EVOLUTION OF EXTENSIVE AGRICULTURE IN ARGENTINA TOWARDS A SUSTAINABLE PRODUCTIVE SYSTEM

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1. The global challenge of food safety

According to United Nations data, by year 2030, the world population will reach 8,500 million people and 9,700 million people by year 2050[1]. This growth will affect food consumption globally, and in particular, in those regions that still experience food safety issues[2].

Consequently, these questions arise: How are production systems preparing to provide safer and better foods for a growing population?
How is this objective achieved without compromising natural resources, that is, with the design of systems that are sustainable in time?

According to the FAO [Food and Agriculture Organization], 1 out of 10 people in the world suffer some type of severe food insecurity, that is to say, about 750 million people[3]. In this context, production must also increase and be accessible and nutritious to nourish those who still suffer hunger. Since 2015, the UN has been promoting 17 Sustainable Development Goals (SDG) that include elimination of poverty and the hunger, actions for the mitigation and adaptation to climate change, education, gender equality, care of the environment and design of our cities, among others. This 2030 Agenda has the challenge of improving the lives of all countries and societies. Developing and promoting sustainable food systems is one more link that contributes to improving the life quality of the people and to food safety[4].

We are witnessing a world in evolution and Latin America in general, and Argentina in particular, do not escape such changes in the way they occur, giving place to technological innovations focused on improving not only productivity levels but also the quality and safety of the resulting production and of their different stages, and care of the natural resources on which productive systems are based.

In the past 50 years, the global population multiplied 2.5 times and humanity had the capacity to increase the amount of produced food 3-fold. That is to say, the global productive systems responded to the challenges of contributing to the increases of offer to contribute to global food safety.

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1 World Population Prospects 2019.
https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf
2 B20A-SFS Policy Paper. https://docs.google.com/document/d/106cn5AC68-nEr_TvTK_NznAFt0WgMFA4tltAKBMAtxE/edit#heading=h.gjdgxs
3 The state of food security and nutrition in the world 2020. FAO.
https://www.unicef.org/media/72676/file/SOFI-2020-full-report.pdf
4 Official Site of Sustainable Development Goals. https://www.un.org/sustainabledevelopment/es/

The technologies derived from the so-called “green revolution”, such as the genetic improvement of plants; first by crossing, now also with genetic engineering and other biotechnologies; the use of fertilizers and the improvements in crop protection, were the developments that most affected this surprising capacity to procure resources for humanity.

Argentina was not out of this trend: it evolved from producing an average of 30 million tons of grain by the end of the 80's to 115 million tons in the past decade. In turn, there was work on water conservation and soil erosion. Direct seeding, crop rotations, genetic improvements and crops nutrition, biological pest control, and more recently, the incorporation of service crops (with no harvest purpose) to the ecosystem and environmental management are some of the advances that allowed achieving this in our country.

The purpose of this document is to describe the practices that are currently being developed in Argentina and in the Region in order to guarantee a sustainable agricultural production, understanding that sustainability is a continuous improvement process at economic, social and environmental level of the production systems. The concept of sustainability itself is in evolution, and it is nourished by the experimentation, data and collaborative work of scholars, scientists, professionals and producers who analyze those systems.

On describing the features of the sustainable production systems that are implemented in Argentina today, we seek to contribute to thinking which actions may be carried out to have healthy and safe food systems throughout the world.

This document proposes recommendations based on scientific knowledge and on the Argentine experience, with the intention of inspiring agricultural producers around the world, public and private academic organizations who wish to develop knowledge, entrepreneurs who propose solutions to the challenges that still face today, international cooperation entities that foster mutual help and the transfer of solutions, and governments and country blocks they compose to achieve public policies that in turn allow promoting the end of poverty and hunger and a sustainable production, access to foods and an inclusive development of all the citizens in an increasingly challenging world.

2. The contribution of integrated production systems

The production systems with a sustainable track record base their design and evolution on scientific evidence, which in turn give rise to the Good Agricultural Practices, innovation in technologies and processes with a positive impact on productive, economic and environmental areas. Below their main components are described.

A. Direct Seeding

When we talk about integrated production systems and direct seeding (DS), this is about a new agricultural paradigm, driven in Argentina by a group of producers more than 30 years ago, as a response to the soil erosion and deterioration issues recorded in the prior decades. This is a productive system based on the absence of cultural labors and the presence of a permanent coverage of the soil through crops and stubbles.

DS has been successfully spread in a wide range of climatic environments that go warm-cold to hot, and from humid to dry; and varied edaphic environments, with diverse contents of organic matter and with different limitations for crop production.

Argentina is a global referent in soil conservation and in the reduction of erosion, and this is in great part due to the broad dissemination of direct seeding and the massive adoption of this system on the part of producers, integrating a productive technology, which provides multiple benefits. In agriculture, it allows reducing the soil erosion in 90%, the loss of water in 70% and the use of fuels in 60%; this improves the balance of the organic matter in the soil, it allows a broader arable surface, it prolongs the agricultural cycle, it reduces the amount of machinery necessary for crop implantation (therefore, reducing the greenhouse effect gas emissions caused by the intensive use of agricultural machinery) and it achieves higher productivity and yield stability.

In cattle raising, the implementation of direct seeding improves the operativeness and opportunity to carry out most of the forage crops; it increases the possibility to insert agricultural crops; it enables the exploitation of soils considered marginal; it facilitates the rejuvenation of degraded grasslands and the improvement of natural fields; it increases the efficiency in the use of machinery and allows for a better exploitation of the soils resources and forage due to a better soil condition.

These are some of the reasons why today direct seeding exceeds 30 million hectares in Argentina, representing more than 90% of the seeded surface with extensive crops in the country (Graph No. 1). In recent years, a wide range of production systems has been introduced, such as improved implanted or natural grasslands, fresh forage and other crops such as rice, beans and cotton, in addition to traditional crops (soy, corn, wheat, barley, rye, sunflower, etc.).

