PROCEEDINGS BOOK

3rd
INTERNATIONAL CONFERENCE ON
FOOD and AGRICULTURAL ECONOMICS
25-26th April 2019
Alanya, TURKEY

ISBN: 978-605-81058-1-2

Harun Uçak (Ed.)
Alanya Alaaddin Keykubat University

3rd

INTERNATIONAL CONFERENCE ON
FOOD AND AGRICULTURAL ECONOMICS

PROCEEDINGS BOOK

(Full Texts-Abstracts-Posters)

25 -26th April 2019
Alanya Alaaddin Keykubat University, Turkey

ISBN
978-605-81058-1-2

PUBLIC POLICIES AND ORGANIZATIONAL STRUCTURE FOR SUSTAINABLE INTENSIFICATION: SYNERGIES BETWEEN POLICY-MAKING AND SCIENTIFIC KNOWLEDGE GENERATION IN URUGUAY

Nicolás Gutiérrez
National Agricultural Research Institute (INIA), Uruguay, Email: ngutierrez@ inia.org.uy

Bruno Ferraro
National Agricultural Research Institute (INIA), Uruguay

Abstract

Global population is expected to reach 9.7 billionon 2050(UN). This will requireincreasing food production by approximately 70%. Therefore, the performance of agricultural production systems and processes should be improved. The growing food demand anticipated for 2050is expected to increase the impact of agricultural production on the environment (Davis et al., 2016). Consequently, robust public policy frameworks will be required to oversee relevant environmental issues (Albright et al., 2016).In this context, the concept of sustainable agricultural intensification has been adopted in the last decade by the major international organizations (FAO, CGIAR, World Bank, etc).

Under these changing circumstances the organizational system around agriculture and food production will face the challenge of designing and implementing robust policies aimed at promoting sustainable intensification. From their side, R&D organizations are called to generate the knowledge required to ensure the sustainability of production systems. The present study contributesto understanding the interactiondynamics between agri-food research and public policy-makingin order to strengthen sustainable intensification processes.

The methodological approach involved two main components: (i)a survey of public policies promoting sustainable intensification in Uruguay, and (ii) an in-depth study of a single policy that required intensive use of scientific knowledge as well as a fluent interaction between public research organizations and policy-makers during the whole policy process. Particular attention was placed on such interaction and the dynamics of the use of scientific knowledge as the basis of policy-making processes.

The results showed an increasing implementation of policies intended to promote sustainable agricultural intensification. Moreover, we founda marked trend towards the use of some types of policy instruments, particularly*Public Support Programs*, Hence, there was small diversity of in therange of policy instruments designed and implemented by policy-making organizations. Compared to other studies, there is space for a greater use of other policy mechanisms such asdirected economic incentives for the adoption of sustainable agricultural practices. The is a need for more coordinated policy cycles involving greater interactionand common agendas between policy-makers and research organizations. The identified policies address different dimensions of sustainability; greater attention is required on freshwater use and conservation.

In addition, we found scarce knowledge generation intended to develop policy monitoring and evaluation mechanisms, as well as to assessing the impact of production systems on natural resources and their long-term sustainability.

Keywords: Sustainable Agriculture Intensification, Public Policy, Science-Based Policy

1. Introduction

Recent estimates suggest that global population would reach 9.7 billion by 2050 (United Nations, 2015). Moreover, increases in wages, quality of life and life expectancy of people globally result in larger access to goods and services. These improvements in wellbeing are associated with increased demand for food, and particularly for protein sources.Meeting thisincreased demand will consequently require a significant growth in global food production (estimated in 70 % by FAO, 2011).

The natural resource available to foster agricultural production is limited. Hence, most of the increase in production should be achieved through a sustainable intensification of agriculture. This involves the development and implementation of productions systems that while increasing productivity also ensure the conservation of agro-ecosystems. Rising food production without an expansion of cultivated area will surely require robust public policies to address environmental issues such as soil conservation and greenhouse gas emissions in agriculture (Albright et al., 2016).

On the other hand, recent studies suggest that the projected rise in food production efficiency would not be enough to satisfy the increased demand expected for 2050 without a negative impact on the environment (Davis et al., 2016). Therefore, these authors suggest that *public policies* should also promote changes in food consumption patterns towards "lower-impact diets" (Davis et al., 2016, p125) as well as reductions in the amount of losses and waste throughout the production, commercialization and distribution processes in food systems (Pretty & Bharucha, 2014).

Sustainable agricultural intensification (SAI) has been defined as a process through which agricultural productivity is incremented without generating negative environmental impacts, improving natural resources, social capital and nutritional security (Pretty & Bharucha, 2014), and without expanding the cultivated area (Royal Society, 2009). SAI places special emphasis on environmental aspects and impacts such as the emission of greenhouse gases, degradation of soils and water sources, air quality, biodiversity, eco-system services and the conservation of natural capital (Rosas & Buonomo, 2016;) Pretty & Bharucha, 2014; Petersen & Snapp, 2013). This definition establishes goals for the process of sustainable intensification, but it does not provide any practical or technological means to achieve them (Pretty & Bharucha, 2014). Hence, some scholars maintain that SAI definition is still vague and subject to debate and (Petersen & Snapp, 2015; Rosas & Buonomo, 2016). This vagueness makes difficult the identification or definition of public policies that address the sustainable intensification of agriculture.

The concept of sustainable agricultural intensification emerged in the 90's (Pretty, 1997). Nevertheless,it was not until the publication of the report of the Royal Society in 2009, thatSAI began to be broadly adopted as a guiding principle for policy-making. Therefore, during the last decade, several organizations, international agreements and programs (NN.UU., FAO, CGIAR, etc.), national governments, ministries of agriculture and public or private organizations involved in research, generation of technology and/or agricultural development (Rosas& Buonomo, 2016) are directing their policies and strategies towards sustainable intensification.

2. The Role of Public Policies and Research on Sustainable Intensification

The public-policy instruments and mechanisms most commonly used to support SAI include, among others: promotion of best management practices; reduction of food waste (Pretty & Bharucha, 2014; Rosas & Buonomo, 2016); subsidies to practices that benefit the environment and "green systems" (Matthews, 2013; Hodge et al., 2015; Silva et al., 2016; Hunter et al., 2017); payment to eco-systemic services (Pretty & Bharucha, 2014); development of production chains and access to differentiated markets and premium prices (Pretty & Bharucha, 2014).

