for the pea variety with a frost resistance level of -13°C will increase along the near future period (2020-2050) for RCP 8.5: with an increase of both the median and the spread of the cumulative frost degree days (Fig. 1B). With a highest warming along the far future period (2070-2100) for RCP 8.5, the results show a significant decrease of the cumulative frost degree days compared to the near future and the historical periods, but the frost risk will persist (Fig. 1B). It suggests that frost risk will significantly increase for an extended winter warming below + 2°C, while it will decrease when this threshold will be overpassed (Fig. 1). The figure 2 depicts the evolution of the two components of the frost stress with warming: intensity and number of the frost stress events. The increase of the cumulative frost degree days in the near future period (2020-2050) for RCP 8.5 is determined by the increase of frost stress events intensity (Fig. 2A). By contrast the number of frost stress events slightly decrease during this period (Fig. 2B). This result differs from the past evolution of these components with the observed warming from 1961 to 2018 (Castel *et al.* 2019) and suggests a change in the winter frost risk structure. For the end of the century (period 2070-2100) and for the RCP 8.5, both intensity and number of the frost stress events will decrease (Fig. 2). Finally the projections show a contrasted geography of the frost risk evolution. This geographic trend depends on the frost resistance level and acclimation rate of the pea variety. Our results seem to confirm subtle evolutions of winter climate warming dynamics revealed by the change in the pea crop frost risk structure. Moreover, this work provides leads for breeding and crop management techniques strategies for winter pea adaptation to climate change to avoid the detrimental effects of frost while taking advantage of the potential of this crop.

Keywords: climate warming, crop model, winter pea, frost risk, adaptation

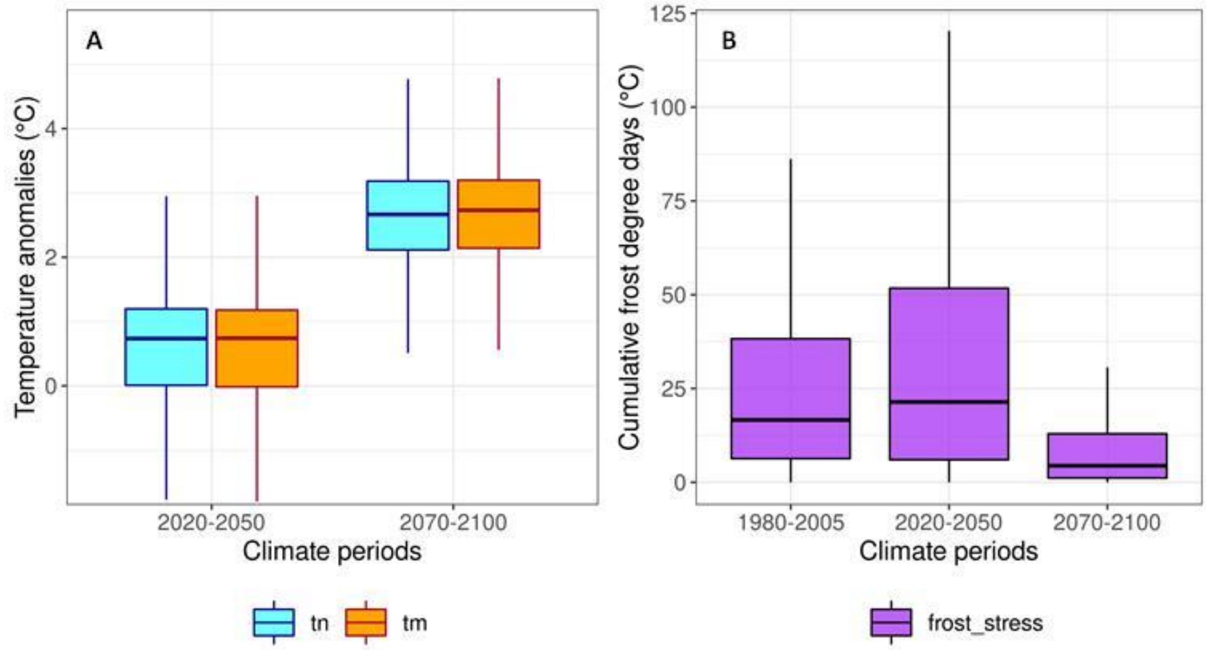

Figure 1: **A)** Anomalies of the minimal (tn) and mean (tm) temperatures computed for near (2020-2050) and far (2070-2100) projected climate which follows the radiative concentration pathway RCP 8.5 (van Vuuren *et al.* 2011). Temperature average of tn and tm are computed for each year and for each climate grid-cell over the extended winter from october to march. The grid-cell have a 8km resolution and cover the whole =. Anomalies are computed for each year by substracting the average tn and tm of the historical period that range from 1980 to 2005 years. **B)** Cumulative frost degree days that indicate the level of the frost stress simulated by the calibrated and validated winter pea frost model for the -13°C varietal resistance level and various sowing dates and acclimation rates (Lecomte *et al.* 2003, Castel *et al.* 2017). The frost stress simulations are realized for the historical (1980-2005), the near (2020-2050) and the far (2070-2100) projected climate (RCP 8.5). Note that outliers have been removed from both graphs for clarity purpose.

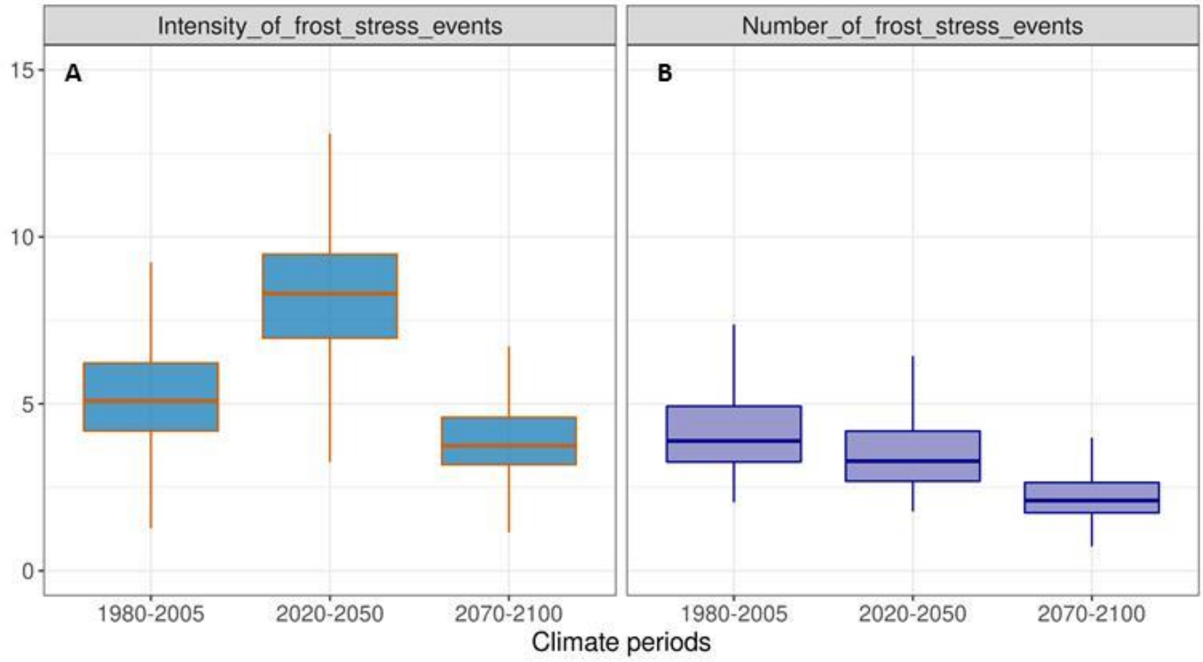

Figure 2: **A)** Intensity of the frost stress events and **B)** Number of the frost stress events estimated along the extended winter from october to march. For each climate period, the values variability represents all years and all grid-cells. The intensity and the number of frost stress events are infered simulteanously from the probabilistic Tweedie model (Dunn 2004). Note that frost stress intensity is expressed in degrees below the varietal frost resistance level (Castel *et al.* 2017) and outliers have been removed from both graphs for clarity purpose.

Bibliography

Boulard, D.; Castel, T.; Camberlin, P.; Sergent, A-S.; Bréda N.; Badeau, V.; Rossi, A. and Pohl B. (2016). Capability of a regional climate model to simulate climate variables requested for water balance computation : a case study over northeastern France. *Climate Dynamics* 46.9-10. p. 2689-2716. doi: 10.1007/s00382-015-2724-9.

Castel, T.; Lecomte, C.; Richard, Y.; Lejeune-Hénaut, I. and Larmure, A. (2017). Frost stress evolution and winter pea ideotype in the context of climate warming at a regional scale. *Oilseeds and fats, Crops and Lipids*, 24(1) D106. doi: 10.1051/ocl/2017002

Castel, T.; Lecomte, C.; Richard, Y.; Lejeune-Hénaut, I. and Larmure, A. (2019). Évolution rétrospective du risque gélif hivernal en climat tempéré suite au réchauffement climatique. *Bourgogne-Franche-Comté Nature*. 29, 323–332

Dunn, P.K. (2004). Occurence and quantity of precipitation can be modelled simultaneously. *International Journal of Climatology* 24: 1231-1239. doi: 10.1002/joc.1063

Lecomte, C; Giraud, A. and Aubert, V. (2003). Testing a predicting model for frost resistance of winter wheat in natural conditions. *Agronomie* 23: 51–66. doi: 10.1051/agro:2002068

van Vuuren, D.P.; Edmonds, J.; Kainuma, M. *et al.* (2011). The representative concentration pathways: an overview. *Climatic Change* 109, 5. doi: https://doi.org/10.1007/s10584-011-0148-z

MESOCOSM EVALUATION OF THE COMPETITTIVE ABILITY OF COMMON AND SEGETAL WEED SPECIES AGAINST BARLEY

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In conventional cropping systems, arable weed species have always been considered undesirable because their presence can significantly reduce the yield and quality of the crop. Among the weed community, segetal weeds particularly inhabit winter cereal fields and are generally described as rare species (Jauzein, 1997). Following the observed decline in biodiversity in the field, there is a renewed interest in conserving segetal weeds as they represent an invaluable plant heritage as wild relatives of cultivated plants (Fried, 2020). The origin of the regression of these particular annual species is strongly linked to intensive agricultural practices (herbicides, fertilization) but also probably to a poorer competitive ability with recent selected cereal crops unlike common species (Denelle et al., 2020). To study in detail the competitive ability of these two categories of weeds, a wide range of species (7 segetal and 16 common species) was studied in the presence of a spring barley crop (*Hordeum vulgare* L.). For that purpose, experiments were carried out using mesocosms (rectangular plastic pot) as experimental units. Each mesocosm was divided into three studied zones: one quarter was dedicated to the growth of barley alone (Zone1), another quarter was dedicated to a weed alone (Zone4) and the remaining half was a mixture of barley and weeds (Zone2&3). For each mesocosm, only one weed species was considered. In total, on the 23 mesocosms, different competitiveness traits were measured during the plant development cycle between March and June 2021: plant height, above-ground biomass and total plant biomass. The calculation of the Relative Competitive Performance index (RCP) with height as a competitive trait revealed different competitive effects caused by weeds and a ranking of the weeds according to their competitive power is proposed and compared to the literature. Under the conditions of our experiment, it does not seem that segetal species showed a lower ability to compete than common species.

