

Considerations on the research and dissemination of agricultural knowledge by the Facultad de Agronomía

Consideraciones sobre la orientación de la investigación en la Facultad de Agronomía y la difusión del conocimiento agrícola

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ABSTRACT

In order to mark the 50-year-history of the Facultad de Agronomía of the Universidad Nacional de Colombia, this article reviews the beginning of agronomy in Colombia, the creation of the Facultad de Agronomía, the development of the Escuela de Posgrados, and the launching of the journal *Agronomía Colombiana*; and analyzes the prioritization of research as a function of undergraduate thesis and theses from 1970 to 2012 and of the articles published in *Agronomía Colombiana* for 30 years. The fruits of its labor show that the Facultad strengthened the discipline of Crop protection in its first two decades with important advances in crops of flowers and cacao and went on to strengthen the fields of Crop physiology, Plant breeding, Soil and water, Economy and rural development, resulting in diversification to fruits, vegetables, the potato, flower species and perennial crops, showing how the Facultad's mission of teaching, research and continuing education has contributed to the development of the agricultural sector in Colombia.

Key words: study plans, agronomy, agricultural research, dissemination of knowledge.

RESUMEN

Con ocasión de los 50 años de creación de la Facultad de Agronomía de la Universidad Nacional de Colombia, se hace una mirada al inicio de la agronomía en Colombia, a la creación de la Facultad de Agronomía, al desarrollo de la Escuela de Posgrados y a la consolidación de la revista *Agronomía Colombiana*; se analiza la priorización de la investigación como consecuencia de trabajos de grado y tesis desde 1970 a 2012 y de los artículos publicados en *Agronomía Colombiana* durante 30 años. Los productos generados muestran que la Facultad desde sus dos primeras décadas alcanzó fortaleza disciplinar en Protección de cultivos con avances importantes en los cultivos de flores y cacao y posterior fortalecimiento en la Fisiología de cultivos, en Fitomejoramiento, en Suelos y aguas, en Economía y en Desarrollo rural; a su vez, presentó diversificación a especies de frutales, hortalizas, papa, flores y cultivos perennes, aportes que la Facultad desde sus actividades misionales de docencia, investigación y extensión ha realizado para contribuir al desarrollo del sector agrícola del país.

Palabras claves: planes de estudio, agronomía, investigación agrícola, divulgación de conocimiento.

Introduction

In the 91 years of agronomy in Colombia and the 50 years of the Facultad de Agronomía of the Universidad Nacional de Colombia, Bogota, obstacles have been overcome and great achievements have been accomplished, forming part of Colombia's legacy by contributing to the development of the country through the formation of the agronomic profession and transformations in agricultural productive systems, research and the dissemination of knowledge related to the agricultural sciences in the rural sectors.

This article contains some aspects related to the development of the Facultad de Agronomía of the Universidad Nacional de Colombia, Bogota and of its principal tool for the dissemination of knowledge: the technical-scientific

journal *Agronomía Colombiana*, 50 years and 30 years ago, respectively. The complete history of agronomy in Colombia and of the Facultad de Agronomía is too long and would require a more detailed and precise article that documented activities in Colombia, including those of international foundations that contributed to the creation of agronomy schools. Rather, the present article provides a reference for the development and sources of this development as related to the process of academic formation, research and continuing education in the agricultural sector of Colombia.

One can get a feel for the specialized agronomic knowledge that has consistently guided the formation of the policies of the national system of science and technology through the thematic classification of the articles published by the journal *Agronomía Colombiana* from 1983 to 2012 and of the

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dissertation and theses studies produced by the Maestría en Ciencias Agrarias, Geomática and the Doctorado en Ciencias Agropecuarias, Área Agraria from 1970 to 2012.

Methodology

Archived documents of the Universidad Nacional de Colombia, Bogota, self-evaluations of the Facultad de Agronomía master programs and reviews published in the journal *Agronomía Colombiana* were reviewed to gain an understanding of the circumstances that led to the beginning of agronomy in Colombia, the creation of the Facultad de Agronomía, the formation of the Escuela de Posgrados and the start of *Agronomía Colombiana*.

A data base was created for the quantification of the articles published in *Agronomía Colombiana*, starting with the first number in 1983 and ending with the third number in 2012. The 755 articles related to the seven disciplines found in the journal were classified by product, with 550 articles defined by a crop. The articles were grouped into three ten-year periods: 1983-1992, 1993-2002 and 2003-2012.

