The Objectives of Agricultural Engineering Training in Argentina

Gabriela Civeira [1], Alexander Maz-Machado [1], Fernando Almaraz-Menéndez [2], Cristina Pedrosa-Jesús [1]

[1] *Universidad de Córdoba, San Alberto Magno s/s, Córdoba, España*
[2] *Universidad de Salamanca, Paseo Canalejas 169, Salamanca, España*

Abstract **– This study analyses the curricular plans of the Agricultural Engineering Degree in the Republic of Argentina, focusing on the objectives of these training plans. It also identifies the fields of work for which their professional preparation is encouraged. A sample of universities based in Buenos Aires was taken and an analysis of the content of the curricula was carried out. Six broad thematic areas were identified for which Agronomy is oriented in these universities. Most of the objectives of Agricultural studies are oriented towards Agricultural production design and management.**

Keywords **– Agricultural engineering, Argentina professional training, curricular plans, university studies.**

1. Introduction

The agro-export model in Argentina reconverted the agrarian social structure and generated new economic actors, which led to a deepening of inequalities between producers and increased the degree of dependence of those with less bargaining power.

DOI: 10.18421/TEM121-14
https://doi.org/10.18421/TEM121-14

Corresponding author: Alexander Maz-Machado,
Universidad de Córdoba, San Alberto Magno s/s, Córdoba, España.
Email: ma1mamaa@uco.es

Received: 20 September 2022.
Revised: 05 December 2022.
Accepted: 09 December 2022.
Published: 27 February 2023.

In addition, changes in the demands for raw materials and foodstuffs in the internal and external market generated a complexity of situations that increased the traditional difference between types of producers. This situation led the most capitalised producers to develop a variety of strategies and behaviours (productive, financial, and commercial) to adopt new technologies and the assistance of public or private programmes to be able to insert themselves into the new agri-food and agro-industrial chines [1].

In Argentina, the development of the agricultural sector requires permanent innovations, which, in general, are not privately appropriated. The characteristics of innovation and technological change in the agricultural sector require the action of state bodies for its wider development, even though it is directed to a greater extent at high-income strata (such as private companies, large producers) and to a lesser extent at impoverished sectors (small producers or peasants and smallholders).

In recent years, there has been a growing concern worldwide for sustainable production (economically, socially and ecologically) that involves a new productive technological matrix, such as those associated with environmental variables: erosion, loss of organic matter, negative nutrient balance, desertification, reduction of biodiversity, the effects of the advance of the agricultural frontier on global climate change, agroecological food production, agricultural production in agrosystems located in urban-rural interfaces; as well as social impacts, such as depopulation of rural areas due to lack of employment opportunities, food security, preservation of small producers and regional economies, and substitution of labour-intensive activities by extensive ones [22].

All these social and economic changes generate the need for professionals to be prepared for these new needs and expectations related to the agricultural sector. In response to these challenges, in Argentina, higher education, academic units and curriculum have undergone transformations in recent decades due to the implementation of the Higher Education

Law through its accreditation body, CONEAU [20], [10], [7], [13]. As [3] points out, the new mode of knowledge production, which is contextual, specific, and transdisciplinary, distance education, transnational education and network organisation show that these changes are reflected both in study plan and in university management structures themselves.

Several Argentinean universities started changes in the curriculum of the Agricultural Engineering degree. These reforms received different influences from the educational, economic, and social sectors. As some authors state, the different actors of the university community that make up the so-called institutional identity can considerably influence the training plan [5], [11], [2].

A study that analysed the study plans and the report of the university accreditation and evaluation commission of 2009, carried out at the Faculty of Agrarian and Forestry Engineering of the National University of La Plata (UNLP), explained that since the return of democracy, one of the institutional policy objectives of this faculty has been to reformulate the study plans of the agricultural and forestry engineering degree programmes [21].

Some research studies that analysed the effect of the evaluation and accreditation processes on the curriculum of engineering degrees have determined that due to this reform generated from the external environment of the university, changes were caused within the degrees [18], [23], [9]. In general, among other changes, there was an increase in seminars and open lectures on topics of interest to students and teachers that were not included in the curriculum. [23] found that Agronomy students had little contact with industry.

