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"SEED MONEY" AND PUBLICATION OUTPUT IN MEXICAN RESEARCH: A CASE STUDY OF IFS GRANTEES

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SUMMARY

This study assesses the effect of grants given to young Mexican researchers by the International Foundation for Science (IFS) on the development of their academic careers through an analysis of their publication output. Since 1974 IFS has supported ~4000 young scientists in developing countries conducting relevant and high quality research on the sustainable use of biological natural resources. In March 2000 publication lists received from 105 of the 138 current and former Mexican grantees were coded for type and format of publication, language of publication, publication in mainstream journals, co-authorships and author position. These variables were analyzed in relation to the time period when the grant was given, number of grants given, research area and membership of the Mexican National Researchers System (SNI). The publication trends show that IFS support contributed to publication output, to more frequent publication in English and more often in mainstream journals, thus increasing the international visibility of their work and contributing to the internationalization of Mexican science. It is suggested that the grantees receiving IFS financing were able to establish themselves as bona fide *scientists in Mexico, especially those from minor universities and research institutes, reducing the likelihood of brain drain and contributing to strengthen national research. Nonetheless, it is concluded that while IFS may not be considered essential to the development of most scientist's research, its funding is an effective facilitator for a continuing research career.*

One of the most pressing problems facing young scientists at the start of their research careers is how to obtain funding that will help set them up as independent scientists, the so-called "seed money". In the competitive field of securing research grants, younger scientists are often overlooked in favor of tenured researchers. In developing countries where funding options are fewer the situation becomes even more acute. In order to help alleviate this situation the International Foundation for Science (IFS) was founded in 1972 to strengthen scientific capacity in developing countries through awards given to young scientists conducting relevant and high quality research on the sustainable use of biological natural resources. Since 1974 IFS has supported almost 4000 grantees.

Although other international sources of funding are available to support the research of young scientists, eligibility is usually different from that set out by IFS, applying, for instance, only to scientists from certain countries or regions, or to those researching into specific subjects of global significance. The Human Frontiers Science Program, HFSP, which supports novel, innovative and interdisciplinary basic research focused on the complex mechanisms of living organisms, provides fellowships for young scientists from anywhere in the world to work in a laboratory in one

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of the supporting countries. However, no countries from Latin America are included in the list of countries which provide financial support for HFSP (www.hfsp.org). Another example is the Earthwatch Institute (www.earthwatch.org), which is committed to helping young scientists start their research careers in sustainable development in a broad range of disciplines, from habitat management to health care, and provides vital support where funding is typically limited to scientists from developing countries, women in science, and long-term monitoring projects. In this sense its philosophy is more akin to IFS; nonetheless, Earthwatch's *mission is to engage people worldwide in scientific field research and education to promote the understanding and action necessary for a sustainable environment and* is one of the largest private supporters of scientific field expeditions.

In the case of Mexico, only since the end of the 1990s has the Mexican Science and Technology Council (*Consejo Nacional de Ciencia y Tecnología*; CONACYT) made special provisions for financing scientists initiating their research careers. In 1997, a program was created to provide money for one year to recent graduates or recently repatriated scientists, to set up research projects. In 2000, awards were for a maximum of 14000USD, 70% coming from CONACYT and 30% from institutional funds. In 1998, funding became available for individual projects of scientists under 35 years of age which in 2000 was for a maximum of 84000USD for a two-year project and 150000USD for three years. The goal was to provide young scientists with the minimal infrastructure necessary for them to carry out independent research work (Gaillard *et al*., 2001). The most recent CONACYT program is exclusively for level 1 members of the Mexican National Researcher's System (see below), regardless of age, to strengthen their research and teaching activities in their institutions. Grants are of 100000 Mexican pesos, just under 10000USD, given for one year and are one-off. Applicants must not be receiving any other CONACYT funding (CONACYT, 2006).

IFS support comes in the form of research grants for a maximum of 12000USD, renewable twice. Applicants which fulfill the following requirements are eligible to apply: citizen of a developing country; a scientist with at least a Master's or equivalent degree/research experience; under 40 years of age and at the beginning of research career; attached to a university, national research institution or a research-oriented NGO in a developing country.

In the thirty years since 1974 when IFS started providing research grants, 1737 have been distributed to young scientists in Latin America and the Caribbean region, mainly to Argentina (331), Mexico (275) and Brazil (258). Almost 1/3 of the total IFS research grants have supported scientists in Latin America (IFS, 2005). Candidates for grants are selected on their potential for becoming the future research leaders and lead scientists in their home countries. They are expected in the short or long-term to become established and recognized both nationally and internationally. To achieve this, the young grantees must aim to publish in journals that are visible and recognized by the international scientific community. Publishing in English is an important part of this strategy, as is authorship in international mainstream journals. Publishing is at the heart of the scientific enterprise and, as such, is an important criterion for the advancement of a scientist's career.

Although developing country scientists, and Mexican scientists in particular (SEP-CONACYT, 2000) tend to publish more papers in mainstream journals today than in previous years, a good part of their scientific production remains locally published and of low visibility (Gaillard, 1989; Cetto, 1998). Numerous studies indicate that in any given country-specific field, a significant portion of the research produced by developing country scientists is published in local journals (Russell and Galina, 1987; Chatelin and Arvanitis, 1989).

