Innovative Performances of Agricultural Research Institutes in Sri Lanka: The Relevance of Knowledge Sourcing and Absorptive Capacity for Innovation Performances

Silva K.N.N.

Department of Agricultural Economics, Faculty of Agriculture, University of Ruhuna, Sri Lanka

**Corresponding Author:*
Email: nadee@agri.ruh.ac.lk

ABSTRACT

This paper explores the relationship between external knowledge sources and absorptive capacity on the one hand and the innovative performance of agricultural research and development institutes in Sri Lanka. Following the literature, we first identify the different types of knowledge sources available to research and development institutions and analyse the ease with which they can access them. The institutions also acquire external knowledge from publications and by attending conferences. Secondly, we test and see whether external knowledge sources lead to higher innovation performance. Based on survey data, our empirical results show that institutes with fewer departments are more innovative and that higher organizational absorptive capacities result in a higher level of innovative output. Interestingly, formal and reliable knowledge sources contribute to higher innovative performance. Anyhow, higher absorptive capacity without engagement in external interaction reduces the innovative performance of research and development institutes. Moreover, this empowers agricultural research and development institutes to engage in more collaborative research approaches to achieve higher levels of innovation performance.

KEYWORDS: Absorptive capacity, Innovative performance, Knowledge transfer

Introduction

In the contemporary knowledge-based economy, organizations increasingly rely upon external sources of information to innovate and sustain competitive advantages (Cassiman and Veugelers, 2005; Cohen and Levinthal, 1990; Kostopoulos et al., 2011; Ter Wal and Boschma, 2009). Significant volumes of this knowledge transfer among organizations occur through mutual learning and inter-organizational cooperation, which stimulates the creation of new knowledge and innovation (Kogut and Zander, 1992).

However, many organizations face difficulties in acquiring and benefiting from such external knowledge (Cassiman and Veugelers, 2005; Escribano et al., 2009). This particularly applies to knowledge that is external to their region. Particularly, Agricultural Research and Development (R&D) institutes in Sri Lanka function as nonprofit public organizations compared to other private and public research institutes that mostly operate on a profit basis. New technologies and knowledge are produced by these R&D institutes, which disseminate this knowledge to the farmers.

External knowledge is constantly gathered from new research publications (PUBL) or patented products by research institutes that are well known for their innovative performance. Therefore, this study focuses on the knowledge-seeking behavior and innovative performance of agricultural R&D institutes.

Innovation performance is a key factor that indicates the success of a business. In general, it is measured by units of output. Anyway, non-profit, state sector agricultural R&D institutes have specific goals for producing innovations. Dissemination of new knowledge is the prime objective of agricultural R&D institutes in Sri Lanka. Generally, we use the number of PUBL and number of PATS as measures of innovative performance.

In the context of the network of R&D institutes, gatekeeper organizations are essential for accessing knowledge from external regions and diffusing this into the regional knowledge network (Giuliani, 2003). Such gatekeepers are typically larger firms or universities (Broekel and Graf, 2012). When there is no large firm to serve this role, which is frequently the case in many developing countries, actors capable of playing the role of knowledge gatekeepers are usually public R&D institutes. In many instances, these organizations are specifically set up to diffuse new knowledge about resources, markets and technologies to local firms (Inkpen and Tsang, 2005). In that context, organizational absorptive capacity (ACAP) takes on a significant role in the innovation performance process.

Whereas many studies have explored the relationship between ACAP and the innovation performance of firms in developed countries (Broekel et al., 2012) and within the industry-specific cluster, we still know little about this relationship in the context of "average" regions in developing countries, i.e. regions where there is a lack of any well-functioning knowledge institutions. In addition, most of the attention has been paid to profit-oriented organizations, with an insufficient investigation being done on the role of non-profit (publicly funded) R&D organizations in developing countries in the context of ACAP and innovation performance. This paper will contribute fresh knowledge to the existing literature regarding the learning behavior and innovation performance of nonprofit state-funded R&D organizations, in order that we might hopefully know as much about them as we do about the privately funded, profit-oriented business firms.

