FACTORS AFFECTING AGRICULTURAL RESEARCH[1]

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ABSTRACT
Research establishments bear the imprints of researchers backgrounds and sociodemographic characteristics. Institutions, in turn, shape research practices and influence researchers' motivations to pursue basic and applied lines of research. Based on the analysis of a national survey of agricultural researchers, the purpose of this paper is two-fold: to characterize the community of agricultural researchers and to assess sources of influence on their research. Evidence is provided of the extent to which sociodemographic and institutional factors influence the process of research in agricultural sciences in Uruguay.
Key words: institutional influences, research motivations, agricultural researchers, Uruguay.

FATORES QUE AFETAM A PESQUISA AGROPECUÁRIA

RESUMO
As organizações de pesquisa revelam os antecedentes e as características sociodemográficas dos seus pesquisadores. As instituições, por seu turno, afetam as atividades de pesquisa e influenciam as motivações dos pesquisadores quanto à orientação da investigação básica e aplicada. Este artigo, baseado na análise de um levantamento nacional sobre os pesquisadores agropecuários, tem dois objetivos principais: caracterizar a comunidade de pesquisadores agropecuários e identificar os fatores que os influenciam na prática de pesquisa. Os resultados evidenciaram a extensão da influência dos fatores sociodemográficos e institucionais no processo de pesquisa na área de ciências agrícolas do Uruguai.
Palavras-chave: influências institucionais, motivações de pesquisa, pesquisadores agrícolas, Uruguai.

INTRODUCTION

Four decades ago, Latin American agricultural research systems were fostered to provide knowledge that could improve the economy and living standards of

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millions of people that directly or indirectly depend on agriculture. Agricultural research has played a central role in the generation and adaptation of technologies and production methods, providing opportunities for scientific training, and advising governments on agricultural development policy. While research is intertwined with a multiple set of interests (institutional, political, academic, economic, social) at the end, it basically rests on researchers and administrators considerations. Research direction and the utility of research results depend, to a large extent, on scientists' decisions and actions. Research establishments are composed by researchers and they bear the imprints of their backgrounds and sociodemographic characteristics. Based on this idea, this study provides evidence of the extent to which sociodemographic and institutional factors influence the process of research in agricultural sciences.

Traditionally, institutional settings and individuals have been the analytical categories of the sociology of science. Early studies indicated that the institutional organization of science influences the direction of scientific research and scientists' motives could be redefined according to different institutional contexts. Inquiring about scientists' motivation for research, Merton (1957) suggested that the same motivations in different institutional settings have different social expressions, and as well different motives may have similar social expressions in a given research context. If research institutional settings influence scientists' motivations for research, we need to know whether the different social contexts in which scientific research is undertaken determine the type of research that is being conducted. In agricultural sciences, where typically two research settings exist (the research institute and the university) we need to assess different motivations for research found among scientists in each of them. Accordingly, we need to know if researchers working in institutions with different organizations of research share different personal and academic characteristics.

A second major contribution in the understanding of the dynamics of science advances that, as a social enterprise, science results from the context in which it is conducted, the interaction among researchers, and their sociodemographic characteristics. In his analysis of the different elements of a paradigm or disciplinary matrix, Kuhn proposes that although scientists are committed to shared values which bind them together, the application of values is affected by the individual characteristics of the group members (Kuhn, 1970). Following this assertion, a sociological analysis of scientists should be able to identify different groups of scientists that share similar social and demographic

characteristics who in turn conduct similar types of research. This paper examines the way in which different social and demographic characteristics of agricultural researchers such as gender, social origin, educational background, and age influence their research.

METHODOLOGY

Fieldwork for this study was conducted from November 1997 to July 1998 involving the two largest institutions conducting agricultural research in Uruguay: the national agricultural research institute (Instituto Nacional de Investigación Agropecuaria – Inia) and the state university (Universidad de la República)[3] . A series of 26 in-depth interviews with key informants in Inia and the University was carried out in order to have a first contact with the subjects of this study. Further, a survey of agricultural scientists was conducted in both institutions under study, which provided the bulk of data for the analysis presented in this paper.

The novelty of the topic under investigation for the Uruguayan case made it necessary to identify the population under study in order to make further data collection possible. The research design is exhaustive including the major institutions engaged in agricultural research in the public and semipublic sector. The universe of this study is the total population of agricultural science researchers working at the Colleges of Agronomy and Veterinary of the Universidad de la República and at Inia[4] . Based on data collected from the University Research Council – CSIC[5] – and the Projects Unit at Inia, the universe of study was defined by 77 Inia researchers, 70 Veterinary professors, and 94 Agronomy professors. All 241 scientists were included in the survey. A pretest of the survey

[3] Inia was created in 1989 in order to design and develop agricultural research programs. The institute is funded by a tax of 0.4% levied on the value of most marketed agricultural products and a government contribution that matches the funds collected via tax. The UR, created in 1849, is Uruguay's state university. As the only institution providing education and conducting research in all fields of knowledge, UR has been the main center for knowledge development in the country. It is administratively and politically autonomous, although it is funded by a portion of the nation's budget.