Bibliography

Denelle, P., et al. (2020). Generalist plants are more competitive and more functionally similar to each other than specialist plants: insights from network analyses. J Biogeogr 47, 1922–1933.

Jauzein, P. (1997). La Notion de Mesicole: Tentative de définition et classification. *Le Monde des Plantes*. N° 458. p 19.23.

Fried, G. (2020). The status of arable plant habitats in northwestern Europe. In: Hurford, C., Wilson, P., Storkey, J. (eds.) The Changing Status of Arable Habitats in Europe – A Nature Conservation Review. Springer, 31-46.

Wilson, P.; Hurford, C.; Reed, M.; Stoate, C. and Storkey, J. (2020). The Future of Europe's Arable Wildlife. in: Hurford, C., Wilson, P. and Storkey, J. (ed.) The Changing Status of Arable Habitats in Europe, Springer.

TAKING INTO ACCOUNT SOILS AND CLIMATE CHANGE IN ASSESSING THE PRODUCTION POTENTIAL OF A LEGUME CROP OF INTEREST: PEA

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In the current context of climate change and increasing pressure on resources, the agricultural production model is being questioned. The challenge of a more autonomous, efficient and sustainable production of proteins must be met by increasing the use of legumes in French cropping systems (Larmure *et al.* 2021). The pea (*Pisum sativum* L.) crop model "Azodyn-Pea" will be used to identify zones and management techniques favorable to the crop in Burgundy-Franche-Comté (eastern France), taking into account abiotic stresses, such as winter frost or water deficit. The first step in this process is the mapping of current soil properties and current and future climate characteristics of the region. Regionalized daily climate data at 8 km resolution were obtained by simulation for the historical period 1980-2005 and for the prospective period 2006-2100 (Boulard *et al.* 2016), exploring two climate change trajectories: an optimistic (RCP 4.5) and a pessimistic one (RCP 8.5). The soil data were extracted from the Regional Soil Geographical DataBase and then processed to create a new semantic database in addition to the spatial data (Soil Map Unit polygons-SMU). The characteristics of the majority Soil Typological Units (STU) in each SMU have been kept. Variables such as soil depth, pH and organic matter were directly read from the database while others such as the soil available water capacity (AWC) or the bulk density were deduced from the semantic data using pedotransfer functions. The second step of the process was the mapping, in Burgundy-Franche-Comté, of historical (1980-2005) and prospective (2006-2100) flowering dates using climatic data for two pea varieties (one winter and one spring) and one sowing date per variety. In the final step of the process, regionalized climate and soil data at 8 km resolution combined to flowering dates data will be used to simulate yield and abiotic stresses encountered by the pea crop during the historical (1980-2005) and prospective periods (2006-2100).

Keywords: Climate and soil data, pea (*Pisum sativum* L.), climate change, crop model, production

Bibliography

Boulard, D.; Castel, T.; Camberlin, P.; Sergent, A-S.; Bréda N.; Badeau, V.; Rossi, A. and Pohl B. (2016). Capability of a regional climate model to simulate climate variables requested for water balance computation : a case study over northeastern France. *Climate Dynamics* 46.9-10. p. 2689-2716. doi: 10.1007/s00382-015-2724-9.

Larmure, A.; Lecomte, C. and Biarnes, V. 2021. Les défis de l'adaptation au changement climatique pour la culture de pois. RFL#3 Rencontres Francophones Légumineuses. Feb 2021, France. (Webinaire). https://www.rfl-legumineuses.com/Rencontres-passees/RFL3/Replays/Conferences-plenieres-et-Tables-Rondes

ECOPHYSIOLOGICAL PROCESSES UNDERLYING SOYBEAN MINERAL NUTRITION UNDER INDIVIDUAL OR COMBINED HEAT AND WATER STRESSES.

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In a context of climate change, with more frequent drought events and heatwaves, it is predicted that soybean yields will drastically decrease in the near future. Soybean being the most widely grown legume crop in the world, there is an urgent need to improve its ability to sustain its growth under such conditions in order to guarantee high levels of productivity.
Numerous studies have focused on the influence of a single stress on the plant. However, the plant is rarely exposed to a single stress, but rather to a combination of several stresses. These combinations of stresses often induce unique and non-additive responses (i.e. synergistic or antagonistic). The aim of this study was to explore the influence of heat and/or water stress on soybean growth and its water and mineral nutritions. Two soybean genotypes, displaying contrasted root architectures during their vegetative stage (Maslard et al., 2021) were grown in RhizoTubes (Jeudy et al., 2016) under controlled conditions in the 4PMI high-throughput phenotyping platform where either optimal conditions, or heatwaves, or water stress, or both heatwaves and water stress were applied. Plants were characterized for their morphology, their water uptake and the mineral composition of their tissues. An ecophysiological structure-function framework, enabled us to link structural variables (leaf area, root architecture, biomass, etc.) to functional variables (water use efficiency, element uptake efficiencies…) in order to understand the interactions between water and element flows, and to quantify plant overall tolerance to each stress. Under combined stress conditions one genotype appeared to be more susceptible than the other genotype. No significant change in structural variable was observed in response to the double stress between the two genotypes. However, it appeared that the genotypic difference was more related to functional changes, especially with regard to water uptake. Moreover, it can also be explained by differences in the content of certain elements in the roots (Figure 1). For instance, it was the case (i) of magnesium and calcium which are known to play a role in osmoregulation, or (ii) of other less understood elements like nickel, sulfur or sodium. A cross-analysis of the ionome, root architectural traits and root transcriptome under different stresses, could offer us new insights into soybean adaptation to climate change.

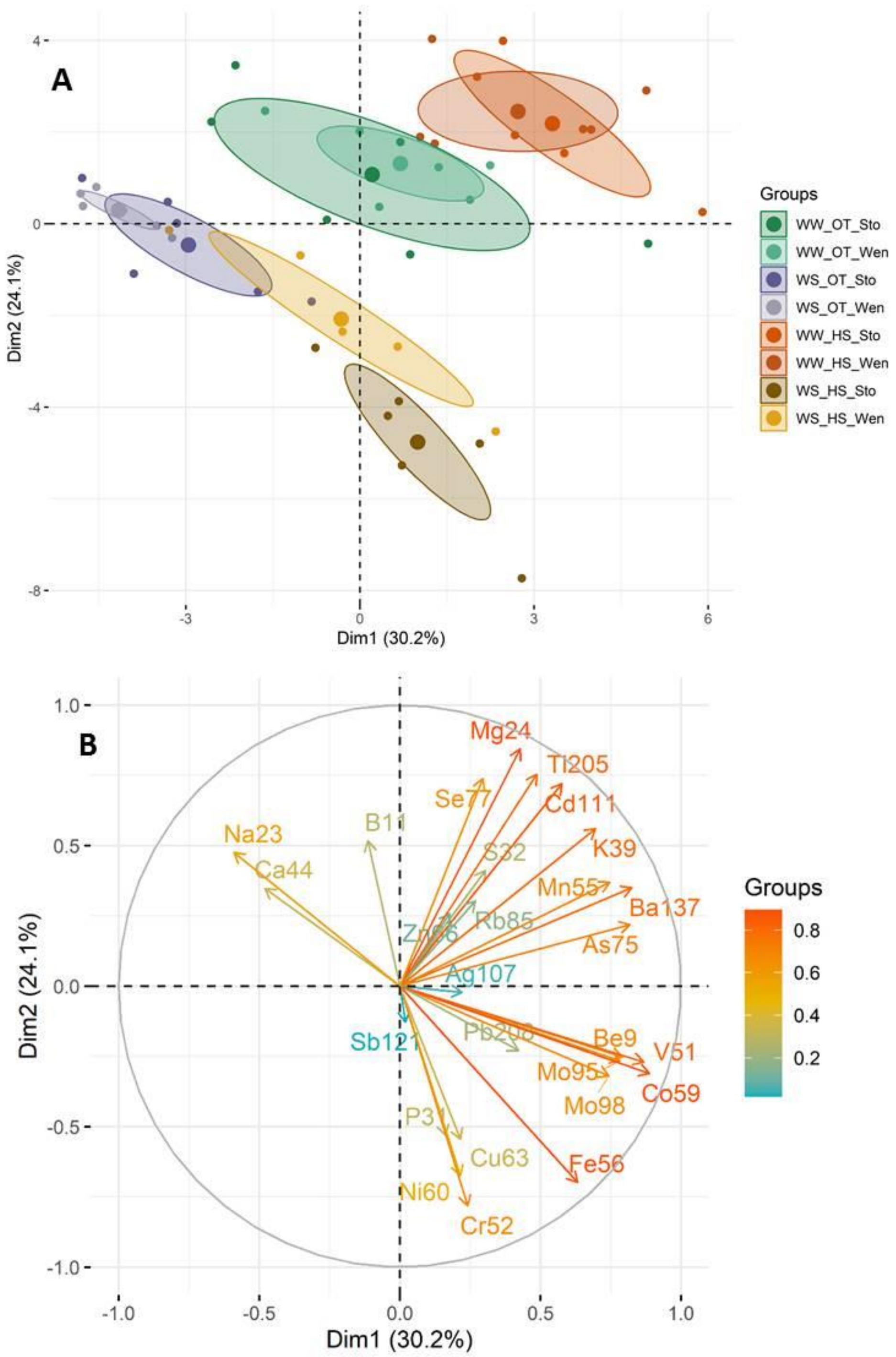

Figure 1: Principal Component Analysis (PCA) of the root ionome measured in two soybean genotypes (Sto: Stocata and Wen: Wendy). **A)** PCA for the 46 root samples for each condition (Eatch colors representing a condition); **B)** Variable correlation plots between the first two principal components (The cos2 values are used to estimate the quality of the representation) WW: well-watered condition; WS: water stress condition; OT: optimal temperature condition; HS: heat stress condition. Na23: Sodium ; Ca44: Calcium ; B11: Boron ; Se77: Selenium ; Mg24: Magnesium ; S32: Sulfur ; Ti205: Titanium ; Cd111: Cadmium ; Zn66: Zinc ; Rb85: Rubidium ; Mn55: Manganese ; K39: Potassium ; Ba137: Barium ; As75: Arsenic ; Ag107: Silver ; Sb121: Antimony ; Pb206: Lead ; P31: Phosphorus ; Ni60: Nickel ; Cu63: Copper ; Cr52: Chromium ; Fe56: Iron ; Mo95-98: Molybdenum ; Co59: Cobalt ; Be9: Beryllium ; V51: Vanadium