The present paper seeks to overcome this research gap by conducting an empirical study on the public agricultural R&D institutes in Sri Lanka. We will investigate the determinants of their ACAP, which is a key factor in their knowledge sourcing, diffusing and innovation activities (Cohen and Levinthal, 1990; Jansen et al., 2005; Zahra and George, 2002). We will also assess the innovation performance of R&D institutes in terms of the number of researches published and the number of PATS obtained.

This paper is structured as follows. Section 2 elaborates on the theoretical arguments and research hypotheses. Section 3 introduces the empirical data and the specifications of the empirical approach. The main findings are presented in Section 4 and discussed in Section 5, which concludes the paper.

Theory and Hypothesis Development

ACAP, Knowledge Transfer and Innovation Performance

The transfer of knowledge from one organization to another is an essential component of today's innovation processes (Kang and Kang, 2009; Escribano et al., 2009). Knowledge transfer is the process through which one organization can gain access to the experience of another and benefit from it (Argote and Ingram, 2000). It is rarely a unidirectional process as usually both the receiving and sending organizations to benefit from this arrangement (Broekel and Boschma, 2012; Kotabe et al., 2003). Crucially, the knowledge possessed by other organizations may not be easy to access or be ready for instant exploitation because the mere acquisition of external knowledge may not be sufficient to internalize it successfully (Escribano et al., 2009).

Organizations vary significantly in their ability to acquire and absorb knowledge. Whether they are successful at this depends on a factor that is conceptualized as their "ACAP".[1] This capacity is defined as an organization's ability to recognize the value of new information, assimilate the knowledge and apply that knowledge productively towards a commercial end (Cohen and Levinthal, 1990).

The ACAP of organizations may be influenced by a number of factors. According to Lazzeri and Pisano (2014), it is primarily determined by their ability to acquire, assimilate, exploit, and share knowledge. These abilities are in turn shaped by the knowledge that the organizations have absorbed previously (Cohen and Levinthal, 1990). Accordingly, organizations' absorptive capacities are based on existing knowledge, learning and knowledge utilization routines, as well as the general resources required for these processes (Tsai, 2001). Consequently, organizations' absorptive capacities are formed through a prolonged process of R&D investments and knowledge accumulation, which means that to some extent they are a by-product of organizations' R&D activities (Cohen and Levinthal, 1990; Bathelt et al., 2004). Innovation performance is achieved when organizations apply new or improved ideas or processes that confer a new utility or quality to the goods and services they market. In this respect, organizational capabilities greatly determine the innovative capacity of the organizations. As this depends on each organization's ability to learn and utilize knowledge, its ACAP is an essential determinant of its innovation performance, which forms the basis of our first hypothesis.

H_1: An organization's ACAP is positively related to its innovation performance.

Differences in the Types of Knowledge Exchange

Accessing external knowledge is not happening in a uniform way. There are various ways of sourcing external knowledge and arranging inter-organizational knowledge transfer, such as informal interaction (Laursen and Salter, 2006), formal R&D collaboration (Shan et al., 1994; Narula, 2004), technology acquisition (Granstrand and Sjölander, 1990; Pyka, 1997), and labour mobility (Breschi and Lissoni, 2001).

[1] Interestingly, organizations' ability to share and diffuse knowledge is rarely addressed and frequently (implicitly) seen as being highly correlated with their ACAP. We follow this view here.

One important dimension in this context is whether the exchange takes place in a formal or an informal manner (Kang and Kang, 2009). Informal interactions are built upon social contacts and lack regular meetings. They are mostly based on mutual trust and personal non-economic relations (Hakansson and Johansson, 1992; Gulati, 1995). These relations require relatively low costs of maintenance. Accordingly, organizations are (principally) able to establish and maintain a large number of these relations. It is therefore argued that informal knowledge sourcing is a valid strategy for accessing a diverse variety of knowledge sources (Hakansson and Johansson, 1992).