Graph No. 1: Evolution of the surface with direct seeding in Argentina as % of the total surface with extensive crops

Evolution of the surface with direct seeding (%) 1988/89 to 2019/20 campaigns

Source: AAPRESID y Bolsa de Cereales (ReTAA).

To sum up, the benefits of direct seeding include reduction of fossil fuels use, which in turn implies less greenhouse effect gas emissions (GE); a more efficient use of rainwater; a biological improvement of the soil based on the carbon sequestration; wider development of the microbial biomass and soil nutrition.

Direct Seeding must be seen as a system and not as an isolated practice. In addition, this system basic principles include: a) No soil removal. b) Covering the soil with a layer of waste/stubble. c) Crop rotation. d) Intensification of rotation. e) Integrated pest management. f) Balanced nutrition. g) Efficient and responsible management of agrochemicals.

B. Crop Rotation

The rotation of crops is the planned and organized sequence of crops with the purpose of maximizing productivity, minimizing risks and preserving and/or improving the involved resources. In addition, according to the data analyzed in different agricultural regions representative of the Argentine agriculture, crop rotation allows for the following benefits:

i) It increases the agricultural crop productivity in more balanced rotation approaches between **gramineae** (mainly corn, wheat and barley) and **legumes** (mainly soy and sunflower), whether by a short-term effect (preceding crop effect), or by a medium-term effect (sequence effect).

ii) It is an important action for adaptation to climate change, as upon adverse

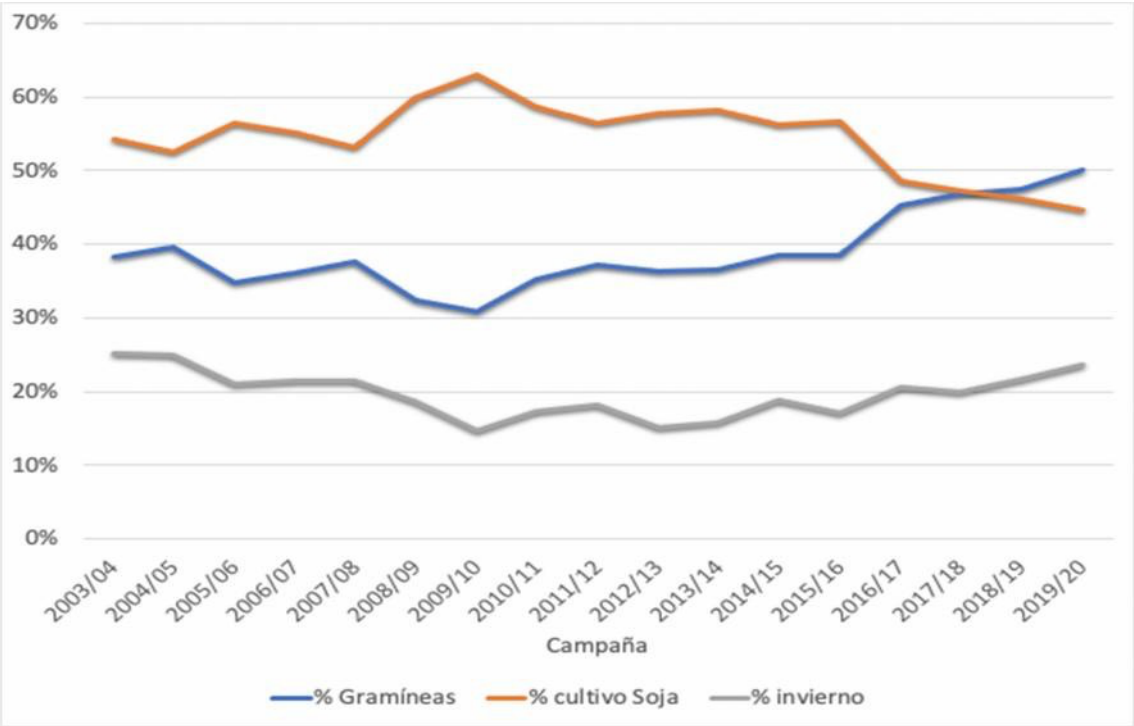
weather conditions and lower than average yields, the productive differences between balanced rotations and monocrop rotations are maximized, mitigating negative effects.

iii) It improves the carbon balances of soils and reduces the total emissions and the intensity of greenhouse effect gas emissions. In addition, and taking the nutritional demand of gramineae crops into account, it also improves the balances of nutrients in the productive system.

At a national level, the proportion of gramineae as regards the total sowed surface has grown, from the minimum of 30% in the 2008 campaign to values near 50% in the most recent agricultural campaigns (2019-2020), according to the data of the Department of Agriculture, Cattle and Fishing of Argentina[5]. Meanwhile, the soy crop reduces its predominance in that period, covering between 60-65% of the agricultural sowed surface, with values near 50% in the most recent campaigns (Graph No. 2).

Likewise, a broader intensification in the use of land is observed in extensive agriculture, through a recovery of the proportion of winter crops in the rotation, mainly wheat and barley, which went from the minimum of 15% in the 2009/10 campaign to 24% in the 2019/20 campaign.

Graph No. 2: Percentage of gramineae and soy on sowed surface in Argentina, 2003-20.