[4] For the purpose of this study, only principal investigators were considered researchers. Professionals who participate in research projects but do not have responsibility in the design and development of research activities were not considered in the study.

[5] Comisión Sectorial de Investigación Científica – CSIC – is a centralized body for the allocation of competitive research grants throughout the University. During the period 1992-97, CSIC annual budget for research averaged US$ 3.753 million (CSIC, 1998).

instrument was conducted in late February 1998 on a group of 12 retired researchers and university professors not included in the sample. Nine questionnaires were eliminated because of retirement or abandonment of research activities, obtaining a corrected sample of 232 researchers. Of these, 169 completed the survey, achieving a 73 percent response rate across the three institutions.

The survey instrument consisted of a self-administered questionnaire, which included a major proportion of precoded items and several open-ended questions. Most response alternatives to closed questions were developed based on the answers obtained in the series of key informant interviews or inspired on previous studies (Busch & Lacy, 1983; Sousa, 1993).

Gender, age and education

The participation of women in agricultural research has traditionally been low. Although their proportion in science has been increasing, women have concentrated on medicine, the humanities and social sciences (Schwartzman, 1993; Shauman & Xie, 1996). In the sample of Uruguayan agricultural scientists, 32 percent are women. This proportion appears as substantially large considering the proportion of women in agricultural sciences found by previous research in other countries such as Brazil (17 percent) in Sousa's study (1993) and the U.S. (8 percent) as reported by Buttel & Goldberger, (1998).

The University has 35.2 percent of female researchers[6]. The highest proportion is found in the College of Agronomy with 40.5 percent followed by a 27.5 percent in the College of Veterinary Sciences. Inia has the lowest proportion, 22.7 percent.

The age distribution of agricultural researchers is shown in Table 1. According to our sample, the highest percentage of researchers is concentrated in the age group between 36-45 years with 43 as the average. While there is no difference in the mean age for the three institutional settings considered in this study, age distribution is not homogeneous across institutions. As seen in Table 1, researchers

[6] An examination of the sex distribution according to university position shows that proportionately more women than men are found in the lower academic ranks. Although the difference is not statistically significant, those women who enter the circle of university science tend to be in lower academic positions compared to men. Additionally, no difference was found in the education credentials of male and female researchers that could account for this trend (data available on request).

Table 1. Age Distribution of Agricultural Scientists by Institution.

Age Group	Agronomy (n = 74)	Veterinary (n = 50)	INIA (n = 44)	Total (Sample)
26 - 35	13.5	28.0	18.2	19.0
36 - 45	60.8	28.0	47.7	47.6
46 - 55	20.3	38.0	31.8	28.6
56 and more	5.4	6.0	2.3	4.8
Total	100%	100%	100%	100%
Mean	42,8	42.9	42.7	42.8

$\chi^2 = 14,47$; df: 4; p = 006; n = 161. Due to the existence of cells with expected frequencies less than 5, the test was conducted for the first three age groups.

in the Agronomy Faculty and Inia were concentrated in the 36-45 age group. Researchers in the Veterinary Faculty are more equally distributed across age groups than in the other two institutions, but show a higher proportion at the 46-55 age group.

It has been suggested that younger scientists are more willing to accept new methods and ideas within their fields of science as well as to respond effectively to changing circumstances (Kuhn, 1970). Human capital-related theories propose that there is a life-cycle effect meaning that as researchers get older they are less productive and less willing to accept alternative theories (Stephan, 1996)[7]. According to this notion, researchers in Agronomy and Inia would be more likely to change and embrace new directions for science than Veterinary scientists. In reference to age, one key informant indicated that agricultural research in Uruguay "is always running behind" because it lacks flexibility to change and accommodate to new situations and demands from the agricultural sector.

The extent of formal education of researchers is commonly assumed to associate with the strength of a research community. To determine the educational level of agricultural researchers the survey registered the highest degree of respondents. As shown in Table 2, the majority of agricultural scientists in

[7] This idea is usually known as the Planck's principle since Max Planck stated that "a new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it." (Planck, 1949 quoted in Stephan, 1996).

Table 2. Percentage Distribution of Researchers' Education by Institution.

Degree	Agronomy	Veterinary	Inia	Total
Bachelor	36.6	60.0	18.2	38.8
Master	39.4	26.0	59.1	40.6
Ph.D.	23.9	14.0	22.7	20.6
Total (n = 165)	100	100	100	100

$\chi^2 = 18.59$; d.f.: 2; p = .001; n = 165.

Uruguay (61.2 percent) have a graduate degree. Researchers with a Masters degree are 40.6 percent and researchers with a Ph.D. are 20.6 percent of the sample. Compared to data from Brazil where several graduate programs in agricultural sciences exist, the proportion of Uruguayan scientists with a doctoral degree is high. In his survey of agricultural researchers in the Brazilian public sector, Sousa (1993) found that 49 percent of scientists had Master degrees and only 12 percent had a Ph.D[8] .