However, this makes informal knowledge sourcing a double-edged sword. On the one hand, it is comparatively cheaper and relatively easier to establish than formal relations. The latter requires some kind of formal (legal) framework to be established and maintained, which cannot be done without effort. On the other hand, due to their relatively low costs, organizations may attempt to make excessive use of informal relations and utilize them to an extent that is far higher than their actual ability to handle, given their limited ACAP. For instance, this can be seen in organizations that are over-embedded in social relationships (Broekel, 2012; Uzzi, 1996), which is likely to harm their innovation activities. Supporting this view, Kang and Kang (2009), Laursen and Salter (2006), and Uzzi (1996) report an inverted U-shape relationship between the extent of using informal knowledge sourcing and organizations' innovation performance.

However, most of the insights on the intensity of information and knowledge sharing and innovation performance are obtained in the context of developed countries that are usually characterized by dense, social networks of highly specialized actors. We argue that in the context of developing countries this is less likely to be the case, as (informal) knowledge relations tend to be less dense and involve a greater heterogeneity of actors and knowledge. The lower density of relations implies that redundant relationships are less likely to occur, and so is the likelihood of over-embeddedness. Our second hypothesis underlines the positive effects of informal knowledge sourcing in the context of developing countries.

H_{2a}: The intensity of informal knowledge sourcing positively impacts an organization's innovation performance.

As pointed out above, R&D-related knowledge sourcing may not only take place in an informal manner but also take place on the basis of formal agreements involving signed contracts and long-lasting established relations (Pyka, 1998). Collaborations based on formal agreements usually involve intensive knowledge/ capability sharing realized through frequent organizational interaction (Hansen, 1999).

Moreover, they have a clear focus and aim with the boundaries and content of the interactions usually being (formally) well defined. Accordingly, they provide a good foundation for inter-organizational knowledge sharing.

The advantages of formal interactions, however, come with a relatively higher maintenance cost and greater difficulty in the establishment.

Depending on the quality of the formal agreements, the lack of social embeddedness and trust in these interactions may involve greater risks of opportunistic behaviour, which eventually may translate into negative effects on innovation (Narula, 2004).

Therefore, we expect organizations with the highest innovation performance to pursue formal R&D collaboration at an intermediate level (Kang and Kang, 2009). Empirical results for developed countries (e.g., Uzzi, 1996) support this argument and we have little reason to suppose why this should be different in the case of developing countries.

H_{2b}: The intensity of engaging in formal R&D collaboration is related to innovation performance in the form of an inverted U-shaped curve.

Methodology

Our empirical investigation is based on data collected from agricultural R&D institutes in Sri Lanka. As shown in figure 1, there are 36 agricultural R&D institutes in Sri Lanka including public, private, and university-affiliated institutes.