For this reason, in the present study to estimate the nature and volume of IFS grantees' scientific output in Mexico, our main analysis was carried out on the full publication lists provided by the grantees and ex-grantees without discrimination of where these were published. A second analysis was done at the level of publications pertaining to the group of mainstream journals included in the Science Citation Index (SCI) database from the Institute for Scientific Information, bearing in mind that firstly, this serves as a universal benchmark for scientific prestige and visibility. For 2001, Mexico was represented in the SCI by only four journals, Argentina by four and all of Latin America by only twelve. Secondly, IFS expects its grantees to publish in journals that are visible and recognized by the international scientific community as a mark of their recogniton by and acceptance into the international scientific community.

The bibliometric study was an integral part of a wider study to measure the overall impact of IFS funding in Mexico, which included the application of a questionnaire and interviews to provide insights into the perceived needs and constraints experienced by young scientists in developing countries (Gaillard *et al*., 2001). Where considered relevant, findings from the qualitative part of the study are included to compare or reinforce the quantitative results from the bibliometric study. While the population of scientists in this study was not chosen to represent the scientific community in Mexico, it is the first detailed analysis of the total scientific output of a large group of scientists in Mexico, and it is anticipated that the results will prove to be a valuable source of comparisons for similar studies conducted in the future.

The analysis looks at the publication levels in general, publication in English, and in mainstream scientific journals of the young Mexican scientists receiving IFS support and particularly those that the grantees considered had resulted, at least in part, from IFS funding. We also look at possible differences between current grantees and former grantees, members and non-members of the National Researcher's System (*Sistema Nacional de Investigadores*, SNI), and IFS research areas. By looking at these and other variables, it was attempted to understand how the IFS grant may have influenced the careers of grantees in Mexico. The Mexican government created the SNI in 1984 in order to advance scientific research and to prevent the possible disintegration of the Mexican scientific community due to declining salaries. Membership is open to researchers from all knowledge fields working full-time in recognized Mexican institutes of scientific research, following an evaluation of their productivity and contribution to the formation of new researchers. Membership at five levels (candidate, I, II, III and emeritus) entitles the scientists to a monthly tax-free payment over and above that received as institutional salary. It is also considered prestigious for a scientist to be an SNI member, especially at the higher levels and is often a requirement to be eligible for other grants and awards (www.conacyt.mx/dac/sni/index.html).

All Mexican grantees were asked to provide a list of their publications, which formed the basis of the present study. Most bibliometric studies conducted on Mexican science have thus far used publication output in mainstream science (Delgado and Russell, 1992; Russell, 1995; Arvanitis *et al*., 1996). However, in order to measure the total publication output of grantees in Mexico, the

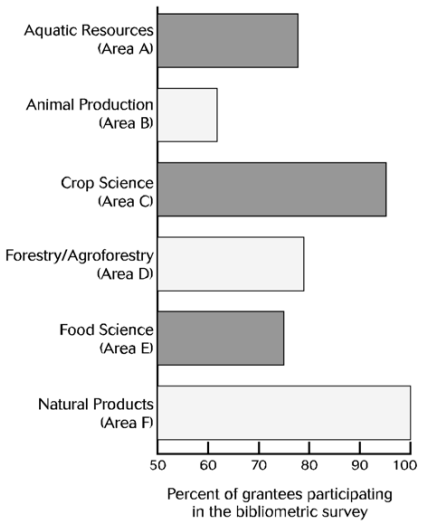

Figure 1. Grantee participation by research area.

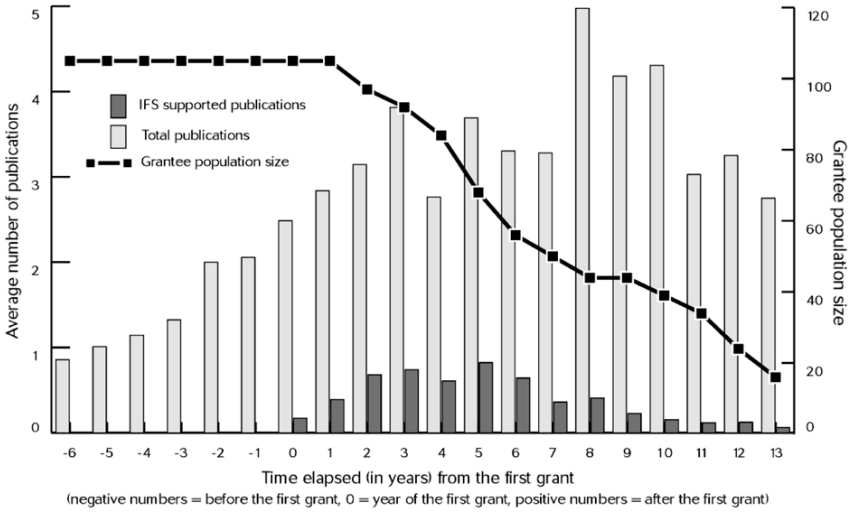

Figure 2. Average publication output in relation to first grant.

present study was not limited to those publications found in the ISI databases but, instead all scientific work produced by grantees in Mexico was considered, using their complete publication lists.

Methods

In March 2000, questionnaires and requests for publication lists were sent to all 138 past and current at the time IFS grantees from Mexico. When grantees responded to the questionnaire, but neglected to submit a publication list, they were contacted again and encouraged to submit their list. Grantees who sent incomplete lists were also encouraged to submit a complete list. Additional lists were also collected during interviews of grantees. Grantees were asked to mark those publications which had resulted from IFS support. Many of the more recent grantees reported IFS supported studies in press or submitted for publication, but these were not considered in the analysis.