Some countries have made efforts and achieved significant progress in promoting 'greener agendas'– e.g. China, Denmark, South Africa, South Korea (Pretty & Bharucha, 2014). Despite these developments at the national and continental levels (Silva et al., 2016), most policy regimes at the national and global levels continue to prioritize food production incentives, but still neglecting or damaging natural capital (Pretty & Bharucha, 2014; Petersen & Snapp, 2015; Davis et al., 2016). Some scholars criticize the IAS approach since the prevailing discourse lacks quantitative environmental conservation goals. Whileemphasizing the urgency of significantly increasing production, the same peremptory character is not given to the environmental challenges and sustainability of production and food systems (Hunter et al., 2017). As a result, contrary to the maintenance or reduction of environmental impacts proposed by the IAS approach, theaggregate impacts are actuallynegative andincreasing in the last years (Hunter et al, 2017).

Regarding the care of natural capital, the focus of public policy has been regulating certain practices and/or preventing specific environmental problems, while incentives to 'positive practices' are rarely used (Pretty & Bharucha, 2014, p1589). Policies or instruments aimed at improving farmers' income and conserving natural resources may eventually fail to meet their objectives due to changes in market conditions that agriculture producers to maximize the use of resources (Pretty & Bharucha , 2014), modify its allocation to different productive activities and, consequently, to an increase in environmental impacts (Rosas & Buonomo, 2016). There is clearly a tension between policies that promote environmental care and those that promote productivity gains. Therefore, there is a need for greater understanding of dynamic models of interaction between public policies, market structure and knowledge generation that allow the expansion of sustainable agricultural practices and production systems (Pretty & Bharucha , 2014).

In the United States, agricultural subsidies and insurance schemes strongly promote production while environmental requirements are scarce resulting in a poor protection of natural resources againstpotential harms(Petersen & Snapp, 2015; Hunter et al., 2017). Due to the low political interest, it has been very difficult in that country to change the orientation of subsidy and financing schemes (which promote increases in production) towards a greater attention to environmental aspects (Petersen & Snapp, 2015). The picture in the European Union (EU) is quite different. It has achieved greater progress in implementing incentives to production systems that take care of natural resources. The EU's environmental policy and Common Agricultural Policy (CAP) have regulated since the 70's the protection of animals and biodiversity, the creation of special protected areas and the maintenance of natural habitats (Hodge et al., 2015). The CAP establishes 'agro-environmental schemes' (AES) as a mechanism for producers' compensation for the loss of income inherent in less intensive systems and natural resource conservation practices (Batáry et al., 2015). From the CAP reform of 2013, subsidies to AES are being reduced. However, 30% of direct subsidies established by the CAP turned to be conditional on the implementation of agricultural practices that favor the conservation and sustainability of agro-ecosystems (Hodge et al., 2015).

Political leaders and policy-makers at local, national and international levels should play a preeminent role in the generation of policy regimes (Geels, 2002) and more robust regulatory frameworks that promote agri-food production systems that combine food supply with the care of natural capital (Pretty & Bharucha, 2014; Petersen & Snapp, 2015). This could include the development of price-correction instruments, for instance on agricultural inputs, so that they reflect the true environmental cost from their use (Davis et a., 2016; Rosas & Buonomo, 2016). In addition, the public sector must ensure the establishment of price signals and subsidies to products obtained through the implementation of sustainable farming practices and systems (Pretty & Bharucha, 2014; Silva et al., 2016). Other authors suggest the need for public policies that modify consumption patterns through market-based solutions, so that prices can incorporate the environmental costs implicit in each type of food (Davis et al., 2016). Likewise, a great challenge for the agencies that set up this sort of policies will be to develop adequate monitoring and control capabilities in order to assess the environmental impact of production systems, as well as sanction capabilities against violations of these regulations (Rosas & Buonomo, 2016).

With regards to the contribution of research to sustainable intensification, the Royal Society emphasizes the key role of R&D organizations in the consolidation of this approach (Royal Society, 2009). Particularly, great efforts will be required for the development of indicators to assess the impact of different agricultural practices on the three dimensions of IAS: productive-economic, social and environmental sustainability (Petersen & Snapp, 2015; Rosas & Buonomo, 2016). Moreover, sinceSAI demands integrated or mixed systems that involve more complex management schemes, research should also generate information on good practices that enable producers to develop the abilities required to manage these complex systems (Rosas & Buonomo, 2016).

The public sector should not only fulfil a central role in the development and validation of environmental and sustainability indicators, but also in the definition of quantifiable long-term goals for those indicators, so as to allow monitoring and evaluating howagroecosystems are changing and consequently make decisions to ensure their long-term sustainability (Neufeldt et al., 2013; Hunter et al., 2017). For example, while many countries have proposed to reduce the carbon footprint per unit of product, there is evidence that the use of this indicator in isolation does not reflect the absolute environmental impact; achieving that requires integrated indicators that also take into account, among others, nutrient balance, loss of biodiversity, pesticides eco-toxicity andwater eutrophication by nutrient enrichment(Picasso et al., 2014; Rosas & Buonomo, 2016). The definition of this type of country-level goals is a prerequisite when accessing United Nations "green funds"that promote climate change adaptation and mitigation (Silva et al., 2016; Fridahl & Linnér, 2015; Klein & Möhner, 2011).

To sum up, the organizational system around agricultureshould face the challenge of designing and implementing robust policies and mechanisms to promote sustainable intensification, and to ensure an effective balance among all three dimensions of sustainability: productive-economic, social and environmental sustainability. R&D organizations are called to generate the knowledge and technologies necessary to ensure the sustainability of the productive systems, as well as to generate indicators to allow effectively characterizing all dimensions of sustainability and monitoring their evolution, for example, in response to the implementation of public policy instruments. This highlights the need for coordination and alignment among R&D organizations and thosein chargeof designing public policies intended to promoteSAI. The development of shared agendas becomes a sine qua noncondition for a long-termconsolidation of the SAI approach. Among other things, the present study aims to contribute to discuss how to strengthen the linkage between agri-food research and the design and implementation of public policies.