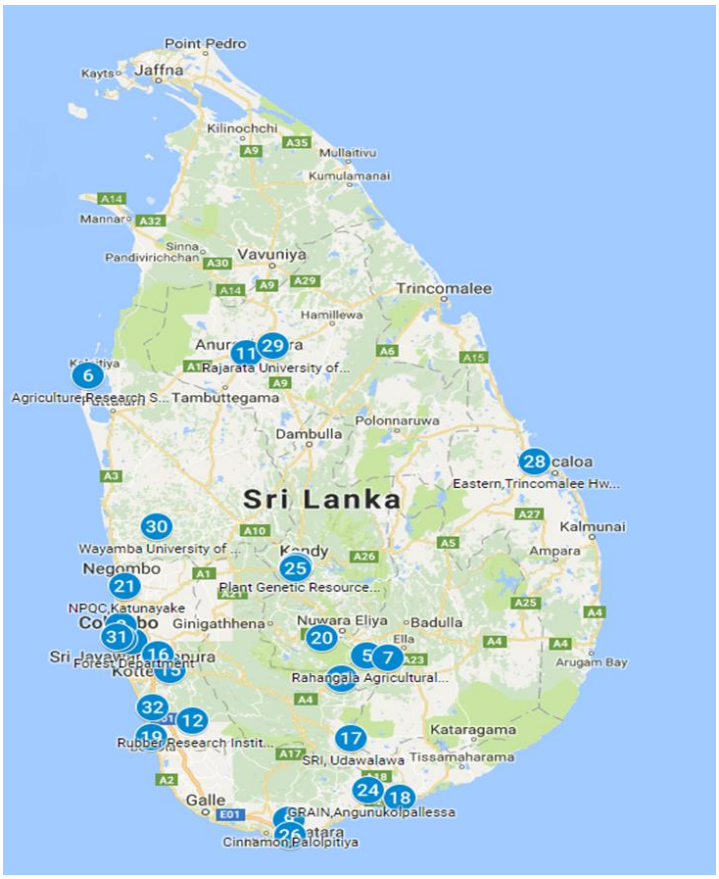

Figure 1: Sample Distribution of Agricultural R&D Institutes in Sri Lanka

Source: Author own figure using Google map, (2017)

They are similar in their general orientation towards agriculture-related research but differ somewhat by specializing in different thematic fields. Of the 36 R&D institutes, staff in 29 was interviewed using a semi-structured questionnaire. The other 7 institutes did not respond satisfactorily upon being approached.

We interviewed the top representatives of the institutes' research department (head of research) as well as the administrative department (chairman/ director of the institute). The interviews were conducted through personal meetings and in a few cases over the phone. In addition to the questionnaire, we scrutinized the internal records and annual reports, thereby gaining some insight into their innovation performance, R&D contracts, and R&D collaboration activities.

Data, Variables and Sample Selection

In the questionnaire, we collected information on the institutes' sources of knowledge and how they interacted with these knowledge sources. The major knowledge sources were identified after intensive informal discussions and by using a pre-defined list of potential sources, which the respondents were asked to rank according to the frequency with which they consulted or relied upon them. In the end, we decided to draw a list of six knowledge sources, which were regarded as relatively important by all the interviewed institutes, as shown in Figure 2 (mean importance was measured on a scale ranging from 1 to 6 with six being the most important).

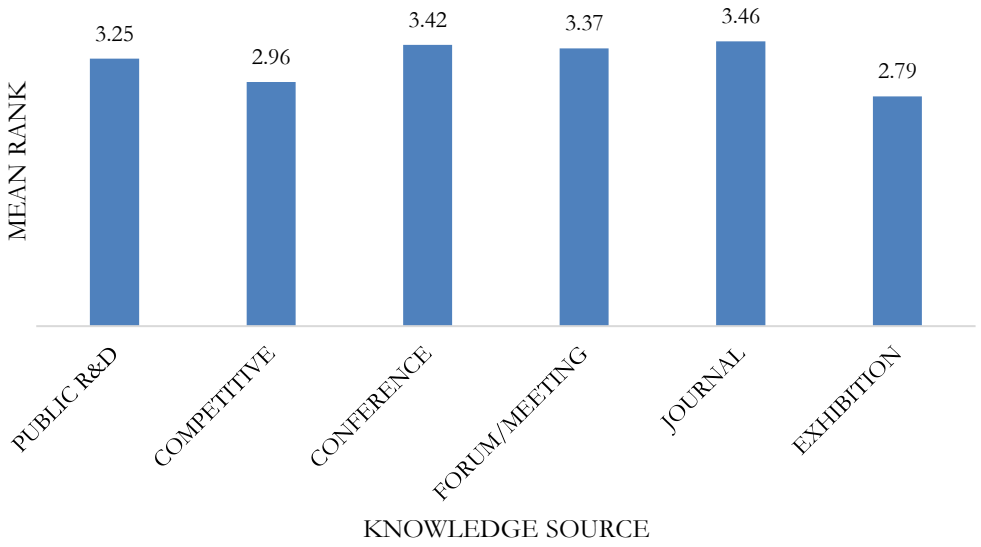

Figure 2: Importance of External Knowledge Sources

Source: Author's own data, 2017

Knowledge sources obtained from the public R&D institutes included knowledge that was acquired from other R&D institutes and which was not related to any particular research theme.

