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Review

Usefulness of Technological Capacity Evaluation for Brazilian Farmer Stakeholders: A Bibliometric Analysis

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Abstract: The use of technology in agriculture plays an important role in the production chain cycle, as well as in the improvement of processes and productivity. To develop a model for measuring the technological capacity of family agriculture systems, it is necessary to assess the gaps related to indicators and the technological potentialities of these farmer groups, which are often not considered when they require financial support and do not get enough. Thus, the aim of this study is to identify the indicators used to evaluate the technological capacity of farm systems and agriculture. A bibliometric analysis between 2005 and 2017 was carried out on five scientific databases, identifying a first set of 233 scientific articles, which, after an in-depth reading, led to outlining an article portfolio of 33 studies. The H-index results estimated over databases verified that Springer is the most important regarding the topic Technological Capability in Agriculture Systems. The Technological Capacity Systems evolution is important in that technologies are in constant development and the use of indicators provides a quantitative evaluation to compare different agricultural properties.

Keywords: technological capacity; research methodology; technological index

1. Introduction

The constant development and use of technology in agricultural production allows the productivity to be constantly improved. One of the challenges in this field is how to make a production system more sustainable, using fewer natural resources and agricultural inputs in line with the need for producing more and of better quality. Regarding the farm environment, whether they are small, medium, or large properties, the use of technology is present in all steps of the supply chain.

In rural systems technological capacity is a concept that can be related to a wide range of aspects, such as disease monitoring, seed storage and viability, as well the productivity indexes themselves. Mori [1] defined the technological capacity as the ability to absorb, use, adapt, generate, develop, transfer, and diffuse technologies, represented by the set of resources, skills, and learning mechanisms employed by stakeholders. Moreover, Figueiredo [2] indicated that technological capacity involves a set of resources that can be tangible, such as systems, database, patents, or products, or intangible, such as management and production techniques, routines, organizational structures, and norms.

Therefore, the use of Information Technology tools for supply chain management not only optimizes the actions needed from production planning to commercialization but also makes it possible to obtain competitive advantages over related businesses [3]. Regarding the efficiency of production chains, Mori [1] stated that a system's efficiency is reached according to the technological capacity available and its performance, but the incorporation of new technologies must be monitored by managers.

Performance indicators can be set by applying management tools, which can be used to define critical points in the process and to monitor whether the objectives are being achieved, as well as to define rural entrepreneurship goals. In this sense, the monitoring of grain production in Brazil for the 2016/2017 crop year came close to 210 million tons [4]. This is 13% higher than in the previous report, while the area used for production in the same period increased by just 2.3%. Moreover, in the last 20 years, the area used to support the Brazilian production of food and agricultural raw materials increased by around 60%, while the grain production increased by nearly 200% [5].

This growth rate endorses the statements of the Brazilian Agricultural Research Corporation (EMBRAPA), which attributed the superior rates in grain production in relation to expanded agricultural area to a strong investment in research and innovation applied in terms of new or enhanced science-based agriculture technologies, allowing Brazil to achieve important advances in the production of a wide variety of food and agricultural raw materials [6].

The state of Paraná has been contributing to the development of Brazilian agriculture, specifically in grain production. In accordance with the data from the Supplies and Agriculture Secretary (SEAB), in the last 10 years Paraná has produced on average 51% of Brazil's wheat.

In Southern Brazil, the Agronomic Institute of Paraná (IAPAR) and the Paraná Institute of Technical Support and Rural Extension (EMATER) are two entities linked to the Agricultural Office of Paraná State. Both institutions are focused on providing innovative solutions for rural systems and agribusiness, through the diffusion of scientific research. Their activities involve new technologies' diffusion through the organization of thematic field days and training, as well as technical assistance to support activities to provide agricultural development. These institutions work with a wide range of groups and associations with common interests, called Reference Nets [7]. Each Net is formed by farmers who receive the technicians' help, looking either to generate good technical references for its products or to assimilate new farmers into the group.

Regarding this sense, it is very important for rural researchers to make use of adequate tools to evaluate the technological capacity of rural producers. The technological capacity indicators must be robust, contemporary, and at the same time flexible to be used by a wide variety of rural stakeholders. Using a flexible and robust tool, the rural agent can provide precise feedback to stakeholders, pointing out weaknesses and potentialities.

Thus, the objective of this study was to identify and classify the Technological Capacity indicators related to performance measured in rural enterprises around the world, to later subsidize the development of a robust and flexible indicator system framework able to be used in performance evaluation of any rural business.

For that, a survey of the technological capacity indicators is mandatory, using the keywords described in Section 2. Once identified, they will be classified into distinct fields with the main goal of making a deeper study of the indicators related to the use of the Technologies on farms—in other words, those that belong to the Agribusiness arena.

