INTERDISCIPLINARITY OF INNOVATION ASSESSMENTS IN PLANT BREEDING - A CITATION NETWORK ANALYSIS

Abstract

The poster contribution asks how interdisciplinary scientific work has become in fields of research relevant to agricultural science. It targets at shedding more light to the answer of this question for identifying structure and quantity of interdisciplinary scientific work within the body of scientific articles concerned with innovation assessments in plant breeding. With a combination of literature and citation network analysis (NEWMANN, 2006, 2011) different quantitative and qualitative methods targeted at analyzing innovations in plant breeding have been identified and the epistemic connections between the life, social and economic sciences were scrutinized.

Keywords

citation network analysis, interdisciplinarity, sustainability assessment, plant breeding, innovation, transaction-cost theory

1 Introduction

‚Sustainability' has been a buzzword for different fashions of inter- and transdisciplinary scientific work since the BRUNDTLAND (1987) report came out. Stipulating discourse in a direction of holistic system understanding sustainability perpetuates linking social, ecological and economic dimensions of humane challenges (ALLEN ET AL., 1991:5ff.). 30 years later we may ask how interdisciplinary scientific work has become in fields of research relevant to agricultural science and planetary sustainability. Agricultural systems as such are a realm of social-ecological interplay (NUIJTEN, 2011:197ff.) and thereby already subject to interdisciplinary research. Presuming these indications for interdisciplinary work one can assume from an epistemic point of view, that any kind of assessment of the sustainability of an innovation in the agricultural sector, should be produced including knowledge from social, life and economic sciences.

2 Theory

However, this knowledge transfer in and between different disciplines can be regarded as a type of trade: Let us assume there is a researcher, who acquires others knowledge by reading an article. Complying with the rules of good scientific practice the gathered knowledge is being cited in the article written by the researcher, where s/he uses the obtained knowledge. FRANCK (2002) calls this an "economy of thought" (FRANCK, 2002:9) manifesting itself in a "market of ideas" (FRANCK, 2002:9) with attention being distributed as a pay-off for knowledge. Presuming that scientists use citations as such a pay-off for knowledge transfer, we can assume that there are transaction costs associated with each and every citation. In accordance with WILLIAMSON's (1985) theory of transaction-cost we assume, that when one wants to acquire knowledge, the transfer of information involves cost of access, selection and understanding of the content of the other researcher's work. The more domain specific to a specialty of knowledge an article is, the more effort is needed by scientists from a different specialty to integrate the entailed knowledge into their own research. We deduce, that scientists engaging in research face the general trade-off between this additional efforts of using domain specific

knowledge weighing against the additional attention received for integrating research relevant to researchers from other domains of knowledge. Especially in interdisciplinary research, such as sustainability or agricultural research, scientists face a trade-off of receiving more attention from other scientists, through citations, which are not just specific to one's own research field, but applicable to many others and the effort entailed in doing so. Sustainability assessments demand, that knowledge from different disciplines is incorporated into one body of scientific work. The transaction costs being mirrored in the mentioned economy of thought should manifest themselves in the implied scientific knowledge transfer of research concerned with sustainability assessments of innovations in plant breeding. We therefore ask how much disciplinary and interdisciplinary research has been conducted so far in sustainability assessments of innovations in plant breeding?

3 Methodology

The poster contribution therefore identifies structure and quantity of interdisciplinary scientific work within the scientific body concerned with sustainability assessment of innovations in plant breeding. With a combination of literature and citation network analysis (NEWMANN, 2006, 2011) different quantitative and qualitative methods targeted at analyzing innovations in plant breeding have been identified and the epistemic connections between the life, social and economic sciences were scrutinized. The sample for the network analysis is drawn from the Web of Science® (WoS) through a search term combining keyword terms from different topic areas with set theory. The sample contains an intersections of a topic search on "innovation", "assessment" and "plant breeding". Keyword terms from a topic like "assessment" were further disaggregated and into a union of keywords like "*assessment*" or "*valuat*" or "*apprais*" and such to finally yield a sample of 12.180 articles citing on average 28,6 articles each. The articles in the network were categorized into economic, social and life sciences according to the categories in the WoS, allowing for articles being part of multiple categories at the same time. With a combination of qualitative and quantitative literature analysis different quantitative and qualitative methods targeted at analyzing innovations in plant breeding have been identified and the epistemic connections between the life, social and economic sciences were statistically scrutinized. In order to identify the structures of distribution and clustering in the overall network a power-balancing layout algorithm was used. The algorithm of power-balancing layout algorithm of FRUCHTERMAN AND REINGOLD (1991) produces a citation network, where articles, which are more often cited attract each other and less cited articles are repulsed. Leading to a spring force between adjacent edges (articles) u and v (see Formula 1):

$$f_{springforce}\left(p_u, p_v\right) = f_{repulse}\left(p_u, p_v\right) + f_{attract}\left(p_u, p_v\right) = \\ = \frac{l^2}{||p_u - p_v||} \cdot p_u\vec{p}_v + \frac{||p_u - p_v||^2}{l} \cdot p_u\vec{p}_v$$

Formula (1.)

3 Results

We built a citation network from scientific articles contributing to the analysis of innovations in plant breeding. Identifying the different scientific groups involved in the discourse we found that interdisciplinary connections between the life, social and economic sciences already exist to certain extend. Interdisciplinary contributions mostly descend from the combination of bio- and economic sciences or bio- and social sciences. Disciplinary relevant contributions to the discourse come only from the life and economic sciences. Social sciences contribute hardly anything disciplinarily relevant level to the discourse over the analysis of innovations in plant

breeding, so far. The most effective journals in the communication of interdisciplinary plant breeding research were identified for the life, social and economic sciences. Looking at methodologies used within our network we found only very few articles rely on quantitative methods, few on qualitative methods and hardly any contributions originate from multi-method approaches. We see this as an indication for a trade-off between the increased effort of knowledge-transfer across disciplines and the pay-offs of being cited by a wider range of researchers.

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