The data base of archived undergraduate thesis dissertation and theses studies carried out by students of the Facultad de Agronomía as found in the Bibliotecas Central and the Facultad de Agronomía, Bogota, was consulted to form an understanding of said studies. The data base contains 1821 studies that cover the years of 1970 to 2012.

The data found in the articles and dissertation and theses studies were compiled and analyzed with simple statistics, such as frequencies and means, Pearson correlations, analysis of variance and Tukey test of mean comparisons. The software SAS[®], version 9.2 was used.

The start of agronomy in Colombia

The formation of agronomic engineering started in Colombia in the year 1915 with different regional influences, such as the Escuela Superior de Agricultura de Bogota, which graduated the first agronomic engineers of the country in 1920: Jorge Díaz Sierra, Roberto Pedraza A., Luís Castañeda Rey, Julio Piñeros, Félix Díaz Granados, Ramón Ríos C., Nicolás Collazos LL., Raúl Varela M., Emiliano Pereañes, Santiago Abadía Jiménez and Maceo C. Jiménez. Of these graduates, only four worked in the agricultural sector, the rest continued on in civil engineering (personal information, J. Díaz-Valderrama, 2013.). Another

important agronomic institution in this time period was the Escuela de Agronomía y Medicina Veterinaria de Antioquia, founded in 1916, which later became the Facultad de Ciencias Agropecuarias of the Universidad Nacional en Medellín (Cuéllar, 1995).

The agronomic knowledge that pervaded the world came from Europe and was based on European agriculture and the experiences of European colonies. This knowledge, along with the basic sciences, formed the foundation for the first agro-professionals in Colombia. Organizing and starting agronomic and veterinarian studies was not easy; there were no professors. And so, the government signed an agreement with a Belgian foundation headed by professor Charles Denemoustier to help start agronomy. Charles Denemoustier had already started the agricultural school Santa Bárbara in Lima, Perú (Macias, 1978).

The Escuela Superior de Agricultura in Bogota disappeared around 1922 due to contradicting policies and social. Meanwhile, in Antioquia, the poor economy led to the closure of the Escuela de Agricultura after only two and half years; after overcoming the difficulties of 1920, the first seven students graduated in September of 1922 (Macias, 1978). The first class of the Escuela Superior de Agricultura Tropical de Cali was organized based on decreto 262 del 20 de agosto de 1934 of the Gobernación del Valle del Cauca; and today is known as the Facultad de Ciencias Agropecuarias of the Universidad Nacional, Palmira (Ibarra, 1966).

Due to the fact that the relationship between education and production was insufficient and that there was no apparatus for generating technology at that time, the government, through the Ministerio de Agricultura and the agricultural secretaries of the country's departments, created agricultural farms where a weak process of technology diffusion began. As stated by Balcázar (1986), during this time, the generation and transfer of agricultural technology was principally furthered by international entities of agrochemical supplies and machinery. This process started in the countries where the modernization and industrialization of agriculture had reached a high level. As a consequence, the production methods and combinations of resources, land, work, supplies and equipment among others were related to the problems specific to those countries, which were very distinct from those of Colombia.

In the first half of the last century, the pedagogical systems of the universities focused on the quality of the teachers, who were well-regarded and had a wealth of experience in

other areas. In Colombia, many of the teachers were Cuban, Puerto Rican and Mexican for the technical professional areas and European for the basic sciences; brought by the sugar refineries, tobacco companies and coffee producers in missions contracted by the government (Macias, 1978).

After the Second World War and the “época de la violencia” in Colombia, the process of intensive production began in order to feed the growing urban population. Furthermore, a large offering started with an emphasis on technological machines such as tractors and motor pumps, along with the construction of districts of risk, the use of agrochemicals such as fertilizers, insecticides and fungicides and an offering of technology, principally of improved seed varieties developed on the experimental farms of the Departamento de Investigaciones Agropecuarias (DIA), with the objective of increasing quality and yield and broadening the agricultural frontier.

Creation of the Facultad de Agronomía

The sixties were pivotal for the rural sector because there were important events as the beginning of the agrarian reform. It was discovered that small producers provided close to 60% of the food needed by the Colombian population; the insufficiency of the knowledge of the production and agrarian sectors was evident (Cuéllar, 1995).