The analysis of the training plan makes it possible to recognise the logic of the transformed contextual knowledge and the correlations between the existing models or paradigms and the reality of the universities. This analysis also allows to evaluate the causes that constitute the knowledge taught and the influencing factors within the socio-cultural context of the historical moment. Therefore, in order to analyse the construction of the study plan, it is necessary not only to evaluate its different dimensions (epistemological, teaching load, professional competences, etc.) but also to examine the interactions that take place between the different actors (universities, official bodies, professionals) and how they influence the development of agricultural university content in response to different socio-cultural and productive contexts [4], [12], [16], [14].

Studies of the training studies of different degrees are not only necessary, but they are also present in recent literature and in Argentina, the curricula of Psychology [8], primary school teaching [15], Economics [6], for instance, have been analysed.

As [17] states, the integration of the study plan content includes professional knowledge and non-professional knowledge, the integration of scientific knowledge and humanistic knowledge, the integration of the expertise of teachers and the expertise of students, as well as the incorporation of theoretical curriculum and practical curriculum.

Within this framework of social changes in the agricultural field that have repercussions on the training of new agricultural professionals, the new plans for the agricultural engineering degree in Argentina are necessary in relation to the objectives. For this reason, we conducted a study of the objectives of this degree in a sample of universities to determine what they are and how they interrelate with each other.

2. Methodology

To achieve the proposed objective, an exploratory descriptive and ex post facto descriptive study has been carried out by means of a content analysis. A fundamental component of the curriculum of a university degree programme is analysed and described, namely the objectives defined in the academic curriculum.

Population and Sample

Four Argentinean universities based in the city of Buenos Aires were chosen: Universidad de la Plata, Universidad del Salvador, Universidad de Morón and Universidad de Buenos Aires. This choice was intentional and for the convenience of the researchers to have access to the necessary information. We consider them to be an adequate sample that allows us to have an overall idea of the profile of the Agricultural Engineering degree.

Data were extracted from each website and from the printed information in the self-assessment reports of the Agricultural degree program of each university. The information was entered into a database which was then analysed using ATLAS.ti software (Figure 1). A series of labels were assigned to the objectives and then different categories were established. VOSviewer software was used to visualise the networks.

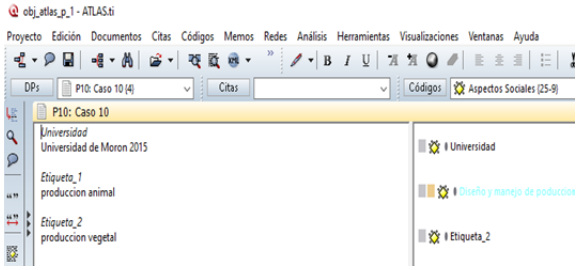

Figure 1. Example of data processing with Atlas.ti for data analysis

3. Results

In these four universities, a total of 72 objectives were obtained, some of which are similar, but with different wording. By assigning labels to these objectives according to the purpose they are intended to achieve, 20 different labels were obtained which can be grouped into 6 clusters:

Cluster 1: Agroindustry, agribusiness, production chines, systemic approach, animal production, plant production, agricultural health.
Cluster 2: Extension and transfer of agricultural technology, environment, appraisals and valuations, agricultural technology.
Cluster 3: Legal framework, deontological standards, agronomist profile reconversion, sanitation, and environmental recovery.
Cluster 4: Coordination with public and private agricultural institutions, design and execution of agricultural projects, agricultural work/rural development.
Cluster 5: Design of parks and gardens.
Cluster 6: Applied research, agronomy, legal framework.

As shown in figure 2, "Plant production" is related to all the other clusters, being the objective label with the strongest interrelation with the others. On the contrary, "legal framework", " agronomist profile reconversion " and "coordination with public and private institutions" are connected only to another objective.