The complete bibliographical information (title, date, pages, publisher, etc.) of each reference in the publication lists was recorded in a database. Entries were classified by publication type: journal article (AI), full paper in conference/seminar proceedings (CP), book chapter (CH), grantee authored or edited book (BK), abstract (AB), report (RE), and other research publications and communications (PS). PS is a broad category that includes material such as posters, theses, bulletins, booklets, monographs, movies, manuals, patents, maps, technical documents, and papers presented at seminars or conferences.

In addition to bibliographic information for each publication, other information was coded for analysis. Publications by IFS grantees could be sorted by the following variables: grant number, research area of grantee, number of authors, language of publication, grantee as first author, host institution of grantee, national or foreign highest degree of grantee, past or present grantee, number of grants awarded, year of first IFS grant, year that IFS support was terminated and IFS-supported publications. Where possible, information from the publication lists was cross-referenced with data from the questionnaire survey that was sent by IFS and CONACYT to all grantees in Mexico. However, not all of those who submitted a publication list, also submitted a questionnaire, or vice versa.

The collected information was fed into an Excel spreadsheet consisting of over 150000 cells and manipulated using simple statistical processes. Values for statistical significance of the results presented below were not calculated; hence the observations made in the following pages should be treated as trends to be confirmed by further studies.

Response Rates

Of the 138 grantees, 105 provided publication lists. Nearly 87% (60 out of 69) of current grantees participated, while 64% of former grantees submitted publication lists (45 of 69). Although the overall rate of participation in the bibliometric study is considered satisfactory (76%), it is not known if those grantees that did not respond are individuals who have published less often or not at all.

There was variation in participation rates between IFS Research Areas (Figure 1). In general, response rates were greater than 75%. However, the largest IFS Research Area in Mexico, Animal Production (Area B), had a uniquely low response rate of only 63% (29 of 46 grantees).

From 1985 to 1999, of the 124 grants awarded to Mexican scientists (Gaillard *et al*., 2001), 29% were in the field of Animal Production, followed by Food Science (17.7%), Crop Science (16.9%), Forestry/Agroforestry (15.5%) and Aquatic Resources (15.3%). From the distribution of the 253 grants awarded worldwide in 2004, five research areas represented more than 10%: Crop Science (19.9%), Natural Products (13.9%), Forestry/Agroforestry (12.7%), Food Science (11.1%) and Sustainable Agriculture (10.3%). Aquatic Resources corresponded to only 8.7% of grants and Animal Production to 8.3% (IFS, 2005). This indicates that the research area distribution of responses from the Mexican scientists is in keeping with the distribution of grants given worldwide, but is underrepresented in Animal Science as previously mentioned, with regard to the Mexican context.

The greatest numbers of publication lists were received from two universities, the *Universidad Nacional Autónoma de México* (UNAM) with 18 and the *Universidad Autónoma de Yucatán* (UADY) with 17, and one research centre, *Centro de Investigaciones y de Estudios Avanzados* (CINVESTAV) of the *Instituto Politécnico Nacional* (IPN) with 12. Current SNI members represent-

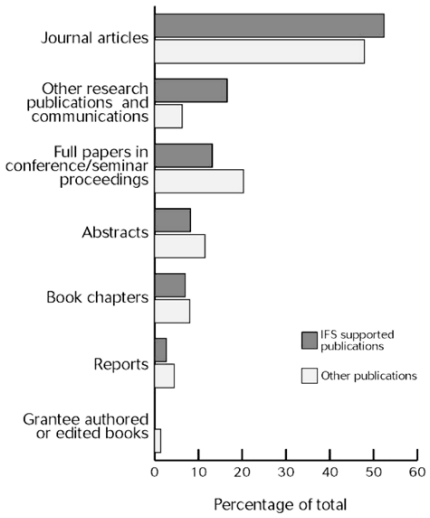

Figure 3. IFS supported and other publications by type.

ed 70.5% of the respondents compared to 61.6% in the overall population of Mexican grantees.

Results and Discussion

Publication output

The 105 lists received contained a total of 4234 publications, of which 441 (10.4%) were identified by the grantees as resulting from IFS support, referred to as IFS publications. The average number of total publications and IFS publications per grantee for the years before and after the first grant are provided in Figure 2. The point 0 on the x-axis corresponds to the year when the first grant was awarded, negative values to the previous years and positive values to the years following that first grant. The total population size of respondants during this time is illustrated by the continuous line, which represents the total of 105 grantees and ex-grantees who form the sample, until year 2 when the size of this group begins to decline as grants are terminated. The fact that the majority of those who answered our questionnaire were grantees at the time, explains why the population of those claiming to publish both IFS-supported and non-IFS supported publications up to 13 years after receiving their first IFS grant is small and corresponds to those ex-grantees who were among the first Mexican IFS recipients.

While the IFS grantees as a whole were already publishing six years prior to receiving the grant, their overall production increased over the years following the IFS award. As is to be expected, their production of IFS supported publications began at year 0 and began to decline around year 6. However, it is interesting to note that IFS funding was still associated with research output even 13 years after receiving the first grant.

Figure 3 shows the breakdown by publication type. The results from grantees' IFS supported research are more often published as journal articles than are the results from grantees' other research. Over 52% of grantees' IFS supported publications appeared as journal articles in contrast to 47.9% of their other publications. Among former grantees, articles in journals accounted for 54.8% of IFS supported publications, and only 44.1% of their other publications.