In 1960, the number of spaces for students in the agronomic faculties in the country did not meet the demand, leading to the Universidad Nacional de Colombia, at the instigation of the professors of the Facultad de Medicina, forming the first class of Agronomy in Bogota. This allowed the faculties of Palmira and Medellín to add to the number spaces for the second year (Macías, 1978). In 1962, the Consejo Superior Universitario (CSU) authorized the running of the third year of Agronomy with a branch at the Instituto de Ciencias Naturales, a decision leading to the creation of the Facultad de Agronomía in Bogota (Torres, 2013) through Acuerdo 048 del 12 de junio de 1963 with the Rectoría of professor José Félix Patiño (Bermúdez, 1983). 1965 saw the graduation of the first class of the Facultad de Agronomía with 52 students.

The agronomic engineers of the sixties sought to integrate research with teaching and continuing education in agriculture. This goal started to come to fruition in 1962, giving rise to the Instituto Colombiano Agropecuario (ICA) on June 15 through decree 1562, using the existing Departamento de Investigaciones Agropecuarias (DIA) as a basis.

Halfway through the same year, representatives of Ford, Kellogg and Rockefeller arrived in Colombia in order to promote the development of the ICA, taking advantage of the works carried out by the DIA with the latter. As a result, the establishment of the first school in Colombia for post-graduates in agronomy and veterinary sciences was studied with the support of the three foundations (Macias, 1978).

Opening of the Escuela de Posgrados

The needs of producing food for a growing urban population and of developing technology in the agricultural sector brought about diverse consequences in the study of Agronomy: the strengthening of the relationship between theory and practice, the establishment in some faculties of the “practical semester”, highlighting the importance of regional knowledge especially for climate and soil, emphasizing the need for masters and specialized degree programs in various disciplines and the need to strengthen technological and scientific research (Cuéllar, 1995). In this vein, the Universidad Nacional de Colombia and the ICA came to an important agreement that involved the faculties of Agronomía y Medicina Veterinaria and Zootecnia in Bogota. This agreement gave birth to the Programa de Estudios para Graduados (PEG) with the goal of preparing professionals with advanced university education in the field of agricultural sciences in accordance with Acuerdos 82 de 1969 and 76 de 1980 of the Consejo Superior Universitario (CSU).

The PEG was a successful enterprise and marked the well-executed training of professionals who were specialized in the agriculture of Colombia and various Latin American countries. The agreement lasted until 1983. In the last year, the agreement was modified and, through Acuerdo 175 de 1983 of the CSU, formally started the programs: Magister en Fitotecnia, Magister en Sanidad Vegetal and Magister en Suelos in the Facultad de Agronomía, forming today the Escuela de Posgrados (Facultad de Agronomía, 2004a).

In 1994, the Consejo Superior Universitario, with Acuerdo 88, approved the creation of the Magister en Ciencias Agrarias program with research on Entomology, Crop Physiology, Phytopathology, Integrated Phytprotection, Genetics and Plant Breeding, Malherbology and Soils and Water. The name Programas de Magister was replaced with Programas de Maestría en Ciencias Agrarias by the Consejo Superior Universitario through Acuerdo 47 de 1995. In the same year, the CSU used Acuerdo 65 to approve the creation of the Doctorado en Ciencias Agropecuarias, área

Agraria and, in 1998, the incorporation of the Desarrollo Empresarial Agropecuario into the Maestría en Ciencias Agrarias with Acuerdo 39 de 1998 of the Consejo de Sede. The creation of postgraduate programs at the Facultad de Agronomía strengthened research, which increased starting in 1983.

In 2001 and 2002, programs that specialize in Horticultura and Desarrollo Rural were approved by agreements 07 and 08 in order to broaden the coverage of the discipline areas and to support the regions. Furthermore, in 2003, the Consejo Académico, with Acuerdo 06, authorized the opening of the Maestría en Geomática through an interinstitutional agreement with the Instituto Geográfico Agustín Codazzi. In conjunction with the Universidad de Córdoba, in 2001 and 2002, the Maestría en Ciencias Agrarias offered studies in Crop Physiology and Agricultural Company Development; the latter was also offered by the Universidad Pedagógica y Tecnológica de Colombia (UPTC) in 2002 and 2003. The offering of regional postgraduate programs was increased in 2005 when the palm producers represented by Fedepalma encouraged the start of the Especialización en Cultivos Perennes Industriales, which is rotated between the branches of: the Universidad de los Llanos, the Universidad Cooperativa del Cesar, the Universidad de la Paz and the Universidad de Pamplona (Facultad de Agronomía, 2004a; Facultad de Agronomía, 2012).

