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Collaboration and the generation of new knowledge in networked innovation systems: a bibliometric analysis

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Abstract

Canola, a high-value, export-oriented agricultural commodity, was developed in Canada over the course of 40 years in public institutions, driven by imported technology and imported research scientists. The evolution of canola R&D closely mirrors the evolution of the Triple Helix Models of innovation. Through the application of longitudinal citation analysis, using five-year intervals, publications from Canadian public institutions involved in canola R&D have been analyzed. In the most recent five-year interval, the relative citation rates of public sector research increased by 60% compared to the global average. A unique fixed-effect negative binomial regression model is used to demonstrate the critical relationship between the institutional arrangement that governs collaboration and the production of knowledge that underscores technological innovation.

Keywords: canola; public-private partnerships; triple helix; regression analysis; citation analysis; agricultural R&D

1. Introduction

Canola is a high-value export-oriented agricultural product that was developed by Canadian public institutions over a period of 40 years by importing the original plant species and using imported technologies and imported researchers. This long-term process culminated in the creation of a global market for this branded and highly-differentiated product. In 2000, a longitudinal citation analysis, using five-year intervals, was performed on Canadian public institutions involved in the transformation of canola, comparing their relative citation rates to a global average [1]. This research demonstrated that changes in the relative citation rates reflected changes in the industrial organization of canola R&D. Specifically, the privatization of a process once dominated by public institutions led to lower relative citation rates, due to the need for confidentiality by the private sector. A follow-on study, conducted 10 years later, again using five-year intervals, confirmed the bias towards lower citation rates

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from the privatization of canola innovation. Interestingly, in the second five-year interval, the relative citation rates of public sector research grew by 60%. This article focuses on the factors that caused this increase. The descriptive statistics indicate three variables behind the increase in relative citation rates: collaborative funding of public R&D; the use of hybrid organizations to fund and manage the innovation process; and the use of innovative public funding tools that facilitate collaboration in funding public R&D. To isolate the variables responsible for the 60% increase in relative citation rates, a regression model was developed to work with the unique nature of citation data.

The changes in the industrial organization of canola R&D closely mirror the Triple Helix Models of innovation. The Triple Helix Models of innovation have evolved over time from Triple Helix I, where the state dominates the innovation process, to Triple Helix II, where the market reigns supreme, to Triple Helix III, where innovation is dependent on the development of hybrid organizations and interactions between the public, private and academic spheres to create new knowledge to drive the innovation process. The Triple Helix Models of innovation provide the analytic framework for this case-study. There are two specific objectives to this paper. First, building from Triple Helix theory, this empirical analysis seeks to determine if innovation is a path-dependent process, based on the historic presence of the state and market, or if innovation can occur in the absence of evolution. The second objective is to address whether commodity-based agricultural innovation systems in the developed world, such as Canada's canola sector, can be transferred to the developing world. In short, can successful processes that led to the development of prosperous export crops like canola provide a model of excellence for developing world economies?

There are five sections to this paper. Section two uses the Triple Helix Models of innovation to develop a framework for understanding the evolution of canola R&D. The methodology is explored in section three, which links the theory and process of citation analysis with a regression model specific to this analysis. Section four contains the findings and interpretations of the results. Section five discusses the implications of these results.

2. State of the Art

All conceptions of the Triple Helix model involve the state, the market and universities. In Triple Helix I, also referred to as the Statist Regime, the state is dominant, occupying a "commanding heights" position over the institutional domains of both university and industry. In the Statist Regime, there are clearly defined boundaries among the public, private and academic domains, with interactions between the spheres controlled and mediated by the state in a linear and institutional process through formal organizations, such as technology transfer offices and contracts [2]. The advent of communications technology coupled with growing globalization represents the force driving the evolution from Triple Helix I to Triple Helix II, where industry, enabled by technological innovation, is the dominant sphere that indirectly drives growth. This regime is characterized by the relative absence of overlap between the three institutions; relations are institutionalized and formal, occurring in a synchronized and linear process. Interactions between the spheres are limited to R&D activities that do not challenge the boundaries or move beyond one-to-one activities between the different institutions, with these relationships taking place through intermediaries such as specific technology transfer organizations, or through arms-length market-oriented transactions [3]. Knowledge generally flows in a direct, linear process from source to use [4].