Journal article productivity

Publication lists contained 2049 journal articles (47.9% of all publications) published in 619 different journals. A total of 112 journals (18.1%) had five or more articles by IFS grantees, while 316 titles (52.1%) had only one. Heading the list were two Mexican journals, *Técnica Pecuaria en México* and *Veterinaria-México* with 109 and 90 articles by grantees, respectively. Among the 17 journals in which grantees publish most, national or Latin American journals dominate. The international mainstream journal with the most articles by IFS grantees in Mexico was the British journal, *Aquaculture*, with 20 articles. However, eight local journals had more articles by IFS grantees than did *Aquaculture*. This is a first indication of the importance of local journals in the publication strategy of the IFS grantees in Mexico. Local journals are used to publish research results despite the fact that they are considered to be one of the least important criteria for promoting scientists in Mexico.

The US publication *Journal of Shellfish Research* had the greatest number of IFS-supported articles (9), followed by the US journal *Comparative Biochemistry and Physiology* (5). Four IFS-supported articles were published in the US journal *Applied and Environmental Microbiology* and the British title *Aquaculture Research*.

Language, visibility and impact are among the many factors that can influence a researcher's choice of the journal in which to publish research results. Publications in international mainstream journals are an advantage for Mexican scientists seeking professional advancement. However, the acceptance of an article for publication in such journals is not dependent only on scientific quality (for a detailed discussion see Arvanitis and Gaillard, 1992). Mainstream journals are generally not interested in publishing articles without broad geographical and/or disciplinary relevance, and most often publish articles in English. Furthermore, when results are relevant to a limited audience, researchers may choose a non-mainstream journal that is especially accessible and targeted to the intended audience. Hence, findings regarding propagation of a local crop in Mexico, for example, might best be published in a national Spanish language journal rather than *Science* or *Nature*, even if when publication in either of these latter two journals would be considered more prestigious.

IFS is concerned with how its support might affect researchers' choice of journals. Do IFS networking activities help broaden the relevance of research? Does the IFS requirement that correspondence and reports be submitted in English or French improve the likelihood that grantees (in the case of Mexico) publish their research findings in English via mainstream journals? Clues can be found in the results presented that follow.

Of the 619 journals found in the publication lists, 292 (47.2%) appear in the ISI master list of journals (www.isinet.com/journals/). As discussed above, journals indexed in the information services provided by ISI such as SCI and Current Contents, are considered to represent the mainstream of international scientific publication. Of the 292 mainstream journals used by grantees in Mexico, 154 (52.7%) are European titles, 108 (36.9%) are edited in the US, and only eight (2.7%) are Latin American. The language of publication of 272 of these journals is English, 4 are published in Spanish, and 3 in French. Bilingual publication was found in another seven titles (3 English/Spanish, 3 English/German and 1 English/French) and trilingual (English/French/German) in 6.

IFS plays a significant role in supporting grantees' production of articles in mainstream scientific journals. Of 2049 journal articles in the grantees' publication lists, 887 were published in mainstream journals. Over 15% of these articles were associated with IFS supported research. Furthermore, while less than half (41.3%) of non-IFS supported articles appeared in mainstream journals, 58.9% of IFS supported articles were published in these prestigious journals.

Language of publication

If indeed the fact that grantees in Mexico communicate with the IFS Secretariat in English has an effect on their choice of language when they publish results from IFS supported research, then it could be expected that IFS supported publications are more often published in English than are grantees' non-IFS publications.

A time analysis of all grantees' publications (Figure 4) shows that publication in English begins to increase prior to the first grant and reaches a peak around the third year after the grant was awarded. Notwithstanding, Spanish was the grantees' most frequent language of publication (58.8% of all documents), followed by English (39.9%) and French (1.2%). Documents in other languages included 2 in German, and one each in Italian and Portuguese.

Several factors explain why Spanish is the most frequent language of publication. One obvious reason is that it is easier for Mexican grantees to write in their mother tongue. Writing in English is, for many of them, a very difficult or even impossible task without the help of colleagues. The capacity to express oneself in English varies a lot between advanced research institutions in and around Mexico City and universities in the provinces. For example, many interviews in the provinces could not be conducted in English, and most questions at an information seminar given in English at UADY in 2001 were asked in Spanish. Furthermore, it is felt, especially by the youngest scientists, that referees from local journals are more understanding or easier to deal with than those from mainstream journals. A senior scientist from UNAM claimed that "prestige does not play a major role in the choice of publication until you are really established and ready to battle the referees in established journals that most of the time don't care a damn about work in developing countries or don't understand the problem at all". Also, by publishing in Spanish in local journals, scientists in Mexico, especially those in applied fields, are more likely to reach potential local users (starting with their own students) while, at the same time, strengthening the quality and sustainability of local journals.

Nevertheless, the IFS grant does seem to have an effect on language choice. Unlike grantees' other publications, IFS-supported publications are more often published in English than in Spanish. Of the 441 IFS-supported publications, 56% were published in English.