This new model of technological capacity evaluation from rural enterprises must work independently of the size or chain production, through identification of variables and technologies related to a variety of rural systems.

2. Materials and Methods

We carried out descriptive research considering the scientific production related to Technological Capacity Evaluation in Agricultural Entrepreneurship. The nature of the research is basic and quantitative, since it seeks to satisfy a lack of knowledge and not a practical application. A qualitative analysis was also necessary for filtering the articles found before the systematic reading, using an approach called Methodi Ordinatio [8].

In order to assemble an article portfolio around the technological capacity indicators in rural entrepreneurships, we carried out a search for the term "Agricultur *", combined initially with "Technological capability *" and later with "Technolog * index". The asterisk character (*) was used to ensure the inclusion of variants adjacent to the main terms [8] (i.e., "capability and capabilities", "agriculture and agricultural", as well as "technology and technological").

This survey covers the period between 2005 and 2017 in five scientific databases—ISI Web of Knowledge, SCOPUS, SCIENCE DIRECT, SPRINGER, and SCIELO. These five databases were selected because they presented a huge number of publications with the researched keywords, providing consistency to the search. The database websites links are listed in Table 1. Exclusively articles in the English and Portuguese languages were asked to contain the research terms in the title, keywords, or summary. Later, these findings were filtered to build an article portfolio, excluding duplicated records and material not related to measure or to evaluate technological capability indicators in rural properties.

Table 1. Nine steps of the Methodi Ordinatio survey.

Steps	*Description*
1	Establish the intention of the research, that is, keywords that will be used in databases
2	Identify the research bases that will be used.
3	Define the combination of research attributes to be used, such as publication period, language, type (article, book, etc.).
4	Perform the initial search and record the result obtained.
5	Conduct a filtering procedure, disregarding repeated publications and/or publications whose scopes are not related to the researched topic.
6	Identify the impact factor, year of publication and number of citations for the articles considered in the portfolio.
7	Apply the InOrdinatio equation to classify the publications by relevance. InOrdinatio = (IF/1000) + $\alpha \times$ [10 − (ResearchYear − PublishYear)] + ($\sum$Ci)
8	Define further detailed reading.
9	Systematically read and analyze the articles with the best classification.

Source: Adapted from [8], where: IF = impact factor. This is divided by 1000 to normalize the value found. α = assigned a weight from 1 to 10 for the year of publication. The higher this weight, the more importance will be given to new articles. Ci = number of article citations.

Once the article portfolio was defined, a bibliometric analysis was conducted applying the Methodi Ordinatio approach [8]. This methodology differs to ProKnow-C [9] in some aspects. The ProKnow-C methodology is composed of four steps, whereas the objective of research is defined later through the identification of gaps around the studied theme. In the Methodi Ordinatio, the research scope is defined "a priori" and nine steps are used to determine the relevance of bibliography in the portfolio. Table 1 summarizes the nine steps of Methodi Ordinatio. After the article portfolio establishment, two distinct values for the variable α were applied in step 7, aiming to compare the relevance of a publication year on article classification. Assigning a weight of 10 to α ensures that the publication year is a relevant criterion, while using weight 1 means that the publication year is considered to be indifferent. Information regarding the periodic impact factor and the number of citations was gathered in Google Scholar.

The deepness lectures of articles remaining in the portfolio allowed for establishing the state of the art and the identification of strong and weak points after the in-depth reading, labeling again the scientific relevance article in relation the researched theme. Later, each database repository was evaluated in relation to its relevance to the theme using the H-index metric [10].

This index can be adopted to evaluate the production of researchers, universities, research groups, and newspapers, being calculated to relate to the number of scientific publications with their citations. The H-index is calculated after verifying the number of citations in all articles contained in the portfolio from each database [11]. The H-index value was set for each database after identifying the largest number of studies that possess the same value in terms of amount of citations. In the case of five articles, it must have at least five citations; this leads to an H-index of 5. Otherwise, if only one of the studies has more than 100 citations and the others have just one, its H-index will be 1.

3. Results

Regarding the bibliometric analysis, the SPRINGER database was the most relevant to Technological Capacity Indicators for Agriculture, with 80% of the articles found in the first research term and 60% in the second round. Moreover, the fact that the majority of studies (70%) were published in the last five years is extremely relevant to building a contemporary framework, based on recent data. Specifically to the studies regarding Technological Capacity Indicators applied in Agricultural Systems, the ages of the four studies identified range from three to 10 years old.