Keywords: ionome, *Glycine max*, climate change, root architecture, water uptake

Bibliography

Maslard, C.; Arkoun, M.; Salon, C. and Prudent, M. (2021) Root architecture characterization in relation to biomass allocation and biological nitrogen fixation in a collection of European soybean genotypes. *Oilseeds and fats, Crops and Lipids* 28 (48). DOI: https://doi.org/10.1051/ocl/2021033

Jeudy, C.; Adrian, M.; Baussard, C.; Bernard, C.; Bernaud, E.; Bourion, V.; Busset, H.; Cabrera-Bosquet, L.; Cointault, F.; Han, S. Lamboeuf, M.; Moreau, D.; Pivato, B.; Prudent, M.; Trouvelot, S.; Truong, H.N.; Vernoud, V.; Voisin, A-S; Wipf, D.; and Salon, C. (2016) RhizoTubes as a new tool for high throughput imaging of plant root development and architecture: test, comparison with pot grown plants and validation. *Plant Methods* 12 (31). DOI 10.1186/s13007-016-0131-9

APIACEAE: ITS RELEVANCE IN CONSERVATION BIOLOGICAL CONTROL, IN AGROECOLOGICAL ORCHARDS OF THE CITY OF ROSARIO, SANTA FE

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Keywords: natural enemies; neutral herbivores; companion plants

Within the framework of conservation biological control (CBC) is necessary to select species of companion plants (CP), spontaneous and implanted, that do not favor the presence of pests and that fundamentally provide various resources to their natural enemies (NE) (Fiedler, Landis & Wratten, 2008; Parker *et al.*, 2013). With the aim of evaluate the role of different CP in 2 urban orchard parks with agroecological management in the city of Rosario, their associated arthropods were studied. The samplings were carried out, during the spring/summer (2015-16), in the orchard parks: Molino Blanco (-33.011719 S, -60.635345635345 W) and Los Horneros (-32.888381 S, -60.729471 W), with a working area of, 0.31 ha. and 0.33 ha respectively. In each one ten plants were randomly selected from each a CP species and from each predominant cultivated one. Nine botanical families were sampled: Apiaceae (5 spp), Boraginaceae (1 sp), Brassicaceae (5 spp), Asteraceae (7 spp), Lamiaceae (2 spp), Fabaceae (3 spp), Amaranthaceae (1 sp), Solanaceae (2 spp) and Cucurbitaceae (1 sp). *Brassica oleracea* var. *capitata* L. and *Brassica oleracea* var. *itálica*, during the vegetative period, were classified as crops and when flowering, were taken as CP. Sampling frequency was fortnightly in CP and monthly in cultivated plants. Abundance (number of individuals or colonies), stage of development and plant organ in which they were found were recorded in the field. Herbivores were classified as pest (PH) or neutral (NH), and NE as predators, adults with predatory larvae or parasitoids. For the comparisons of abundance, richness, evenness and diversity of NE between CP and the comparisons of abundance of NH vrs. PH between: 1- companion families 2- companion species, the non-parametric Kruskall-Wallis statistical test was used ($p<0.05$), it was carried out with the statistical software Infostat (Di Rienzo *et al.*, 2014). The comparison of abundance ($H=25.81$, $p<0.001$), richness ($H=24.03$, $p<0.001$), evenness ($H=13.46$, $p<0.0061$) and diversity (H=22, 50, $p<0.001$) of NE between CP was significantly higher in Apiacecae (Table 1). The main NE belonged to the families Coccinelidae and Syrphidae, both controllers of aphids (Aphididae), main pests in horticultural crops. Comparison analyzes between abundance NH and PH, within each companion family, did not result in significant differences .The same comparison in each CP species resulted in significant differences for: Brassicaceae ($H=3.95$; $p=0.0294$) and *Wedelia glauca* (Asterareceae) ($H=5.47$; $p= 0.0149$). In both the average number of herbivores was low and there were not NH or the number of NH was very low and exceeded by the plague. The highest abundance of NH was found in Apiaceae with 1.16 colonies per plant of *Cavariella aegopodii* a specialist aphid of Apiaceae (Berenbaum, 1990) and in *Sonchus oleraceus* with 1.12 colonies per plant of *Hyperomyzus lactucae* that is not considered horticultural pest (Andorno *et al.*, 2014) (Table 1). In conclusion Apiaceae could be considered one of the main botanical families to be taken into account in the CBC given the scarce records of PH, the predominance of NH and the maintenance of NE of the most abundant pests.

Table 1. First column shows abundance, richness, evenness and Shannon diversity values of natural enemies in companion plants (CP) and statistical p values resulting from comparisons of these variables between CP species. Second column shows mean of neutral (NH) and pest herbivores (PH) and p statistical value resulting from comparisons between NH and PH abundance in each CP. Significant p statistical values from the Kruskal-Wallis analysis are highlighted in grey.

		NATURAL ENEMIES				HERBIVORES		
		Abundance	Richness	Evenness	Shannon diversity	NH	PH	p
COMPANION PLANTS	Apiaceae spp	1,72	4,07	0,7	1,02	1,16	0,14	0,5725
	Sonchus oleraceus	0,22	1,53	0,45	0,42	1,12	1,19	0,6188
	Calendula officinalis	0,18	1,08	0,16	0,14	0,38	0,49	0,6516
	Borago officinalis	0,16	1	0,18	0,16	0,02	0,11	0,0721
	Brassicaceae spp	0,15	1,11	0,31	0,26	0	1,22	**0,0294**
	Matricaria chamomilla	0,14	0,92	0,13	0,15	0,17	0,22	0,3378
	Wedelia glauca	0,09	1	0,15	0,13	0,07	0,28	**0,0149**
		p<0.001	**p<0.001**	**p<0.0061**	**p<0.001**			

Bibliography

Andorno A.V; Botto E.N; La Rossa F.R and Möhle R. 2014. Control biológico de áfidos por métodos conservativos en cultivos hortícolas y aromáticas. Insectario de Investigaciones para Lucha Biológica, Instituto de Microbiología y Zoología Agrícola (IMYZA) INTA Castelar, Buenos Aires, Argentina.
Berenbaum, M. R. 1990. Evolution of specialization in insect-umbellifer associations. Annual review of entomology, 35(1), 319-343.
Di Rienzo J.A; Casanoves F; Balzarini M.G; González L; Tablada M and Robledo C.W. 2014. Infostat Versión 2014. Grupo Infostat, Fca, Universidad Nacional de Córdoba, R. Argentina
Fiedler, A. K; Landis, D. A and Wratten, S. D. 2008. Maximizing ecosystem services from conservation biological control: the role of habitat management. Biological control, 45(2), 254-271.
Parker, J.E; Rodriguez-Saona, C; Hamilton, G.C and Snyder, W.E. 2013. Companion planting and insect pest control. INTECH Open Access Publisher. Weed and Pest Control-Conventional and New Challenges. Sonia Solenesky y Marcelo Larramendy (eds). 1: 1-29.

ANALYSIS OF THE EFFECT OF AUTOCHTHONOUS ISOLATES OF *STREPTOMYCES* SPP. ON GROWTH, DEVELOPMENT AND PLANT PROTECTION IN SOYBEAN.

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Currently, the development of sustainable and eco-friendly strategies to reduce the intensive use of agrochemicals in crop production is essential. The utilization of soil beneficial microbes as plant growth-promoters and biocontrol agents has been proved to be one of the main alternatives. In this work, seventy-eight actinobacteria belonging mainly to the genus *Streptomyces* were isolated from the rhizosphere of soybean plants from the core productive zone of Argentina. Particularly, two strains were selected based on their compatibility with *Bradyrhizobium japonicum*, their ability to produce phytohormones, siderophores and solubilize phosphate and their antagonism to different fungal pathogens, *in vitro*. Then, the effect of adding these selected *Streptomyces* strains on growth and development at different stages of soybean plants and their effect on plant protection, was tested. As results, plant growth and development promotion were evidenced. The percentage of seed germination and seedlings emergence were higher in non-sterile soil compared to the non-treated control and the antifungal (AF) treatment ($P<0.05$). Moreover, leaf area, the number of nodes and branches, and dried weight of aerial parts and roots, were significatively greater in treatments with *Streptomyces* strains ($P<0.05$) when compared to the conventional AF treatment, in assays under greenhouse conditions. Then, the bacterial effect as growth promoters was tested in field trials. In addition, their biocontrol capacity was tested against the fungal pathogens *Diaporthe aspalathi* and *Macrophomina phaseolina*, showing a marked delay in the symptom's development and a significant decrease in the percentage of dead plants ($P<0.05$), compared to the non-treated control and also the AF treatment. Thus, we demonstrated that the isolated actinobacteria promote growth and development of soybean plants, and also enhance the defense status in the tested conditions.

REDUCING HERBICIDE USES AND LOSSES IN CONSERVATION AGRICULTURE – AVAILABLE KNOWLEDGE AND PERSPECTIVES FOR WEED CONTROL

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Technical solutions used by farmers to install crop strongly influence their crop protection strategies (Fig.1). The most cited example – concerning many cropping systems – is the adoption of no-tillage combined with an extensive use of foliar herbicides such as glyphosate. In such situations, farmers can hardly avoid the dependency on herbicides and this requires sometimes radical changes in the cropping systems.

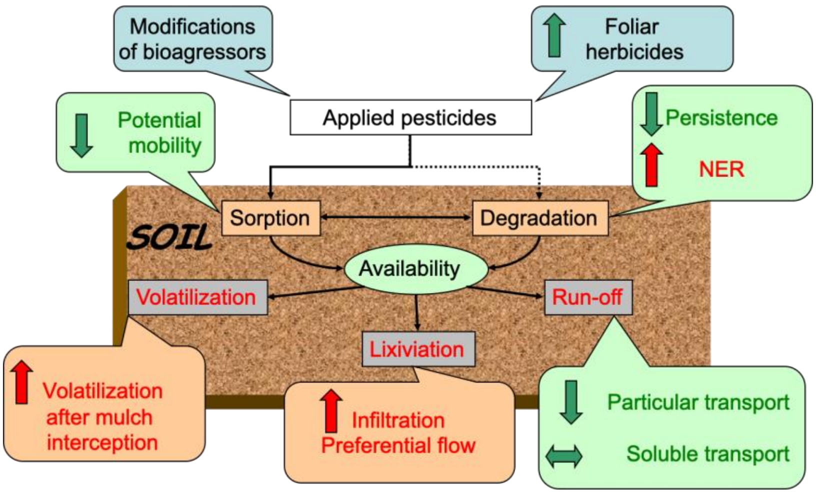

Fig. 1. Effects of reducing tillage on crop protection strategies and potential environmental impacts.
NER : non-extractable residues

Several levers used in integrated pest management (IPM) need to be combined: reducing weed seed stocks through extending and diversifying the rotation, sowing cover and companion crops, and mechanical weeding. In such systems, farmers can also occasionally use ploughing.