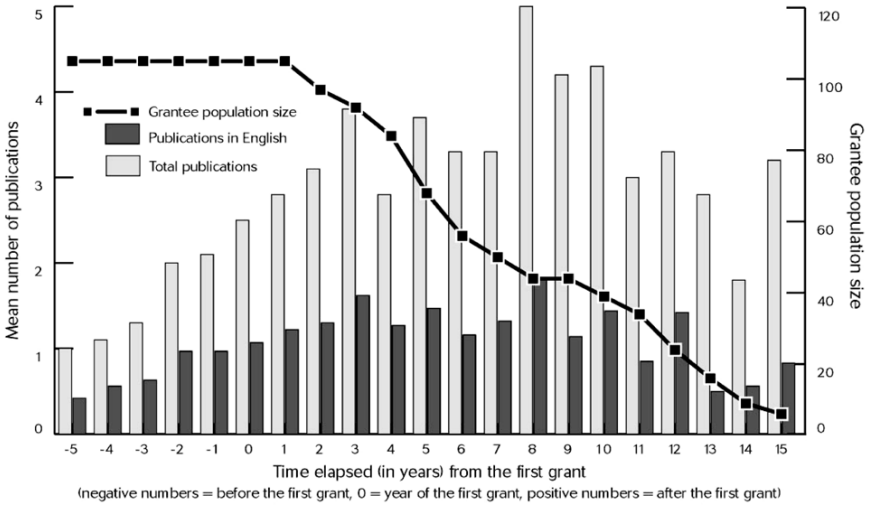

Figure 4. Publication language: a time analysis.

The trend is even more striking among articles, as 74.9% of IFS supported articles are published in English, while the corresponding number for non-IFS supported articles is only 47.7%. Moreover, the 45 former grantees published a smaller percentage of their IFS supported articles in English (66%) than did current grantees. This may indicate that English is increasingly a preferred language of publication among the younger generation of Mexican scientists.

Given that IFS supported research is more likely to result in internationally accessible and recognized publications, one may expect that IFS support improves grantee visibility and provides better chances for advancement within promotional systems that reward scientists for mainstream publications.

Format

The rapid development of new electronic means for distributing information, such as electronic journals, was not reflected in grantees' publication lists. Only 19 publications were reported in electronic format, 10 of which were Other Research Publications (PS) and 9 were Abstracts (AB). No publication in electronic journals was reported.

Co-authorship and patterns of collaboration

IFS provides incentives in the form of research grants to individual scientists while recognizing that through collaboration scientists generally achieve their best results. Grantees' patterns of collaboration suggest that the individual nature of the IFS grant does not hinder scientists from working in teams.

Regardless of whether their research was supported by IFS or another organization, researchers' publications were equally likely to be produced in collaboration with other scientists. Rates of collaboration were almost identical for the two sets of documents: all publications (84.6%), and IFS-supported (84.1%).

For both total publications and only IFS supported publications, it was most common to publish as a team of 2 to 4 scientists (66.6% of non-IFS publications and 64.4% of IFS supported publications; Figure 5). These data indicate that IFS support does not alter the trend toward working in small research teams. The same trend is even more strongly illustrated by co-authorship patterns of journal articles (Figure 5) though, here, the percentage of grantees working in small research teams is somewhat greater for all articles than for

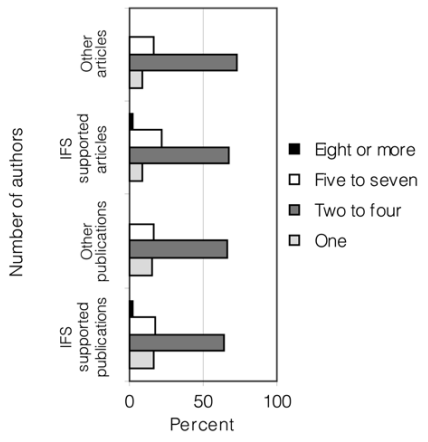

Figure 5. Co-authorship patterns.

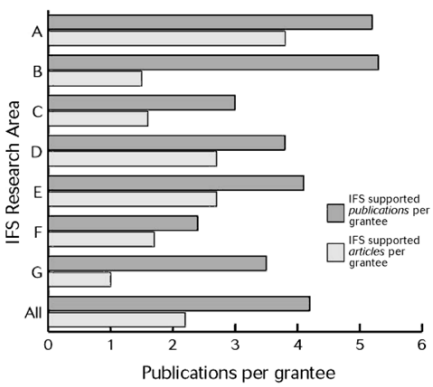

Figure 6. IFS supported publication output by research area.

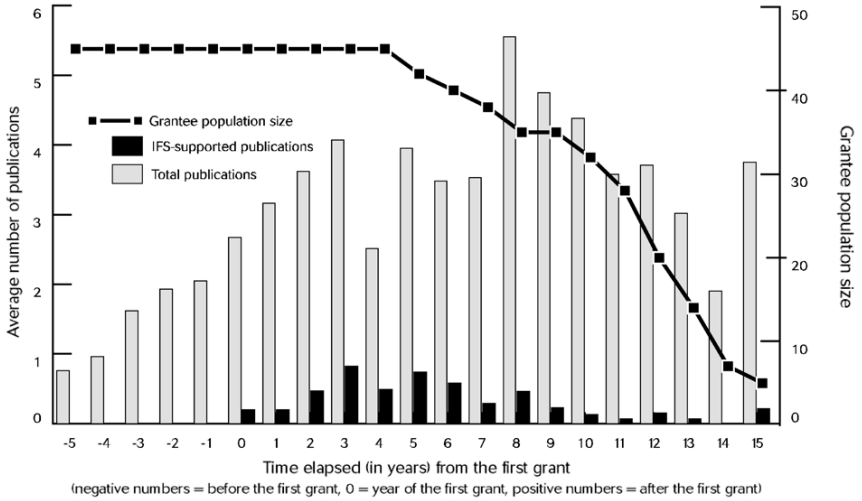

Figure 7. Publication output of former grantees: a time analysis.