In the same vein, the Escuela de Posgrados offers advanced training geared towards updating, delving into and the development of basic research and as applied in different areas of the academic programs in order to generate the needed foundation for the broadening, adaptation and application of the knowledge inherent to the field of agriculture.

Undergraduate thesis for the development of agricultural research and knowledge dissemination

For the Facultad de Agronomía, agriculture is an essential human activity with a social function, forms civilization and is necessary for the survival and well-being of humanity (Facultad de Agronomía, 1999). The mission of the Facultad, as far as the training of professionals is concerned, is to contribute to the nation, to the articulation of the regions of the country and to the connection with the international scene; to preserve, assimilate, develop and share universal agricultural knowledge, which are facilitated by the Facultad's research, teaching, continuing education and interaction with the academic community

and the production sector for the benefit of society and the government.

In regards to the mentioned aspects that bring an outlook of science, autonomy and social commitment, it will be seen that dissertations have been a basis for the growth of research and the dissemination of knowledge. In the beginning of the Facultad, the professor-student relationship was not very close, generally speaking, in the first semesters but the development of dissertations and the participation in elective courses have led to closer relationships. However, this relationship was restricted by the removal of the dissertation requirement in 1969.

The reform of the study plan in 1977 aimed to transform the unidirectional professor-student relationship by incorporating research processes into teaching. The plan sought to strengthen the relationship between theory and practice and, in this vein, reestablish dissertations and stimulate course research. Fieldwork was increased and part of the research developed by the Facultad was linked to the curriculum (Cuéllar and Mosquera, 2001). The reorientation of dissertations towards the study of specific, local problems was part of the integral and practical solutions that were thought of as policy in the attempt to form professionals capable of regional development (Pérez, 1991). As a result, in the late eighties, laboratory and greenhouse research weakened, as in the case of the Centro Experimental Marengo.

The implementation of dissertations in the reform of 1977 generated a process of approximation of the agrarian sector and of the study of and contribution to the solutions of production problems. This process facilitated the continuation of postgraduate programs in the Maestría en Ciencias Agrarias and Doctorado en Ciencias Agropecuarias (Cuéllar and Mosquera, 2001). Nevertheless, postgraduate theses and dissertations have not been the only opportunity to draw students closer to research. In fact, an important tool has been placing students in group projects related to the formal research of the Facultad.

The need for resources resulted in professors doing research in association with producers on their farms, with the entailing problems and lack of resources. This model predominated until 1994 when changes brought a new focus to the financing system for research by introducing competitions, both open and by invitation, for example by Colciencias, the Ministerio de Agricultura, Fontagro and the University. Said competitions were first for individual projects and later for research programs. This mode of

financing opened the confines to the strengthening of national doctorate programs with vital support for financing researchers in training, visiting researchers and for acquiring infrastructure that is useful in basic and applied research.

Incentivizing research has been a fundamental principle in the developmental plans of the Facultad with a clear, strategic and visible result in the strengthening of the Escuela de Posgrados and the Centro de Investigación y Extensión Rural (CIER), the consolidation of research lines and groups and the dissemination of knowledge through the journal *Agronomía Colombiana*. Currently, the Facultad has ten research groups and two interfaculty research groups that are recognized by Colciencias and that carry out a number of projects, achieving an essential position due to the investigative function and dissemination of knowledge that has been recognized by different associations, research agencies and academics.

The research of the Facultad continues to advance. It has prioritized significant contributions to high-level human resource training, to the production of knowledge and to the development of current technology and to a bright future for the development of agriculture in the country, such as: biotechnology, molecular biology, identification of promising genetic resources and of species with a potential for exportation, production of new varieties of food security species such as the potato and the pea, ecophysiology, postharvesting, application of new foci of interdisciplinary management, environmental relationships and impacts of agriculture, implementation of new methods of soil and water management, integrated pest, disease and weed management techniques, and incorporation of geographical information systems and geo-positioning technologies; aspects that are fundamental in the search for competitiveness and sustainability in agriculture (Facultad de Agronomía, 2007).

Significant successes have been achieved in the continuous activities of disclosure in aromatic species, production, postharvest and exportation of fruits, genetic breeding of horticultural species, fertirrigation equipment, geographic information systems, urban agriculture, bio-supplies, crop protection, biotechnology and molecular biology, natural resource management and sustainability projects, among others. Similarly, continuing education courses have increased in their offering, for which CIER labor has been vital; such as a support center, management and execution of outreach in the Facultad and the

continuous investment of efforts with the expectation that they will produce a greater development or impact (Facultad de Agronomía, 2004b).