The level of educational attainment of agricultural scientists differs for each research institution. Inia researchers have the largest proportion of postgraduate degrees with 82 percent of the respondents holding a Masters or Doctoral degree. The College of Agronomy has a smaller proportion of researchers with postgraduate degrees but still, they are the majority among the college faculty (63 percent). The College of Veterinary Sciences has the least graduate degrees with 60 percent of the faculty trained only at the Bachelors level[9] . Additionally, no significant relationship was found between researchers' gender and education

[8] It needs to be taken into account that Freire de Sousa's data were collected during 1986-87. Proportions might have increased by the time his results were published in 1993 and are at present probably closer to the Uruguayan results. Today, 50% of Embrapa researchers hold PhDs (Embrapa, 2001); the institute comprises about 40% of Brazilian agricultural researchers.

[9] It is to be noted that the requirements for a Dr. of Veterinary Medicine within the College of Veterinary include six years of courses.

with similar proportions of female and male researchers in each educational level (data available on request)[10] .

Overall, studying abroad was until very recently the only opportunity for Uruguayans to receive a graduate education. Even now, graduate opportunities in Uruguay are limited and at the time of the survey there were no graduate programs in the Universidad de la República in any agricultural field. The few agricultural scientists who earned a graduate degree in Uruguay were trained in one of the basic sciences (genetics, biology, physiology, and chemistry) rather than in agricultural disciplines. Most agricultural scientists working in the Universidad de la República were trained at the national level. In addition, one fifth of the faculty were trained in Europe, and smaller portions received their highest degree in Latin America and the U.S. By contrast, most Inia researchers were trained abroad and slightly over one fifth of the total received their highest degree in Uruguay. In addition, the training has been concentrated in a few countries with the largest proportion of Inia scientists studying in the U.S. Similar to their university colleagues, smaller proportions studied in Europe and Latin America. The distribution of countries where Inia scientists receive their higher training is the result of an explicit institutional policy to promote the training of the research personnel in academic institutions of more developed countries. Inias first board of directors recommended graduate programs in the U.S.A., Australia, and New Zealand based on the good quality of the educational institutions in those countries. An agreement signed with the International Development Bank provided funds to support the training of Inia researchers in cooperation with an association of nine American universities led by Michigan State University. No specific funds were obtained to send researchers to Australia or New Zealand. The availability of funds is the fundamental reason why so many Inia researchers were trained in the United States.

Overall, agriculture related professionals were encouraged to pursue graduate degrees abroad earlier than scientists in other disciplines. In the late 1950s and early '60s, agronomists were encouraged to join graduate programs abroad (Porzecanski & Díaz, 1986). During that time, the Alliance for Progress encouraged agricultural development projects throughout Latin America including

[10] In addition, a comparison of age distribution showed no significant differences between male and female mean ages (F=1.59; d.f.: 1; p=.209).

funds for agricultural professionals to study overseas. A key informant has indicated that at that time, "there was a lot of money for agricultural development. One only needed to say 'I want to study abroad' and he or she would get a scholarship. And there were very good scholarships available."

Nevertheless, an examination of the graduation years of current researchers reveals that most graduate training of Uruguayan scientists occurred during the '90s. Only a handful of agricultural researchers pursued graduate degrees before the 1980s. By the mid-1980s graduate training gained popularity with an increased number of researchers interested in improving their education. Almost two-thirds of university scientists and three-fourths of Inia scientists with Masters or Ph.D.s obtained their degrees on or after 1991 (data available on request). Many more Uruguayan researchers not included in this sample have earned graduate degrees abroad, but are no longer working in the country. Because of the lack of opportunities, Uruguay is not very effective in retaining highly trained scientists. Although quantitative data are not available on this topic, one key informant suggested that "the main tragedy of agricultural sciences in Uruguay, and of many other scientific fields, is the lack of continuity. People are sent abroad, they receive graduate training, but some return and some others do not. Even the ones who return may stay working at home for sometime and then leave again to work in other countries."

Additionally, another avenue of study open to researchers is short-term training (not leading to a graduate degree) in foreign countries. Since it was created in 1992 within the University, CSIC has funded an average of 30 internships each year for agricultural researchers to conduct research outside Uruguay (CSIC, 1998). The internship program contributes to the training of local researchers in more advanced institutions, favors the exchange of ideas about specific disciplines and research topics, and facilitates the formation of networks which are vital resources for a scientific community as reduced as the Uruguayan.

Scientists' Residential Origin

In addressing the influences that personal characteristics and social backgrounds may have on the practice of agricultural sciences, an examination of the residential background of scientists is in order. Because the agricultural sciences are interested in a specific sector of society, understanding the experience

of scientists with agricultural production may shed light on the way research is oriented. Also, studies in other countries have found that farm background affects agricultural scientists' work (Busch & Lacy, 1983; Sousa, 1993).

Two indicators were used in order to explore the agricultural background of scientists: the locality where they resided until age 16, and the existence of a close relative who had worked or owned a farm until the same age. Age 16 is a transition point because at that age youngsters finish the basic (compulsory) secondary school cycle after which they can either join the work force or continue studying. For any of these options, migrating to a different place is very common.