Based on the list of objectives, a process of grouping them according to the common goals sought was carried out. This gave rise to the following six groups or categories:

1. Social aspects (category 1). This category groups together all those objectives whose purpose is to provide tools so that the agronomist can interact, influence, advise and, in general, perform correctly and adequately in relation to society. Some of the objectives that make up this category are Regulations, laws, ethics, extension, transfer, education, ethical standards of the profession, agricultural work/rural development, coordination with public and private agricultural institutions, design and execution of agricultural policies and projects.
2. Management (category 2). This category groups together all those objectives whose purpose is to advise on: the determination of agricultural economic units, economic-accounting programming of farms, the study and analysis of agricultural markets, the division of rural properties and the preparation of agricultural cadastres. Valuating and assessing plantations, natural plant formations, agricultural and forestry holdings and agricultural and livestock production units, their land improvements and the elements involved in their operation. Participate in the administration of agricultural enterprises. Some of the objectives that make up this category are organisation, agribusiness, coordination and management, appraisals and valuations.

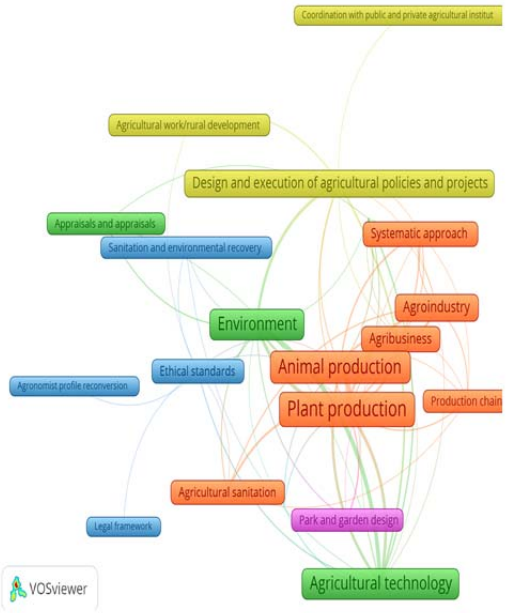

Figure 2. Network of objectives grouped by clusters

3. Natural resource management and conservation (category 3). This category groups together objectives related to the interpretation and evaluation of studies and analyses of natural resources and residues of agricultural inputs. To carry out surveys of productive sites to programme, implement and evaluate methods of conservation, management, recovery and enabling of these for agricultural and forestry purposes. Participate, using agronomic techniques, in the management, conservation, preservation and sanitation of the environment and in the control and prevention of pests that affect the human environment. Some of the objectives that make up this category are environmental impact, environment (soil, water, air); ecology, sanitation and environmental recovery.
4. Agricultural production design and management (category 4). This category groups together all those objectives whose purpose is to plan and execute the implantation of plant species in different spaces, in accordance with their characteristics, function and destination, and to determine the management conditions for these species. Participate in the elaboration and execution of projects for parks, gardens, sports and recreational fields and other green spaces, with regard to the implementation of plant species. Determine the necessary actions for the

optimisation of the relationship between animal and plant resources, for productive purposes. Plan, implement and evaluate control actions and measures to prevent pests and diseases affecting plant species, seeds, and plant propagation organs; plan, implement and evaluate the prevention and control of biotic and abiotic factors affecting agricultural and forestry production. Some of the objectives that make up this category are animal production, plant production, agricultural technology, agricultural sanitation, park and garden design.

5. Industry (category 5). This category groups together all those objectives whose purpose is the planification of agricultural and agroindustrial enterprises; carrying out quality control tasks of agricultural products; organising, directing, controlling, and advising establishments destined for agricultural and forestry production and participating in the same functions in establishments destined for agroindustrial production. Determine the conditions of storage, conservation, sanitary treatment and transport, and everything related to the post-harvest handling of grains, fodder, fruits, seeds, and other vegetable products. Some of the objectives that make up this category are agroindustry, food production, production chains, storage, transport.
6. Investigation (category 6). This category groups together all those objectives whose purpose is: to conduct studies, diagnoses, evaluations, and predictions related to agricultural and forestry production and the relationship between animal and plant resources for productive purposes. Participate instudies and research aimed at the production and adaptation of new animal and plant species for the purpose of improving agricultural production. To carry out information, dissemination and technology transfer actions aimed at agricultural and forestry production. Some of the objectives that make up this category are research, alternative approaches and foresight in agronomy, systemic approach, restructuring agronomist profile, applied research in agronomy.