Source: Department of Agriculture, Cattle and Fishing of Argentina

5 http://datosestimaciones.magyp.gob.ar

C. Service Crops

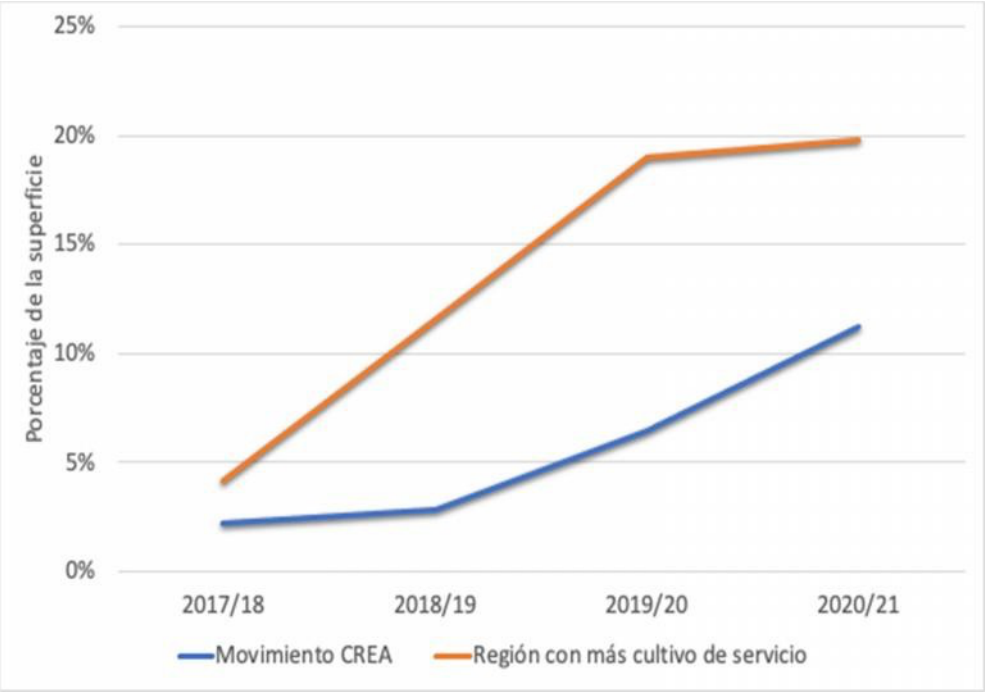
Another pillar to point out in the evolution of the agricultural production in Argentina is the incorporation of service crops (SC) to intensify the use of soil. This practice has shown to have great benefits for the production and for the environment. The SC are used without a harvest purpose, normally replacing the winter chemical fallows, with the purpose of providing different services to the agricultural ecosystem, among which the following may be mentioned:

a) Capture of carbon in the soil
b) Reduction of the pressure of weeds and in the use of herbicides
c) Increase of biological diversity of the soil
d) Control of hydric and wind erosion
e) Increase in the efficiency of water use
f) Contribution of nitrogen by biological fixation
g) Reduction of soil temperature
h) Fixation of stubble
i) Production of forage
j) Soil de-compaction

According to the data disclosed by AAPRESID, the number of producers who adopt the SC increases every year with an average of 20% annually. In the movement agriculture CREA[6], the proportion of surface with first class crops and service crops as preceding crop grew from 2% in the 2017/18 campaign to 11% in the 2020/21 campaign, reaching 20% of surfaces in the region where this practice (Center) is most used.

6 Data disclosed by CREA (DAT CREA 2017-19 and SEA survey systems, 2021)

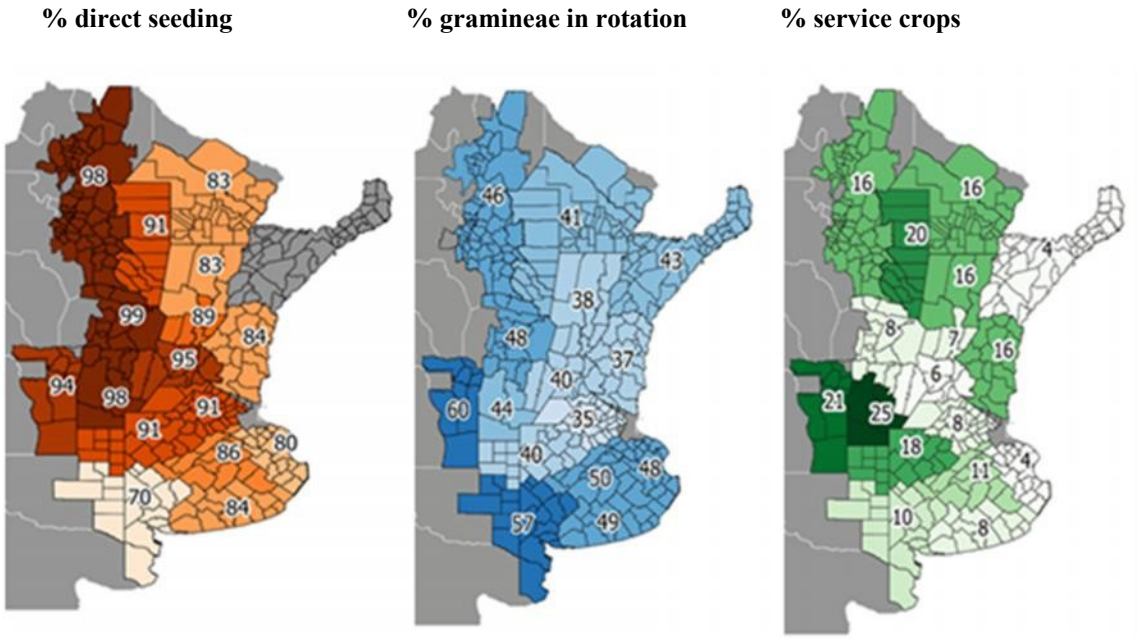
Graph No. 3: Evolution of the adoption of service crops in the Movement CREA and in the region with most use of the practice (Center in 2017/18, Southern Littoral in 2018/20 and Center in 2020/21).