Knowledge sources from competitive R&D institutions referred to the external knowledge getting through R&D institutes conducting similar research themes. The third type of knowledge source meant national and international conferences and symposiums, which are rather common in the R&D sector.

The fourth type of knowledge source meant scientific meetings and forums. Scientific research journals were considered as the fifth type of knowledge source, while scientific and academic exhibitions conducted by public and private R&D institutes comprised the last type of external knowledge. All data refer to the time period 2015–2016.

The figure highlights that R&D institutes acquire external knowledge mainly through conferences, journals and forums/ meetings as these are perceived as being more relevant. Accordingly, knowledge sharing among institutes is not the most important mechanism of knowledge diffusion in this context. However, the differences are marginal and should not be over emphasized.

For the purpose of empirical analysis, we created a number of variables that allow us to explore the relevance of knowledge, its sourcing and diffusion on the innovation performance of institutes in a quantitative empirical setting.

Innovation performance: We assess an institute's innovation performance in terms of the number of research papers (PUBL) published by their employees and the number of PATS granted to them in the (two) years 2015 and 2016.

The numbers are obtained from the organization's internal records. It is generally argued that PUBL is a better indicator of an institute's contribution to basic research, while PATS indicate stronger application-oriented research (Laursen and Salter, 2006; Ahuja and Katila, 2001). These two indicators will be used as dependent variables in the models used to identify the factors that shape an organization's innovation performance.

Knowledge sourcing: There are various ways of sourcing external knowledge, such as information transfer from an informal network (Laursen and Salter, 2006), R&D collaboration (Pisano, 1990; Brockhoff, 1992; Shan et al., 1994), and technology acquisition (Granstrand and Sjolander, 1990). We differentiate between two types of external knowledge sourcing, viz. information transfer based on informal network/ sourcing (INFORM) and formal R&D collaboration. The first is captured by the variable INFORM, which represents the sum of importance assigned to six external information sources from which knowledge is acquired without formal agreements. These sources include all agricultural R&D institutes (A), all other R&D institutes that provide knowledge free of charge (B), conferences and seminars (C), annual meetings (D), journals (E) and exhibitions (F). Each of these elements is measured on a five-point Likert scale ranging from no-use = 1 to strong use = 5. INFORM represents the sum of these six types (A to F) of informal knowledge sources. Accordingly, the variable has a minimum value of 6 and a maximum of 30. In contrast to the alternative approach of taking the average across the six sources, summing creates a single index combining the number of sources used and their relative importance.

Formal information sourcing is approximated by the variable COLLAB, which is the sum of the scores assigned on a scale of 1 to 5 to the three most important formal collaboration partners. These are similar to R&D institutes, private R&D institutes, and universities. The variable can range between 3 and 15.

Next, we create a measure capturing the institutes' ACAP. To do so, we focus on the main dimensions of ACAP (acquisition, assimilation, transformation, and exploitation) as defined by Szulanski (1996) and Zahra and George (2002).

Each of these dimensions is represented by multiple items that are measured on a 5-point agree/disagree (Likert) scale. Four items represent the efforts invested in knowledge acquisition, two items represent assimilation activities and six items capture knowledge transformation. The last dimension assesses the extent to which the strategies of the institute are able to facilitate recognizing opportunities and possibilities of the newly acquired external knowledge (Zahra and George, 2002). An additional set of five items assesses the extent to which organizations are able to exploit new external knowledge. For each of these dimensions, we estimate the average for each associated item and subsequently sum the averages to obtain the final variable ACAP.