3. Conceptual Framework and Methodology

The methodological approach involved two main components: (i) a survey of public policies promoting sustainable intensification in Uruguay, and (ii) an in-depth study of a single policy that required intensive use of scientific knowledge as well as a fluent interaction between public research organizations and policy-makers during the whole policy process. Particular attention was placed on such interaction and the dynamics of the use of scientific knowledge as the basis of policy-making processes.

The survey of policies was intended to identify the existing policies that currently promote or comprise sustainable intensification guidelines. Public policies have been defined as *a set of deliberate decisions that define "a course of action or inaction", the definition of its objectives and the means to achieve them* (Hill & Varone, 2017, p16 [1]). Through this survey we developed a standardized policy database that describes the following attributes of each policy: (i) basic descriptive information (policy name; the policy objectives; date when they have been enacted and implemented); (ii) the target audience; (iii) the organization that was in charge of the policy design and implementation; (iv) the *type* of policy instruments; (v) the dimensions or approaches to sustainability encompassed by each policy (productive, economic, environmental, and/or social); (vi) the stakeholders who compelled to put the policy problem on the public agenda; and finally (vii) intensity of the interaction and contribution of public science to policy-making. This information was collected from secondary sources (information available on websites, documents, institutional publications and previous research) following methodological guidelines designed for this study.

All policies included in the survey are in effect regardless when they were designed and implemented. The study does not attempt to provide a historical account of the policies, but a mapping exercise for their characterization and current situation. The limits of the universe of SAI policies are not clear-cut. Therefore, to the best of our knowledge, the set of policies identified through the survey offers a comprehensive account of that policy universe. This is the first account and characterization of sustainable intensification policies in Uruguay, their policy instruments, target population, as well as of how public research has contributed to the policy design and implementation processes.

The survey portrays each policy from several dimensions. Hence, below we provide the conceptual definition of the main dimensions and categories used to characterize them. First, the *sustainability approach* identifies which dimensions of sustainability are actually addressed by the policy. These dimensions may include: (i) productive-economic; (ii) environmental; and (iii) social. For a policy to be included in this survey, it should address at least two of these dimensions. The *intensity* with which a policy addresses each of these dimensions was ranked using an interval variable that could take value 0, 1, 2, or 3, corresponding respectively to nil, weak, medium or strong *intensity* [2].

The type *of policy instrument* classifies each policy in: (i) certifications, (ii) subsidies; (iii) infrastructure; (iv) public controls; (v) support programs; (vi) fiscal regulations; (vii) preferential prices; and (viii) tax exemptions.

The *policy driving forces*refer to those actors or mechanisms that influenced the decision to formulate and implement each policy. These drivers were standardized into the following categories: (i) public opinion; (ii) international markets; (iii) government; (iv) agricultural producers; (v) large enterprises of the agriculture sector; (vi) agriculture service firms; (vii) international agreements; (viii) foreign governments; (ix) international law; (x) interest groups (NGOs, etc.); and (xi) certification systems.

Finally, we also assessed the *intensity of public R&D contribution* to policy design and implementation. We have argued that the design of SAI policies increasingly demands sound contributions from public research organizations (Royal Society, 2009). Consequently, this study attempted to identify those policies that required a more intensive use of scientific knowledge. Moreover, in order to complement the policy survey, through a case-study approach, we conducted a more detailed examination of the interaction between public research organizations and policy-makers throughout the whole policy cycle (Kingdon, 1984; Hewlett et al., 2015).

A single *sustainable intensification policy* was selected as case study (Yin, 2003) in order to perform an in-depth analysis of the policy-making process and its contribution to sustainable intensification. For its selection we looked for a policy with significant impact on the productive sector, and a case where public research had played a key role on policy design and implementation. Following these criteria we selected the Uruguayan Soil conservation policy, and specifically its more recent policy instrument called *Soil Use and Management Plans*.

The specific objectives of the case study were: (i) to identify factors that promoted setting the policy problem in the public agenda, and triggered the subsequent design and implementation of the selected policy; (ii) identify difficultiesthat SAI policies have faced in their different phases (problem definition, design, implementation, evaluation); and (iii) analyze key driving forces and processes underpinning the interaction between public research (scientific and technical capabilities) and policy development and decision-making (SAI policy).

The conceptual framework and methodological guidelines developed for the case study were based on extant literature that studies *the policy process* (Kingdon, 1984; Sabatier, 1991; Hewlett et al., 2015; Hill & Varone, 2017; Sotirov & Memmler, 2012). In general terms, public policies go through a *cycle* that involves the following stages or phases: (i) agenda setting; (ii) policy formulation (iii) decision-making; (iv) implementation; and (v) policy evaluation (Howlett et al., 2015, 2016). This framework provides an empirical tool to analyze, understand and explain change and evolution in public policies. A complementary approach on public policy-making has been postulated by Sabatier (1988; 1991). His approach places greater emphasis on the role of different actors and collective actions as the drivers of the development, implementation and evolution of public policies (Hewlett et al., 2016). By combining both, the stage-cycle and actors-driven approaches on the policy process, the case study analyzed institutional, technical and stakeholder processes, playing singular attention to the role and contribution of *public research organizations* throughout the different stages of the policy process.

For the empirical implementation of the case study, in addition to a review of previous studies and extant information, we conducted semi-structured interviews torecognized individuals from different stakeholders involved in the policy-making cycle. Interviewees included people from: (i) government agencies in charge of the design and implementation of policies; (ii) universities and research institutes; and (iii) agriculture sector organizations. The findings from the policy survey and case study are presented in the next section.

4. Results and Discussion

4.1. Survey Results: Overview of Sustainable Intensification Policies in Uruguay

The survey resulted in a consolidated database of ten (10) policies that to some extent address sustainable intensification dimensions. We first analyzed how the implementation of sustainable intensification policies has evolved over time (Figure 1).