Scientists were asked to indicate the place where they lived most of the time until age 16. Survey results indicate that agricultural researchers in Uruguay are overwhelmingly urban. Only 2.4 percent of university researchers and 11.4 percent of Inia researchers come from rural backgrounds. This is consistent with the fact that Uruguay is one of the world's most urbanized countries. In 1996, 91 percent of the population was classified as urban[11] . Table 3 shows that in our sample of agricultural scientists, two thirds lived in the nation's capital until age 16. This is a high proportion compared to 42 percent of the general population living in Montevideo. Additionally, 20.7 percent of researchers lived in other capital cities in Uruguay and only 11.8 percent lived in smaller cities and towns. Those who lived outside Montevideo tend to maintain social networks in

Table 3. Percentage Distribution of Researchers by Origin Indicators.

	University	**Inia**	**Total**	**n = 169**
Residential origin				
Montevideo	72.0	54.5	67.5	χ^2 = 8.03
Interior Capital Cities	19.2	25.0	20.7	df: 2 p = .091
Other localities	8.8	20.5	11.8	
Relative on farm				
Yes	46.4	52.3	47.9	χ^2 = .450
No	53.6	47.7	52.5	df: 1 p = .502

[11] Urban residents are defined as living in towns of 2000 inhabitants or more (INE, 1997).

"the interior"[12] where most agricultural production takes place. In this sense, they are closer to the objects of study of agricultural sciences and might be more familiar with production needs and problems.

Some differences exist in the distribution of residence according to the institutional affiliation of researchers. Inia researchers are more likely than University faculty to have spent their youth in the Interior with one-fifth having resided in smaller localities. This phenomenon is probably affected by the fact that this institution is decentralized in five regional centers based outside Montevideo recruiting some of its research personnel from the local population. University researchers predominantly lived in the nation's capital and other departmental capital cities when they were young.

The second indicator of social origin reveals that in the general sample, 47.9 percent of the scientists were in some way or another exposed to the world of agricultural production by the presence of a close relative living or working on a farm. No significant differences by institution were found with both University and Inia researchers having about half of their research personnel experiencing some kind of farm life when they were young.

Research Motivation and Practices

The selection of research lines by researchers is assumed to be linked to fundamental motivations for research. Merton indicated that scientists may be motivated by "a disinterested desire to learn, by hope of economic gain, by active (…) curiosity, by aggression or competition, by egotism or altruism" (Merton, 1957, p.532). Puzzle solving satisfaction has been also suggested as an implicit force driving research lines (Stephan, 1996). For the case of agricultural research, Burkhardt (1986), drawing on the work of Rosenberg (1977) and Hadwiger (1982), theorized about the two basic forces driving research. According to Burkhardt (1986) different groups interested in agricultural research generally subscribe to the values of scientism and utilitarianism. In setting agendas for agricultural research, utilitarianism refers to the idea of "service to the greater good to the greatest number" (28) motivating scientists by concerns for useful results. Similarly, scientism is understood as "a belief in the goodness of scientific

[12] Montevideo, the capital city, concentrates 42.5 percent of the total population (INE, 1997). For this reason, the country has traditionally been divided into Montevideo and "the interior" referring to the rest of the country.

progress" (29) with scientists valuing science in itself. Utilitarianism relates to the search for better production techniques and devices to serve societal needs and may be associated with local issues in particular agricultural systems. Scientism may be linked to fundamental research geared towards the advancement of new concepts in scientific theory.

Research motivation was assessed by three indicators of the main sources of inspiration for particular research topics. Scientists were asked to indicate the degree to which each of three factors related to their main motivation in developing their main research line using a scale from 1 to 5 where 1=not related at all; 5=very closely related. The following factors were considered:

- An attempt to contribute to the solution of problems in agricultural production.
- Your scientific curiosity and/or personal academic interest in the topic.
- The availability of funds for the topic.

Results reported in Table 4 reveal that, regardless of institutional settings, current agricultural research is mainly inspired by agricultural production problems and followed by scientific and academic interest of researchers. In general, when selecting a line of research, agricultural researchers are more motivated by the possibility to contribute to the solutions of agricultural problems than they are by their own scientific curiosity and academic interests. As reported by researchers, available funding opportunities appear to steer research topics in a much smaller proportion. As expected, Inia researchers are more inclined than University peers to pursue topics of practical production importance.

Researchers are involved in a variety of activities and not exclusively in research. They often have teaching, extension, and administration responsibilities to which they allocate more or less time according to their preferences and

Table 4. Current Research by Source of Inspiration of Researcher.

Source of inspiration	Sample mean	University	Inia	F test
Agricultural problems	4.57	4.46	4.88	11.12**
Academic curiosity	3.90	3.98	3.65	3.32
Availability of funds	2.31	2.31	2.17	.38

** p = .01.

possibilities. Researchers also divide their research time between basic and applied research activities.

In this study, researchers were asked to indicate the actual percentage of time devoted to research, teaching, extension, and administration during 1997. Overall, we found that 46 percent of researchers' time was devoted to research, 20 percent to teaching, 9 percent to extension, and 14 percent to administration activities (Table 5). Additionally, results indicate that the proportion of researchers mainly devoted to research activities (those who devote more than 60 percent of their time to research) is fairly low (22 percent). There appears to be a high degree of diversification of activities among researchers with most of them doing a little bit of everything.