IFS supported articles (72.7% and 67.5%, respectively).

Author position

The frequency with which grantees were the first author of a publication was slightly greater when the publication was the direct or indirect result of IFS support. In 47.3% of all non-IFS publications the grantee appeared as first author, whereas among IFS-supported publications the percentage was 54.4%. In total article production, the grantee was first author in 44.4% of non-IFS articles and in 45% of IFS-supported articles. This suggests that the position of the IFS grantee is virtually unaffected by IFS funding.

IFS research areas

The data collected by IFS suggest that there are important differences in publication productivity between scientists from the different research areas (Figure 6). For example, Area B researchers had the greatest mean number (5.3) of IFS supported publications, but they had the fewest number (1.5) of IFS supported articles. Meanwhile, Area A researchers had a similar number of publications (5.2), but 2.5 times the number of articles (3.8) of those of Area B. The overall mean for all areas was 4.2 IFS publications and 2.2 IFS articles.

Animal Production researchers are a unique group among IFS researchers. For instance, they use journal articles as outlets for their research results much less frequently than other researchers. Nevertheless, when all publication types are considered, animal production grantees are among the most productive. Rather than publish less, they more often publish abstracts or items that were defined as "other" in this study. It may be of relevance that during interviews at UADY, in Merida, Area B grantees indicated that the main mandate of their institution was teaching and transfer of technology, not research. Of course, it could also be argued that the main mandate of any school in Mexico (not only at UADY) is teaching, but this does not prevent faculty members from publishing in journals. Thus, it remains to be shown whether the institution's mandate of Area B grantees has an effect on their journal article production.

A time analysis of publication output by Area B researchers reveals that their publication patterns are different from the IFS grantees as a whole. Area B researchers published more often prior to the first grant than did colleagues in other areas. However, their number of publications show only small increases after the grant, while other research areas show a stronger increase that continues well beyond the first grant. If only articles are considered, Area B grantees and others share a trend towards increasing article publications until one year after the first grant. At this point Area B grantees' article production levels off and then decreases five years after the first grant. Meanwhile, the other areas continue to increase their article production into the tenth year after the first grant. The lower level of article production is offset by production of other types of publications.

Number of grants

As expected, former grantees that received multiple grants subsequently produced more IFS supported publications. However, the increase was not as strong as might be expected. The average number of publications for all former grantees (45) was 5.1 and for those who received only one grant (27) it was 4.4. Fifteen former grantees received 2 grants, and only 3 received 3 grants. The share of articles in the total of IFS-supported publications increased with the number of grants: 50.8, 56.2 and 73.7% for 1, 2 or 3 grants.

Former grantees

The relationship between IFS funding and publication output for the 45 former grantees, regardless of the number of grants they received, is shown in Figure 7. Year 0 is when the grantees received their first grant. Publication output was already increasing during the 5 years previous to the award of IFS funding, and showed a continued upward trend thereafter. IFS-supported publications reached a maximum 3 to 5 years after funding and were still being published 15 years after the first grant.

From the third year onwards, mean total publication output per year for former grantees receiving two or more grants is greater than for those who received only one grant. The number of IFS publications per grantee is also greater after the third year for the group receiving more than one grant. This production is sustained for a greater number of years, as would be expected. However, the number of former grantees who received only one grant begins to fall after the fourth year, whereas for those receiving ≥2 grants this decrease occurs during the seventh year, thereby affecting the total number of publications.

It is interesting to note that even though a more sustained pro-

duction of IFS-supported publications is seen in the group receiving more than one grant (up to year 15), in the group with only one grant IFS-supported publications appear up to 12 years after they were assigned funds. Nonetheless, these data suggest that the former grantees who received more than one grant are generally more productive than those who received only one grant. The first group reached production levels >6 publications per former grantee per year in year 8 after funding, compared to 4 to 5 publications per former grantee per year of the second group in year 5 after funding and again in year 8.

Membership in the SNI

Many Mexican researchers aspire to SNI membership because it is both prestigious and financially advantageous. Of the more than 260000 individuals working in S&T who have postgraduate training, only an elite 2.6% were members of the SNI in 2000. Researchers who qualify for the first level of membership achieve their status primarily based upon their mainstream scientific publications and their contribution to the recruitment and training of new scientists. Hence, it is not a surprise that in this study significant differences were found between the publication records of 75 grantees who were current SNI members and 30 who were not. However, it would be incorrect to state that the SNI disregards publications in local journals. The two Mexican journals topping the list in which IFS grantees have published >10 articles, *Técnica Pecuaria en México* and *Veterinaria México*, are considered important journals in the SNI system. Two former IFS grantees who are established and recognized as successful researchers in Mexico published the largest part of their output in these two journals. Both of them had achieved level III in the SNI. Nevertheless, it is of interest to find that IFS grants appear to have greater impact on the publication output of non-SNI members than those presently in the SNI. The data presented below are sorted according to SNI membership status, regardless of whether it was attained before or after the IFS grant was awarded.