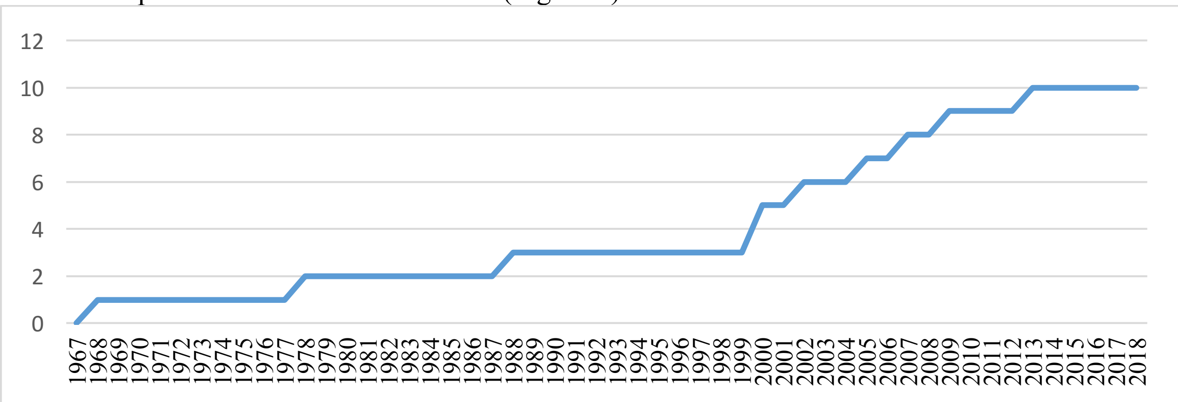

Figure1.Evolution of Sustainable Intensification Policies

SAI policies had little development in the country until late 1990s. From year 2000 onwards, the enactment and implementation of public policies for sustainable intensification (PPSI) showed a significant increase. Similar trends have been observed at the international level (Rosas & Buonomo, 2016). The signature of Uruguay to international agreements passed in the 1990s such as the United Nations Convention on Biological Diversity (CBD), the Framework Convention on Climate Change, and the Kyoto Protocol triggered the enactment of local policies concerning sustainable development goals mostly from 2000 onwards.

We then assessed how the different dimensions of sustainability are addressed by the surveyed policies, using an interval measure of *intensity*. Figure 2 reflects the aggregate results for all surveyed policies which point to the environmental and productive-economic dimensions as the main approaches to sustainability promoted by Uruguayan policies. Less attention is paid to social factors when designing SAI policies in Uruguay.

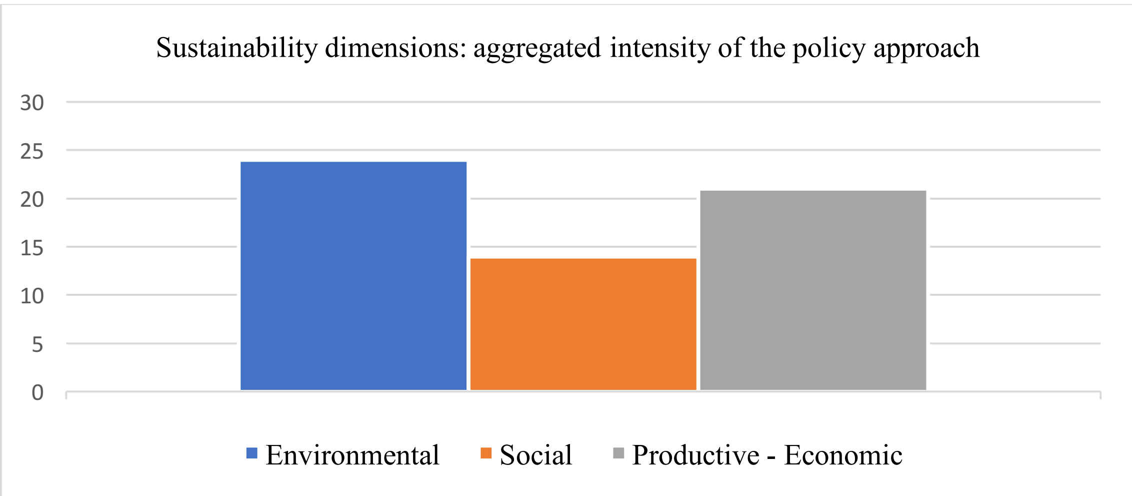

Figure 2.Sustainability Approach

Diverse environmental issues are addressed by SAI policies in Uruguay. These include, water, soil and biodiversity use and conservation, renewable energies and greenhouse gas emissions. Four out of ten policies address biodiversity issues, including the sustainable use and conservation of natural grasslands, the conservation of native forests, the definition of biodiversity protected areas, and regulations on the introduction of genetically modified organisms.

Turing to the type of *policy instruments* and intervention mechanisms employed by SAI policies, the observed distribution (Figure 3) highlights that 42% involve *support programs* as intervention approach, while *public controls* account for 21% of the total number of the instruments analyzed. These figures are even higher (46 and 34 % respectively) if we only consider the policy instruments designed by the Ministry of Agriculture and the Ministry of Environment. This evidences aprevalence of classic policy instruments.