49% of the objectives that universities in Argentina based in Buenos Aires indicate in the initial training plans for agricultural engineers are related to the "Design and management of agricultural production", that is they represent almost half of all objectives (Figure 3).

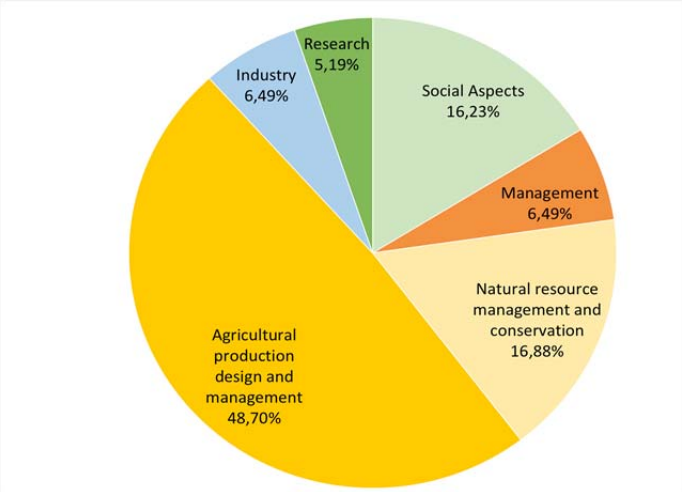

Figure 3. Classification of objectives according to field of action

It is remarkable how few percentages correspond to "industry" or "research", although these sectors are fundamental for the development and innovation of agricultural processes, both technically, economically and in terms of sustainability. The percentages corresponding to the objectives of action on "social aspects" and "natural resource management and conservation" are almost equal.

When analysing the distribution of the areas of action of the objectives proposed for this engineering according to each university, the six categories are present in three of them. Only the University of Morón incorporates four of these categories but does not address "industry" or "management". This is worrying because, as has been pointed out above, it is important for an agronomist to know how to develop his or her work in industry, agricultural or farming, and it is as important to have knowledge as it is competencies in human resources, technical, forestry or environmental management.

In contrast to the great sectoral change, university agricultural education, as well as agroindustrial and agri-food research, have not undergone a similar transformation. This has been previously observed in some works carried out by different national organisations (National Institute of Agricultural Technology, INTA, and the University Association of Higher Agricultural Education: AUDEAS) and international organisations (Inter-American Institute for Cooperation on Agriculture: IICA; through the Cooperative Programme for the Technological Development of Agri-food and Agribusiness in the Southern Cone: Procisur). Despite the efforts aimed at achieving a professional profile in accordance with the national productive reality, the theoretical foundations that support these changes have not reached the curricular spaces in the final stages of the training plan to ensure the professional profile that adapts to the new demands of society, in accordance with the above.

In general, the connection between research topics and the productive sector is more common in agricultural science faculties. In these faculties, the contents of the subjects are usually more closely linked to the productive sector. In this sense, research carried out at the universities of Mar del Plata, Buenos Aires and Misiones observed that there were links between the demands of local agroindustry and the professional profiles with the curricular aspect to be achieved by agronomists graduating from these academic units [19]. This is particularly relevant in some academic units that are in regions where agribusiness has a great weight in the local economy.