Research and teaching occupy most of researchers' time, and extension and administration represent marginal portions of their time. Oddly enough, administration takes proportionately more time than extension activities. Significant differences were found by institution in the mean time devoted to the four activities. Not surprisingly, research is Inias first priority occupying, on the average, 60 percent of the time. Research is also the single largest time proportion in the University, but University researchers are committed to teaching a

Table 5. Researchers' Time Allocation to Different Activities in 1997.

Percentagem of time	Activities (%)			
	Research	Teaching	Extension	Administration
0 - 20	13.9	41.0	493.4	80.1
21 - 40	34.9	36.7	6.0	13.8
41 - 60	29.5	17.4	0.6	4.8
61 - 80	19.8	4.8	0	0.6
81 - 100	1.8	0	0	0
Total (n - 166)	100.	100	100	100
Mean Time	46.2	19.9	8.8	1.3
Mean Inia	60.5	4.3	14.8	20.5
Mean University	41.2	37.3	7.0	14.2
F value	35.71***	184.40***	30.01***	5.87*

* p = .05
*** p = .001

comparable proportion of time. The average amount of time devoted to extension in Inia is twice the average time in the University. Administration activities take significantly more time in Inia than in the University, but in both institutions administration comprises one-third of the time devoted to research activities.

Time budgeting is not a simple task and agricultural researchers are frequently bogged down by the amount of time they find themselves devoting to tasks indirectly related to research that they need to perform in order to make research possible. Among them, the weight of bureaucratic procedures they often have to follow in order to receive material and buy equipment was a recurrent topic in the key-informant interviews. Regarding this issue, an interviewee had the following to say.

"The time consumed by bureaucracy is tremendous. The institutional controls and requirements imposed by granting agencies are continuously preventing researchers from concentrating on research. Every time I want to spend money from my own research budget assigned to a project that has been approved by the institution and by the funding agency, I need to get so many signatures and authorizations that when I finally get what I needed, it is too late."

Finally, researchers often do not limit their research activities to basic or applied research but divide their research time between both types. Basic and applied research may be vague concepts. In fact, what is defined as basic in one context may be characterized as applied in another (Mulkay 1977). Despite the ambiguity of the terms, classifications into basic and applied projects are commonly used among researchers in several fields. Basic or pure science implies the search for understanding of a particular object of study for the sake of advancing knowledge. This type of research is mostly theory-oriented rather than product-oriented. Applied science is concerned with producing useful results, "that can be utilized by its clientele" (Randolph & Sachs, 1981, p.92). Thus, basic science promotes a fundamental understanding of the natural world while applied science attempts to control and modify the natural world. In the agricultural sciences, basic research usually "includes investigations in engineering and the physical, biological, and social sciences that may bear upon agriculture, while applied research includes such things as the development of improved cultivars, fertilizer experiments oriented toward making recommendations to farmers, the formulation of new animal rations, and the development of a mechanical harvester" (Umali, 1992, p.5).

A trend towards an increasing share of research time devoted to basic research has been documented for the agricultural sciences in the U.S. (Buttel & Goldberger, 1998). In order to evaluate research orientations in the Uruguayan case, surveyed scientists were asked to indicate the percentage of their research time devoted to basic and applied research during 1997 according to the following definitions.

Basic research: mainly directed to reach a fuller understanding of a particular object under study with the fundamental goal of advancing scientific knowledge.

Applied research: mainly directed to the creation and/or adaptation of scientific knowledge for the generation of new knowledge that is directly applicable to products or productive processes.

On the average, scientists classify 31.4 percent of their research time as spent on basic type research and 68.6 percent as applied. Consistent with the data on sources of inspiration of research previously presented (Table 6) according to which most research is inspired by the possibility of providing solutions to agricultural problems, most research time is devoted to activities that are linked to social utility. These proportions conceal significant differences between institutions since the University percentage of basic research is 11 percentage points larger than Inias. Likewise, the proportion of researchers mainly devoted to basic research (those who spend more than 60 percent of their research time on this type of research) is three times larger in the University than in Inia.

The Funding of Research

Agricultural research in Uruguay is not only funded by the public sector. Several research projects are entirely funded by private firms, and many more

Table 6. Mean Time Devoted to Basic and Applied Research in 1997.

Research Type	All Sample	University	Inia	F value
Basic Research	31.4	34.4	22.9	4.298*
Applied Research	68.6	65.6	77.1	

* $p < .05$.

are funded jointly by public and private enterprises. Although still slow, international patterns show overall trends towards a diversification of funding mechanisms and increased shared responsibility between private and public sector in the funding of research (Echeverría, 1998). In the academic sphere, the importance of private funding is growing, as the University budgets are relatively stagnant. In a situation in which money for science and technology is limited as is the case in Uruguay, an important proportion of institutional budgets are spent on salaries and operating expenses. Institutional funds can hardly meet the needs of all the research personnel, so looking for extramural grants is increasingly important. This situation, coupled with the emergence of different types of university-enterprise relationships, has produced an increase in the research contract modality in order to address particular research issues. In general there has been, during the last two decades, an increasing combination of traditional research grants and competitive funds or special designated areas (Mullin, 2001). Research funds from a variety of funding agencies and research organizations are sought by agricultural scientists in order to carry out their projects. In the survey conducted, respondents were asked to name the agencies and organizations from which they have received research funds during the last five years (1994-1998). Using the multiple response tool of SPSS, responses were classified by type of granting institution and are presented in Table 7.