The primary survey in five scientific databases produced a total of 251 articles. Among them, 208 used the term "Technological Capability," whereas 43 used the term "Technology Index" in the keywords. Of these, a total of 18 articles were found twice in relation to the results obtained from the ISI database. Likewise, the SPRINGER database returned three articles with the same combination of terms. In both cases the duplicated records were excluded, considered just one finding. Thus, after the first filtering process, 233 scientific studies were considered. Figure 1 summarizes the primary findings in the five databases and the first elimination of overlap.

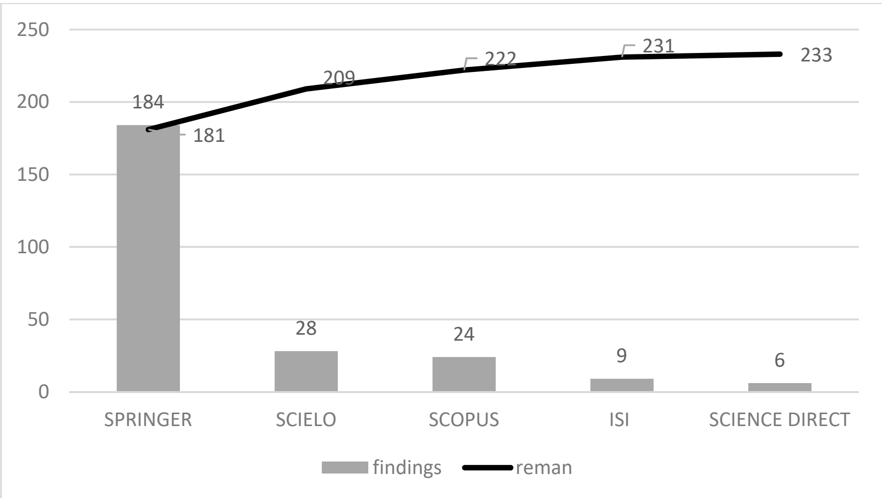

Figure 1. Number of studies found and overlapping results in the five databases searched for the two term combinations (Search 1 + Search 2). Source: Author data.

SPRINGER had the highest number of scientific articles among the five databases, achieving almost 75% of results according to the indexes asked. Later we checked the title and summary against the theme and scope of this study, and of the 233 initial findings a total of 33 scientific articles were selected. The 200 rejected articles were excluded because their scope was not related to the definition of indicators, but rather to more theoretical aspects.

The results after the second exclusion round indicate that scientific articles around the Technological Capacity of agricultural systems have increased significantly in the last five years, encompassing 70% of portfolio studies in this period. The 33 remaining articles were published in 25 journals, whereas the Journal of Technology Management & Innovation was identified as the most relevant, totaling three records. Another six journals contributed with two articles, while of the remainder just one study counts. Details of the article portfolio are available in Appendix A.

The H-index pointed to the SPRINGER database as the main repository for the theme, resulting in an H-index = 9 due involving a larger number of articles as citations (see Figure 2). However, we could not find an estimated H-index for the SCIENCE DIRECT database because none of the articles considered had at least two citations.

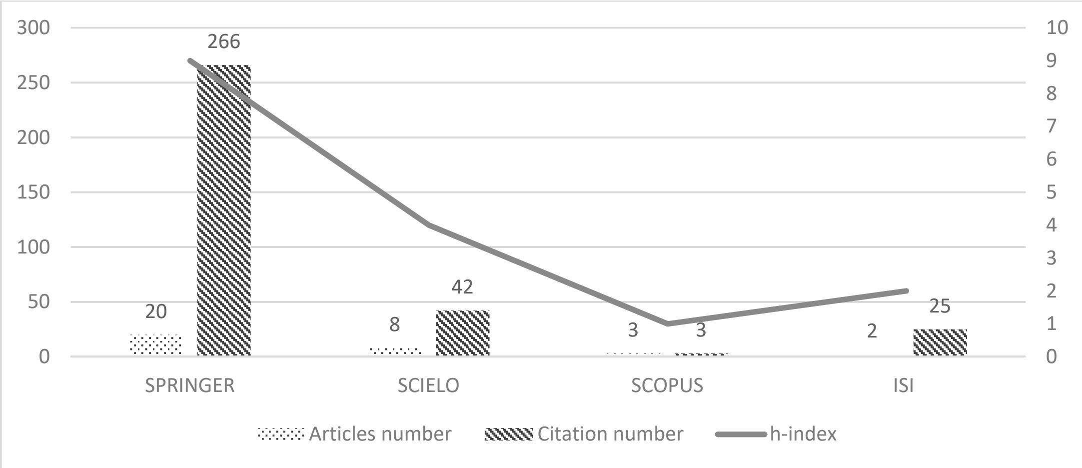

Figure 2. H-index over databases with selected articles in the portfolio. Source: Author data.