This paper presents an update of available knowledge on the possibility to reduce (1) pesticide use (Munier-Jolain et al., 2018) and consequently (2) the pesticide losses to air and water in innovative cropping systems (Alletto et al., 2012; Benoit et al., 2014; Bedos et al., 2017; Cueff et al., 2020). Most of the results have been obtained in the last decades through long term field experiments in different French pedoclimatic regions (example given Fig 2.) and used to simulate pesticide fate and transfer at the plot scale (Aslam et al., 2018; Marin-Benito et al., 2018; Mamy et al., 2018). New information on the fate of pesticide residues were also obtained in several cover crops (Cassigneul et al., 2018). These findings are discussed regarding the trends in the last decades and the difficulty to significantly reduce the use of pesticides in the case of annual crops despite the actions implemented under the French Ecophyto plan (Guichard et al., 2017; Hossard et al., 2017).

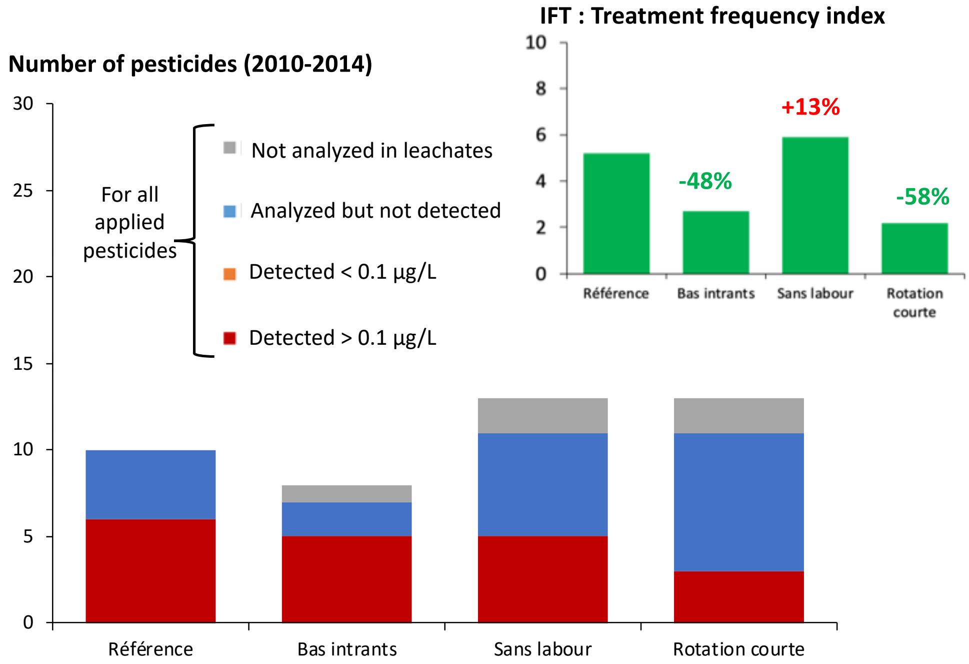

Fig. 2. Results obtained on irrigated maize croping systems : Reference (conventional) is compared to 3 innovative systems based on cover crops and low inputs (Bas Intrants), reduced tillage and cover crops (Sans labour), including maize in a crop rotation (Rotation courte).

Bibliography

Alletto, L; Benoit, P; Justes, E and Coquet, Y (2012) Tillage and fallow period management effects on the fate of the herbicide isoxaflutole in an irrigated continuous-maize field. *Agriculture, Ecosystems and Environment*, 153, 40-49.

Aslam, S; Benoit, P; Chabauty, F; Bergheaud, V; Geng, C; Vieublé-Gonod, L and Garnier P. (2014) Modelling the impacts of maize decomposition on glyphosate dynamics in mulch. *European Journal of Soil Science*, 65, 2, 231–247.

Benoit, P; Bruckler, L; Ciuraru, R; Genermont, S; Ouvry, J.F; Pelosi, C and Recous, S. (2020). "*Implantation des cultures et gestion de l'environnement*" in "*Réussir l'implantation des cultures : enjeux agroécologiques, raisonnement agronomique*". Boiffin J., Laurent F, Richard G. (Coord.) Quae.

Benoit, P; Alletto. L; Barriuso, E; Bedos, C; Garnier, P; Mamy, L; Pot, V; Real, B and Vieublé-Gonod, L. (2014). "*Travail du sol et risques de transfert de produits phytosanitaires*" In: "*Faut-il travailler le sol ? Acquis et innovations pour une agriculture durable*", Labreuche J., Laurent F., Roger-Estrade J., (Coord.) Quae.

Cassigneul, A; Benoit, P; Nobile, C ; Bergheaud, V; Dumény, V; Etiévant, V; Maylin, A; Justes, E and Alletto, L. (2018) Behaviour of S-metolachlor and its oxanilic and ethanesulfonic acids metabolites under fresh vs partially decomposed cover crop mulches: A laboratory study. *Science of the Total Environment*, 631-632, 1515-1524.

Cueff, S; Alletto, L; Marjolaine Bourdat-Deschamps, M; Benoit, P and Pot, V. (2020). Water and pesticide transfers in undisturbed soil columns sampled from a Stagnic Luvisol and a Vermic Umbrisol both cultivated under conventional and conservation agriculture. *Geoderma, 377.*

Guichard, L; Dedieu, F; Jeuffroy, M.H; Meynard, J.M; Reau R and Savini I. (2017). Le plan Ecophyto de réduction d'usage des pesticides en France : décryptage d'un échec et raisons d'espérer. *Cahiers d'Agriculture,* 26, 14002.

Hossard, L; Guichard, L; Pelosi, C and Makowsky D. (2017) Lack of evidence for a decrease in synthetic pesticide use on the main arable crops in France. *Science of the Total Environment* 575, 152–161.

Mamy, L; Alletto, L; Bedos, C; Benoit, P; Justes, E; Lammoglia, S.-K; Marín-Benito, J. M; Munier-Jolain, N; Nicolardot, B; Pot, V; Ubertosi, M and Barriuso, E. (2017). Evaluation et comparaison des impacts sur l'environnement et la santé des pesticides utilisés dans des systèmes de culture conventionnels et innovants : synthèse des résultats du projet ECoPESt. *Innovations Agronomiques,* 59, 149-169.

Marín-Benito, J. M; Alletto, L; Barriuso, E; Bedos, C; Benoit, P; Pot, V and Mamy, L. (2018) Pesticide fate modelling in conservation tillage: Simulating the effect of mulch and cover crop on S-metolachlor leaching. *Science of the Total Environment,* 628-629,

Munier-Jolain, N; Abgrall, M; Adeux, G; Alletto, L; Bonnet, C; Cordeau, S.; Darras, S; Deswarte, C; Farcy, P; Gavaland, A; Justes, E; Giuliano, S; Meunier D; Pernel, J; Raffaillac D; Gleizes, B; Tison, G and Ubertosi, M. (2018) Projet SYSTEM-ECO4 : Evaluation de systèmes de grandes cultures à faible usage de pesticides. *Innovations Agronomiques,* 70, 257-271

Soil Science

EFFECTS OF APPLE TREES ON THE SPATIAL DISTRIBUTION AND TEMPORAL DYNAMICS OF ORGANIC MATTER IN A GARDEN-ORCHARD SYSTEM

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Litterfall and tree root turnover are important sources of organic matter in agroforestry systems. In garden-orchard systems where vegetables are intercropped with fruit trees, fruit trees can improve soil organic matter (SOM) content but complicate the management of soil fertility in the vegetable beds. Indeed, litter supply and tree root turnover can generate a heterogeneity of SOM distribution in the plot (Cardinael et al., 2015) with both a horizontal effect related to the distance to the tree, and a vertical effect related to soil depth and composition. Furthermore, trees can modify both the temperature and the moisture of the soil, which will modify the SOM mineralization rate and the composition of microbial communities (Guillot et al, 2018), thus affecting the availability of nutrients for vegetable crops. In horticulture, fertilization practices need to be reconsidered to limit their environmental impacts. Associating vegetables with fruit trees could be very promising as trees can enhance soil microbial activity and improve soil fertility via leaf litterfall and root turnover. This study aims at evaluating the effects of 20-year-old apple trees on soil quality in an apple tree-vegetables intercropping system.

The study site was previously described by Ramananjatovo et al. (2021). The experiment was conducted at L'Institut Agro Rennes-Angers (49), France. The plot (36 m x 12 m) consisted of two rows of seven varieties of apple trees (*Malus* × *domestica* Borkh, var. 'Elstar', 'Gala', 'Fuji', 'Granny Smith', 'Red winter', 'Golden Delicious', 'Reine des Reinettes'); the inter-row was divided into five 1.8 m-wide vegetable beds. Apple trees were planted in 2000 and were approximately 2 m tall. Apple tree rows were 12 m apart and oriented North to South.
From September 2019 to August 2021, we performed measurements under an apple tree row (R) and on vegetable beds situated at 1.5 m (B1), 3 m (B2) and 5 m (central bed, C) from the apple tree row (figure 1). Litterfall and soil organic matter (SOM) were quantified, and the soil microbial activity as well as its biodegradation capacity characterized by measuring the decomposition rates of apple tree leaf litter and basal (BAS) and glucose-induced soil potential respiration (SIR).

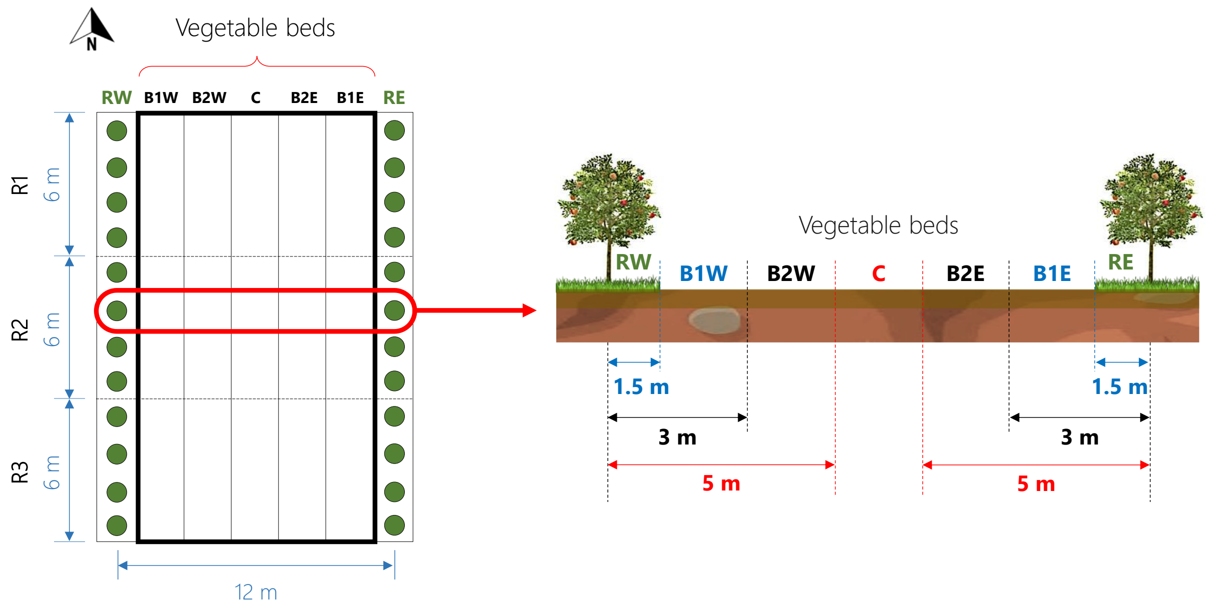

Figure 1: Experimental design

Apple tree litter enriched the soil surface in organic matter (70 in R vs. 45, 32 and 30 $g.kg^{-1}$ in B1, B2 and C, respectively) (Figure 2). Litter biomass was highest below the apple trees (RW, RE). The decrease in litter relative to the distance to the tree, from West to East, is probably due to the dominant wind (West).