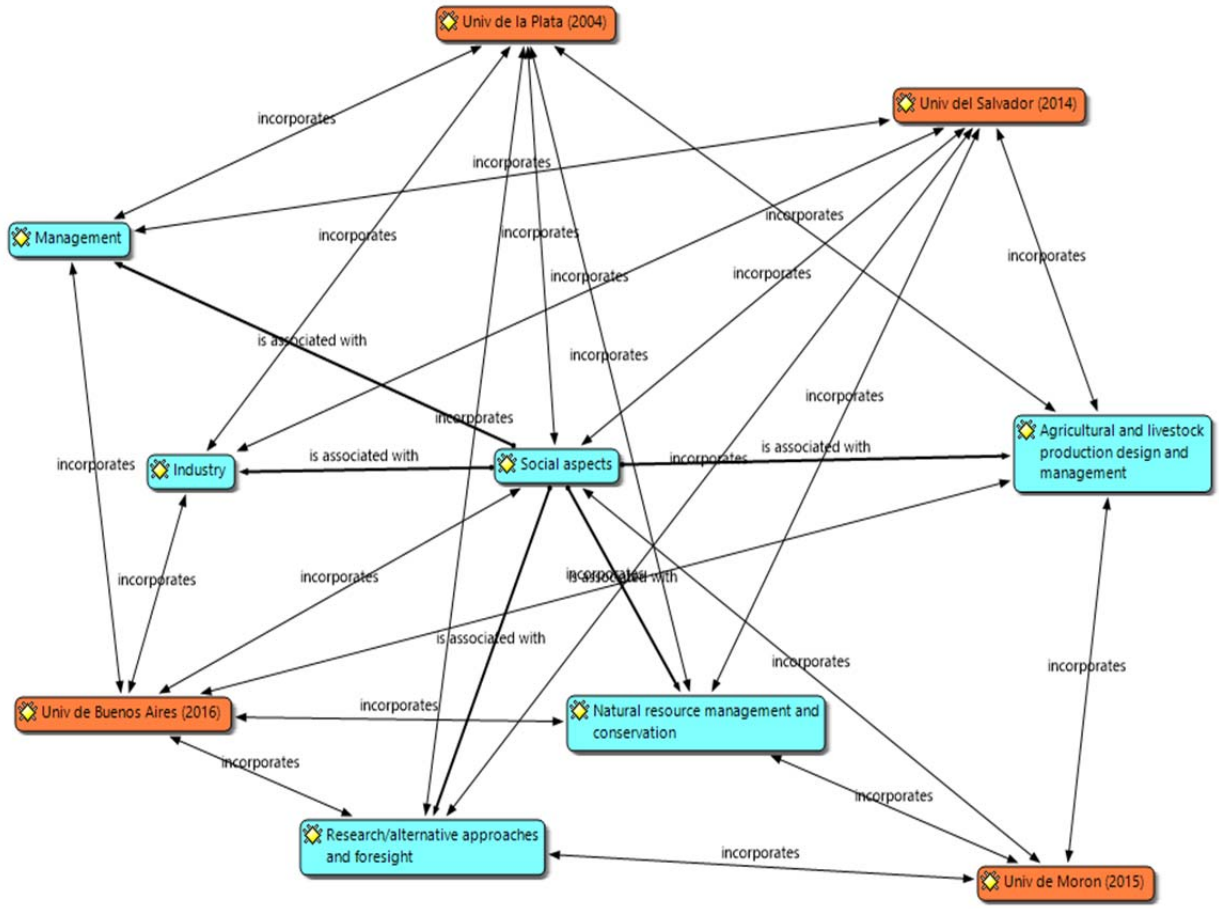

Figure 4. Fields of action according to objectives by university

In the case of the University of Misiones, this work indicated that there was a very direct link between the demands of local agribusiness, the contents taught in the subjects and research in the academic units [18, 19].

4. Discussions

The "productivist" orientation of the agricultural degree has been criticised by groups of teachers and researchers who are more closely linked to the social development and "marginal" sectors and who claim that the agronomist lacks comprehensive training and are calling for a "profile" in the training plan that includes the problems of sustainable development and social transformation. In this sense, an analysis of the curriculum of the Faculty of Agronomy and Zootechnics of the National University of Tucumán (FAZ), that evaluated the processes of curricular change from 1947 to 2004, showed that although there were changes in the training plan that evolved

from privileging the acquisition of information to a constructivist conception tending towards a change in the role of the student towards a more active subject, in general, apparent and simplistic reformulations of the curriculum were carried out [11].

The existence of antagonistic visions of the actors influencing the curricula means that some changes have been implemented and others are still part of the renovation of the curricula, without yet materialising in the specific objectives of the agronomy degree programmes in some of the institutions analysed. Thus, in the modification of the curricula in the different agronomy institutions in the country, the differences described above are beginning to be resolved, although with differences in time and in the way they are implemented in the curriculum.