An example of this is the article that, among the 33 works evaluated, was the 13th if the year of publication is considered relevant, and 23rd if the year of publication is not considered. In Appendix A it is also possible to verify the difference to assign contrasting weight to the publication year in the ordination procedure.

After the in-depth reading, these studies were classified into five categories according to the subject (see Figure 3). Of the 33 articles evaluated, a third part (33%) relates the Technological Capacity measurement to Sustainability Indicators in some way. Two areas follow the Sustainability Indicators with almost a quarter each (24%), represented by the subjects Business Strategy and Transference of Technology. Only four studies in the portfolio (12%) had as their scope the application of Technological Capability Indicators to Agricultural Development—classified as "Agribusiness". Concluding this analysis, another two studies could not be grouped into any earlier category, representing the Education and Socioeconomic areas.

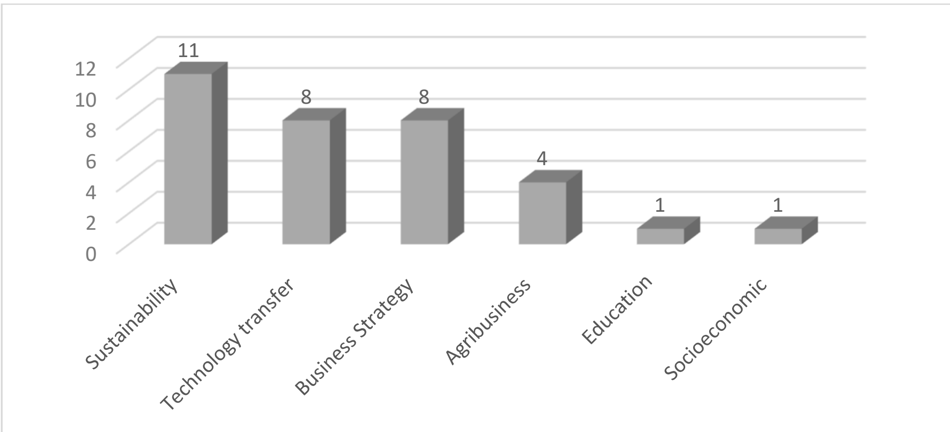

Figure 3. Subject areas of portfolio articles applying Technological Capacity Indicators in Agricultural Systems. Source: Author data.

Among the four searches about the Technological Capacity on Agriculture, the newest model found is described by Mori [1], where three dimensions were discussed: (a) Operational, which relates to the productive process itself, the financial resources, the human resources, the available infrastructure, and the technological updates; (b) Organizational, which refers to the process of management and support, including the organizational routines and management processes, as well as the learning mechanisms developed in the enterprise; (c) Relational, which explores the profile of links the enterprise has with other economic agents. According to James [12], whose study is a comparison between two technological capacity measuring models on a farm, one must make an analysis of the applicability of the indicators in small, low-rent properties. One justification is that a rise in productivity and a reduction in unit costs can help farmers to improve their quality of life. Baker [13] tried to specify a model that could measure agricultural growth and identified the technological advances that most contributed to changes in the rural environment. With a similar objective, Sanyang [14] tried to determine the level of development and strategies for technological transference in the rural environment. This study identified that 90% of technological dissemination for farmers is through extension systems, showing the importance of the technical agent's role.

Figure 4 shows the conjunction of propositions for technologies that already exist in technological capacity measuring models with the new technologies that have emerged in the last few years.