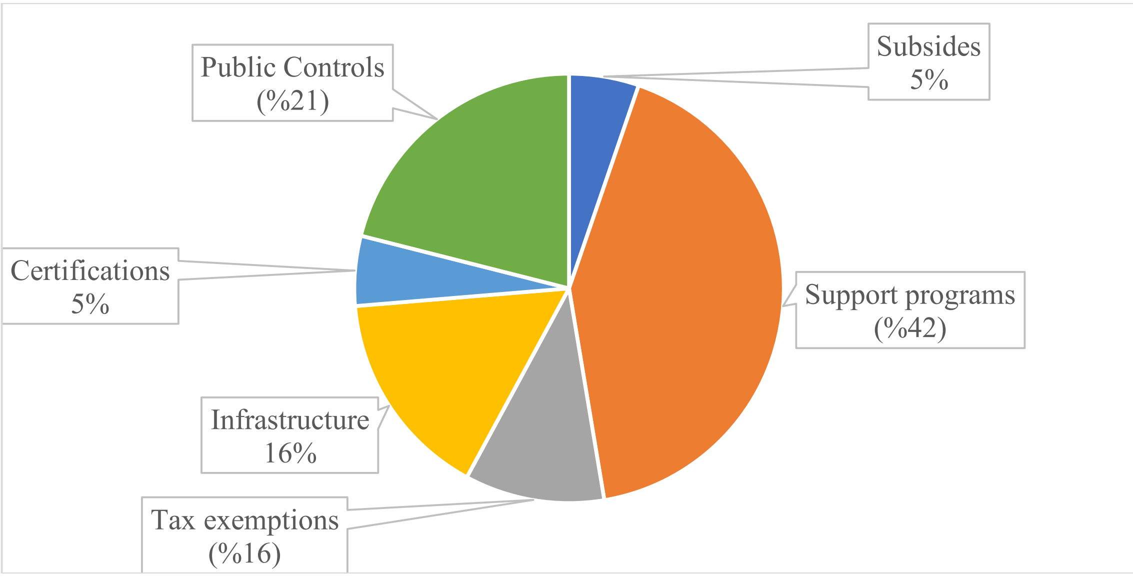

Figure 3. Policy Instruments

On the other hand, mechanisms involving economic incentives such as subsidies, tax exemption or preferential prices represent only 16% of the surveyed instruments. Among these instruments, we found financial incentives to forest tree production, biofuels industry development, waterwaste treatment and irrigation infrastructure, as well as to the adoption of sustainable agricultural practices and technologies.Similar patternshave been seen at the international level, where incentives for positive practices are seldom used (Pretty & Bharucha, 2014, p1589). However,some developed countries make greater use of subsidies to the adoption of beneficial practices – compensating economic losses intrinsic in those production systems thatensure environmental sustainability (Matthews, 2013; Batáry et al., 2015; Hodge et al., 2015; Hunter et al., 2017), as well as mechanisms supportingdifferential prices and market development (Pretty & Bharucha, 2014).

With regards to the organizational structure that supports SAI policies, we examined the involvement of different kinds of organizations in the design and implementation of each SAI policy (Figure 4).As expected, the Ministry of Agriculture has participated in the design of almost all the instruments implemented by SAI policies (13 out of 15 instruments), followed by the Ministry of Environment and the Ministry of Economy, with 6 and 5 instruments respectively.

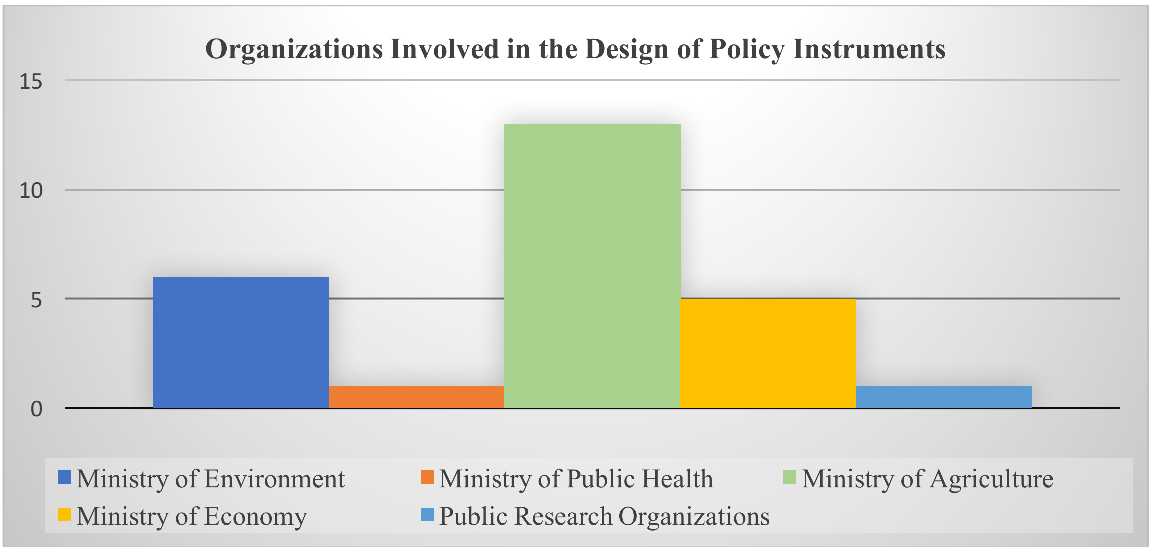

Figure 4. Policy Instruments Designed by each Organization

In addition, we analyzed the *policy driving forces*, namelythose actors or mechanisms that influenced the decision to formulate and implement each policy. Figure 5 illustrates the *aggregate intensity* (AI) of each driving force across all surveyed policies. It highlights that civil society, opinion groups and NGOs with influence on the national Government exert the most salient force driving the advent and implementations of SAI policies in Uruguay (AI = 27). Moreover, Uruguay'sinsertion in the international context plays a highly relevant traction role: the aggregate driving intensity of foreign government and international agreements, markets and regulations reach 21 points in the scale. On the other hand, organizations form the agriculture primary sector exert also a significant driving intensity (reaching 14 points in the AI scale).

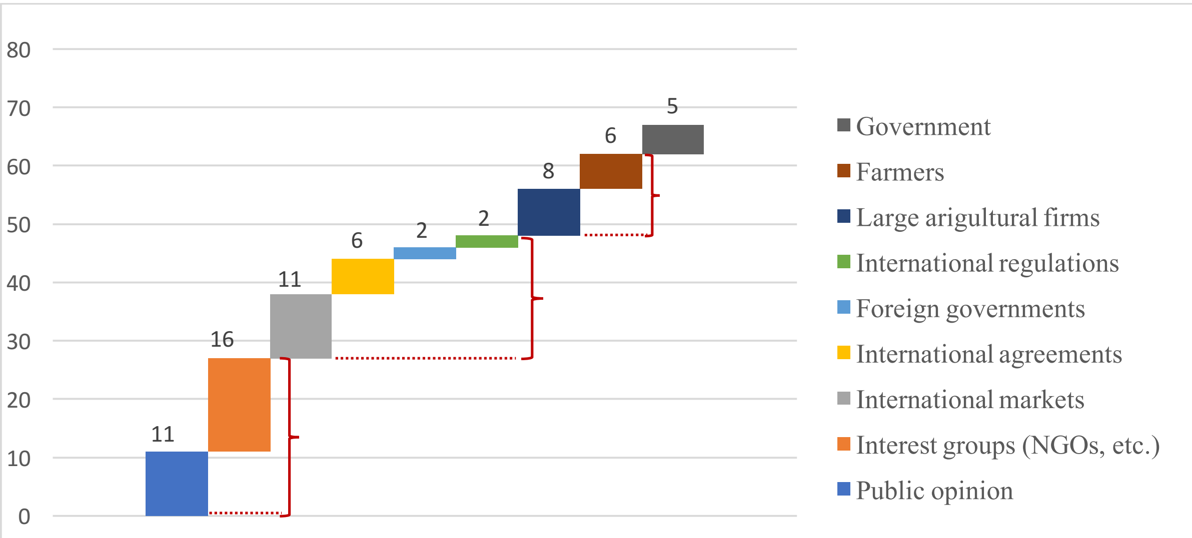

Figure 5. Intensity of Policy Driving Forces

We now dig into the specific type of policies pulled by different groups of actors. Policies backed by civil society agents pay greater attention to broader environmental concerns, to water, soil and biodiversity conservation and food safety. Forces coming from the international context and markets drive the development of similar policies as civil society but also embrace broader environmental issues such as climate change, and renewable energies policies. Finally, stakeholder from the primary sector have influenced the development of policies that address the productive-economic dimension of sustainability, such as sectoral promotion policies (husbandry and forestry), product differentiation policies (integrated pest management), biofuel production incentives and regulations for the introduction of GM plant varieties.