Among respondents, SNI members' publication lists were, on average, more than twice as lengthy as those belonging to grantees that are not members (47.7 *vs* 21.8). By the nature of the SNI selection process, it is expected that SNI members will be much more productive and probably have their publication list in order and handy. However, there was not a great difference in the average number of IFS publications produced by SNI members and non-members (4.3 and 3.9, respectively). SNI members averaged slightly more renewal grants than non-members, and there was almost no difference when the total number of IFS supported publications was divided by the number of IFS grants (2.9 IFS publications per grant for SNI members and 2.8 for non-members). IFS publications accounted for 17.8% of all non-member publications, and members' IFS publications accounted for 9.1% of their total publication record. Hence, in terms of total publications, SNI members did not publish IFS research results significantly more often than did non-members. In addition, the IFS grant was significantly more important to non-member productivity than it was to SNI members.

In terms of English publications, IFS support had a greater impact on non-SNI members. Though SNI members tend to publish much more often in English than their non-SNI counterparts (1486 publications or 41.5% of the total *vs* 200 or 30.6%, respectively), non-SNI members' English publications were more often the result of IFS support than SNI members' English publications. Of non-members' English publications, 26.5% were IFS supported. The corresponding percentage for SNI members was 12.9%.

Differences were found in the rates of article publication among SNI and non-SNI grantees as well. SNI members are much more likely to publish articles; they published an average of 23.9 articles per scientist, accounting for about half of their total publication production. Non-SNI members published an average of 8.7 articles per scientist, accounting for 38.7% of their total publications. Furthermore, SNI members published 58% of their articles in English while less than 39% of non-members' articles were in English. IFS supported research was the foundation for 19.4% of non-SNI members' English article production and for 14.6% of SNI members' article production.

If IFS support has a significant impact on researcher output, one might expect that an IFS grant will further a researchers' career by providing a solid publication basis on which to apply for SNI membership. Surprisingly, this is not generally the case. Most of the SNI members discussed here were members prior to their first grant from IFS; 42 became members at least one year prior to the first grant, 15 became members the year of their first grant, and 14 became members after the first grant. Four grantee members that received their grant prior to the establishment of the SNI in 1984 are not included.

When the mean year of the first grant was calculated for members and non-members, the difference was minimal (1992.3 for members and 1992.5 for non-members). Nevertheless, most of the grantees have progressed significantly in the SNI system since receiving their first grant (Gaillard *et al*., 2001).

The information presented in this section consistently shows that IFS support contributes to a significant percentage of all grantee's publications, regardless of SNI status. However, it is clear that the influence of IFS support is greater for Mexican scientists who are not yet SNI members, than it is for SNI members. It should be noted, however, that some grantees entered the SNI system during their IFS supported project. IFS research consistently counts for a greater percentage of their publications and articles, regardless of publication language. Hence, a simple step towards increasing the effectiveness of IFS support could be to provide grants only to those researchers who are not already full members of the SNI (non-members and those at the "candidate" level). The mechanism for this already exists in the IFS guidelines, whereby researchers deemed to be "too established" are normally not eligible for IFS support.

Conclusions

The present study suggests that IFS has made a positive contribution to Mexican grantee's overall scientific production, as well as to their publication in English and in mainstream journals. This implies increased international visibility of their work, which in turn contributes positively to the internationalization of Mexican science. Given the existence of the SNI program, the relative importance of SNI members in the IFS grantee population and the importance of international publication to qualify for membership, a sizeable share of the IFS grantees' scientific production (and as much as 58.9% of IFS supported articles) is published in mainstream scientific journals. On the other hand, despite the fact that national publication has low priority for the promotion of scientists in Mexico, most of them do continue to publish in Spanish via local journals. This dual strategy of publishing both in mainstream and in local journals in basic and applied fields such as those supported by IFS, is indicative of a healthy future for Mexican science. Moreover, Mexico has

developed relevant local scientific journals that will hopefully continue to flourish as the Mexican scientific community gains clout in the international arena. Grantees generally believe that science should support their country's development and this is also in part reflected by their continued publication of a majority of their work in Spanish.

It is considered possible that IFS, as a provider of resources for research within the Mexican scientists' home environment, may have been a factor in keeping at least some of the young scientists from migrating to institutions in the more scientifically advanced countries, especially the US, thus avoiding the brain drain which has so damaged the scientific apparatus in numerous developing countries. We found only two clear cases of brain drain of the 137 IFS supported scientists in our study, 27 years after the first grant was given to Mexico; in one of these the interview revealed that the grantee kept close professional ties with Mexico, through which he was still contributing to the development of science in the country.

Differences in publication output between scientists from the different research areas were notable. In particular, animal production researchers in Mexico, having the least number of published articles and IFS supported articles, stand out as a distinct group among IFS researchers. A previous questionnaire applied to 110 Latin American IFS grantees in the field of animal health and production showed that they published predominantly in peer reviewed journals from their home country and that little of their production was registered in the SCI, suggesting a reduced international presence (Galina *et al*., 2000). The difference in publication patterns between animal production scientists and other scientists also suggest that yardsticks for judging scientific production may also need to be geared towards the type of science that is being practiced.

The publication trends among IFS grantees in Mexico revealed in this study point to a positive influence of IFS support on scientific productivity as measured by the total number of publications and articles in scientific journals. The data suggest that IFS support is a contributing factor to grantees publishing more frequently, more often in English, and increasingly in international mainstream journals. Significantly, each of these effects of IFS support is more pronounced among grantees who are not among the elite group of SNI members. The outcomes were also much more visible in the group of researchers at UADY, a university with modest resources when compared to UNAM. Thus, IFS support in the form of small grants and network building may have a greater relative impact on scientists that have fewer resources to draw upon at their institutions.