Unlike the first two models, the Triple Helix III Model is characterized by interdependent relations between the spheres. In this model, the three institutional domains overlap, creating new spaces and methods of collaboration for developing new knowledge [5]. In this model, the formal delineation between the spheres disappears and each of the institutional domains takes on the attributes and functions of the other domains, thus creating networks and new organizational structures to manage the non-linear and spiral flows of new knowledge that transcend the boundaries of Triple Helix I and II. This model is also known as the balanced model, reflecting the interdependencies generated through the spherical overlaps of the knowledge-based system. Knowledge and communication continually shape and re-shape the physical configuration of the innovation networks and spawn the novel organizational structures required for collaborative R&D efforts [6]. Relations in this model are reciprocal, based on a culture of institutional entrepreneurship driven by the social nature of knowledge. The complexities of developing science-based knowledge in this model result in the development and use of specialized, organically-configured hybrid organizations that incorporate the activities of each sphere, including financing, technology transfer and commercialization. The hybrid organization can be conceptualized as a structure that transcends the boundaries between the three spheres and allows the transfer of ideas to support the capitalization of knowledge "through collaboration" to enable innovation [7]. In agricultural biotechnology, the creation of new knowledge is a complex process that depends on face-to-face endeavors grounded in trust among actors drawn from the three spheres; hybrid organizations provide the institutional and organizational proximity required for personal interactions [7].

The evolutionary nature of the three Triple Helix Models closely mirrors the ongoing revolution in governance, where organically-developed and self-governing networks appear to be replacing the vertically organized and hierarchical state as a means of social and economic organization. This new model of networked governance, as opposed to the vertical governing model dominated by the state, represents a transformation away from centralized government to distributed governance, which is characterized by interdependence, the multiplicity of new, hard-to-categorize actors and indistinct boundaries between the public, private, and academic spheres [8]. The arrival of self-organizing networks has facilitated the growth in the use of public-private partnerships (PPPs or P3s) to provide a flexible and developing organizational structure capable of facilitating collaboration. One area where P3s have emerged is in the management of national and international agricultural R&D innovation networks. Agricultural P3s function as innovation brokers and intermediaries as they link the heterogeneously configured actors into coherent systems to develop and commercialize transformative agricultural technologies [9, 10]. One view is that agricultural P3s provide a structural means of linking top-down, technology-push innovation systems with bottom-up demand-pull innovation systems by creating feedback loops and horizontal linkages that drive the evolving and self-organizing innovation process [7].

2.1 Research focus

The Triple Helix Model of innovation provides a framework of analysis for a case study on the development of canola, which, from an historical perspective, closely mirrors the evolutionary nature of the structure of the three models, the transformation in knowledge production and the transition to self-organizing networks.

Canola is a Canadian innovation that transformed rapeseed into a globally recognized product that provides the world's third largest source of edible oil. Historically, rapeseed has been used as cooking oil, an industrial lubricant and animal feed. However, due to high levels of erucic acid (linked to heart problems in humans) and glucosinolates (which lowers the animal feed value), rapeseed faced market limitations that prevented large-scale cultivation. After importing the raw plant species from Poland (and possibly Argentina), numerous technical innovations performed at Canadian public agencies transformed rapeseed into a low erucic acid and low glucosinolate product, trademarked as canola by the Canadian trade association, thus creating a global market for this transformed rapeseed product [11]. As a part of the transformative process, new breeding technologies and agronomic traits were developed using imported biotechnology tools, creating the world's first transgenic crop [12]. From a Canadian perspective, canola is often referred to as a "Cinderella" crop, as it created new export markets for producers facing declining prices and profits in existing crops. Due to first mover advantages derived from public investments that created a regional innovation cluster providing R&D economies of scale and scope, Canada is the world's leading exporter of canola and is a world-leading entrepôt for agricultural R&D and innovation as measured by the number of scientists employed, by the number of technical innovations, and by the flows of codified and non-codified knowledge [13].