Concluding the SAI policy survey, we also assessed the intensity of the interaction between policy-makers and R&D organizations during the design and implementation of eachSAI policy in Uruguay.The increasing complexity of the environmental and sustainability constraints that need to be faced demand robust solutions and evidence-based policy approaches. So having sound contributions from public R&D organizations becomes a salient input and success factor in policy-making.We found that 6 out of 10 surveyed policies required high or medium interaction with public R&D for their design. The remaining four policies made small or none use of locally developed scientific evidence since they were mostly the result of or adapted from foreign policy schemes.

In the next section, we deepen the analysis of the interaction between public R&D and policy-making. Namely, we examine a single SAI policy as case study looking at the whole policy process. When selecting the case, based on the survey results we looked for a policy that:(i) required a close involvement of publicresearch organizations and a fluent interaction with policy makers; (ii)the solution of the policy problem as well as the design and implementation of the policyinvolved significant local research contributions; and (iii) there was a clear influence of agriculture producers as drivers of the policy need and implementation.

4.2. Contribution of Public Research to Policy-Making: The Case of Soil Use, Management and Conservation Policy in Uruguay

Following the criteria described in the previous section we selected, as our case study, a public SAI policy enacted by the *Law for use and conservation of soil and surface water for agricultural purposes*, in Uruguay.

The Uruguayan Ministry of Agriculture and Fisheries (MGAP) is the main actor involved in regulating and promoting the use of natural resources for agricultural purposes. A law promulgated in 1968 in Uruguay declared of national interest the conservation of soils and waters. As a response to agricultural intensification, in 2008 the MGAP passed new regulations for the technical implementation of the Law in force, thus updating public soils policy. This regulation (decree 405/08) is today referred to as *Soils Use and Management Plans* (SUMP).

The SUMPs are a public policy tool that establishes clear technical criteria so that crop production systems in Uruguay do not exceed the tolerable use and erosion capacity of soils. This norm also establishes sanction mechanisms if infringed and defines control responsibilities. The following sections describe the conditions preceding the design and implementation of the *Soils Use and Management Plans*as well as the instruments established to promote a sustainable soiluse.

As we presented in section 2, the conceptualapproach used splits the policy “cycle” in five phases (Howlett et al., 2015, 2016):(i) agenda definition; (ii) policy formulation; (iii) decision making; (iv) implementation; and (v) evaluation. Therefore, we examine below how the SUMP policy went through these stages.

4.2.1. Agenda Definition

A relevant preceding soils erosion crisis took place in the 1950s, when the area cultivated with wheat reached 1.6 million hectares (Interviewee 1) under continuous cropping and conventional tillage systems (Ernst & Siri-Prieto, 2011). This event triggered a strong scientific research work that was the basis of all subsequent soil policies. Since then, soil conservation has been prioritized by different public actors and in particular by public research organizations (Interviewee 1).

Therefore, a relevant factor driving the historical evolution of soil conservation policyhas been previous scientific evidence on soil erosion and the development of technological solutions to address this problem.Hence, public R&D has led the construction of the policy problem as well as the definition of the policy agenda. Such knowledge and technical solutions were transferred over time to producers and technical advisors that graduated in public R&D organizations. So, public R&D played a key role in anticipating soil conservation problems. Scientific research and graduate training were proactively oriented to the adaptation of an erosion estimation model and the development of sustainable production systems so when the decision to implement the SUMPs policy was taken, the model was adjusted and validated for Uruguayan conditions (Interviewee 1).

In 2001 the Universal Soil Loss Equation model (USLE/RUSLE) was already adapted and validated in local soils as a result of collaborative efforts between the Faculty of Agronomy (FAgro-UdelaR), MGAP and the National Agricultural Research Institute – INIA (Pérez-Bidegain et al., 2018;Interviewee 1). Despite soil conservation problems were already identified, during long periods,the institutional system did not offer effective planning and regulatory instruments on the use and management of soil resources.

During the decade 2000-2010, market factors generated significant changes in land use in Uruguay, demanding new adjustments in the regulations. Specifically, in response to the intensification of crops production and particularly soybean, in 2008 MGAP passed Decree 405/08 in order to technically implement the current law though the SUMPs instrument.

Having scientific information on the problem and its technical solutions were not enough for the emergence of the new policy. Triggering the new soil use regulations involved a convergence of multiple driving forces: (i) the expansion of soybean that tripled total cropping area of the country; (ii) farmers concernsabout soil damage and productivity losses; (iii) community of technical advisors also worried about soil deterioration; and (iv) realization of political will to tackle the identified problems (Interviewee 2). The historical trajectory of this problem, the accumulated evidence on its causes and technological solutions as well as theextensivestakeholder'sawareness resulted in a high willingness of the primary sector to adopt the regulatory changes enacted in 2008 (Interviewees 1, 2, 3, 4, and 5).

4.2.2. Policy Formulation and Decision Making

During the analysis of policy alternatives, two policy approaches toregulate the use of soils were considered within MGAP. One of the models considered was based on the control of good practices and sanctions. Another alternative considered was the implementation of incentives based on indicators of soil use capacity and productivity (Interviewees 2 and 3). Nevertheless, there were weak previous knowledge and capabilities required to measure and monitor the application of incentive instruments. So, despite there was plenty of scientific evidence to characterize soils conservation problems and technological solutions, there were no specifictechnical developments for a proper monitoring and evaluation of the impact of the policy. Therefore, based on the experience of other countries, the control and sanctions approachwereselected (Interviewees 1 and 2).