Overall, in-house budgets provide the largest proportion of funds for agricultural research (56.4 percent). Similar proportions of funds are provided by the international agencies (16.9 percent) interested in agricultural research and development and by other public national institutions different from the

Table 7. Percentage Distribution of Funding Sources During Last 5 Years[1].

Source of Funding	University (n = 311)	Inia (n = 86)	All Sample
In house[2]	58.8	47.7	56.4
Other public instituions[3]	17.7	9.3	15.9
Private firms	10.6	11.6	10.8
International foundations	12.9	31.4	16.9
Total (n = 397)	100	100	100

[1] % based on responses.
[2] Includes CSIC grants for the University.
[3] Conicyt, Inia, MGAP.

researchers' institution (16 percent). Private sector funding comprised the smallest proportion, averaging 11.6 percent for the whole sample. Some institutional differences were found in the sources of funds for research with the University research relying more on internal funds than Inia research. Similarly, University researchers receive proportionately more funds from national public institutions than Inia researchers (they even receive some funds from the Agricultural Technology Development Fund – FPTA – program in Inia, a competitive fund for the promotion of applied technology). Accordingly, Inia researchers are more dependent on international funding sources than their University counterparts with almost one-third of researchers at Inia receiving funds from international foundations. The level of private funding of research is stable across institutions.

Demographic and Institutional Influences on Research

In the previous sections, an overview of the main demographic characteristics and social backgrounds of agricultural scientists was presented followed by a characterization of some features of agricultural research. In this section, several research characteristics are used as independent variables to explore how social and demographic characteristics of researchers influence their research practices. Scientists' allocation of time to research activities and to applied research during 1997 and scientists' motivations to pursue their current research topics were selected as dependent variables for this analysis because they allow us to describe agricultural scientists as research practitioners. The influences of scientists' characteristics on time budgeting and research motivations were examined with one-way analysis of variance at the bivariate level and ordinary least squares regression at the multivariate level.

Table 8 shows the effect of several social and demographic characteristics of scientists on their research. The agricultural background indicators show some differences regarding time allocation and researchers' motivation. Residence influences research motivation meaning that researchers with an Interior background are more likely to be moved by pragmatic aspects linked to agricultural production than those who lived in Montevideo. The latter group of researchers is motivated by scientific concerns and academic interests in a larger proportion than the former. Residential origin also has an effect on the type of research conducted. While, on average, researchers from Montevideo and Interior devoted the same amount of time to research during 1997, researchers who lived in the

Table 8. Sociodemographic Influences on Research.

Independent variable	Research motivation		Time allocation		
	Contribute to the solution of agricultural problems	Scientific curiosity & academic interest	Availability of founds for the topic	% research time	% applied researc (h)
Residence					
Mdeo.	4.48	4.03	2.36	46.6	64.1
Interior	4.77	3.61	2.06	45.1	77.9
F test	5.77*	5.88*	1.99	.203	7.06**
Relative on farm					
Yes	4.70	3.77	2.32	43.6	74.3
No	4.46	4.01	2.23	48.5	63.5
F test	4.40*	2.31	.23	2.47	4.91*
Gender					
Male	4.57	3.88	2.15	45.31	69.91
Female	4.58	3.98	2.52	48.17	65.78
F test	.003	.30	3.04	.74	.60
Degree					
Bachelor	4.63	3.93	2.37	41.92	67.86
Ms+Dr	4.55	3.87	2.22	49.09	69.48
F test	.45	.14	.50	5.06*	.10
Age					
< 35	4.25	3.94	2.23	51.06	56.82
36-45	4.68	3.80	2.40	48.79	70.13
46 +	4.61	4.02	2.10	39.84	73.70
F test	4.10*	.75	.89	3.23*	4.65*

* p < .05.

** p < .01.

Interior until age 16 spent significantly more of their research time on applied research than scientists from the nation's capital.

Similarly, the existence of a close relative with a farm background has an effect on the type of research that scientists performed during 1997. Respondents who had a close relative on a farm conducted devoted a larger proportion of time to applied research than those that did not. Further, researchers' motivations

to conduct research to solve agricultural problems are influenced by their contact early in life with a close relative living or working on a farm. Researchers who had a relative on a farm are more inclined to pursue production topics than researchers who did not. Also, they tend to be less motivated to pursue research topics of scientific or academic importance than scientists with a relative on a farm, but this difference is not statistically significant. These results confirm the idea that closer contacts with agriculture have an effect on scientists' research orientations predisposing the researcher to conduct research that will directly bear upon agricultural production.