As a part of a study on the political economy of canola [1], a longitudinal citation analysis was performed on the Canadian public institutions involved with canola innovation, comparing their relative citation rates on peer-reviewed and published canola articles to the global average from 1981–1996 in five-year intervals. In this 15-year period, based upon quantity, Canada was the leading publisher of peer-reviewed canola papers, with Agriculture Canada (now called Agriculture and Agri-Food Canada, or AAFC) being the largest source of papers in Canada and globally. In this 15 year segment, AAFC was the primary funder and provider of canola R&D and innovation as measured by the number of scientists in canola research and the percentage of acreage using AAFC canola varieties. During this era, as explored in more detail in section four, the relative AAFC citation rates, compared to the global average (normalized to 1.0), ranged from 0.84 during the 1981–85 interval to 1.22 in 1986–90 and 0.93 during 1991–96. Interestingly, during this 15-year period, AAFC collaborated with other public and private organizations on 21% of its papers, resulting in a slightly lower citation rate, challenging the notion that collaborative R&D should improve the quality of the output [1]. As noted above, this era was punctuated by the transition of canola R&D from a public-dominated venture to the large expansion of private activity in response to the expansion of private intellectual property rights beginning in the late 1980s. By 1995, more than 75% of the new canola varieties were developed and commercialized by private corporations. As a part of the privatization of canola R&D and due to public austerity measures, AAFC began fee-for-service R&D activities with the private sector. At that time, it was predicted that due to the private sector requirement for confidentiality and non-disclosure, AAFC relative citation rates would decline precipitously [11].

A follow-on analysis was recently conducted on AAFC citation rates over two intervals, spanning 1997–2002 and 2003–2007. In the first interval, AAFC citation rates declined to 0.66, confirming the earlier hypothesis. However, AAFC relative citation rates increased over 60% in the 2003–2007 interval to 1.11. The descriptive statistics suggest that changes to the structure and process of the funding of AAFC canola papers could be the cause of the improvement in the relative citation rates. Specifically, three items appear to have changed and possibly influenced this increase: the role of collaborative funding; the rise of producer-funded P3s; and the use of innovative public financing mechanisms that engendered public–private R&D collaborations.

2.2 Research question

The remainder of this article, using the methodology described in section 3, examines how these three factors influenced the 60% increase in relative AAFC citation rates. In doing so, this study uses the Triple Helix framework to determine if innovation systems are evolutionary, meaning whether a system depends on developing a state-dominated Triple Helix I Model and progress into the market-dominated Triple Helix II Model as a means of creating a knowledge-based economic system. This case-study explicitly questions whether innovation is path-dependent [14] . The ultimate objective of this paper is to explore how technology-oriented agricultural innovation systems that exhibit attributes associated with the evolutionary perspective of the three Triple Helix Models can be exported to the developing world.

3. Methodology

Citation analysis is the scientific and quantifiable measurement of citation data from peer-reviewed publications. Citation analysis introduces objectivity to the evaluation of research by comparing relative rates against absolute counts, such as global averages, to determine emerging trends in the development and dissemination of new knowledge [15] . The use of relative counts allows for comparing individuals, institutions, and countries to global averages to document and measure the flow of knowledge. A highly cited paper indicates that a relatively large number of other papers have found utility in that particular research [16]. In addition to comparing like–to-like and identifying emerging trends in the flow of knowledge, citation analysis permits a deeper understanding of the processes that govern the generation of knowledge, providing the basis for generating better informed decisions over the allocation of scarce resources [17]. In sum, citation analysis provides benchmarking capability, and the mapping of knowledge facilitates the identification of trends that otherwise would not be observable.

This paper utilizes the same data collection method as the original research [1]; a keyword search through the ISI Web of Science uses canola, rapeseed, brassica rapa, brassica napus, and brassica campestris as the keywords. In the 1997–2002 interval, there were 4,692 peer-reviewed canola articles published worldwide with an average citation rate of 14.02 per paper. In this period, AAFC papers had an average citation rate of 9.27, representing a 0.66 relative rate. In the 2003–2007 timeframe, there were 4,712 papers published with a global citation rate of 3.75. The AAFC papers published in the period were cited an average of 4.16 times per paper for a relative citation rate of 1.11, representing a 60% increase.

The highly skewed distribution of the citation data presents challenges to research that need to be addressed. There are two factors influencing the distribution of citation data. First, the high prevalence of papers without citations, called “the zero-inflation” problem, contributes to the skewed distribution [18]. Second, there are a small number of papers with extreme measurements, also known as outliers, skewed in the opposite direction in a process referred to as “over-dispersion,” creating a situation where the conditional data variance exceeds the conditional mean [19]. The skewed distribution phenomenon is common to citation data analysis [17].