4.2.3. Policy Implementation

The normative framework has two main components: (i) the mandatory requirement for crop producers to present their Soil Use and Management Plans signed by a certified Agronomists; and (ii) a control of actual soil use compliance with the crop rotations proposed in the SUMPs. Each SUMP provides an estimateof erosion associated with the proposed crop rotation whichshould be lower that the tolerable erosion limits defined by MGAP for different types of soils in the country.

Agronomists were trained and certifiedby the Faculty of Agronomy in order to technically assist farmers in the formulation and presentation of theirSUMPs (Interviewee 2). The compliance control of SUMPs is based on the analysis of actual soil use fromsatellite images. This is complementedwith field visits when deviations are identified (Bidegain et To., 2018; Interviewee 1).

Based on scientific evidence, the SUMPs policy forcesfarmers to adopt practices, technologies and production systems technically designed to prevent soil degradation while ensuring productivity and economic sustainability.Despitemuch of this technological package was being adopted by farmers over the years, the SUMPs made itmandatory. Another policy impact took place at the level of public research organizations that were pushed to broaden their research agendas to new problems and challenges resulting from the policy implementation such as the introduction of winter crops in the rotation. They were also required to workin a more coordinated waywith actors involved in the policy design and implementation (Interviewee 6).

4.2.4. Policy Evaluation

The evaluation of the *SUMPs policy* that has been carried out by the MGAP, has focused on assessing policy implementation. That is, it is monitoring indicators that reflect the degree of adoption of the *SUMPs* by crop producers in Uruguay. These indicators include, among others, the number of *SUMPs* presented by farmers, the agricultural land covered by the *SUMPs*presented and the percentage of the total cultivated area covered by the *SUMPs* (Interviewee 2). The goal defined by the MGAP was to have 100% of the area under crops covered by the *SUMPs*. This goal that has been achieved almost entirely (Interviewee 2).

Based on the USLE model that was adapted to Uruguayan conditions, the application of SUMPs is expected to significantly reduce the erosion generated by crop production, thus maintaining adequate levels of soil health. However, it is still pending to implement mechanisms and indicators for monitoring the actual level of erosion in soils under crop agriculture, their evolution over time, and to assess if the erotion predictions of the USLE model are being accomplished (Interviewees 1, 2, 3 and 4). These indicators were not developed and there is no baseline information to develop them. Nor was an impact study anticipated when the policy was formulated. This particular limitation results from scientific research being strongly focused on the identification of soil conservation problems and the design of their technological solutions but leaving unattended the development of soil health monitoring systems and indicators (Interviewee 3).

5. Conclusions

The survey of SAI policies identified the instrument base, type of policies and driving forcesthat havebeen generated in Uruguay to introducethe *sustainability* of agricultural production systems of as a pillar of the country's development.It represents a valuable resource to promote discussions and long-term collaborative agendas among policy makers and research organizations in order to anticipate policy problems that might require sound contributions from the scientific community.

There is a partial use of some types of policy instruments. Control mechanisms and support programs appear as the most used. We found evidence that this imbalance could be partly due to a lack of scientific progress in the development of monitoring and impact evaluation tools. These topics have little development in the agendas of public research organizations in Uruguay. The evidence offered by the survey seems to indicate that, in view of the growing implementation of policies promoting sustainable intensification, there will be space to further diversify the spectrum of policy instruments used, particularly towards a greater use of economic incentive mechanisms.

The case study allowed us to examine the interface between policy making and agricultural research organizations. The role of public research in the development of SAI policies includes, among others, the identification and characterization of technical problems;the generation of technological solutions and recommendations of best agricultural practices that ensure the sustainability of the production system; the development of models and tools to quantify the environmental and economic impact of crop production systems; and the development of indicators for impact assessment. Moreover, given the complexity ofassessing the different dimensions of sustainability, R&D organizations must deepen their efforts in the development of indicators that allow effective monitoring and evaluation of the impact of production systems on natural resources and their long-term sustainability.

Both, the policy survey and the case study suggest the need to make further progress on capacity building and research onthe assessment of how production systems impact the different dimensions of sustainability, the generation of indicators for defining baselines and monitoring the outcomes from policy implementation.

The results also suggest that the abruptintensification of crop production systems resulting from changes in international markets, and the country compliance with international agreements and regulations, were the main forces that generated the political will to create and implement new public SAI policies.

Acknowledgements

This paper draws upon the research project *'Políticas públicas e institucionalidad para la intensificación sostenible',* supported by the Cooperative Program for Technological Development in Agriculture in the Southern Cone (PROCISUR), with the involvement of INTA (Argentina), Embrapa (Brazil), INIA (Chile), INIA (Uruguay) and IPTA (Paraguay). Useful comments andsupport from all the participants to that projectare gratefully acknowledged.

References

Albright, M.K. et al., 2016. Public and private sector interventions for global food security - A report of the Aspen Food Security Strategy Group.

Batáry, P. et al., 2015. The role of agri-environment schemes in conservation and environmental management. Conservation Biology, 29(4), pp.1006–1016.

Campbell, B.M. et al., 2014. Sustainable intensification: What is its role in climate smart agriculture? Current Opinion in Environmental Sustainability, 8, pp.39–43.

CEPAL (Comisión Económica para América Latina y el Caribe). 2012. El desafío de la sostenibilidad ambiental en América Latina y el Caribe, Santiago de Chile. http://repositorio.cepal.org/bitstream/handle/11362/37791/LCM23_es.pdf

De Sy, V., Herold, M., Achard, F., Beuchle, R., Clevers, J.G.P.W., Lindquist, E. y Verchot, L.V. 2015. Land use patterns and related carbon losses following deforestation in South America. *Environmental Research Letters*, 10(12): 124004.

Ekboir, J.M., 2003. Research and technology policies in innovation systems: Zero tillage in Brazil. Research Policy, 32(4), pp.573–586.

Ernst, O.; Siri-Prieto, G. (2011) ' Agriculture in Uruguay: Its Trajectory and Consequences ', In: Ribeiro A. [Ed.]. II National Symposium on Agriculture. University of the Republic. Faculty of Agronomy. Hemisphere South. Pp. 149-63.

FAO. 2016. *El Estado de los bosques del mundo 2016. Los bosques y la agricultura: desafíos y oportunidades en relación con el uso de la tierra.* Roma. http://www.fao.org/3/a-i5588s.pdf

FAO.2012. *Pérdidas y desperdicio de alimentos en el mundo – Alcance, causas y prevención.* Roma.