Interestingly enough, sex differences did not show any significant effects on any of the variables considered in this section. Analysis of variance results give some indication that female researchers seem to devote slightly more time than males to research activities, which are slightly more of a basic research nature than those performed by male researchers during 1997. Also, female scientists might be more motivated to pursue investigations based on funds availability than males.

Researchers' educational level shows an effect on the time allocated to research activities indicating that researchers trained at the posgraduate level devote significantly more time to research activities than researchers with only Bachelor degrees. Scientists' degree does not produce any significant differences on research motivations or type of research.

Age of researchers exerts a significant effect on their allocation of time to research activities with researchers under 36 years devoting the largest proportion of time to research activities during 1997. Middle aged scientists devote slightly less time than their younger colleagues, and scientists who are 46 and older devoted the smallest proportion to research activities. As they get older, researchers tend to assume administration responsibilities, which occupy some of their research time. Additionally, the proportion of time devoted to applied research projects significantly increases with scientists' age. While there is a rather small difference in the percentage of time in applied research between scientists in the middle age group and older group, there is a difference of 17 percent between the group of youngest scientists and older scientists. Consistently, younger scientists are significantly less motivated than their older colleagues to pursue research lines oriented to contribute to the solution of agricultural production problems.

To summarize, bivariate analyses showed that the time allocation to research activities during 1997 is affected by scientist's age and degree. Additionally, the

time devoted to applied research is influenced by age and the social origin of scientists measured by the place of residence and contacts with a close relative with a farm background until age 16. Researchers' motivation to pursue topics geared to the solution of agricultural problems is effected by age, residential origin of scientists and farm background. Researchers' motivation to conduct research on topics of scientific and/or academic interest is influenced by scientists' place of residence only. Research motivations based on the availability of funds did not show any significant relationship with the variables considered at the bivariate level. Researchers' sex did not show any significant effects on the variables considered.

Multivariate regression models (OLS) are used to provide additional information to assess the relationships of sociodemographic variables and research characteristics to agricultural research. The purpose of this analysis is to examine whether the relationships found at the bivariate level and/or other significant relationships emerge when the effects of other variables are held constant. Table 9 shows the variables used in the regression analyses.

Table 9. Description of Variables in Regression Models.

Variable neme	**Description**	**Values**
Applied research[1]	Percentage of research time devoted to applied research in 1977	0 - 100
Research motivation for current research[1]	To contribute to the solution of problems in agricultural production	1 - 5 not at all = 1 a great deal = 5
Residence	Place of residence until age 16	Montevideo = 0 Interior = 1
Gender	Gender of researcher	Male = 0 Female = 1
Age	Age of researcher	Years
Degreee	Highest degree	Bachelor = 0 Master or Doctor = 1
Institution	Institutional affiliation	University = 0 INIA = 1
International funding	Use of international research funds during the last 5 years	No = 0 Yes = 1
Institution[1] Intl. funding	Interaction term between institution of researcher and use of international funding	University, No = 0 University, Yes = 1 INIA, No = 0 INIA, Yes = 1

[1] Dependent variable.

A first model included the percentage of time spent on applied research during 1997 as the dependent variable with age, place of residence, gender, degree, institutional affiliation, and international funding, as independent variables. An additional predictor variable resulting from the cross product of institutional affiliation and international funding was included in the model in order to test the interaction between these two variables (Table 10).

As seen in Table 10, adjusting for the other independent variables in the model, the relationship of age to time devoted to applied research persists as positive and significant meaning that older scientists tend to devote more time to applied research than younger scientists. In other words, there is a trend towards increasing basic research led by young agricultural researchers. Similarly, place of residence maintains its effect on the dependent variable confirming that in 1997, researchers from the Interior spent significantly more time on applied research than researchers from Montevideo. Simultaneously controlling for the

Table 10. Regression Analysis for the Relationship of Age, Residence, Gender, Degree, Institution, and Funding on Researchers' Time on Applied Research[13] .

Predictor variables	Zero order correlation	b value	Beta coefficient
Age	.206**	.864**	.207
Residence	.206**	10.582*	.159
Gender	-.061	-3.261	-.019
Degree	-.025	-1.205	-.049
Institution	.162*	-2.010	-.029
International funding	-.218**	-25.239***	-.381
Institution[(1)] Intl. Funding	.140	33.825**	.362
Constant		34.953*	
R Squared		.199	
F value		5.295***	

* p < .05.
** p < .01.
*** p < .001
n = 156.

[13] Because the dependent variable in this model varies between 0 and 100, it might resemble the case of a truncated distribution for which special regression models apply. However, special models are used when population characteristics are inferred from a sample of a restricted part of the population. In this case, the full distribution is used and the data are a representative sample of the population of interest. Models for limited dependent variables are found in Greene (1990).

effect of the other independent variables, scientists' degree and gender did not produce a significant effect on the scientists' time devoted to applied research in 1997. The institutional affiliation of researchers did not produce a significant effect on the dependent variable until the variable of international funding was included in the model. A significant statistical interaction emerged between the use of international funding and institutional affiliation of researchers. The relationship of international funding to researchers' time devoted to applied research differs for Inia and the University. Among Inia researchers, those who received international funds devoted significantly more time to applied research during 1997 than those who did not receive any international funds. By contrast, University researchers who received international research funds devoted significantly less time to applied research during 1997 than researchers who did not. That is, while in Inia, funding from international sources promoted more applied research, in the University, international funding promoted more basic research. Table 11 illustrates this conditional relationship with estimated percentages of time devoted to applied research for each of four possible situations.