The journal *Agronomía Colombiana* as a tool for disseminating knowledge

Chronological development of the journal

In August of 1983, the first number of the journal *Agronomía Colombiana* was edited as a commemoration of the 20th anniversary of the founding of the Facultad de Agronomía of the Universidad Nacional de Colombia, Bogotá. Since then, and for 30 years, the journal has been a tool for sharing and giving visibility to the technical-scientific contents with the goal of indirectly and directly participating in the solution of those problems that negatively affect the agriculture of Colombia and of the tropical region.

The journal *Agronomía Colombiana* was registered in the national science and technology system as a scientific publication in 1989. Initially, the journal was printed at the half-letter size until 1988. Afterwards, the publication was changed to the letter size with the Facultad de Agronomía building on the cover. In 2002, the cover varied for each publication, with photographs of subjects that were related to the content. Later, in 2005, the Comité Editorial decided to change the presentation of the journal to an international format, arranging the articles in the following disciplines: Plant breeding, genetic resources and molecular biology, Propagation and tissue culture, Crop physiology, Crop protection, Postharvest physiology and technology, Soils, fertilization and management of water and Economy and rural development. The journal was published biannually until 2008 and, since then, every four months.

The indexing process of the journal started in 2002. Initially, the journal garnered a C classification in the Índice Nacional de Publicaciones Seriadas, Científicas y Tecnológicas –Publindex. Its entrance in the Scientific Electronic Library Online - SciELO started in 2007 and the journal was given a B classification in 2008. In 2010, the journal was placed in the A2 category in Publindex. The journal is also found in: Network of Latin-American institutions for the dissemination of scientific publications– Latindex and the Network of scientific journals of Latin America, the Caribbean, Spain and Portugal– Redalyc, AGRIS (FAO), CABI Full Tex and CAB Abstracts. Recently, in October of 2012, the journal was accepted into the international index Scopus and the Directory Open Access Journal – DOAJ.

Considering the importance of academic and scientific visibility in the open access for the contents of the journal and that, in recent years, the number of articles by external authors, both domestic and foreign, that have been submitted and published has increased, the Comité Editorial prioritized publishing in the English language. This involved a gradual process that attained 80% of total content in volume 28, number 3 of 2010 and 100% of total content since volume 29, number 1 of 2011. In the growth and scientific contribution to the journal *Agronomía Colombiana*, has done to society has been essential interest, effort and dedication of 10 teachers of the Facultad de Agronomía that have been editors of the journal, and recently directors Editorial Center of the Faculty.

Orientation of the journal publications

The publication of technical-scientific articles in serial and index publications along with postgraduate theses and dissertations reflects the orientation of the generated scientific knowledge, here agricultural science (Arango, 2005). The orientation of the publications of the journal *Agronomía Colombiana* corroborates the disciplinary emphasis established in the Facultad de Agronomía, which has outlined the very specific norms of the theses and dissertations in Agronomic engineering and related postgraduates and reflected the development of the productive sector and the financial sources of the research.

Table 1 shows the participation percentage by discipline in the numbers of research, review, revision and scientific note articles published during the three ten-year periods; there were no statistical differences between the first and second periods with 145 and 185 articles respectively in *Agronomía Colombiana*. In contrast, the third period had 425 published articles, a number that has statistically significant differences with the numbers from the first two periods.

The significant increase in the number of articles published in the last period (2003-2012) is due to the incentivizing state policies that, in recent years, have been instated to stimulate expenditures in science and technology (S&T) of the agricultural sector in Colombia, representing: an average annual increase of 2.6% in the total of full-time equivalent (FTE) agricultural researchers in the public sector, growing from 540 in 1981 to 999 in 2006 and a progressive increase in total expenditures for S&T from 300 billion Colombian pesos in 1998 to 423 billion pesos in 2003 (as adjusted to 2003 prices) (Stads and Romano, 2008). Additionally, in 2012, Colombia invested 0.45% of its gross domestic product (GDP) in S&T, an increase from 0.39% in 2004 and 0.30% in 1995 (OCyT, 2012).