In recent years, in several universities to achieve the teaching of different knowledge and its link with the training of engineers, the methodology called "integration" was used. Due to this, different faculties of agronomy have begun to address the problems described and generated new study plans that include subjects with an articulating axis for students training [16], [24].

New study plans include integrative workshops that work on new contents and concepts in the last years of the degree. What has been described above allows the incorporation of concepts included along the agronomic study plan and improves training and adaptation of the new knowledge into the professional profile [14], [16], [24].

In this sense, an agronomist profile is improved by generating a better interpretation of reality and by integrating new concepts and knowledge. Integration activities, notions of system behaviour, actors and territory are newly addressed topics that allow new concepts incorporation in order to improve agronomist action and better territory planning [24].

5. Conclusions

The articulations and conflicts between the different actors involved in the preponderance of the different development models in the curriculum cause that these training plans prioritise, in their objectives, the categories that cover the themes they consider to be a priority, at least during the periods that encompass their predominance over other groups with less influence.

To a certain extent, universities have tried to incorporate the current needs demanded by the agricultural production sectors. Even so, the training of agricultural engineers in the Argentinean universities analysed is marked by a major emphasis on agricultural production design and management and natural resource management and conservation. Industry, research, and resource management are also considered, as well as the social aspects of agronomy. However, there is a lack of specific aspects of biotechnology (ecological, molecular, etc.) among the objectives set for the training of agronomists in the 21st century, given the scientific advances in these fields at world level.

For the new situations, it is essential to have an academic agricultural and environmental training that involves educational aspects that are very different from those contemplated in the past. Therefore, in agricultural education it is necessary to promote and generate strategies for the transfer of updated knowledge that will allow agronomists to broaden and deepen their knowledge, skills and abilities and strengthen the sustainable development of the Argentinean agricultural sector.

References

[1]. Balsa, J. (2000). Transformaciones en los modos de vida de los productores rurales medios y su impacto en las formas de producción en el agro bonaerense (1940-1990). *Ponencia presentada a las XVII Jornadas de Historia Económica, Tucumán*.

[2]. Cap, M. (2011). *Actores y procesos en la definición del perfil académico y profesional de los Ingenieros Agrónomos de la Universidad Nacional de La Plata: Perspectivas y experiencias de grupos académicos de la Facultad de Ciencias Agrarias y Forestales* (Bachelor's thesis, Universidad Nacional de La Plata. Facultad de Humanidades y Ciencias de la Educación).

[3]. Civeira, G. (2015). Estructura, organización y gestión de las facultades de agronomía en Argentina: breve análisis. *Revista iberoamericana de educación*, *67*(2), 83-102.

[4]. Cubero Pérez, R., Cubero Pérez, M., Santamaría Santigosa, A., Mata Benítez, M. D. L., Ignacio Carmona, M. J., & Prados Gallardo, M. D. M. (2008). La educación a través de su discurso. Prácticas educativas y construcción discursiva del conocimiento en el aula. *Revista de Educación, 346, 71-104*.

[5]. Etkin, S. & Schvarstein, J. (1989). *Identidad de las organizaciones: invariancia y cambio*. Paidós.

[6]. Buraschi, S., Ciribeni, F., Dvoskin, N., Fanzini, J., Massi, M. F., Sosa, G. O., & Viego, V. (2015). La formación de economistas en Argentina y Uruguay: la distribución de la carga horaria por áreas temáticas en nuestros planes de estudio. *Cuadernos de Economía Crítica*, *2*(3), 155-164.

[7]. Fernández Lamarra, N. (2012). La educación superior en América Latina. Aportes para la construcción de una nueva agenda. *Revista Debate Universitario*, *1*(1), 1-29.

[8]. Fierro, C., Di Doménico, M. C., & Klappenbach, H. A. A. (2016). Formación de grado en Psicología en universidades publicas y privadas en Argentina en el contexto de los procesos de evaluación y acreditación (2009-2015): Una propuesta de relevamiento empírico. *Anuario de Proyectos e Informes de Becarios de Investigación,* (13), 1414-1456.