In our analysis, we also include the size of the organization. Organizations with large numbers of employees tend to have more resources that can be invested in the production of innovations. The variable EMPLOYMENT (Number of employees) is considered accordingly. We also employ an alternative indicator for the size of the organization and the number of departments it has (DEPARTMENTS).

However, and in particular, when being simultaneously considered to EMPLOYMENT, it may also be interpreted as an indication of specialization whereby smaller values indicated greater.

Empirical Analysis and Regression Analysis

Even though we only have 29 observations, we still apply multivariate regression techniques to test our hypotheses. As our dependent variables determine the organizations' innovation success by counting the number of PUBL and patents (PATS), we apply Poisson regression. Given the low number of observations, we estimate multiple models with varying sets of explanatory variables.

Results and Discussion

Determinants of Innovation Performance

While the previous subsections give insights into the context of inter-organizational knowledge sourcing in the agricultural research sector in Sri Lanka, we now turn towards the question if the identified differences relate to these institutes' innovation performance.

Table 1 reports the results of the Poisson regression models relating knowledge sourcing activities and the institute's size to innovation performance. We split the estimations into those using PATS and those using PUBL as the dependent variable.

Table 1: Poisson Regression, Explaining the Relation of ACAP and Innovation Performances

Square Model	Model 1				Model 2			
Dep. Variable	**PUBL**		**PAT**		**PUBL**		**PAT**	
Indep. Variable	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
EMPLOYMENT	0.04**	0.001	0.02**	0.06	0.04**	0.00	0.02**	0.01
DEPARTMENT	-0.10**	0.018	0.25**	0.77	-0.10**	0.02	-0.09**	0.08
ACAP					0.21**	0.09	-1.27	0.71
Log. Likelihood	-397.88		31.58		-394.89		-29.83	
Chi-square	2429.89**		29.66**		2435.86**		33.17**	

Note: p<0.1; p**<0.05; p***<0.01*
Source: Author's own data, 2017

Model 1 serves as a baseline model containing only the control variable EMPLOYMENT and DEPARTMENTS. As expected, the first becomes positively significant indicating that larger organizations generally show higher levels of innovation output. This holds for the innovation performance in terms of basic research, i.e. the number of PUBL (PUBLICATIONS) and for the case of applied research with PATS approximating innovative output (PATENTS). The second control for institutes' size, DEPARTMENTS, shows a more complex behavior. While it is negatively significant in the case of PUBL, it is positively significant for PATS.

The latter is clearly in line with an interpretation in terms of size – larger institutes tend to have more departments and are also more innovative. In contrast, larger numbers of PUBL seem to go along with smaller DEPARTMENTs. As pointed out above, we suspect this is an expression of specialization advantages. Smaller DEPARTMENTs are likely to correspond to greater thematic focus and specialization, which is frequently assumed to positively influence innovation performance (Damanpour, 1991). According to our results, this effect seems to be of relevance for basic (PUBL) but not for applied research (patents).

Model 2 tests the relationship between organizations' ACAP and their innovation performance, which we hypothesized to be positive (H_1). This is confirmed by our results. As expected, organizations' ACAP is significantly positive, which indicates that organizations with higher ACAP generally show higher levels of innovation output. This holds true for the innovation performance as reflected by the number of PUBL. A non-significant coefficient is obtained for applied research output (PAT). Consequently, in this context, other factors are more decisive for innovative success.

Previous studies on innovation have supported these findings by showing an interactive correlation between ACAP and the degree of success of innovation performance (Chandrashekar and Hillemane, 2018). ACAP of the agricultural R&D institutes in Sri Lanka helps them to assimilate external knowledge and share it among other actors of the R&D network (Silva and Broekel, 2019). Therefore, agricultural R&D with higher ACAP leads to higher innovative performance. This is proved by this study.

Through models 3 and 4 we test the importance of informal and formal knowledge sourcing respectively, for R&D institutes' innovation performance.
The results are shown in the table 2.