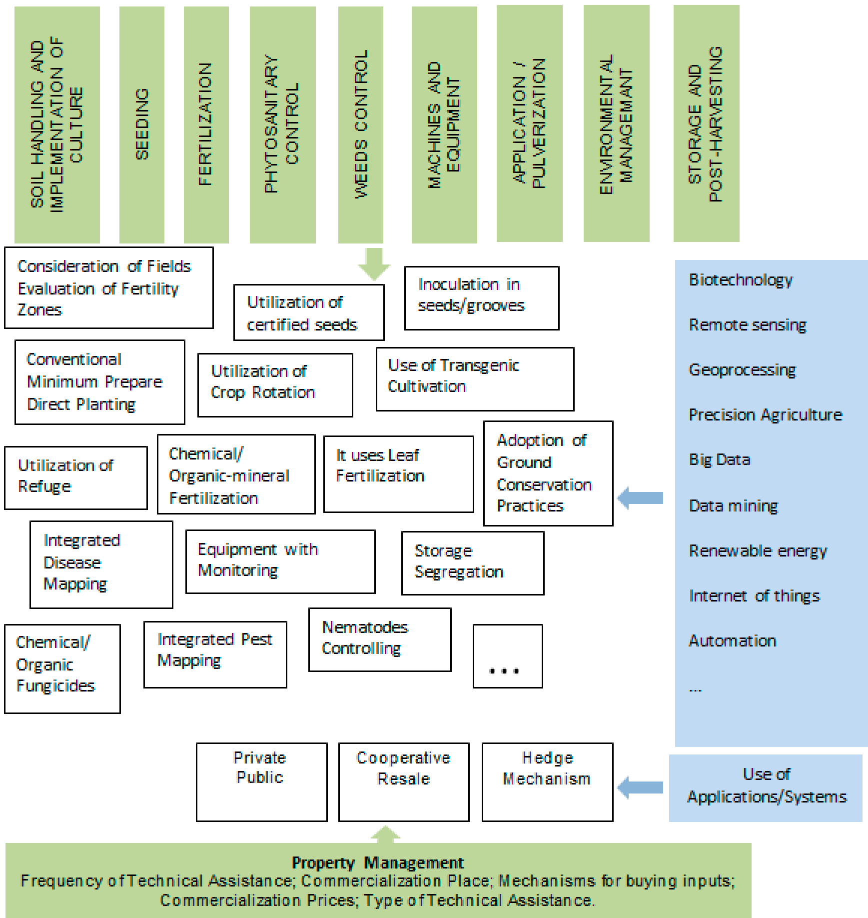

Figure 4. View of the conjunction of technology models of Technological Capacity with new technologies that are being developed. Source: Author data.

With the appearance of new technologies from research and applications on farms, it is possible to see that a strict model for measuring the Technological Capacity might not reflect actuality.

Therefore, a system that allows us to customize the variables that will be part of the indicator, according to the size of the property, will better reflect the indicator results, allowing technicians to set plans for improvement.

Figure 5 shows one proposal of a model structure that will be built to increase new technologies that can be adopted later on. In the image is shown a model with two new technologies that are not found in the survey made about the technological capacity indicators and that will be used in the productive process: geolocalization for correcting the soil [15], and the adoption of a consortium of cultures [16].

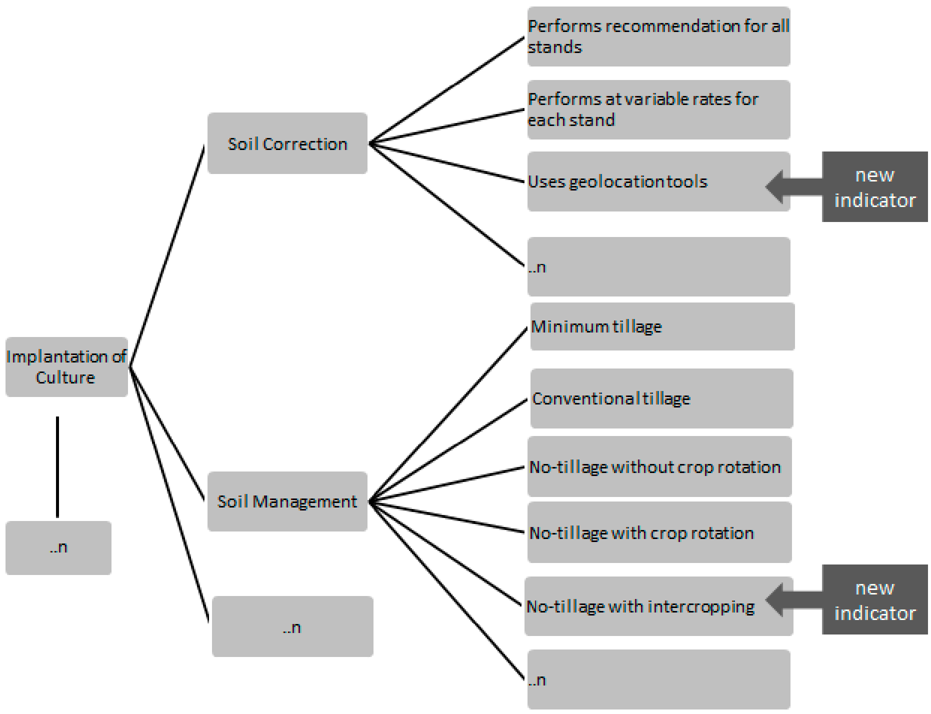

Figure 5. Proposal of the customizable structure of the model for measuring the technological capacity. Source: Author data.

This structure will allow for including as many technologies as needed for making the model more realistic—for example, the technologies shown in blue in Figure 5, or any other new technology that may be adopted later for correcting the soil.