Another factor that has favored an increase in published articles is the diversification of institutional structure and of the focus of agricultural research and development (R&D) in Colombia. In the early eighties, there was almost exclusive dependence on only one national agricultural research institute. In addition, there has been an increase in the research activities undertaken by producer associations and universities. In 1981, the researchers of the ICA/Corpoica represented 71% of the agricultural R&D personal. This percentage has progressively fallen in the passing years with 53% in 1991, 36% in 2001 and 27% in 2006 (Stads and Romano, 2008).

It is worth mentioning that, in the 2003-2012 period, the higher education sector reached the highest percentage of researchers with doctorates. In regards to other research institutes, such as Corpoica and producer entities, the registration of research groups in the national system of science and technology has grown from 725 in 2003 to 12,774 in 2011, accelerating the bibliographic production of authors linked to Colombian institutions in the journals indexed in the Web of Science of the agricultural sector,

TABLE 1. Disciplinary classification of the Revista *Agronomía Colombiana* articles during the three ten-year periods.

Discipline	Period 1983-1992		Period 1993-2002		Period 2003-2012		All 30 years	
	Number	%	Number	%	Number	%	Number	%
Plant breeding, genetic resources and molecular biology	22	15.17	25	13.51	56	13.18	103	13.64
Propagation and tissue culture	5	3.44	13	7.02	18	4.26	36	4.77
Crop physiology	24	16.55	33	17.84	98	23.06	155	20.53
Crop protection	61	42.06	61	32.97	91	21.41	213	28.21
Postharvest physiology and technology	3	2.06	7	3.78	28	6.59	38	5.03
Soils, fertility and management of water	16	11.03	19	10.27	72	16.94	107	14.17
Economy and rural development	14	9.66	27	14.59	62	14.59	103	13.64
Total	145 b	100.00	185 b	100.00	425 a	100.00	755	100.00

Values in the last row with the same letter do not have significant differences according to the Tukey mean comparison test ($P \leq 0.05$).

increasing from 895 articles in 2003 to 3,462 in 2011; and in the journals indexed in Scopus, increasing from 1,022 articles in 2001 to 5,047 articles in 2011 (OCyT, 2012).

The disciplines with the two higher numbers of article contributions in *Agronomia Colombiana* from 1983 to 2012 were Crop protection with 28.21% and Crop physiology with 20.53%, as compared to the other topics (Table 1). It is noteworthy that the contributions from the field of Crop protection decreased from 42.06% in the first period to 32.97% in the second period and further decreased to 21.41% in the period of 2003-2012. This was due to the fact that, during the first two periods, the publications were the products of dissertations and of professors and researchers of the projects developed by the Facultad. In this period, research on phytosanitary problems in flowers and cacao predominated, with a contribution of 33.92% for crops and 29.20% for flowers during the first and second periods and with 20.54% for perennial species of warm climates, mostly for cacao in the first period but with a drastic decrease in the second period (Tab. 2). In the third period, the scientific divulgence for flowers in *Agronomia Colombiana* decreased to 7.64%, a result of the importation of foreign technology by Ceniflores (Stads and Romano, 2008).

On the other hand, Crop physiology, in the first period, contributed 16.55% of the articles published in *Agronomia Colombiana* with articles on vegetable species, cereals in cold climates and grasses. This percentage increased to 23.06% in the third period with contributions principally on flowers, vegetables, fruits, the potato and perennial species (Tab. 2). The prioritization of species depends on the financial support of production chains and on the specialization of teachers and researchers; on the diversity of the other institutes that submit their products for publication in the journal and on the limitations imposed on

the production sector by the market changes that regulate the export prices.

The increase in the percentage of publications related to fruits is noteworthy, with increases from 8.04 to 24.09 and to 27.57% from the first to second period and from the second to the third, respectively. This coincides with the results of surveys carried out by IFPRI 2007-2008 for 38 agricultural research agencies (seven of which were governmental agencies), 13 national research centers, and 18 higher education agencies in Colombia. Said results showed that fruits in the country receive the focus of most research in the higher education sector, with 55% of all research being carried out on fruit. Similarly, 23% of the researchers at Corpoica are primarily focused on fruits, followed by the potato and vegetables, products that also stand out for the growth in number of publications in *Agronomia Colombiana* (Stads and Romano, 2008).

The development of the areas of agronomic disciplines depends on the application of new knowledge as implemented by external development and research agencies and the need to construct agricultural development of the country by the production chains. In this sense, the seven topics and the nine product groupings, as related in Tab. 3, comprise the 30 years of contributions to the journal *Agronomia Colombiana* for the dissemination of agricultural knowledge in the tropical zone.