The combined effects of the variables in the model account for 20 percent of the total variation of the time devoted to applied research in 1997. The standardized regression coefficients (Beta) indicate that in this model, the combination of institutional affiliation and international funding appears to have a stronger effect on the percentage of time devoted to applied research than both scientists' place of residence and age.

Table 11. Interactive Effect of Institutional Affiliation and International Funding on Researchers' Time on Applied Research.

Use of International Research Funds	Institution	
	University	INIA
	--estimated time on applied research--	
No	72%	70%
Yes	47%	79%

Predictive equation: Time = 34.953 + (.864*Age) + (10.582*Residence) + (-.3.261*Gender) + (-2.010 *Institution) + (-25.239*Intl.funding) + (-1.205*Degree) + (33.825*Institution*Intl.funding)

A second regression model included as the dependent variable the reported motivation to pursue the current research in terms of the contribution to the solution of agricultural problems. The independent variables in this model are age, place of residence, gender, degree, international funding, and institutional affiliation. A conditional relationship of institution and international funding with research motivation did not emerge in this model. Table 12 shows that holding constant the effect of the other predictors in the model, (gender, residence, institution, degree, and international funding), older scientists are significantly more motivated than younger scientists to pursue their current research because of the potential contribution to agriculture. Also, researchers at Inia were significantly more motivated than researchers at the University by the potential contributions to agriculture when they selected their current research. Similarly, controlling for the effects of other predictor variables in the model, researchers who used international research funds are significantly less motivated to pursue their current research based on possible contributions to agriculture than researchers who did not receive international funds. No significant relationships emerged between researcher motivation and place of residence, gender, and researchers' degree when the other independent variables are in the model. The effect of the place of residence on research motivation that was significant in the

Table 12. Regression Analysis of Age, Residence, Gender, Degree, Funding and Institutional Affiliation on Research Motivation.

Predictor variables	Zero order correlation	B value	Beta coefficient
Age	.153*	.016*	.164
Residence	.185*	.220	.140
Institution	.252***	.512**	.311
International funding	-.174*	-.283*	-.183
Sex	.004	.064	.041
Degree	-.053	-.192	-.128
Constant		3.869***	
R Squared		.166	
F value		5.070***	

* p < .05.
** p < .01.
*** p < .001.
n = 159.

bivariate analysis disappears when other variables such as institution and international funding are in the analysis.

The combined effects of all the variables in the model account for 16.6 percent of the variance of scientists' motivation to pursue their current research topic based on the contribution to agriculture. Beta coefficients indicate that institutional affiliation is the best predictor of scientists' motivation for research.

CONCLUSION

This study analyzed two major sources of influence on public agricultural research and researchers' motives: the institutional organization of science and a set of individual characteristics of researchers. In different ways, both of them proved to be influential in the process of research.

First, it was shown that the community of agricultural researchers is a diverse group of individuals with different characteristics and backgrounds. Some of these such as age and residential origin have an influence on research. A clear distinction is found between younger scientists' greater valuation of basic research from that of an older generation of agricultural scientists trained in the applied mission of agricultural sciences. Moreover, scientists' closer contacts with agricultural settings predispose them to engage in research that will directly impact the production sector. Therefore, researchers from the Interior are more inclined to devote more time on research linked to the solution of practical agricultural problems than researchers from Montevideo. Coupled with a majority of researchers with an urban background, the aging process of the research community may account for a stronger trend towards basic research in the future. Further, the practice of research is incorporated into a variety of activities in which most agricultural researchers are involved; those devoted full time to research are a minority.

Second, the analysis presented provides some evidence that scientific research is not independent from the context in which is conducted with institutional settings playing an important role in the process of agricultural science. Multivariate analysis indicated that the institutional context in which research is conducted influences researchers' motives to pursue research aligned with the

goal of contributing solutions to agricultural production. In this sense, researchers at Inia are more motivated than their university peers to pursue research lines based on the potential contribution to agricultural production. However, in the analysis of the relationship between institutional affiliation and type of research conducted, the availability of research funds from international funding agencies and foundations emerged as an important intervening factor. That is, international funds have an effect on the distribution of time between basic and applied research depending on the type of institution. Because of its applied mission, the research center seeks international funding to foster applied research. By contrast, in the university, researchers who succeed in obtaining international funds are more likely to reinforce basic research.

The manifestation of the two fundamental values proposed by Burkhardt (1986) indicate different motivations for the engagement of scientists in particular lines of research. Some of them conceive of science as an intellectual adventure while some others are more committed to the practical implications of their work. A good combination of both orientations may be ideal for the development of a national agricultural research system that could meet today and tomorrow's challenges, demands and opportunities for science in a developing country.

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