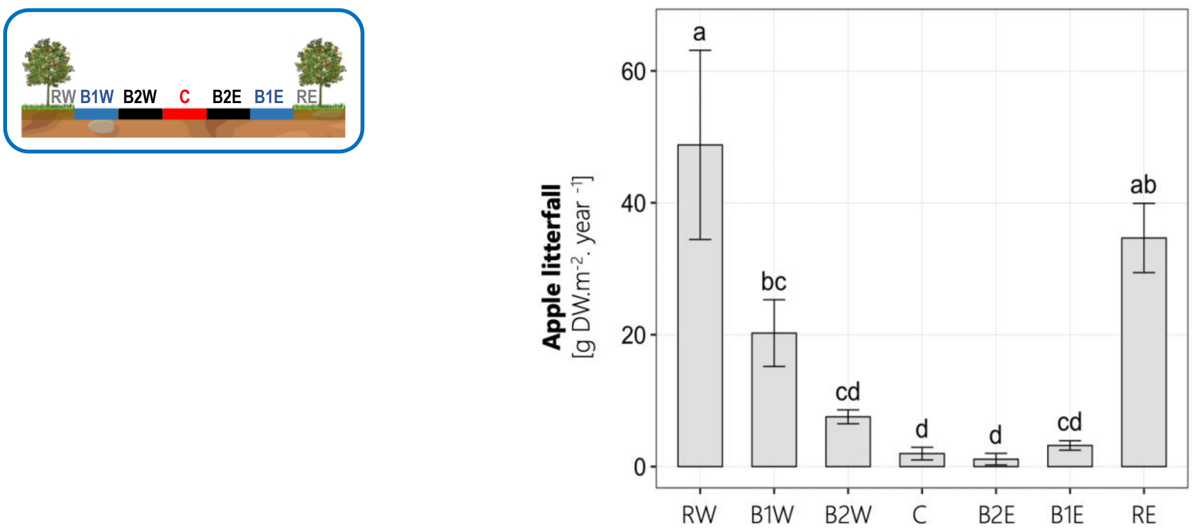

Figure 2: Litterfall distribution at the experimental site

During the 120-d period, the litter decomposition rate was significantly higher under the tree rows than in vegetable beds (figure 3A). Biomass loss curves were modeled using first-order kinetics, allowing the decomposition constant k to be determined. This constant is particularly correlated to SOM and N (figure 3B).

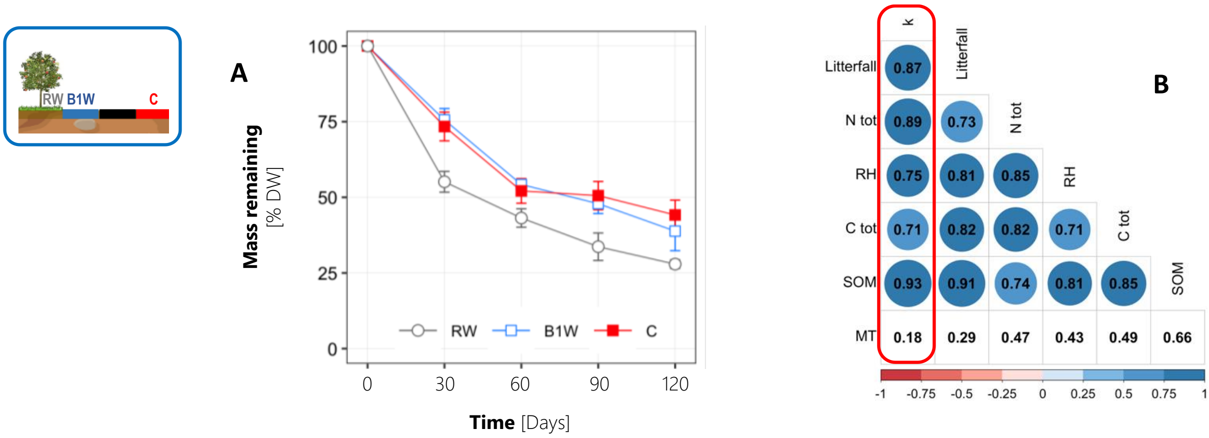

Figure 3: Residual litterfall biomass along the decomposition process (A), and correlation matrix (B)

Under laboratory conditions, we observed that BAS was significantly higher in R, B1 and B2 than in C (5, 4.5, 4.7 and 3.5 µgC-$CO_2.h^{-1}.g^{-1}$ soil DW in R, B1, B2 and C, respectively). Furthermore, soil in R was more responsive to glucose induction than soil in vegetable beds. These results suggest that soil microbial activity was enhanced near the apple trees due to the enrichment in SOM.

In conclusion, this work has answered two questions:
1° How do fruit trees affect the SOM and soil microbial activity in garden-orchard systems?
The trees had a direct effect on the enrichment of the soil in organic matter, and an indirect effect via the modification of the microclimate, particularly the temperature and humidity of the soil.
2° How do the effects vary with distance from the trees?
Trees contribute up to 1.50 m away to higher soil OM, C and N content, a more active microbial community and faster litter decomposition.
Thus, fruit trees in a garden-orchard system improve SOM content. Nevertheless, at more than 3 m distance from the trees, the vegetable beds remain dependent on fertilizer inputs.

Keywords: Agroforestry, decomposition, mineralization, organic matter, soil respiration

Bibliography

Cardinael, R., Chevallier, T., Barthès, B.G., Saby, N.P.A., Parent, T., Dupraz, C., Bernoux, M., Chenu, C. (2015). Impact of alley cropping agroforestry on stocks, forms and spatial distribution of soil organic carbon — A case study in a Mediterranean context. *Geoderma* 259–260, 288–299. https://doi.org/10.1016/j.geoderma.2015.06.015
Guillot, E., Bertrand, I., Rumpel, C., Gomez, C., Arnal, D., Abadie, J., Hinsinger, P. (2021). Spatial heterogeneity of soil quality within a Mediterranean alley cropping agroforestry system: Comparison with a monocropping system. *European Journal of Soil Biology* 105, 103330. https://doi.org/10.1016/j.ejsobi.2021.103330
Ramananjatovo, T., Chantoiseau, E., Guillermin, P., Guénon, R., Delaire, M., Buck-Sorlin, G., Cannavo, P. (2021). Growth of Vegetables in an Agroecological Garden-Orchard System: The Role of Spatiotemporal Variations of Microclimatic Conditions and Soil Properties. *Agronomy* 11, 1888. https://doi.org/10.3390/agronomy11091888

IMPACTS OF THE GRAZING METHOD ON CARBON AND SOIL BIOLOGICAL ACTIVITY IN GRASSLANDS OF THE LOWER SALADO RIVER BASIN.

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In recent years, the environmental role of livestock production has been discussed with regarding to air pollution with greenhouse gases (GHG) (Grossi et al. 2019). Due to the importance in the GHG balance of the dynamics between emissions and carbon sequestration in terrestrial ecosystems and because of the large areas they cover, sequestration by grasslands and pastures constitutes an important mechanism for mitigating emissions from the livestock sector (Soussana et al. 2010). The potential for organic soil C sequestration (SOC) of all permanent grasslands and pastures in the world has been estimated at between 0.01 and 0.3 gigatonnes of C per year, the upper value of which would be equivalent to 4% of total global emissions (Batjes 2019, Bai and Cotrufo 2022). In this wide range, the potential sequestration capacity of grassland ecosystems depends on the productivity of resources and the nature, frequency and intensity of disturbances associated with them (Soussana et al. 2010). This capacity increases when pasture and grassland productivity increases (Conant et al. 2001, Soussana et al. 2007) and decreases when they degrade.

The grazing method and animal stocking density are important factors in determining the sequestration capacity of soils (Conant et al. 2001). Continuous grazing reduces carbon inputs by decreasing productivity, diversity and cover of the vegetation, hence also reducing the microorganism’s diversity that feed on it (Bymes et al. 2018). The potential for achievable SOC sequestration in grasslands worldwide is greater in grassland ecosystems that restore biodiversity, promote microbial necromass and increase C input through roots (Bai and Cotrufo, 2022), because the carbon contributed by roots is five times more efficient in stabilizing SOC than that contributed by above ground biomass (Jackson et al. 2017). The fractions of SOC i.e. particulate organic carbon (POC) and mineral-associated organic carbon (MAOC) differ in their physicochemical properties, time of residence in the soil and origin. POC formed by microbial and plant residues, while MAOC formed by radical exudates and microbial necromass (Bai and Cotrufo 2022).

Grazing management in the grasslands of the lower Salado River basin

The grasslands of the Salado River basin have been managed under continuous grazing for more than a century. This management has led to the deterioration of natural vegetation (Jacobo and Rodríguez, 2009) and the decrease in net primary productivity because of the degradation process (Recavarren and Martinefsky 2009). Controlled grazing, on the other hand, determines structural changes in vegetation, including increasing the contribution of floristic groups of high forage value and reducing bare soil through the accumulation of brush (Jacobo et al. 2006). However, little information is available on the process of soil C sequestration. For these reasons, the objective of this work is to measure and explain changes in the SOC and microbial communities of the humid mesophyte meadows of the Salado River basin under different grazing methods. Controlled grazing is expected to increase microbial diversity, SOC and its POC and MAOC fractions by increasing below ground biomass, biological activity and decreasing soil compaction. In addition, contribute to the design of livestock systems that improve soil fertility and C sequestration, contributing to the mitigation of climate change

Methods

The location of the study area is the lower basin of the Salado River (Vervoorst 1967), province of Buenos Aires, Argentina. Ten paddocks located in different livestock farms managed in the traditional way (continuous grazing) and ten adjacent paddocks where controlled grazing has been implemented for at least 7 years (paired experiment with 10 pairs) will be selected. It will assure that differences in texture between pairs is less than or equal to 5 percent. From each paddock 12 subsample of 0-60 cm will be extracted using a 1.7cm wide soil core. The top 30 cm of soil will be sampled for POC, MAOC and bulk density and 30 to 60 cm of soil will be sampled for total organic carbon and bulk density. Samples will be separated into 0-5, 5-15, 15-30 and 30 to 60 cm depth intervals. All composite samples will be sieved (2mm) before separating them into fractions. Soil organic carbon fractions will be determined according to Cambardella and Elliot (1992). C and N concentration will be determined by dry combustion using the Carlo Erba elemental analyzer at Duke University (USA). Soil organic C and N contents at each fraction and depth in the continuous sites will be corrected to an equivalent soil mass as measured in the controlled treatment.