4. Discussion

The Methodi Ordinatio has assisted with the selection of the portfolio to be systematically analyzed, defining the scientific relevance of articles using three criteria: impact factor, publication year, and number of citations.

The analysis of the technological capacity models gives a framework with the flexibility to define the parameters that will be part of the indicator. This becomes important as technology is in constant evolution. The framework may be customized according to the responsible agent's needs.

Thus, the indicator provides a quantitative evaluation for comparing different agricultural properties, excluding the subjectivity of the evaluator. The identification and monitoring of the Technological Capacity assists with the implementation of improvements, which contributes to the advancement of the production chain development, as well as the potentialities of a particular region in comparison to another.

5. Conclusions

Through this study it was possible to identify that, on the basis of the scientific articles studied, there is a lack of publications that define a measuring model for technological capacity in the agricultural arena.

After filtering to exclude articles that appeared in more than one database, there were 233 articles for evaluation. Only the 33 articles that specifically described models for measuring the technological capacity were selected. The remaining ones were not considered because, even though they contain the keywords studied, they do not focus on measuring technological capacity in agriculture. Among the 33 articles selected for full analysis, 11 are related to technologies that pursue sustainability in agricultural production, while only four propose quantitative indicators. Those articles evaluated are relevant to the specification of a measuring model that allows the inclusion of new technologies. This is because, if a model is not adaptable to receiving new technologies that are developed, it will not reflect what actually occurs in the productive cycle.

The measurements and analysis performed by field technicians help with establishing a standard for measuring how technologically advanced the production process of a certain producer is, as well as finding critical points in the process and optimizing improvements.

New technologies are emerging in the biotechnology field, remote sensing, geoprocessing, etc. These are being used, though most of the time by large-scale producers. However, there needs to be a more significant uptake by smaller producers, so that through cooperatives or technical assistance from specialized institutes this technology can be made more accessible to all.

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Conflicts of Interest: The authors declare no conflict of interest. Moreover, the founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

Appendix A

Details of articles comprising the portfolio and classification according to variations applied in the InOrdinatio equation.

Article Title	Reference, (Number of Citations)	Journal and Database	Main Scope	$\alpha = 10$ (Score)	$\alpha = 1$ (Score)
The Evolution of Technologies: An Assessment of the State-of-the-Art	Dosi, G., et al., 2013 (68)	*Eurasian Business Review* SPRINGER	Technology transfer	1° (113)	3° (41)
Linking technological and educational level diversities to innovation performance	Subramanian, A.M., et al., 2016 (2)	*The Journal of Technology Transfer* SPRINGER	Education	2° (103.2)	15° (13.2)
Assessing relative vulnerability to sea-level rise in the western part of the Mekong River Delta in Vietnam	Nguyen, T.T.X., et al., 2016 (0)	*Sustainability Science* SPRINGER	Sustainability	3° (103.3)	16° (13.3)
How does the partner type in R&D alliances impact technological innovation performance? A study on the Korean biotechnology industry	Shin, K., et al., 2016 (0)	*Asia Pacific Journal of Management* SPRINGER	Business Strategy	4° (102.1)	17° (12.1)
A New Multidimensional Measure of Development: The Role of Technology and Institutions	Ganegodage, K.R., et al., 2017 (0)	*Social Indicators Research* SPRINGER	Socioeconomic development	5° (101.4)	18° (11.4)