A fixed-effects negative binomial regression model was utilized to predict the likelihood of the occurrence of a specific variable against an estimated base-line value. This model creates a dummy variable to standardize the effects of the over-dispersion of the data, permitting the estimation of the conditional probability of a specific event against a reference value or group [19]. A logarithmic likelihood count model determines the probability of occurrence [20]. The analysis was conducted using Stata Statistical Software version 11.2 [21]. The output is measured in incident-rate ratios (IRR) against the estimated base-line value [22]. In this analysis, the base-line value is an AAFC peer-reviewed canola paper published in the absence of collaboration, in the absence of funding from a producer P3, and in the absence of public funding mechanisms. Therefore, each explanatory variable in question is compared to this non-collaborative paper by estimating the likelihood that each variable, in the absence of the other variables, will increase the incidence of a canola paper being cited by another peer-reviewed canola paper.

4. Findings and Interpretations

As discussed, there are three variables that appear to have influenced the 60% increase in citation rates between the two intervals in question. The descriptive statistics indicate that collaborative funding (i.e. more than one funder per AAFC canola paper), the use of producer P3s in funding AAFC canola research and the use of the Matching Investment Initiative (MII), a public funding mechanism designed to engender collaboration, appear to have contributed to the increase in AAFC relative citation rates. First, as indicated in table 1 below, in the 1997–2002 interval the use of pluralistic funding did not lead to a marked increase in relative citation rates. However, in 2003–2007, there is a marked increase in citation rates associated with an increase in funding partners. The increase in citation rates is most evident with three funders, in which case the AAFC citation rate is 78% higher than the global average and almost twice the citation rate of papers involving three funders in the 1997–2002 period. The use of two funders generates a 1.26 relative citation rate, about a 60% increase from the previous era. The use of four or more funders leads to a 1.42 relative rate, which is consistent with the 1997–2002 data. However, this was based upon 10 papers, suggesting the small sample size calls into question the validity of the 1997–2002 citation rate.

Table 1. Collaborative Funding Descriptive Statistical Comparison

	1997–2002		2003–2007	
Number of Funders	Relative Citation Rate	N	Relative Citation Rate	N
One Funder	0.65	72	0.7	65
Two Funders	0.74	47	1.26	59
Three Funders	0.94	26	1.78	44
Four or More Funders	1.42	10	1.48	37

Second, as indicated in table 2 below, in the 1997–2002 interval producer P3s were not an important factor in the financing of AAFC canola papers as signified by the small number of papers and a relative citation rate below the global average of 1.0. This changed in the 2003–2007 era as the number of papers financed by producer P3s expanded from 15 to 62, with a relative citation rate of 1.61, almost doubling the citation rate from the previous interval. A number of factors have influenced the rise in the use of producer P3s for financing AAFC canola papers. First, producer P3s first appeared in the 1970s and they were instrumental in the financing and managing of the R&D innovation process that transformed rapeseed into low erucic acid and low glucosinolate canola, creating the product that opened new international markets for this branded, trademarked and differentiated product. This process marked the beginning of P3s venturing into the management of the canola innovation process through the financing and coordinating of R&D activities taking place in AAFC and Canadian university laboratories.

Table 2. Producer PPPs and MII Descriptive Statistical Comparison

	1997–2002		2003–2007	
	Papers	Relative Citation Rate	Papers	Relative Citation Rate
Producer PPPs	15	0.84	62	1.61
MII	11	0.92	52	1.66
Both	2	1.6	36	1.78

During this period, a number of producer associations began using crop levies to finance canola R&D and to help shape government agriculture policy to accelerate the development of this sector. Second, government austerity programs created a requirement for new sources for the financing of canola R&D, a process that began in the early 1990s and gave rise to a number of producer P3s devoted the management of the R&D process. Third, the introduction of intellectual property rights opened an institutional space for the private sector to dominate the upstream R&D process, primarily in the development of breeding technologies and proprietary traits, and use those positions to control the flow of new crop varieties. The privatization of the downstream R&D process resulted in a number of technology needs of producers going unfulfilled, something the levy-financed producer P3s have worked to address. Fourth, the era beginning in the 1990s and reaching fruition in the 2003–2007 interval marked the end of AAFC as the dominant actor in canola innovation and the beginning of the

AAFC as a support organization to both the private sector and producer P3s. Last, as a part of the funding of AAFC canola papers, many producer P3s require the publication of a peer-reviewed research article, creating a process conducive to knowledge development and dissemination.