Table 2: Poisson Regression, Explaining the Relation of Knowledge Sourcing with Innovation Performances

Square Model	**Model 3**				**Model 4**			
Dep. Variable	**PUB**		**PAT**		**PUBL**		**PAT**	
Indep. Variable	**Coeff.**	**S.E**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
INFORM	0.02	0.02	-0.05	0.14	2.07**	0.22	3.51**	1.49
COLLAB	-0.01	0.03	-0.06	0.26	0.89	0.44	0.06	3.26
$INFORM^2$					-0.05	0.01	-0.10**	0.04
$COLLAB^2$					-0.05	0.01	-0.02	0.17
EMPLOYMENT	0.04**	0.00	0.02	0.01	0.05**	0.00	0.07**	0.03
DEPARTMENT	-0.08**	0.02	0.27**	0.11	-0.06**	0.02	0.18	0.13
ACAP	-0.22**	0.09	-1.12	0.80	-0.41**	0.08	-1.03	0.70
Log. Likelihood	-394.3		29.64		-334.9		-23.01	
Chi-square	2436.9**		33.56**		2555.83		46.82	

*Note: *p<0.1; **p<0.05; ***p<0.01*
Source: Author's own data, 2017

Interestingly, in these models, ACAP is characterized by a significant negative coefficient in the case of PUBL. This appears to be rather counter-intuitive and seems to be related to the inclusion of the collaboration-based variables. Accordingly, when controlling the collaboration intensity, ACAP is rather negative. Put differently, ACAP is only positive when translated into actual external knowledge sourcing (asking for knowledge). High ACAP without actual engagement in external interaction seems to be rather a waste of resources, as it reduces innovation performance. According to Malipiero et al. (2005), organizations are well equipped to identify and acquire new information from external sources but they still require sufficient ACAP to utilize and 'absorb' this knowledge (Broekel and Mueller, 2017).

In the case of hypothesis 2 (H_{2a}), informal knowledge sourcing by organizations does not significantly relate to their innovative performance. Potentially, it is the greater heterogeneity of knowledge sources and the non-strategic behavior in this context that prevents these activities from helping organizations to be innovative. Further, R&D organizations might prefer to depend on formal and reliable knowledge sources than on some informal knowledge base for their innovative activities. For instance, Silva and Broekel (2019) found that R&D institutes in Sri Lanka rely mostly on formal knowledge-sharing platforms for knowledge acquisition and assimilation.

In light of hypothesis 2 (H_{2b}), which suggests an inverted U shape relationship between formal collaboration intensity and organizations' innovation performance, we included COLLAB in both a linear and squared fashion. However, our results strongly suggest the rejection of this hypothesis. Both variables' coefficients remain insignificant with one exception being the squared INFORM variable, which becomes significantly negative. This fits in with the idea of negative effects related to over-embeddedness, which means that organizations that are strongly engaged in social relations may experience harm from this. Over-embeddedness or lock-in effects will limit the openness and flexibility of the organization in the context of external knowledge sources (Van Staveren and Knorringa, 2007; Bærenholdt and Aarsæther, 2002), which in turn will harm their ability to generate novelty (Broekel, 2012; Uzzi, 1996).

Summarizing the results for hypotheses H2a and H2b, it seems to be the case that differentiation between formal and informal knowledge sourcing is of little relevance for the observed variances in R&D institutes' innovation performance. This is in contrast with the findings made so far for developing countries. In this connection, we can suggest to R&D institutes to improve their innovation performance by entering into external agreements and by arranging training programs for their staff with external knowledge sources (Clausen, 2013).