Belowground biomass samples will be extracted with a 7-cm-wide core, taking four subsamples in each paddock. Samples will be taken at 0–5, 5–15 and 15–30 cm depth. Roots and other belowground organs will be separated from the soil by washing, oven-dried at 60^0C, and weighted. Results will be averaged to give a single value.

To characterize the microbial diversity in each paddock, five subsamples of soil 0-5 cm deep will be taken with wide soil core. All composite samples will be sieved (2mm) before being cooled to -80°C. DNA will be extracted using standard commercial kits and the V3-V4 region of the gene coding for the 16S rRNA gene, and the ITS1 region in fungi will be sequenced in a sequencing service. The sequences obtained will be processed with the Qiime2 bioinformatics software (https://qiime2.org/) in order to filter the sequences by quality, group them, and obtain taxonomic classifications and alpha and beta diversity estimators.

C in microbial biomass (mCB) will be determined by fumigation–extraction (Vance et al. 1987) and basal respiration (SR) will be measured in vitro (Isermeyer, 1952). Subsequently, the metabolic coefficient (qCO2) will be determined according to the following equation:

qCO2 (mgCO2 μgCBm-1 gsseco-1 h-1) = RS * CBm-1

Bibliography

Bai, Y., and Cotrufo, M. F. (2022). Grassland soil carbon sequestration: Current understanding, challenges, and solutions. Science, 377(6606), 603-608.

Batjes, N. H. (2019). Technologically achievable soil organic carbon sequestration in world croplands and grasslands. Land degradation & development, 30(1), 25-32.

Byrnes, R. C., Eastburn, D. J., Tate, K. W., & Roche, L. M. (2018). A global meta-analysis of grazing impacts on soil health indicators. Journal of environmental quality, 47(4), 758-765.

Cambardella, C. A., & Elliott, E. T. (1992). Particulate soil organic-matter changes across a grassland cultivation sequence. Soil Science Society of America Journal, 56, 777–783.

Conant, R.T., K. Paustian, y E.T. Elliott. (2001). Grassland management and conversion into grassland: effects on soil carbon. Ecological Applications 11:343-355.

Grossi, G., Goglio, P., Vitali, A., & Williams, A. G. (2019). Livestock and climate change: impact of livestock on climate and mitigation strategies. Animal Frontiers, 9(1), 69-76.

Isermeyer, H., (1952). Estimation of soil respiration in closed jars. In: Alef, K., Nannipieri, P. (Eds.), Method in Applied Soil Microbiology and Biochemistry. Academic Press, London, pp. 214–216.

Jackson, R. B., Lajtha, K., Crow, S. E., Hugelius, G., Kramer, M. G., and Piñeiro, G. (2017). The ecology of soil carbon: pools, vulnerabilities, and biotic and abiotic controls. Annual Review of Ecology, Evolution, and Systematics, 48, 419-445

Jacobo, E. J., Rodríguez, A. M., Bartoloni, N., & Deregibus, V. A. (2006). Rotational grazing effects on rangeland vegetation at a farm scale. Rangeland Ecology & Management, 59(3), 249-257.

Jacobo, E. and Rodríguez, A. (2009). Valorization of natural grasslands in humid environments. In Sustainability indicators. V Congress of the Argentine Association for the Management of Natural Grasslands. Argentine Animal Production Site

Recavarren, P. M., & Martinefsky, M. J. (2009). Yellow alert: the degradation of forage resources. Farm view. 16(77), 29-31.

Soussana, J. F., Allard, V., Pilegaard, K., Ambus, P., Amman, C., Campbell, C., ... y Valentini, R. (2007). Full accounting of the greenhouse gas (CO2, N2O, CH4) budget of nine European grassland sites. Agriculture, Ecosystems & Environment, 121(1-2), 121-134.

Soussana, J., Tallec,T y Blanfort, V. (2010). Mitigating the greenhouse gas balance of ruminant production systems through carbon sequestration in grasslands. Animal 4:334-350.

Vance, E. D., Brookes, P. C., & Jenkinson, D. S. (1987). An extraction method for measuring soil microbial biomass C. Soil biology and Biochemistry, 19(6), 703-707.

Vervoorst, F.B. (1967). Plant communities of the Salado Depression. The Vegetation of the Argentine Republic, Phytogeographic Series No. 7. Buenos Aires INTA. 259 p.

FUNCTIONAL TRAITS FOR SEDIMENT RETENTION AND RUNOFF CONTROL IN HERBACEOUS VEGETATION: A REVIEW AND APPLICATION TO NORTHWEST EUROPEAN AGRICULTURAL CATCHMENTS

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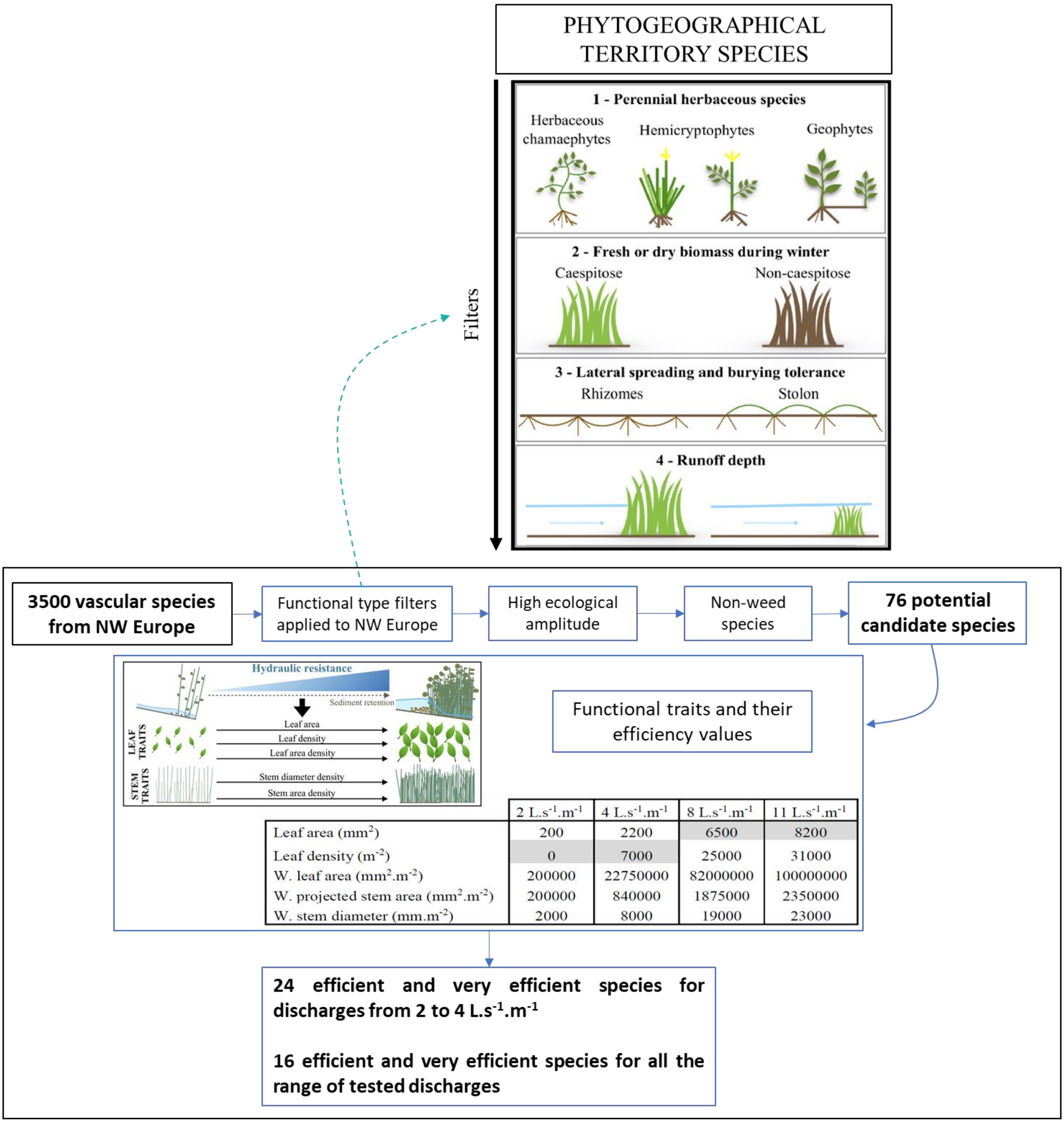
Soil degradation by concentrated runoff and soil erosion induces major environmental and economic damages, notably in agricultural areas under temperate climates. The use of herbaceous vegetation aims to increase the hydraulic resistance and thus reduce runoff and soil erosion while retaining sediments on site. However, the identification of the most suitable species to mitigate runoff is often specific to a phytogeographical territory and hampered by the intraspecific variability, which reduces the transposition of a solution to other territories and the ability to quantify the effects of the vegetation. This review ambitioned to develop a selection method based on a plant functional trait and type approach, which would allow to generalize the selection methods to a number of phytogeographical territories and create herbaceous hedges efficient for occurring processes. Here, we reviewed the effects of aboveground plant functional types and traits of herbaceous vegetation on the hydraulic resistance and sediment retention within agricultural catchments. Indeed, the functional types involved in the increase of the hydraulic resistance and sediment retention could constitute a set of criteria to select potential candidate species within a specific phytogeographical area for soil erosion control. Integrating functional traits effects in the selection criteria would also further improve the plant selection to create herbaceous infrastructures capable of reducing efficiently soil erosion. Both stem and leaf traits have been identified for the past decades as efficient for triggering sediment retention and hydraulic resistance. These criteria were applied to the north-west European context (Figure 1) in order to develop the method and identify plant species, based on their functional types and traits, to create herbaceous hedges (narrow strips 0.5-1.5m) of dense and stiff perennial herbaceous vegetation) which are known to be efficient against concentrated runoff flows and soil erosion. From the 3500 vascular plant species from north-west Europe, 24 were found efficient and very efficient for processes occurring twice and once a year in the studied phytogeographical territory and 16 for all tested processes (from twice a year to once every five years). Herbaceous hedges showing dense perennial herbaceous vegetation on a narrow strip constitute a major structure to reduce concentrated flows and soil erosion under temperate climates in agricultural catchments Their design should consider the selection method based on the functional types and traits of the indigenous species located in the implantation area. Perspective would be to quantify the effects of traits at the catchment scale by integrating the effects of the agricultural activities and plant traits in the adjacent fields in addition to the hedge effects.