Third, the use of the MII, similar to the use of producer P3s expanded both the quantity of papers and relative citation rates. While the MII was used in 1997–2002 to finance only 11 papers, which resulted in an citation rates slightly below the global average, in 2003–2007 the MII was used to finance 52 AAFC papers, resulting in a 1.66 relative citation rate, representing about an 80% increase over the previous period. The MII was an AAFC funding mechanism designed to link AAFC research capabilities with industry needs in a process that was intended to keep AAFC scientific capabilities relevant and to compensate for the reduction in public spending [23]. The MII is a tool that permits the AAFC to exert influence over agri-food R&D activities in an operating environment characterized by austerity and privatization. AAFC began using the MII in the mid-1990s.

One last explanatory variable of interest is the simultaneous use of producer-financed P3s and the MII in the financing of AAFC canola research. Only two AAFC papers were financed by both producer P3s and the MII in the first interval. This changed dramatically in the 2003–2007 period as 36 papers were financed by both, resulting in a 1.78 relative citation rate.

Therefore, there are six variables of interest to this analysis: two funders, three funders, four or more funders; producer P3s; the MII; and the use of both the producer P3 and MII in financing AAFC canola papers. As discussed in section three, each variable is being compared directly to AAFC papers that did not use collaborative funding, producer P3s or the MII. Put simply, this investigation seeks to determine, through a regression analysis, the impact of each variable on the increase in citation rates by determining the likelihood of a canola paper being cited through the use of each variable, compared to a canola paper without the variable in question.

In table 1, the regression analysis indicates two statistically significant variables, both related to the number of funders. In 2003–2007, using three funders on an AAFC canola paper resulted in 2.3x increased chance of being cited as opposed to a non-collaborative paper (significant at a 95% confidence level). Using four or more funders resulted in a 2.0x increased chance of being cited, although it should be noted both the Z and P values indicate that the results are ambiguous as each value is only marginally significant. This suggests that the benefit from collaboration, in this analysis, is maximized at three partners with declining returns in evidence at four or more funders. This suggests there may be limitations on the returns from collaboration.

Building from theory and from this analysis, there are two areas that warrant further research--the role of enablers, plus the role of P3s and other hard-to-define organizational structures that facilitate collaboration. While neither the MII, as an enabler, nor the producer P3s, as collaborative structures, were statistically significant factors in the increasing citation rates (although they did have modest, positive coefficients), it is important not to underestimate their role in creating a process conducive to collaboration. Innovation in the canola sector has migrated to a new space and process defined by collaboration and the presence of novel organizational structures such as P3s.

One important issue is whether agricultural science and technology systems from the developed world, such as Canada's canola innovation system, can be exported to the developing world. The answer is a qualified yes. The Canadian canola story presents a model for emulation. Canada's agricultural sector is small compared to its competitors in the United States and the European Union--Canada lacks many of the economies of scale to compete effectively. Therefore, Canada must pursue innovative strategies in identifying and developing novel crops such as canola to remain at the forefront of global markets. The development of canola provides an institutional model for the developing world, as interconnectedness with global knowledge flows and global markets provides the means for agriculturally-based economic growth in a process known as techno-leapfrogging [24]. This process enables lesser-developed economies to leverage the technological assets of developed economies to accelerate economic growth and development.

Table 3. Regression Results

Variable	IRR$^{\phi}$	STD Error	Z	P>|z|	[95% Conf. Interval]	
2 Funders	1.76	0.665	1.49	0.136	0.837	3.693
3 Funders	2.36	0.812	2.50	0.012*	1.203	4.634
4 or more Funders	2.00	0.700	1.98	0.048*	1.006	3.975
MII	1.10	0.536	0.19	0.847	0.422	2.860
Producer P3	1.03	0.346	0.08	0.933	0.531	1.990
Both MII and P3	1.14	0.327	0.47	0.637	0.653	2.005
/lnalpha	0.63	0.143			0.349	0.913
Alpha	1.88	0.270			1.418	2.493

$^{\phi}$ IRR=Incident rate ratios, represents the likelihood of an AAFC paper being cited compared to non-collaborative, baseline canola papers.
* Denotes statistically significant result