FAO. 2011. *El estado de los recursos de tierras y aguas del mundo para la alimentación y la agricultura. La gestión de los sistemas en situación de riesgo.* Organización de las Naciones Unidas para la Alimentación y la Agricultura, Roma, y Mundi-Prensa, Madrid. http://www.fao.org/3/b-i1688s.pdf

FAO, FIDA y PMA. 2015. *El estado de la inseguridad alimentaria en el mundo 2015. Cumplimiento de los objetivos internacionales para 2015 en relación con el hambre: balance de los desiguales progresos.* Roma, FAO. http://www.fao.org/3/a-i4646s.pdf

Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, Vol. 31, pp. 1257-74.

Hill, M.; Varone, F. (Eds.) (2017) The Public Policy Process. London and New York: Routledge. Seventh edition. ISBN 978- 1- 138- 90950- 2, www.routledge.com/9781138909502

Hodge, I., Hauck, J. & Bonn, A., 2015. The alignment of agricultural and nature conservation policies in the European Union. Conservation Biology, 29(4), pp.996–1005.

Howlett, M.; McConnell, A.; Perl, A. (2015) 'Streams and stages: Reconciling Kingdon and policy process theory', *European Journal of Political Research*, Vol. 54 (3), pp419-34. https://doi.org/10.1111/1475-6765.12064

Howlett, M.; McConnell, A.; Perl, A. (2016) 'Weaving the Fabric of Public Policies: Comparing and Integrating Contemporary Frameworks for the Study of Policy Processes', *Journal of Comparative Policy Analysis: Research and Practice*, Vol. 18 (3), pp273-89. https://doi.org/10.1080/13876988.2015.1082261

Hunter, M.C. et al., 2017. Agriculture in 2050: Recalibrating targets for sustainable intensification. BioScience, 67(4), pp.386–391.

INIA, 2016. Desafíos de la intensificación sostenible para la política pública. Serie técnica. INIA.

Kingdon, J. (1984) Agendas, Alternatives, and Public Policies. Boston: Little, Brown & Co.

Klein, R.J.T. & Möhner, A., 2011. The Political Dimension of Vulnerability: Implications for the Green Climate Fund. IDS Bulletin, 42(3), pp.15–22.

Levin, K. et al., 2015. Designing and Preparing Intended Nationally Determined Contributions (INDCs). World Resource Institute, p.124. Disponible en: http://www.wri.org/publication/designing-and-preparing-indcs.

Matthews, A., 2013. Greening agricultural payments in the EU's Common Agricultural Policy. Bio-based and Applied Economics, 2(1), pp.1–27.

Naciones Unidas, 1998. Protocolo de Kioto de la convención marco de las naciones unidas sobre el cambio climático. Protocolo de Kyoto, 61702, p.20. Disponible en: http://unfccc.int/resource/docs/convkp/kpspan.pdf.

Neufeldt, H. et al., 2013. Beyond climate-smart agriculture: toward safe operating spaces for global food systems. Agriculture & Food Security, 2(1), p.12. Disponible en: http://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/2048-7010-2-12.

OECD/FAO (2015), *OCDE-FAO Perspectivas Agrícolas 2015*, OECD Publishing, París. DOI: http://dx.doi.org/10.1787/agr_outlook-2015-es

Pérez-Bidegain, M.; Hill, M; Clerici. C.; Terra, J.A.; Sawchik, J.; García-Préchac, F. (2018): 'Regulatory utilization of USLE/RUSLE erosion rate estimates in Uruguay: a policy coincident with the UN Sustainable Development Goals' [in Press].

Petersen, B.; Snapp, S. (2015) 'What is sustainable intensification? Views from experts', *Land Use Policy*, Vol. 46, pp1-10.

Pretty, J.N., 1997. The sustainable intensification of agriculture. Natural Resources Forum, 21(97), pp.247–256. Disponible en: http://dx.doi.org/10.1111/j.1477-8947.1997.tb00699.x.

Pretty, J. & Bharucha, Z.P., 2014. Sustainable intensification in agricultural systems. *Annals of Botany*, 114(8), pp.1571–1596.

Rosas, F. & Buonomo, M., 2016. Marco conceptual para un desarrollo del sector agropecuario basado en la intensificación sostenible, (En) INIA, 2016. Desafíos de la intensificación sostenible para la política pública. Serie técnica. INIA.

Royal Society (2009) Reaping the benefits: science and the sustainable intensification of global agriculture. London: The Royal Society.

Sabatier, P.A. (1991) 'Toward Better Theories of the Policy Process', *Political Science and Politics*, Vol. 24 (2), pp147-156.

Silva, M.E.; Bervejillo, J.E.; Lanfranco, B.; Ferraro; B. 2016. La iniciativa «red de soluciones para el desarrollo sostenible» y las políticas públicas de intensificación sostenible en Uruguay, (En) INIA, 2016. Desafíos de la intensificación sostenible para la política pública. Serie técnica. INIA.

Sotirov, M.; Memmler, M. (2012) 'The advocacy coalition framework in natural resource policy studies - recent experiences and further prospects', *Forest Policy and Economics*, Vol. 16, pp51-64. https://doi.org/10.1016/j.forpol.2011.06.007

Tittonell, P., 2014. Ecological intensification of agriculture-sustainable by nature. Current Opinion in Environmental Sustainability, 8, pp.53–61. Disponible en: http://dx.doi.org/10.1016/j.cosust.2014.08.006.

United Nations, 1992. Rio Declaration on Environment and Development. Environmental Conservation, 19(04), p.366.

United Nations, Department of Economic and Social Affairs, Population Division. 2015. *World Population Prospects: The 2015 Revision, Key Findings and Advance Tables*. Working Paper No. ESA/P/WP.241. https://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf

United Nations, Human Settlements Programme, 2016. Urbanization and development: Emerging futures. Nairobi, Kenya.

Yin, R. K. (2003). Case study research: Design and method (3rd ed.). Thousand Oaks, CA: Sage.

[1]The authors cite also Heclo, 1972; Smith, 1976; and Jenkins, 1978.

[2] Intensity was ranked by the authors for each policy and dimension of sustainability. The resulting rates where then validated with local and regional experts on public agricultural policies.