Source: DAT CREA 2017-20 and SEA-CREA 2021.
Note: The Center region of CREA covers mainly the southern half of the province of Cordoba and east San Luis. The Southern Littoral region matches the province of Entre Ríos.

As a summary of the first three described practices, Figure No. 1 indicates the adoption percentage of each in the different agricultural regions in the country.

Figure No. 1: Maps per agricultural zones for the 2018/19 campaign. From left to right, the initial map shows [7]: a) % of adoption of direct seeding, b) % of gramineae in the rotation; and c) % of producers who use service crops.



Source: AAPRESID and Bolsa de Cereales de Buenos Aires, ReTAA System.

D. Integrated Pest Control Based on Biotechnological Innovations

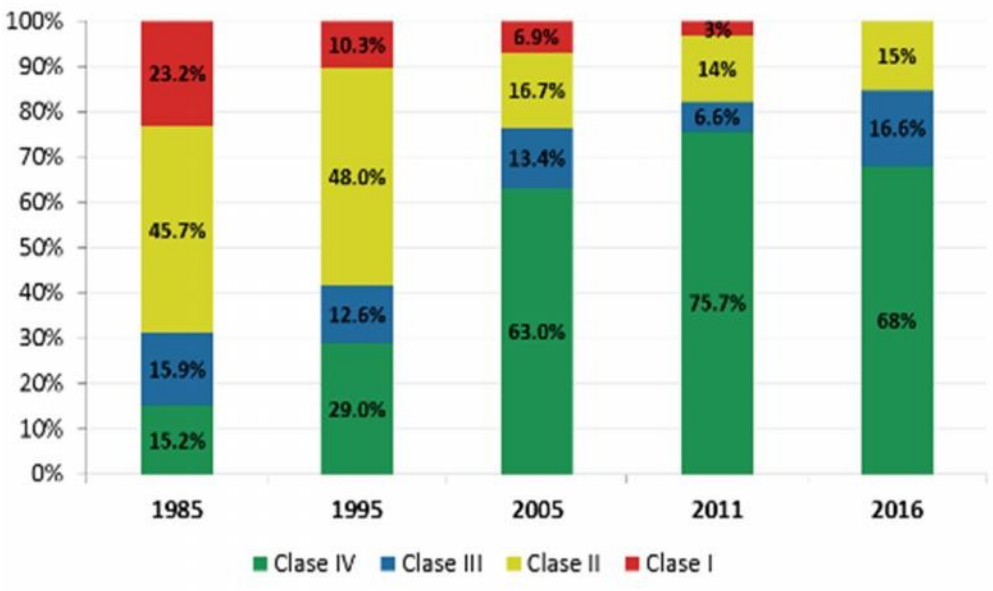
The use of seeds with gens resistant to herbicides, insects, and other biotic and abiotic adversities allow for a lesser use of agrochemicals and, consequently, it minimizes possible adverse effects for the workers' health, possible environmental contamination and greenhouse effect gas emissions (GE).

The use of agrochemicals for the control of adversities in the Argentine agriculture grew in recent times. However, the use of genetics with resistance to herbicides and insects, together with the development of new molecules enabled the use of less toxic products and with less persistence in the environment and the reduction of their use per unit of surface.

The percentage of agrochemicals of the categories that represent less danger for the health and the environment (identified with green and blue toxicological band), in extensive mode approaches of the CREA group was 31% in 1985, 42% in 1995 and more than 80% in the latest survey of 2016 (Graph No. 4).

7 https://www.aapresid.org.ar/blog/evolucion-de-siembra-directa-en-argentina-campana-2018-19/

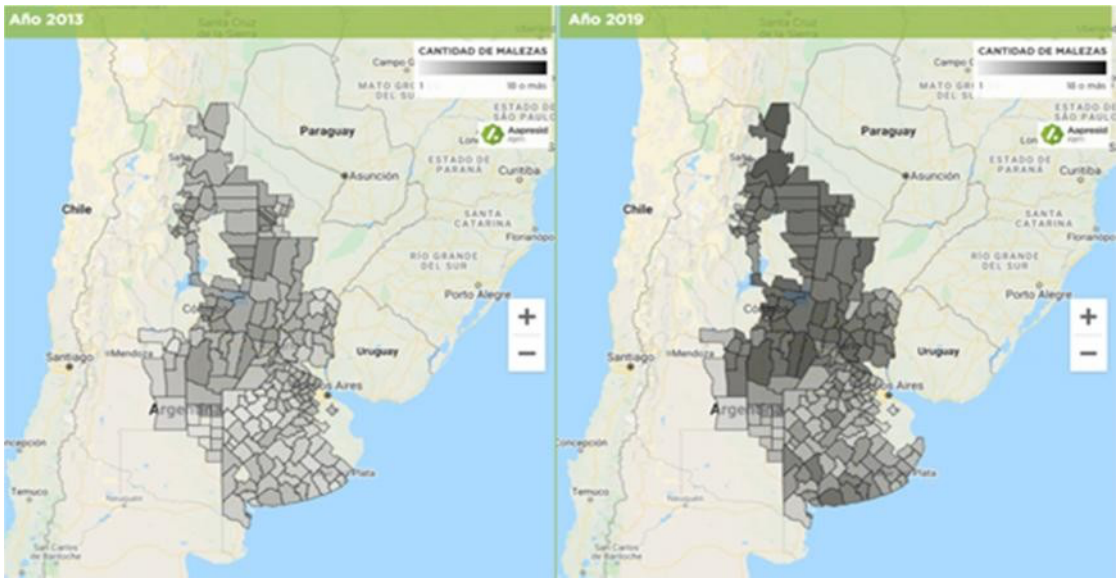
Graph No. 4: Evolution of toxicity of the agrochemicals used in modal agricultural approaches for the selected years.