	$2\ L.s^{-1}.m^{-1}$	$4\ L.s^{-1}.m^{-1}$	$8\ L.s^{-1}.m^{-1}$	$11\ L.s^{-1}.m^{-1}$
Leaf area (mm^2)	200	2200	6500	8200
Leaf density (m^{-2})	0	7000	25000	31000
W. leaf area ($mm^2.m^{-2}$)	200000	22750000	82000000	100000000
W. projected stem area ($mm^2.m^{-2}$)	200000	840000	1875000	2350000
W. stem diameter ($mm.m^{-2}$)	2000	8000	19000	23000

Figure 1. Plant selection following the functional types and traits criteria applied for north-west Europe to create herbaceous hedges. The included table shows the minimal threshold values of the efficiency range of each trait and weighted trait on the hydraulic resistance and sediment retention. Non-significant effects for the relevant discharges were darkened.

Bibliography

Kervroëdan, L.; Armand, R.; Rey, F.; Faucon, M.P (2020) Trait-based sediment retention and runoff control by herbaceous vegetation in agricultural catchments: A review. *Land Degradation & Development*, 32(3), 1077-1089.

SHORT-TERM IMPACT OF BIOGAS DIGESTATES ON SOILS MICROBIAL COMMUNITIES

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Anaerobic digestion of organic waste is considered a key process to produce renewable energy to meet the growing sustainable energy demand. Digestates can be used in agriculture as soil amendments and improve crop yields. However, their use at large scale in agricultural fields still requires to prove their innocuity on soil biota, especially on microorganisms that play important roles in soil ecosystem. Here, we designed a microcosm experiment to compare the short-term (42-days) effects of four different digestates (derived from cattle manure, energy crop, food residues or slurry with bio-waste) on the soil microbial communities. Each digestate was applied on three contrasting soils representing a range of physicochemical characteristics (BOU, silty clay loam texture; PDL, loam texture and PACA, sandy loam texture). These soils are termed BOU, PDL and PACA hereafter, respectively. None of them had a historical record of digestate application; BOU and PDL were under annual cropping systems, while PACA was a vineyard soil. In addition, selected soils had never received digestates inputs before. Amended microcosms were compared to a control (undigested cattle manure). The effect of digestate inputs on the soil microbial communities was assessed using molecular DNA-based tools (quantification of extracted soil DNA and high-throughput sequencing) to measure microbial biomass and diversity, respectively. The impact of the digestates depended on the soil type. No digestate significantly affected the microbial biomass or diversity of the soil presenting the highest organic matter content ($P > 0.05$), as compared to the cattle manure. In the other soils, digestate addition led to lower microbial biomass compared to undigested manure. The intensity of this effect was dependent on the digestate type, and so were the microbial diversity indicators. Our results show that 42 days after biogas residue application, the effect of digestates on the soil microbial community structure depends on both the soil type and the digestate characteristics. To summarized, our results suggest that the soil microbial communities of coarse-textured soils with an acidic pH and a low C/N ratio are more sensitive to nitrogen-rich digestate inputs.

Keywords: Organic fertilization; High throughput DNA sequencing; Microcosm experiment; Soil microbes

MICROBIOTERRE: STUDY OF THE RELATIONSHIPS BETWEEN INDICATORS OF SOIL STATUS AND C AND N FUNCTIONS IN DIFFERENT CONTEXT OF AGRICULTURAL PRACTICES (META-ANALYSES)

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Sustainable management of cropping systems involves the preservation of soil quality and the promotion of soil biological functions. The Microbioterre project contributed to the development of agro-ecological advice, based on the evaluation of soil functions such as carbon transformation and nutrient recycling. This project proposed to extend the soil physico-chemical analysis to the microbiological component of the soil to provide farmers and their advisors a diagnostic of soil state to support changes in farmers' agricultural practices. In order to ensure the operationality of these indicators, several criteria were taken into account: i) the links between the indicators and soil functions; ii) the links between the indicators and agricultural practices. The study of these links was conducted by reviews literature.

- ***Links between indicators and soil functions***: 3 major functions were identified (nutrient recycling, carbon transformation and maintenance of soil structure) and each of these functions included several processes. The objective of the first meta-analysis was to identify the relationships between soil physico-chemical or microbiological indicators with each of the 16 identified soil processes based on the analysis of 80 articles. The results of this meta-analysis were used and integrated in the diagnosis of farmer's practices.

- ***Links between indicators and agricultural practices***: the impact of six agricultural practices (soil tillage, livestock effluents and organic amendments, cover crops, rotation type, cropping systems) were studied. The objective of this second meta-analysis was to study the ability of soil physicochemical and microbiological indicators to discriminate agricultural practices that are representative of French cropping systems, based on the analysis of 147 articles. The results show a predominant effect of the livestock effluents and organic amendments on the variations of soil indicators. For example, the value of microbial biomass carbon increase about 48.7% under organic inputs and about 15.9% under cropping systems.

This project focused on the determining of the set of indicators that should be added to the routine soil analysis to provide advice adapted to farmer' objectives. The project offered a methodological framework to routine laboratories, as well as a support in the interpretation of the results for advisers and farmers, in the form of a guide of interpretation and training.

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ROOTS OF AGROECOLOGY: REVEAL PLANT ABILITY'S TO DRIVE THE SOIL FUNCTIONING TO ITS BENEFITS

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Nature Based Solutions for a climate resilient, sustainable food production requires to take into account above-below ground interactions mediated by soil microbes. These interactions define a unique soil microbiome wherein plants harbor microbial consortia in root vicinities. Plant roots and microbial consortia synergistically, named as rhizosphere effect, interplay to mine nutrients from soil or to better face soil pests without synthetic external inputs. Agricultural practices interfere with the build-up of the soil microbiome and consequently with the rhizosphere effect. In our study, we have designed a rhizophere effect indicator quality based on soil and rhizosphere enzymes involved with the key processes of soil organic matter turnover and nutrient cycling. Indicator values based on soil sampling in six winter wheat (Triticum aestivum LG Absalon) field plots in Northern West France differing by the crop diversity index and tillage intensity. Results were analysed by Linear Mixed Models to evaluate (i) the existence and intensity of a rhizosphere effect (i) to disentangle the influence of crop diversification and soil perturbation, herein tillage, on rhizosphere effect. Rhizosphere effect was systematically significant for the three enzymes whatever the crop diversity index (Mira et al. 2022), with a greater arylamidase activity (82% compared to 27 and 43% for β-glucosidase and acid phosphatase) in the rhizosphere compared to bulk soil. Accordingly, the modern elite cultivar has the ability to intensify soil processes whereas literature pointed out the depressive effect of modern breeding on root traits related to rhizosphere functioning. In addition, we have demonstrated that tillage intensity shuts down benefits of crop diversification on rhizosphere effect. According to these results, an integrative rhizosphere index was defined to evaluate and design cropping systems by farmers and advisors paving the way to an immediate, low risk transition to agroecology.

Bibliography

Mira, S., Emily, M., Mougel, C., Ourry, M. and Le Cadre, E. (2022). A field indicator for rhizosphere effect monitoring in arable soils. Plant and Soil.

Vineyard Agro ecosystem

GRAPEVINE AGROECOSYSTEMS WITH SPONTANEOUS VEGETATION. AGROBIODIVERSITY, ECOSYSTEM SERVICES, SOIL QUALITY AND ECOPHYSIOLOGICAL RESPONSE OF VINES TO THESE ENVIRONMENTS.

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Summary

The increase in agricultural production (by increasing the cultivated area or by productive intensification) can lead to a reduction in biodiversity and, therefore, to a decrease in the capacity of ecosystems to provide ecosystem services (Martín-López and Montes, 2011). Agroecology, as an alternative, still requires developing practices that can properly accomplish its bases: improvement and conservation of biodiversity, soil quality and water care (Tonolli *et al.*, 2019) and thereby ensure the provision of ecosystem services.

Agrobiodiversity is the biodiversity of agricultural production and includes wild and cultivated species that are part of agroecosystems. It also includes the diverse ways in which producers can use it to produce and manage crops, soil and biota (Thrupp, 2000). Increasing plant diversity develops animal diversity and both contribute to soil quality (Nicholls and Altieri, 2002) and improved water resource utilization (Uliarte *et al.*, 2009). Vandermeer and Perfecto (1995) classify cultivated species within the planned diversity, spontaneous species surrounding the crops within the associated diversity and species found in the surrounding area of the agroecosystem within the surrounding diversity.

A method to analyze and quantify the plant diversity of an agroecosystem is to subdivide it into three aspects: composition (identity, richness and abundance of species, as well as diversity), structure (spatial arrangement) and function (roles that species play in the agroecosystem) (Noss, 1990).

One of the main tools to promote agrobiodiversity consists of developing a permanent or temporary vegetation cover, on the entire or part of the surface (Uliarte *et al.*, 2009). This practice increases soil structure, reduces soil compaction, improves water infiltration and maintains biodiversity, among other qualities. Figure 1 shows the vegetation management strategies associated with perennial crops (vines and fruit trees).

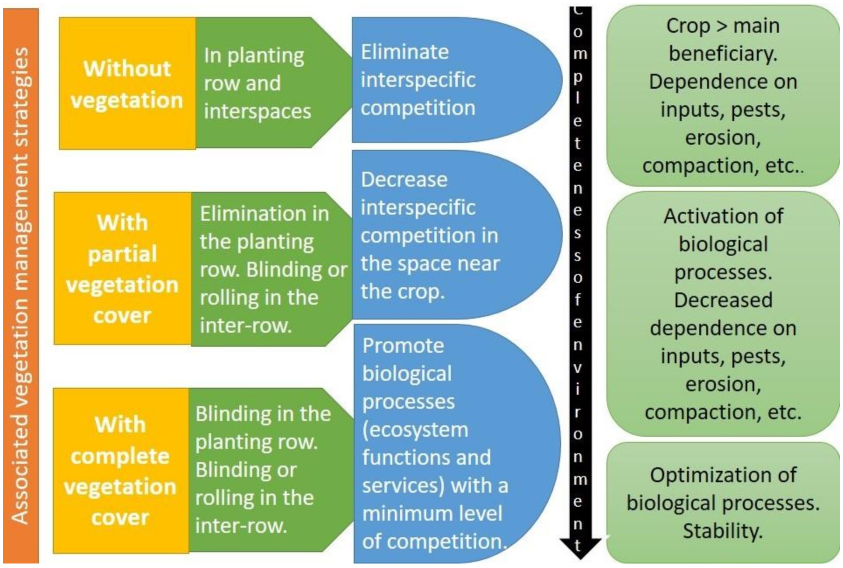

Figure 1. Management strategies for vegetation associated with perennial crops.