Article Title	Reference, (Number of Citations)	Journal and Database	Main Scope	α = 10 (Score)	α = 1 (Score)
The coevolution between public policies/institutions and technological development: The case of Petrobras Biofuels	Câmara, S.F., et al., 2015 (0)	*Revista de Administração Pública* SCOPUS	Business Strategy	6° (100.2)	24° (10.2)
Do eco-innovations need specific regional characteristics? An econometric analysis for Germany	Horbach, J., 2014 (10)	*Review of Regional Research* SPRINGER	Sustainability	7° (100)	11° (19)
Spatial variation of deforestation rates in the Brazilian Amazon: A complex theater for agrarian technology, agrarian structure and governance by surveillance	De Souza, R.A., et al., 2013 (15)	*Land Use Policy* ISI	Sustainability	8° (97.6)	6° (25.6)
Technological Capability and Firm Performance	Reichert, F.M., et al., 2014 (6)	*Journal of Technology Management & Innovation* SCIELO	Business Strategy	9° (96.2)	14° (15.2)
Front Line Demonstration Program: An Effective Technology Transfer Tool for Adoption of Oilseed Production Technology in Himachal Pradesh, India	Choudhary, A.K., et al., 2014 (2)	*Communications in Soil Science and Plant Analysis* SCOPUS	Sustainability	10° (92.4)	19° (11.4)
Technological Innovation and Developmental Strategies for Sustainable Management of Aquatic Resources in Developing Countries	Agboola, J.I., 2014 (0)	*Environmental Management* SPRINGER	Sustainability	11° (91.7)	21° (10.7)
Dynamic technological specialization, aggregated convergence and growth	Urraca-Ruiz, A., et al., 2016 (1)	*International Economics and Economic Policy* SPRINGER	Business Strategy	12° (91.6)	22° (10.6)
Technological capability: an index model and application to wheat agro-industrial complex firms	De Mori, C., et al., 2014 (1)	*Production* SCIELO	Agribusiness	13° (91.2)	23° (10.2)
Explaining differences in sub-national patterns of clean technology transfer to China and India	Bayer, P, et al., 2016 (0)	*International Environmental Agreements: Politics, Law and Economics* SPRINGER	Sustainability	14° (90.9)	25° (9.9)
Technological capabilities accumulation: evidences in building companies connected through a learning network	Freitas, A.A.F., et al., 2014 (0)	*Ambiente Construído* SCIELO	Technology transfer	15° (90.1)	28° (9.1)
Internationalization Process and Technological Capability Trajectory of Iguaçu	Kuramoto, R.G., et al., 2012 (15)	*Journal of Technology Management & Innovation* SCIELO	Business Strategy	16° (85.2)	8° (22.2)
Benchmarking green innovation	Walz, R., et al., 2012 (12)	*Mineral Economics* SPRINGER	Sustainability	17° (82)	10° (19)
Measurement Preconditions Systemic Action: The Case of Integral Low-Carbon Country and Sustainable Development Indicators	Bečić, E., et al., 2013 (1)	*Systemic Practice and Action Research* SPRINGER	Sustainability	18° (81.5)	26° (9.5)
Technological capability development: the role of Infrastructural Technology	Gallina, R., et al., 2013 (1)	*Gestão e Produção* SCIELO	Technology transfer	19° (81.2)	27° (9.2)
Technological Capability's Predictor Variables	Reichert, F.M., et al., 2011 (14)	*Journal of Technology Management & Innovation* SCIELO	Business Strategy	20° (74.2)	9° (20.2)
Developing a model to analyze technological capabilities accumulation in the construction industry: building sector	Gradvohl, R.F., et al., 2011 (5)	*Ambiente Construído* SCIELO	Technology transfer	21° (65.1)	20° (11.1)
Creation of Biotech SMEs in France	Autant-Bernard, C. et al., 2006 (50)	*Small Business Economics* SPRINGER	Business Strategy	22° (61.8)	1° (52.8)
Economic dimension of integrated crop–livestock systems	Júnior, M., et al., 2011 (1)	*Pesquisa Agropecuária Brasileira* SCOPUS	Sustainability	23° (61.5)	31° (7.5)

Article Title	Reference, (Number of Citations)	Journal and Database	Main Scope	α = 10 (Score)	α = 1 (Score)
A structural model of the transition to agriculture	Baker, M.J., 2008 (28)	*Journal of Economic Growth* SPRINGER	Agribusiness	24° (61)	5° (34)
The role of capability in technology valuation	Jiménez, C.N., et al., 2011 (0)	*Ingeniería e Investigación* SCIELO	Technology transfer	25° (60)	32° (6)
Innovation for sustainable development: from environmental design to transition management	Mulder, K.F., 2007 (30)	*Sustainability Science* SPRINGER	Sustainability	26° (53.1)	4° (35.1)
How Important Is Trade and Foreign Ownership in Closing the Technology Gap? Evidence from Estonia and Slovenia	Damijan, J.P., et al., 2005 (49)	*Review of World Economics* SPRINGER	Technology transfer	27° (50.4)	2° (50.4)
Comparative study of sustainable and non-sustainable interventions in technology development and transfer to women's vegetable gardens in the Gambia	Sanyang, S.E., et al., 2009 (3)	*The Journal of Technology Transfer* SPRINGER	Agribusiness	28° (44.2)	29° (8.2)
Transfer of Technology to and Technology Diffusion among Non-farm Small and Medium Enterprises in Indonesia	Tambunan, T., 2007 (16)	*Knowledge, Technology & Policy* SPRINGER	Technology transfer	29° (36)	12° (18)
Hub-and-Spokes Free Trade Agreements in the Presence of Technology Spillovers: An Application to the Western Hemisphere	Das, G.G., et al., 2006 (22)	*Review of World Economics* SPRINGER	Technology transfer	30° (33.4)	7° (24.4)
Productivity Indicators for the Rural Poor in Developing Countries	James, J., 2007 (1)	*Social Indicators Research* SPRINGER	Agribusiness	31° (22.4)	33° (4.4)
Land suitability, water balance and agricultural technology as a Geographic-Technological Index to support regional planning and economic studies	Fontes, M.P. F., et al., 2009 (10)	*Land Use Policy* ISI	Sustainability	32° (52.6)	13° (16.6)
Does technology and innovation management improve market position? Empirical evidence from innovating firms in South Africa	Oerlemans, L., et al., 2005 (8)	*Knowledge, Technology & Policy* SPRINGER	Business Strategy	33° (8)	30° (8)

Source: Author data.