Source: CREA based on the data of modal approaches of the core Pampa region.
Notes: i) Weighted average of the use of phytosanitary products in a rotation according to tabs, considering the applied volume of agrochemicals of each toxicological class on the total volume of the entire rotation.
ii) The toxicological classification was made according to the ranges of the World Health Organization (WHO) as of August 2012 until the productive approach of 2011 (SENASA Resolution 302/12). For the productive approach of 2016, the current WHO classification was considered.

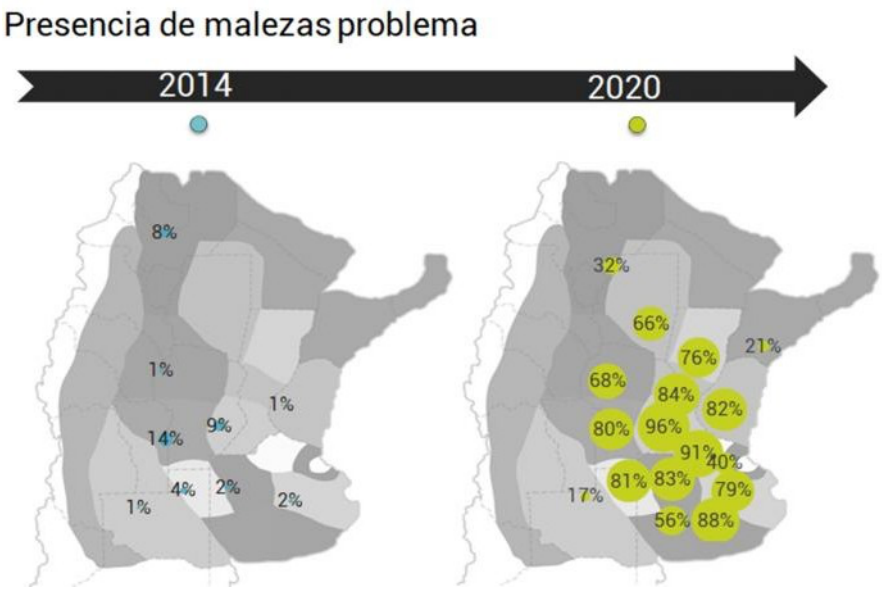
We can also see that Argentine agriculture managed to increase the production with a system that uses products that are less harmful for the health and the environment. But new challenges appeared: the appearance of weeds with tolerance and resistance to the most frequently used herbicides and resistance of insects to transgenic events. The resistant weeds are an issue that increasingly affects the production systems (Figures No. 2 and 3).

Figure No. 2: Presence of weeds as from a survey in the core and northern zone of Argentina. Showing the evolution from 2013 to 2019.



Source: REM (Pest management network) AAPRESID.

Figure No. 3: Presence of problematic weeds for the years 2014 and 2020 according to the survey by CREA.

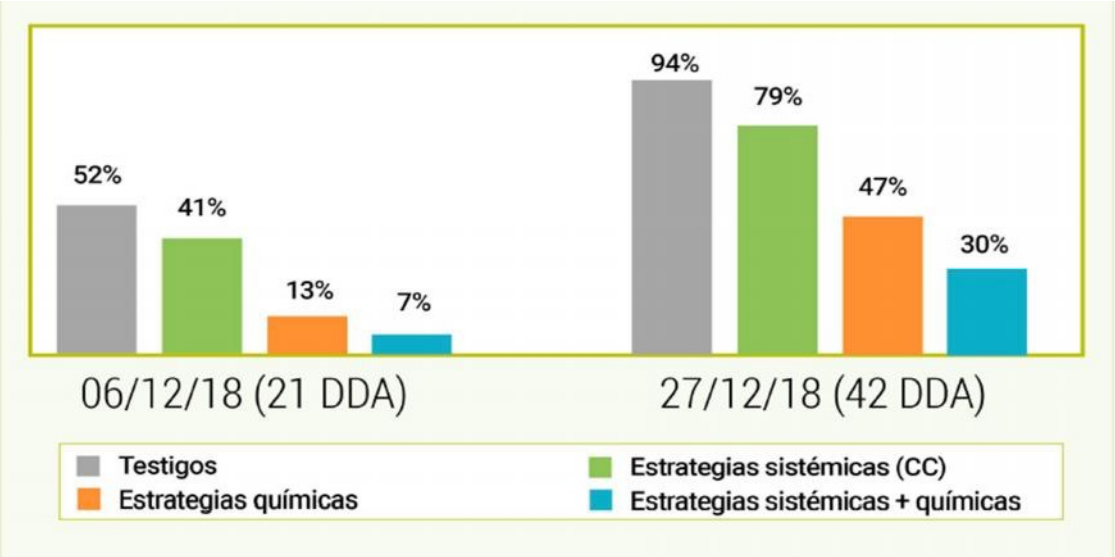


Source: Survey SEA CREA 2014 and 2020

As regards the management of resistant weeds, the adjustment of the productive systems currently takes into consideration the integration of chemical tools, with cultural practices such as the incorporation of service crops for the control of weeds, adjustment of density and seeding dates, among others. As an example, this shows the type of results attained

in regional modules of weed control (CREA Weed Project), where we can observe that the combination of chemical and systemic strategies (in this case, service crops) reaches the best results as regards the witness for the problem weed control (Graph No. 5).

Graph No. 5**: Average frequency of Amaranthus quitensis based on the control strategy (%). Assessment module Center CREA region, 2018/2019 campaign.**



Source: CREA, 2020. Sustainable Productive Systems.[8]

As regards the protection of insects, the appropriate use of shelter (portion of a productive plot planted with seed without protection event) allows for prolonging the useful life of technologies. At the same time, the integration with other insect management practices (population monitoring, use of insecticide application thresholds and rotation of active principles among others) optimizes the management of crops and minimizes the environmental impact.