Conclusions

In recent years, few issues have received more attention than the crucial role of knowledge sourcing in ensuring the innovative success of firms (Clausen, 2013; Kang and Kang, 2009; Tsai, 2001). However, what has been insufficiently explored in general and particularly with respect to the situation in developing countries, is the relevance of knowledge sourcing of (public) R&D institutes for their innovation activities. The present paper seeks to fill this gap by studying the knowledge sourcing practices of agricultural R&D institutes in Sri Lanka. Our analysis relies on primary data collection, differentiates between formal and informal knowledge relations, utilizes the ACAP of R&D institutes as the key determinant of innovative performance, and measures it in terms of basic and applied research outcomes.

Our findings indicate that larger institutes tend to be more active in innovation processes.Interestingly, more specialized institutes perform better in terms of application-oriented research (patenting), while more diverse institutes seem to take the lead in basic research (PUBL).

Potentially, this mirrors the greater need for diverse knowledge in the case of basic research. In contrast, applied research appears to benefit from focusing on a narrower field. This matter surely deserves more research in the future. For better policy formulation, we can suggest some strategic approaches to access diverse sources of external knowledge by the agricultural R&D institutes in Sri Lanka.

Our findings with respect to knowledge sourcing are rather inconclusive. Most of our variables remained insignificant, suggesting that knowledge sourcing does not seem to be a crucial determinant of R&D institutes' innovation activities.

There could be a few explanations for this. For one thing, our empirical setup had a number of limitations that could have caused these results. This will be discussed further below.

Another explanation is that most of the existing research confirming a positive relationship between knowledge sourcing and organizations' innovation performance were done in the context of developed countries and with a focus on profit-oriented firms. In contrast, institutes studied in this paper are located in Sri Lanka, a developing country. It is possible that other aspects are more relevant to the institutions here for their success (such as access to funding, relations with customers, ministries, and knowledge sourcing from abroad) than knowledge relations between them. The empirical findings of this study support this view as the surveyed research institutes claimed conferences and scientific journals as being more important for obtaining knowledge than their relations with other institutes.

Silva and Broekel (2019) have stated that the agriculture R&D knowledge network is very dense in Sri Lanka and hence, knowledge is able to quickly diffuse throughout it. This suggests that it is less likely to be a limiting factor in the research activities of the institutes. This is in keeping with the observation that in Sri Lanka, innovations (as judged in terms of PUBL and patents) are not the primary objective of public R&D institutes. Rather their aim is to disseminate knowledge that has either been discovered by themselves or by somebody else. Consequently, their knowledge sourcing practices are geared more towards successfully acquiring and disseminating the knowledge than utilizing it for their own innovative projects. It is advised that future research be also conducted to look at this issue.

There are a number of (empirical) shortcomings that need to be mentioned so that the findings of this study can be put into perspective. First, we were able to interview only 29 institutes, which means that our analysis suffers from a small sample size. A more ambitious approach in the future would no doubt yield a greater volume of data, which will help to identify any statistically significant relationship. Secondly, our empirical analysis is cross-sectional in nature and hence restricted from a methodological point of view. In particular, we cannot deal with the issue of potential endogeneity. Future researchers are advised to make use of longitudinal or panel data to empirically approach this issue.

Thirdly, we collected information on how two R&D research institutes interact with each other with respect to knowledge sharing. However, we did not look at the type of knowledge that they sourced from their contacts. Fornahl et al. (2011) showed that it matters with whom organizations interact and what type of knowledge they can access through this contact. Accordingly, what really matters are not so much that institutes simply interact with each other, but that they should interact with the right type of institutes.

Given these limitations of the study, we refrain from making strong policy recommendations. However, what seems crucial is that R&D institutes in Sri Lanka should maintain or even expand their access to conferences and scientific journals, which are important knowledge sources.

Moreover, research institutions need to provide sufficient training facilities to their research officers to assist them to improve their scientific knowledge and innovation performance.

Declarations

I have all the used data and materials to be provided in any need. I have obtained consent from all individual participants in this study I declare that I have not any conflicts of interest. This study was not supported by any grant and I funded the research activities by myself thus I am the main contributor of this manuscript.

Acknowledgements

I acknowledge all those who contribute to this manuscript.

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