Expanding from this research, collaboration in P3s appears to be an emerging organizational structure and process for identifying, developing, and transferring relevant technologies from the developed world to the developing world for agricultural economic growth. At the time of this paper, an online database compiled by the Syngenta Foundation for Sustainable Agriculture has identified 203 agricultural P3s in the developing world. A total of 122 of these P3s have been in operation less than five years, and another 61 have been in operation for less than 10 years, suggesting that agricultural P3s in the developing world are a recent and growing phenomenon. Given the difficulties both the state and market actors have in effectively operating in these areas, this may be both a response and solution to the gaps in organizational capacity in developing countries.

Recent research into the growing use of agricultural P3s in the developing world suggests that P3s are a revolutionary structure capable of operating in environments that are beyond the capabilities of either the state or the market. Specifically, it has been demonstrated that agricultural P3s in the developing world provide a structure and process that facilitate the development of local governance capabilities and social capital that can compensate for the absence of a state or a rule-based, transparent economy with functioning markets [25]. Because P3s facilitate both trust and transparency, they can work to generate higher levels of technology transfer between the developed and developing worlds, resulting in yield gains, lower costs for small farmers, and increasing farm incomes [26]. Developing world P3s specialize in “orphan crops”—so named because they are neglected by both the public and private sectors—in an effort to create an institutional space dedicated to sustenance crops such as millet, cassava, and sorghum by merging public and private technologies and capabilities to develop new crops for the “bottom billion” of the world.

5. Conclusion

This empirical analysis extends our knowledge about the role of collaboration in generating higher rates of knowledge development and transfer. Four items warrant comment. First, the evolution of canola closely emulates the evolutionary nature of the three Triple Helix Models as measured by the citation data. The changes in the structure of the financing and management of the canola R&D process progressing from state to market to collaboration mirrors theory. This suggests that collaboration and communication are primary drivers of innovation in a knowledge economy, which in turn supports the view that collaboration has replaced the linear systems characterized by institutional hegemony as the primary driver of innovation. Second, the critical role of collaboration in this study suggests that innovation is not path-dependent, but rather is based on emerging qualities derived from interdependencies that create economies of scale and scope that are difficult to measure and evaluate. This analysis suggests that pluralistic funding measures, collaborative problem solving, and institutional synergies can lead to a process of techno-leapfrogging that can accelerate technological-driven agricultural development. Third, the recent growth in the use of agricultural P3s in the developing world indicates that collaboration is an emerging process. Fourth, this model suggests that there may be certain physical limits to collaboration, as the returns were maximized at three partners.

Theory and this empirical analysis indicate that innovation is driven interdependencies created by collaboration. This suggests a recasting of the conventional approach, moving away from vertical processes characterized by the dominant position of a particular institutional sphere, to a horizontal process characterized by the absence of hierarchy may be warranted. Policy needs to reflect this transformation, as governments can influence but not directly control the processes that govern the generation of new knowledge. Therefore, policy needs to be directed to creating tools, processes, and organizations that enable collaboration. The public sector needs to develop tools that permit the leveraging of public research assets with the needs and capabilities of other sectors to create interdependencies and generate economies of scale and scope. Additionally, policies need to be developed to permit the lessons of multi-sectoral collaboration to be absorbed, analyzed, and transferred; there is a need for learning communities and learning organizations to develop the conditions that underpin innovation. Government policies should reflect the need for trust and transparency in both the development and implementation of policies but also the need for new tools and organizational structures that engender trust and transparency to provide a framework that is conducive to collaborative ventures.

Moving from the general to the specific, this research demonstrates that collaboration in the pursuit of technologically-driven agricultural solutions to poverty appears to be an emerging process and that P3s are increasingly used to organize this effort. The problems of developing technological solutions to elevate poverty and hunger in the developing world exceed the capabilities of both the public and private sectors. Therefore, national and international policies should be directed to developing a global institutional environment that permits public-private sector collaborations at the micro, mesa, and macro levels for the purpose of identifying relevant technologies and practices that can be transferred to farmers and farmer organizations in the developing world. Policies are needed to develop incentives and enablers to facilitate linkages between developing world farmers and farmer cooperatives and the global repositories and flows of agricultural technologies and practices that revolve around the public, private and academic spheres.

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