[9]. Huertas Castelblanco, O. B. (2014). *Acreditación de las carreras de ingeniería de la Universidad Tecnológica Nacional sede Buenos Aires* (Doctoral dissertation, Universidad Nacional de Mar del Plata).

[10]. IICA. (1998). *La Reforma curricular en agronomía en la Argentina*. Foro de análisis de la educación superior agropecuaria. IICA: Buenos Aires.

[11]. Lagomarsino, E. D. *y* Amado de Fernandez M. E. (2010). *La historia de los procesos de cambio curricular en la Facultad de Agronomía y Zootecnia de la Universidad Nacional de Tucumán, desde el año 1947 al año 2004.*

[12]. Lopez, M. V., Fabrizio, M. D. C., Plencovich, M. C., & Giorgini, H. E. R. N. A. N. (2004). Some issues about the status of Statistics teaching in agricultural colleges in Argentina. *Statistics Education Research Journal*, *3*(1), 60-71.

[13]. Mendizábal, A., & Hang, G. M. (2019). Transformaciones en los planes de estudio (curriculum) de Ingeniería Agronómica: una recorrida contextualizadora. In *XXVII Jornadas de Jóvenes Investigadores de la Asociación de Universidades Grupo Montevideo (Brasil, 23 al 25 de octubre de 2019)*.

[14]. Petrazzini, G. (2011). *Modelos productivos en la formación del ingeniero agrónomo. Análisis de la carrera de agronomía de la UBA* (Tesis de grado para acceder al título de ingeniero agrónomo). Buenos Aires, Argentina: FAUBA.

[15]. Pinna, A. (2020). Tensiones entre modelos de formación en los planes de estudio de Ciencias de la Educación, FCH-UNCPBA (1983-2001). *Revista Argentina de Educación Superior*, (20), 108-122.

[16]. Plencovich, M. C., Costantini, A. O., & Bocchicchio, A. M. (2009). *La educación agropecuaria en la Argentina: génesis y estructura*. Ediciones CICCUS.

[17]. Qian, Y. (2020). On the Reform of the Course System of Agronomy Professional Curriculum Based on Students' Ability. *International Conference on Educational Training and Educational Phenomena* (ICETEP2020), 1-5. Wenzhou: SPG.

[18]. Rodríguez, G. L., Gallo, A., Giuliano, G., Ferrando, K., & Durán, G. (2020). Introducción a la Ingeniería: aportes para la formación en competencias: IV y V Encuentro Nacional de Cátedras de Introducción a la Ingeniería. *Rosario: Universidad Nacional de Rosario.*

[19]. Rodríguez J. (2008). Capacidades de las universidades frente al sistema agroalimentario. In Riquelme, G. (Ed.): Las universidades frente a las demandas sociales y productivas estudio y trabajo de estudiantes universitarios (pp. 145-178). Buenos Aires: Miño & Davila.

[20]. Rodríguez, A., & Martínez, M. (2005). Situación de las carreras de Ingeniería Agronómica de la Argentina. *CONEAU–MECyT, SPU, Panorama General de las Carreras de Ingeniería de la Argentina, Buenos Aires*.

[21]. Schalamuk, S., & Acciaresi, H. A. (2012). El cambio del plan de estudios en la carrera de Ingeniería Agronómica, el rol profesional y la ciencia academica actual:¿ una vinculación posible?. In *IV Congreso Nacional y III Congreso Internacional de Enseñanza de las Ciencias Agropecuarias*, 1269- 1277.

[22]. Soleri, D., Cleveland, D. A., & Smith, S. E. (2019). *Food gardens for a changing world*. CABI.

[23]. Zalazar, M. F., & Arquier, J. P. (2019). Estrategias innovadoras para favorecer el desarrollo de competencias. Aplicación en la enseñanza de ingeniería de las reacciones químicas. *Extensionismo, Innovación y Transferencia Tecnológica*, *5*, 253-262.

[24]. Albaladejo, C., Cieza, R. I., Moreyra, A., Bernal, M. C., & Dell'Aquila, M. (2014). La formación profesional y sus ámbitos de acción: el caso del Taller de Integración Curricular II. *Ciencia y tecnología*, (14), 219-232.