The vegetation accompanying the crop or crops generates an environment of simplified biological relationships (few organisms) or of greater complexity (Quezada *et al.*, 2020) depending on the composition, relative abundance and seasonality of the vegetation. Promotion provides the possibility of activating and optimizing biological processes that lead to situations of stability and reduction of erosion, compaction and pest problems. The promotion of accompanying vegetation can be developed by means of service crops (species selected and cultivated to accomplish one or more determined functions (Langemeyer *et al.*, 2017)) or by means of spontaneous vegetation (practices that allow the establishment of species found in the agroecosystem itself or that arrive to them without intentional human intervention, reaching together, values of cover and height favorable to the crop or crops that are the object of production (Ovalle *et al.*, 2007).

The combination of accompanying vegetation management strategies, productive environments and the type of promotion of accompanying vegetation makes it possible to visualize productive intensification strategies, ecological intensification strategies and ecological and productive stability strategies (Figure 2).

Strategies for managing productive environments		
Production intensification	**Ecological intensification**	**Ecological and productive stability**
Population approach. Maintains crops without accompanying vegetation. Maximizes production of a species (population) by optimizing inputs and practices.	Systemic approach. Maintains crops with accompanying vegetation. Service crops that contribute to maximizing production by intensifying ecosystem processes.	Systemic approach. Maintains crops with accompanying vegetation. Development and management of spontaneous vegetation to achieve stable productive environments and provision of ecosystem services. Optimization of ecosystem processes. Basis for appropriate and stable production
Simplified productive environments.	**Productive environments with biological complexity**	**Productive environments of greater biological complexity.**

Figure 2. Characteristics of production strategies.

Mendoza has 158,585 ha under vine. The dominant vineyard production model corresponds to the conventional managementand for a few decades there have been concerns about the environmental sustainability of these agroecosystems. In response, several producers have chosen for the implementation of certified organic management systems and in general terms: agroecological management (Van den Bosch et al., 2015).

Agroecology has contributed to the demonstration of the negative environmental impacts of conventional agricultural management, but it still needs to develop practices that can properly accomplish its bases. In this sense, it is observed in the field that many winegrowers have advanced in strategies for managing accompanying vegetation, productive environments and types of promotion of spontaneous vegetation. Thus, it is common to observe green cover in the inter-rows to provide some type of ecosystem service. In particular, the use of spontaneous vegetation has been poorly practiced and therefore it is unknown which vegetation cover, floral composition, richness and diversity promotes ecosystem services and favors the cultivation of vines.

Within the framework of a strategy of ecological and productive stability, the project seeks to contribute to the understanding of the characteristics acquired by agrobiodiversity, ecosystem services and soil in grapevine agroecosystems with an approach of promotion and development of spontaneous vegetation, as well as to know the ecophysiological response of grapevines to these vegetation environments (Figure 3).

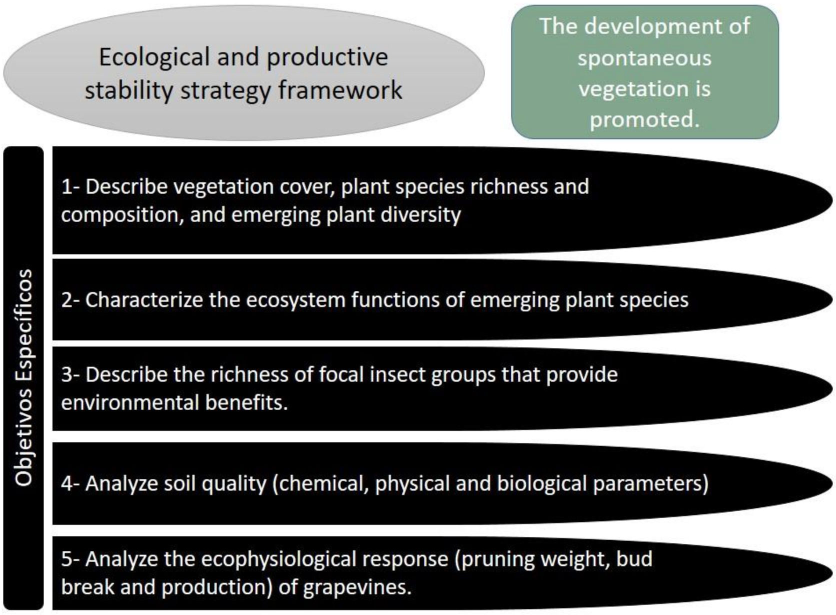

Figure 3. Specific objectives of the research.

The work will be developed during 3 vegetative cycles in an agroecosystem in the upper zone of Tupungato, Mendoza, in cultivar Malbec, conducted on high VSP (vertical shoot position) trellis system, furrow irrigation and spontaneous vegetation in rows and inter-rows according to the methodological design shown in Figure 4.

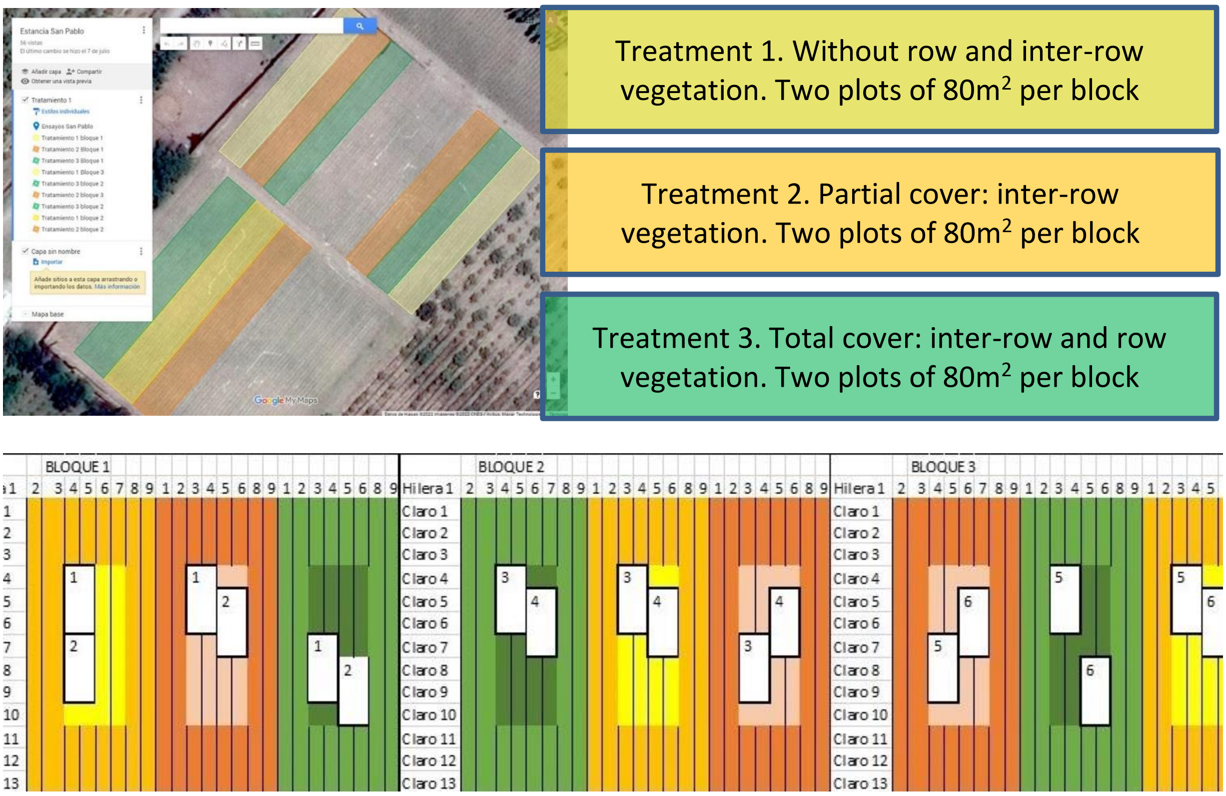

Figure 4. Methodological design.

The following observations will be made in each plot during the months of September, December and March

- Richness, composition and abundance of plant species and vegetation cover using the phytosociological method.
- Richness of groups of focal insects by means of the sampling technique with a D-Vac aspirator modified to accommodate a fine mesh of 40 cm in diameter.
- Soil quality in samples at -20 cm both in the inter-row and in the row, at 30 cm from the plant, to determine organic matter, texture, bulk density, compaction, microbial activity and functional microbial groups related to mineralization, N fixation and related to cellulose metabolization).
- Pruning weight, % sprouting and production.
- Morphological, physiological and phenological characteristics of the most abundant (> 2% of cob.) and most frequent species to assign ecosystem functions.

Bibliography

Langemeyer, J.; Palomo, I.; Gómez-Baggethun, E. (2017). *Evaluación de alternativas de apoyo al viñedo tradicional de Doñana y a los servicios de los ecosistemas que suministra*. Informe Final, OpenNESS, EC FP7 Grant Agreement, N° 308428.

Martín-López B. y Montes, C. (2011). Biodiversidad y servicios de los ecosistemas. En *Observatorio de la Sostenibilidad en España (OSE)*, pp. 444-465.

Noss, R. (1990). Indicators for monitoring biodiversity: a hierarchical approach. *Conservation Biology*, 4: 355-364.

Nicholls C. y Altieri, M. (2013). Agroecología y cambio climático: metodologías para evaluar la resiliencia socioecológica en comunidades rurales. *Revista Agroecología*, 8, 91 pp

Ovalle, C.; Del Pozo, A.; Lavin, A. y Hirzel, J. (2007). Cubiertas Vegetales en Viñedos: Comportamiento de mezclas de Leguminosas Forrajeras Anuales y Efectos sobre la Fertilidad del Suelo. *Agric. Téc.* vol.67, n.4

Quezada, C.; Sandova, M.; Ovalle, C.; Pérez, V. (2020). Influencia de cubiertas vegetales en la disponibilidad de agua y rendimiento en viñedos de secano. *Chilean J. Agric. Anim. Sci.* 36(2):140-150.

Thrupp, L. (2000). Linking agricultural biodiversity and food security: the valuable role of agrobiodiversity for sustainable agriculture. *Int. Aff.*, 76:283-297.

Tonolli, A.; Greco, S. y Sarandón, S. (2019). Algunos aspectos emergentes y de importancia para la construcción del enfoque agroecológico *Rev. De La Fac. de Cs. Agrarias, UNCuyo*, 51(1):205-212.

Uliarte, E.; del Monte, R.; Ambrogetti, A.; Montoya, M. (2009). Evaluación y elección de diferentes especies de coberturas vegetales en viñedos bajo riego de Mendoza. *Revista 13°*, 2(15): 18-34.

Vandermeer J. y Perfecto, I. (1995). *Breakfast of biodiversity: the truth about rainforest destruccion*. Oakland: Food First Books

Van den Bosh, M; Abraham,L y Alturria, L. (2015). Viticultura agroecológica en la provincia de Mendoza. Razones de su adopción y consecuencias de la experiencia. *Memorias del V Congreso Latinoamericano de Agroecología*. La Plata

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