Table 3 shows, for the publications in the journal *Agronomia Colombiana*, the highly significant associations between the disciplines Plant breeding, genetic resources and molecular biology in the potato; the Physiology of crops with fruits, vegetables and aromatic species; Crop protection with flowers and warm climate crops; Postharvest with fruit species and the area of Soils, fertilization and management of water with fruits and aromatics. An

TABLE 2. Crop classification of the articles of the journal *Agronomia Colombiana* during the three ten-year periods.

Crop	Period 1983-1992		Period 1993-2002		Period 2003-2012		All 30 years	
	Number	%	Number	%	Number	%	Number	%
Flowers	38	33.92	40	29.20	23	7.64	101	18.36
Vegetables	7	6.25	20	14.60	67	22.26	94	17.09
Fruits	9	8.04	33	24.09	83	27.57	125	22.73
Potato	2	1.79	23	16.79	49	16.28	74	13.45
Cold climate cereals	12	10.71	9	6.57	9	2.99	30	5.45
Warm climate annuals	8	7.14	4	2.92	14	4.65	26	4.73
Warm climate perennials	23	20.54	5	3.65	40	13.29	68	12.36
Forest	13	11.61	3	2.19	4	1.33	20	3.64
Aromatics	0	0	0	0	12	3.97	12	2.18
Total	112 b	100.00	137 b	100.00	301 a	100.00	550	100.00

Values in the last row with the same letter do not have significant differences according to the Tukey comparison of means test ($P \leq 0.05$).

opposite response occurred in the fields Plant propagation and Economy and rural development, which did not correlate with the crops. That is to say, they are transversals without specificity by plant species.

The grouping of the disciplines of the Journal presented isolated foci with limited complementation because, of the 21 possible associations between the seven fields, there were significant degrees of association in only three of them: Crop physiology and Soils attained a positive coefficient of correlation ($r = 0.31$), the opposite occurred with the association between Physiology and Postharvest with Crop protection, that is to say, with publications in the first two areas, there is a decrease in Protection publications. The other possible relationships were not statistically significant or the relationship was independent where the agrarian disciplines contribute to each other, aside from the purpose of being a new agricultural science (Tab. 3).

When observing the association between the articles published in the Journal by products, it appeared that flowers were the product that presented the highest significant relationship, with a negative relationship with the publication

of articles on vegetables, fruits, the potato and warm climate crops, possibly because, in the first two periods, the Journal was dependent on the results of the research of the Facultad, with the primary topic being research on flower crops and, in the third period, the research diversified towards vegetables, the potato, fruits and aromatics with notable positive associations between the publications on vegetables with those of fruits and aromatics; those of fruits with those of the potato and those of aromatics and those of the potato with those of aromatics; a response to the contribution of the products of the research of the Facultad de Agronomía and to the high number of external researchers that contributed their publications to *Agronomia Colombiana* (Tab. 3).

Figure 1 presents the percentage of participation in the undergraduate thesis and theses for the period of 1970 to 2012. The high level of contribution from the fields of Crop protection with 31% of the 1821 publication sample and of Soils, fertilization and management of water with 19% was notable. Furthermore, Fig. 2 shows the contribution seen from fruit crops with 22%, from vegetables with 18%, from flowers with 16% and from the potato with 12%, products that, as previously mentioned, capture a high percentage

TABLE 3. Degree of association between the disciplines, crops and disciplines and between the crops, according to the articles published in the journal *Agronomia Colombiana*. 1983-2012.