A few points which resulted from the questionnaire survey and interviews with the Mexican IFS grantees and ex-grantees (Gaillard *et al*., 2001) help contextualize the results of the bibliometric analysis. Firstly, lack of funds was identified as the main constraint by over 50% of scientists, when asked to name the three factors that most limited their research activity. Lack of time and limited equipment, materials and facilities followed. The mean grantee research budget for 1999 was 22300USD (0-200000USD), with 47% of funding provided by the Mexican government and 26% from the grantee's institution. International organizations accounted for 14% of the budgets. Nevertheless, interviews with the grantees document several cases where international support played an important role for individual scientists, such as one of the first grantees who described access to international funding as a turning point in his research career. When grantees and ex-grantees were asked whether they would have been able to continue their research without IFS funding, 70% said they would but in a substantially different form or on a more reduced scale. A significant minority (17) would have been able to find other support and 4 said they could have carried out the work without any external support. Only 9 grantees claimed that IFS support was crucial. Nonetheless, 57% reported that it had become easier to obtain funding from their institutions following IFS funding, and 53% said the same with respect to national funding.

Another relevant fact is that soon after IFS started its program in Mexico in the 1970s, CONACYT was established. In later years, this government body responsible for national science policy and funding, established many new research grants at federal and local level including grants to young scientists from the late 1990s onwards. While conditions have changed, the results of the present study suggest that the IFS grant continues to be an important influence at the beginning of research careers, especially in institutions with modest resources. While it is clear that IFS funding is not the only factor at work and in most cases is considered non-essential to the scientist's research, it is nonetheless seen as an effective facilitator or catalysis through the provision of "seed money" and as such, has a positive influence on the career development of its young Mexican recipients.

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FONDOS PARA LA INICIACIÓN A LA INVESTIGACIÓN Y PRODUCCIÓN CIENTÍFICA MEXICANA: ESTUDIO DE CASO DE LOS BECARIOS DE LA IFS

Jane M. Russell, Jacques Gaillard, Nora Narváez-Berthelemot, Eren Zink y Anna Furó Tullberg

RESUMEN

Este estudio determina, a través de un análisis de publicación, el efecto de los recursos otorgados por la International Foundation of Science (IFS) a investigadores mexicanos para su desarrollo académico a comienzos de sus carreras. Desde 1974 el IFS ha apoyado ~4000 investigadores jóvenes en países en desarrollo, que lleven a cabo investigaciones relevantes en el uso sostenible de los recursos naturales biológicos. En marzo 2000 se recibieron 105 listas de publicaciones de los 138 actuales y anteriores mexicanos subvencionados, se codificaron según tipo y formato de las publicaciones, idioma de publicación, publicación en revistas de cobertura internacional, coautorías y colocación del autor. Estas variables fueron analizadas en relación a cuándo se otorgó el financiamiento, número de donaciones recibidas, área de investigación del proyecto financiado, y membresía en el Sistema Nacional de Investigadores (SNI). La tendencia de publicación muestra que el apoyo del IFS contribuyó a aumentar el volumen de publicaciones, con más frecuencia en inglés, y más a menudo en revistas científicas de corriente principal, además de incrementar la visibilidad internacional y su contribución a la internacionalización de la ciencia mexicana. Se sugiere que los investigadores becados del IFS fueron capaces de establecerse como científicos bona fide *en México, incluso aquellos en las universidades e instituciones de investigación de menor ranking. Se redujo la probabilidad de fuga de cerebros y se contribuyó a fortalecer la investigación nacional. Sin embargo, se concluye que más que un factor crucial para el desarrollo de sus investigaciones, la beca IFS es un facilitador importante para el avance de la carrera de los becarios.*

FUNDOS DE CAPITAL SEMENTE E PRODUTIVIDADE NA CIÊNCIA MEXICANA: ESTUDO DE CASO DOS BENEFICIÁRIOS DE FUNDOS DO IFS

Jane M. Russell, Jacques Gaillard, Nora Narváez-Berthelemot, Eren Zink e Anna Furó Tullberg

RESUMO

Este estudo determina, através de uma análise de publicação, o efeito dos recursos outorgados pelo International Foundation of Science (IFS) a investigadores mexicanos para seu desenvolvimento acadêmico no começo de suas carreiras. Desde 1974 o IFS tem apoiado ~4000 investigadores jovens em países em desenvolvimento, que realizam investigações relevantes no uso sustentável dos recursos naturais biológicos. Em março de 2000 foram recebidas 105 listas de publicações dos 138 atuais e anteriores mexicanos subvencionados, se codificaram segundo o tipo e formato das publicações, idioma de publicação, publicação em revistas de cobertura internacional, co-autorias e colocação do autor. Estas variáveis foram analisadas em relação a quando se outorgo o financiamento, número de doações recebidas, área de investigação do projeto financiado, e membresia no Sistema Nacional de Investigadores (SNI). A tendência da publicação mostra que o apoio do IFS contribuiu a aumentar o volume de publicações, com mais freqüência em inglês, e mais seguido em revistas científicas de corrente principal, além de incrementar a visibilidade internacional e sua contribuição à internacionalização da ciência mexicana. Sugere-se que os investigadores com bolsa de estudo do IFS foram capazes de estabelecerem-se como científicos bona fide *no México, reduziu-se a probabilidade de fuga de cérebros e se contribuiu a fortalecer a investigação nacional. No entanto, se conclui que mais que um fator crucial para o desenvolvimento de suas investigações, a bolsa de estudo do IFS é um facilitador importante para o avanço da carreira dos bolsistas.*