E. Precision agriculture for efficient use of soil and consumables (seeds, fertilizers, agrochemicals)

Since the beginning of the 2000, the sustained growth of yield monitors installed in the harvest equipment has given rise to the advent of precision agriculture, a technique by means of which it is possible to identify the environmental variability of soils and adjust the use of consumables based on the productive potential of each sector of a field or plot.

8 Manual de Sistemas Productivos Sostenibles, CREA 2020 https://www.crea.org.ar/manualsps/

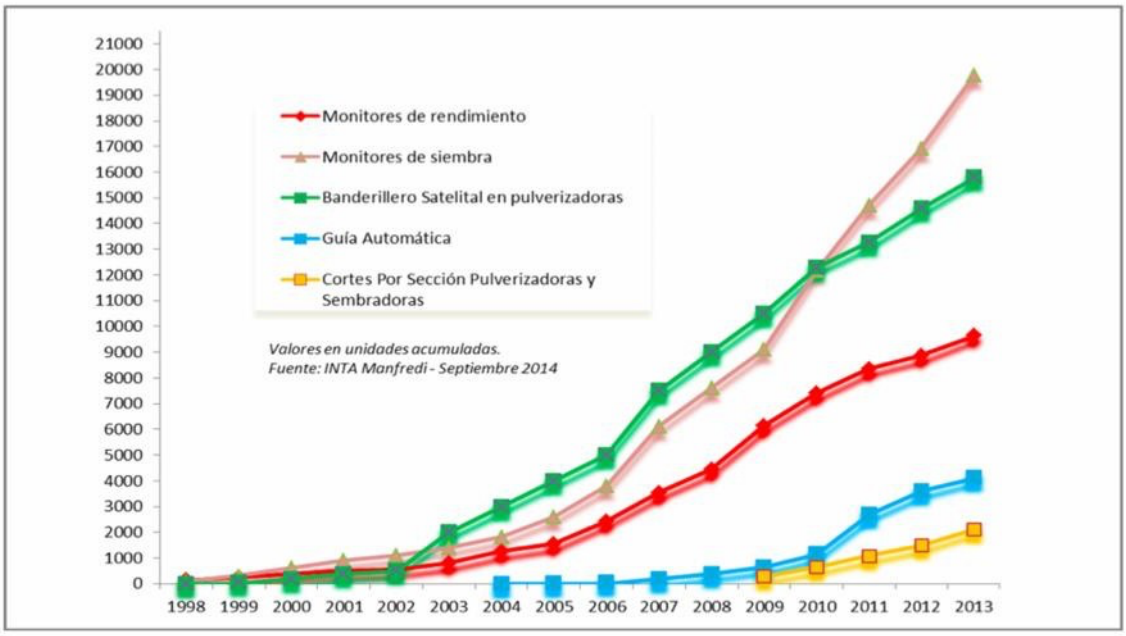
In the past years, the development of remote sensor technologies and automatic variable dosing in the agricultural machinery enabled to considerably increase the number of users of this technology, which provides efficiency in the use of seeds, fertilizers and agrochemicals at the same time it improves economic and environmental indicators of the productive system [9] (Graphs No. 6 and 7).

Graph No. 6: Estimation of the annual evolution of telemetry systems in agricultural machinery in accumulated units[10].

Source: INTA Manfredi, 2020.
Remarks: Estimations of INTA Manfredi based on data by INDEC and Bolsa de Cereales de Córdoba of agricultural machinery sales and the collaboration of leading companies in the sector, estimate of incorporation of telemetry in new agricultural machinery units. Telemetry systems allow consulting or collecting data in real time to take decisions and provide solutions. Some examples are the connection with a weather station, the possibility of solving mechanical problems, sharing information with professionals and enabling the traceability and transparency. In turn, the data generated and integrated in platforms allows for the management of this information. (Cfr.INTA Manfredi, 2020).

9 Evolution of Precision Agriculture in Argentina in the past 15 years. A. Méndez; J. Vélez; D. Villarroel; F. Scaramuzza. Red Agricultura de Precisión - INTA EEA Manfredi https://inta.gob.ar/sites/default/files/script-tmp-inta_g4-evolucin_de_la_agricultura_de_precisin_en_arg.pdf
10 https://inta.gob.ar/sites/default/files/inta_estimacion_de_evol_ap_inta_manfredi_2020.pdf

Graph No. 7: Evolution of updated accumulated sales of precision agriculture, per category, as of September 2014[11].



Source: e A. Méndez; J. Vélez; D. Villarroel; F. Scaramuzza, in Evolution of Precision Agriculture in Argentina in the past 15 years. Red Agricultura de Precisión - INTA EEA Manfredi.

F. Recent Developments of Bioeconomics and Circular Economy (Waste Usage)

The Department of Agriculture, Cattle and Fishing of Argentina understands bioeconomics, defined as the exploitation of biological resources for sustainable production of goods and services, as the synthesis between demands and opportunities as regards the sustainable production of foods. Within this framework, the agriculture is viewed as an activity strongly integrated to the industrial and service processes, based on the production of energy and materials - biomaterials- of any kind from vegetable, animal and microbial biomass.

The bioeconomics strategies highlight the inter-relationships existing between the different productive chains, looking at the set of products that may derive from a raw material and at the fact that raw materials themselves are also replaceable, focusing on the synergies and on how the inter-relationships between the chains, the circularity of the system and the total generated value may be optimized.

Argentina is a key player in the production of first-generation biofuels, particularly, biodiesel from soy crop, of which it is one the main exporters, and increasingly of cane and corn ethanol, and of biogas of different sources. Currently, the installed capacity for the processing of soy oil is about 200 thousand tons per day, mainly concentrated (72%) in 14 plants.