	Propagation	Physiology	Protection	Postharvest	Soils	Economy and rural development	Flowers	Vegetables	Fruits	Potato	Cold climate cereals	Warm Climate Annuals	Warm climate perennials	Forest	Aromatic
Plant breeding	0.23	0.07	-0.06	0.10	-0.01	-0.03	-0.11	0.08	0.16	0.42**	0.25	0.23	0.03	0.00	-0.03
Propagation	1.00	0.04	-0.22	0.01	0.00	-0.13	0.02	0.13	0.24	0.04	-0.01	-0.17	-0.05	0.09	0.15
Physiology		1.00	-0.33*	0.17	0.31*	0.08	0.34*	0.58**	0.44**	0.21	0.02	0.10	0.14	-0.03	0.39**
Protection			1.00	-0.29*	-0.17	-0.16	0.51**	-0.20	-0.24	-0.04	-0.24	0.01	0.36**	0.06	-0.02
Postharvest				1.00	0.25	0.02	-0.27	0.21	0.51**	0.13	-0.12	0.08	0.07	0.07	0.16
Soils					1.00	0.11	-0.27	0.11	0.39**	0.32*	0.04	0.27	0.08	0.03	0.39**
Economy and rural development						1.00	-0.16	-0.03	0.03	-0.03	0.04	0.25	-0.15	-0.14	0.01
Flowers							1.00	-0.28*	-0.36**	-0.29*	-0.13	-0.20	-0.28*	0.16	-0.21
Vegetables								1.00	0.33*	0.12	-0.22	-0.11	0.03	-0.26	0.32*
Fruits									1.00	0.30*	-0.05	0.05	0.01	-0.12	0.28*
Potato										1.00	-0.08	0.22	-0.01	-0.29*	0.36**
Cold climate cereals											1.00	0.22	-0.10	-0.06	-0.14
Warm climate annuals												1.00	0.03	-0.03	0.01
Warm climate perennials													1.00	-0.07	0.11
Forest														1.00	-0.12

Significance of the Pearson coefficient of correlation, * significant ($P \leq 0.05$), ** highly significant ($P \leq 0.01$); observed correlations = 53.

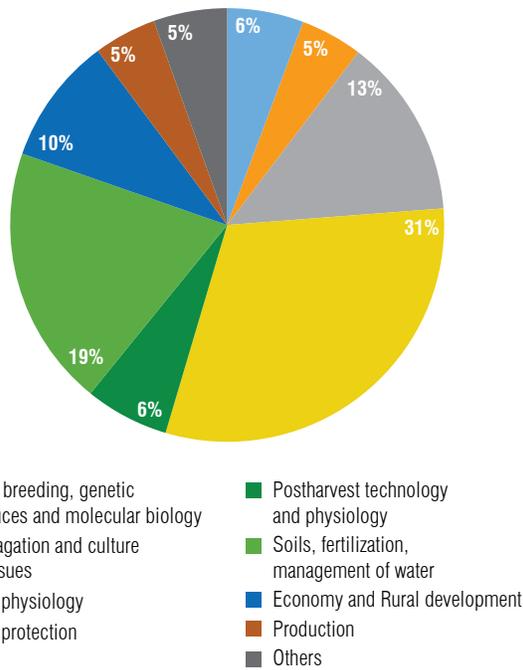


FIGURE 1. Undergraduate thesis and theses according to the disciplines of the Ingeniería Agronómica, Facultad de Agronomía, Bogota, 1970-2012. Sample size = 1,821.

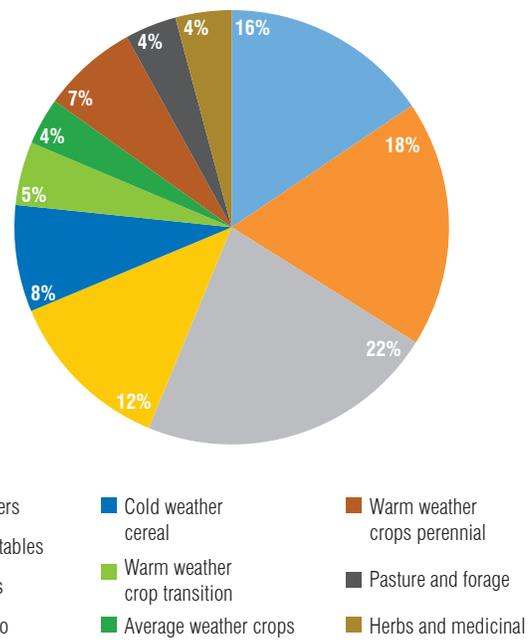


FIGURE 2. Undergraduate thesis and theses according to the crops or products, Facultad de Agronomía, Bogota, 1970-2012. Sample size = 1,821.

of the financial resources and scientific personal dedicated to research and to the development of the country (Stads and Romano, 2008).

After the growth of the capacity for research reflected in the protection of crops and in the development of flower and perennial cultivation in the eighties in the Facultad de Agronomía, research stabilized in the nineties and, in the first decade of the new millennium, research with an emphasis on fruits, vegetables, the potato, flowers and perennial crops increased. When considering the contributions in research and knowledge sharing, it is evident that the Facultad, since its creation, has produced significant contributions to the process of integration in the Colombian agricultural sector and to the increase in productivity and competitiveness of the sector through the pursuit of its academic, research and continuing education missions.

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