References

1. Mori, C.; Batalha, M.O.; Alfranca, O. Technological capability: An index model and application to wheat agro-industrial complex firms. *Production* **2014**, *24*, 787–808.
2. Figueiredo, P.N. Capacidade Tecnológica e Inovação em Organizações de Serviços Intensivos em Conhecimento: Evidências de institutos de pesquisa em Tecnologias da Informação e da Comunicação (TICs) no Brasil. *Revista Brasileira de Inovação* **2006**, *5*. [CrossRef]
3. Buainaim, A.M.; Batalha, M.O.; De Souza Filho, H.M.; Salles Filho, S.; Da Silveira, J.M.; Guanzirolli, C. *Agricultura Familiar e Inovação Tecnológica*, 1st ed.; Editora da UNICAMP: Campinas, Brazil, 2007; Volume 1, 257p.
4. Companhia Nacional de Abastecimento (CONAB). *Acompanhamento Grãos da Safra Brasileira*; Acompanhamento Safra Brasileira de Grãos, v. 4, Safra 2016/17; CONAB: Brasília, Brazil, 2016; pp. 1–164.
5. Ministério da Agricultura, Pecuária e Abastecimento (MAPA). *Secretaria de Política Agrícola*; Plano Agrícola e Pecuário 2014/2015; MAPA: Brasília, Brazil, 2014.
6. Embrapa. *Visão 2014–2034: O Futuro do Desenvolvimento Tecnológico da Agricultura Brasileira: Síntese*; Embrapa: Brasília, Brazil, 2014; 53p.
7. Llanillo, R.F. Indicadores de Sustentabilidade da Produção Familiar Mecanizada de Grãos em Modalidades de Plantio Direto no Norte do Paraná, Brasil. Ph.D. Thesis, Universidade Estadual de Londrina, Centro de Ciências Agrárias, Programa de Pós-Graduação em Agronomia, Londrina, Brazil, 2007.

8. Pagani, R.N.; Kovaleski, J.L.; Resende, L.M. Methodi Ordinatio: A proposed methodology to select and rank relevant scientific papers encompassing the impact factor, number of citation, and year of publication. *Scientometrics* **2015**, *105*, 2109–2135. [CrossRef]
9. Lacerda, R.T.O.; Ensslin, L.; Ensslin, S.R. A bibliometric analysis of strategy and performance measurement. *Gestão Producão* **2012**, *19*, 59–78. [CrossRef]
10. Barendse, W. The strike rate index: A new index for journal quality based on journal size and the h-index of citations. *Biomed. Digit. Libr.* **2007**, *4*, 3. [CrossRef] [PubMed]
11. Braun, T.; Wolfgang, G.; András, S.A. Hirsch-type index for journals. *Scientometrics* **2006**, *69*, 169–173. [CrossRef]
12. James, J. Productivity indicators for the rural poor in developing countries. *Soc. Indic. Res.* **2007**, *80*, 535–553. [CrossRef]
13. Baker, M.J. A structural model of the transition to agriculture. *J. Econ. Growth* **2008**, *13*, 257–292. [CrossRef]
14. Sanyang, S.E.; Kao, T.; Haung, W. Comparative study of sustainable and non-sustainable interventions in technology development and transfer to the women's vegetable gardens in the Gambia. *J. Technol. Transf.* **2009**, *34*, 59–75. [CrossRef]
15. Fieuzal, R.; Duchemin, B.; Jarlan, L.; Zribi, M.; Baup, F.; Merlin, O.; Hagolle, O.; Garatuza-Payan, J. Combined use of optical and radar satellite data for the monitoring of irrigation and soil moisture of wheat crops. *Hydrol. Earth Syst. Sci.* **2011**, *15*, 1117–1129. [CrossRef]
16. Bedoussac, L.; Justes, E. The efficiency of a durum wheat-winter pea intercrop to improve yield and wheat grain protein concentration depends on N availability during early growth. *Plant Soil* **2010**, *330*, 19–35. [CrossRef]