11 https://inta.gob.ar/sites/default/files/script-tmp-inta_g4-evolucin_de_la_agricultura_de_precisin_en_arg.pdf

As regards the production of ethanol, there are about 15 plants in the country that are estimated to have produced around one thousand million liters in year 2016[12].

Other examples of circular economy consist in the use of waste of intensive systems of animal production for the elaboration of biogas and fertilizers. In this sense, it is worth pointing out the work made for the regulation, which allows the reutilization of waste in dairy production systems in the province of Buenos Aires and a pilot milking yard program in process of adaptation to the regulation of agricultural use effluents.

G. Work in Collaborative Research and Dissemination Networks, both public and private

The work in collaborative networks occurs in Argentina between different organizations in the public and private sector and it allows sharing knowledge and jointly generating recommendations that may guide the decision taking based on science (at producer scale) and also the informed decision of public policy. In turn, public policies based on science let the private players to be able to take appropriate production decisions within the framework of sustainability and the demands of global consumers.

These work networks provide an institutional framework to generate agreements and consensus within the sector, and achieve an ambitious dissemination and implementation of the knowledge and technologies available as of today.

The Good Agricultural Practices (GAPs) Network [13] is a clear example in this sense, which was created more than 7 years ago, with more than 95 participant entities and representation of different Argentine provinces, with the mission of contributing to the sustainable development, promoting the dialog with the community, understanding that the GAPs are an adequate way to produce and process agricultural products so that they comply with the necessary requirements for a healthy, safe and environment-friendly production.

In the same sense, Red de Estudio de Sistemas (RedES)[14] is a network of collective knowledge looking to generate and disseminate knowledge related to agricultural sustainability. This network is an example of collective work between different entities (FAUBA, INTA, CREA and AAPRESID) in search of a common objective. In this way, the results and scope are leveraged, and a more efficient use of resources is achieved.

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12 "Bioeconomía Argentina: Visión desde Agroindustria"; "Medición de la Cadena de Valor en la Bioeconomía: Hacia una cuenta satélite" - Department of Agriculture, Cattle and Fishing of Argentina https://www.magyp.gob.ar/sitio/areas/bioeconomia/_archivos//000000_Bioeconomia%20Argentina.pdf

13 Red de Buenas Prácticas Agropecuarias. https://redbpa.org.ar/

14 Red de estudio de sistemas RedES https://www.crea.org.ar/red-de-estudio-de-sistemas/

The purpose of this project is to define, measure and communicate aspects associated to the sustainability of the agroecosystems, with the mission of contributing to the adoption of managements that derive in sustainable extensive production systems in the different regions of the country. The actions of RedES will enable a basis for:

- the development of new sustainability indicators
- the projection of the impact of technological alternatives to be incorporated due to their effects on the chosen indicators or those new ones to be developed
- the design of an experimental approximation to the search of technical, design and structural alternatives, and
- the identification and maintenance of sustainability observatories in the universe of extensive agricultural systems.

H. Evolution of the Yields

As previously pointed out, the transformations of the Argentine productive system towards a sustainable agriculture approach initiated three decades ago were achieved with improvements in the yields per hectare in the main crops, taking into account the objective of its contribution to the national economic development and to the global food safety. This simultaneous process of yield increase within the framework of a sustainability strategy that we describe in this document as sustainability trajectories has also been called "sustainable intensification"; and emerges as a great challenge for the future development of the technological and organizational innovations necessary to attend to the multiple objectives currently posed for food systems at a global level. In Chart No. 1, we see the evolution of the biennial averages of the yields in the three main crops (corn, soy and wheat), since the initiation of the transformation process of the productive systems in Argentina detailed in the previous points with the incorporation of direct seeding up to this day[15]. In the last column, we see the percentage increase of the yields during the three decades.

We can appreciate that in the case of corn, the increase for the three decades reached 100%. For soy, the increase in the national average yield was 26%; but it must be pointed out that the national average has been incorporating the yields of regions with lesser productive capabilities, by virtue of the great expansion of the crop in that period (the planted area with soy grew from 4.9 million hectares in the 1989/90-1990/91 biennial to 17.0 million hectares in the 2019/20-2020/21 biennial, incorporating great surfaces in less productive regions). If the evolution of the yields in the province of Cordoba (main soy producing province in the Pampa Region) is considered for the same period, it was 81%. For wheat, the increase of the national average of yield per planted hectare was 53% for such period. The grow of the total national planted area with wheat in that period was 101% and that also had some impact in the weight of the national average.

15 Biennial averages were used to prevent the eventual impact of a year with yields that are very different from the trend for climatic events.

Chart 1: Evolution of the national average yields of corn, soy and wheat per hectare during the past three decades
(In kilograms per planted hectare)

	1989/90-1990/91 Biennial	1999/2000-2000/2001 Biennial	2009/2010-2010/2011 Biennial	2019/2020-2020/2021 Biennial	% Increase three decades 1989-1991 to 2019-2021
Corn	3753	5444	7077	7507	100%
Soybean	2216	2450	2765	2800	26%
Wheat	1864	2489	3130	2850	53%

Source: Data by MAGYP.

3. Key Messages and Recommendations

1 **The sustainable production systems present in Argentina, are part of a continuous improvement process , that is, of a sustainable trajectory, where the design of the systems becomes more complex looking to boost natural processes, maintain or increase productivity and care for the natural resources on which it lies.** The scientific evidence shows that certain practices (such as direct seeding), certain processes (balanced rotations, incorporation of service crops), the precision technologies applied to agriculture and the look of the system (integrated management of weeds and pests), allow to make a more efficient use of the resources and even capture carbon in the soil under certain management types and environments. They also apply an improvement for the communities (ecosystem services, mitigation of climate change and relationships with society) and they are profitable. This process of continuous improvement started more than 40 years ago with the so-called Green Revolution and is currently reflected in all the dimensions of sustainability.

2 **A comprehensive look on the sustainable productive systems is necessary, because, as they produce food (for animals, consumables and persons), fibers, energies and ecosystem services, they make an efficient use of the natural resources, simultaneously tackling different goals of the UN 2030 Agenda**. So, the concept of efficiency become relevant: producing more and better food per surface unit, minimizing the negative impact on the health and the environment. This comprehensive look implies recognizing that as regards the compliance with the SDG, the production and its value chain does not only contribute to but is also affected by climate change.

3 **Deepening scientific research on sustainable productive systems will be key to generating a common language and guiding the decisions related to production, inclusion and care for the environment, based on scientific evidence.** These decisions are of the producers, those in charge of decisions of public policy and in the scope of international cooperation. Sustainability is a

concept in constant evolution, and to the extent that we progress in the sustainability of systems, new challenges appear. That is why, the coordination of efforts between the public and private sector, as well as national and international, promoting and orienting resources towards the challenges that require science, will contribute to achieving sustainable development.

4 **Technological innovation enables us to find solutions and to optimize the production, commercialization and decision-taking processes.** The *Agtechs* specifically accompany the complexity of the production systems, allowing them to be more similar to nature, to become more efficient in processes, times and costs. Innovation is developed within an environment of motivation, investment and infrastructure; and private and public efforts together with integration to the world energize innovation.

5 **The key role, the initiative of producers and the learning among peers have been core in the development and implementation of sustainable production systems in Argentina. The ongoing exchange between producers in different regions, sharing experiences, problems and needs was, and is today, key for the development of innovative solutions and the adoption of new technologies. It is recommended to deepen and escalate this collaborative innovation process at national and global levels, through which the research strategies and lines are defined to achieve sustainable production systems appropriate for each specific context.**

6 **The sustainable production systems that are widely spread and adapted to all the regions in the world will only be achieved, working collaboratively between countries, regions and sectors.** Learning among peers, sharing successful experiences and working in network among academic institution, both private and public, together with the producers and all the sectors in the productive system chain, is a requirement to systematize these experiences, to be able to share and escalate them through the international cooperation and to achieve the development goals. The non-participative approaches generated in a non-agreed manner with all the relevant players will not be conducive to the required transformations.

4. Conclusions

The challenges of sustainable production are complex; they are inter-related and are key for humanity to reach sustainable development (2030 Agenda).

The dialog and decisions have to be based on the best technical scientific evidence available. Science is the best tool humanity has to understand complex problems.

In Argentina, the production systems described in this document reflect that it is possible to achieve productive efficiency and profitability and the care for natural resources and the environment at the same time, by means of the collaboration among peers and with the community. Innovation and learning among peers are two pillars of one strategy to accelerate the process for the transfer of knowledge and to advance towards sustainable production systems. This presents a huge opportunity for the global community.

That is why producers, States, international bodies and international cooperation spaces are recommended to consider and deepen the analysis of the production system of Argentina, and of the South Cone as inspiration. It is possible to work like that in global cooperation formats to accelerate the compliance with the sustainable development goals.

In this way, it is possible to collectively:

- Guarantee the sustainability of food production systems and apply resilient agricultural practices that increase productivity and production, contribute to the maintenance of ecosystems, strengthen the capacity of adaptation to climate change, to extreme weather phenomena, to draughts, floods and other natural disasters; and that progressively improve the quality of soil and the earth by 2030. **SDG 2. End hunger, goal 2.4.**

- Help developing countries to strengthen their scientific and technological capacity to advance towards more sustainable consumption and production patterns. **SDG 12. Ensure sustainable consumption and production patterns, goal 12.a**

- Strengthen resilience and the adaptation capacity to the risks related to the climate and natural disasters in all the countries. **SDG 13. Take urgent action to combat climate change and its impacts, goal 13.1**

- Incorporate actions related to climate change in the national policies, strategies and plans. **SDG 13. Take urgent action to combat climate change and its impacts, goal 13.2.**

5. Additional Bibliography

- https://repositorio.inta.gob.ar/handle/20.500.12123/9513#
- Bioeconomiahttp://www.cursobioeconomia.mincyt.gob.ar/wp-content/uploads/2016/04/Medicion_de_la_Bioeconomia_-_Cuantificacion_del_Caso_Argentino-COSTA.pdf
- https://www.magyp.gob.ar/sitio/areas/bioeconomia/_archivos//000000_Bioeconomia%20Argentina.pdf

6. Participating Organizations

AAPRESID (Asociación Argentina de Productores en Siembra Directa): this is a non-profit NGO. Composed by a network of agricultural producers who, based on their interest on the conservation of their main recourse, the soil, adopted and drove the dissemination of a new agricultural paradigm, supported on Direct Seeding.

AAPRESID's mission is: "To drive sustainable food, fiber and energy production systems through innovation, science and in-network knowledge management".

https://www.aapresid.org.ar/quienes-somos

CREA (Consorcios Regionales de Experimentación Agrícola): this is non-profit civil association composed and run by agricultural businesspeople who meet in groups to share experiences and knowledge.

The CREA Movement is composed of more than 2,000 agricultural companies that intend to improve the results of their organizations through the exchange of ideas and experiences. The members of CREA work jointly to improve the work process of the company and respond to technical, economic and human needs.

The Mission of CREA is "We are agricultural businesspeople working in group. We share experiences, generate knowledge and boost ideas for the sustainable development of the companies and the country".

https://www.crea.org.ar/

Grupo de Países productores del Sur-GPS: it is a network of private institutions and experts in the agribusiness sector of Argentina, Brazil, Paraguay and Uruguay (ABPU) looking to contribute to the integration of the agroindustry of the countries in the region and for their international projection. From its inception, GPS is looking to generate and share knowledge, therefore, it constantly publishes reports and documents related to their areas of expertise.

https://grupogpps.org/web/