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Crowdsourcing for agricultural applications: A review of uses and opportunities for a farmsourcing approach

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ABSTRACT

Crowdsourcing, understood as outsourcing tasks or data collection by a large group of non-professionals, is increasingly used in scientific research and operational applications. In this paper, we reviewed crowdsourcing initiatives in agricultural science and farming activities and further discussed the particular characteristics of this approach in the field of agriculture. On-going crowdsourcing initiatives in agriculture were analysed and categorised according to their crowdsourcing component. We identified eight types of agricultural data and information that can be generated from crowdsourcing initiatives. Subsequently we described existing methods of quality control of the crowdsourced data. We analysed the profiles of potential contributors in crowdsourcing initiatives in agriculture, suggested ways for increasing farmers' participation, and discussed the on-going initiatives in the light of their target beneficiaries. While crowdsourcing is reported to be an efficient way of collecting observations relevant to environmental monitoring and contributing to science in general, we pointed out that crowdsourcing applications in agriculture may be hampered by privacy issues and other barriers to participation. Close connections with the farming sector, including extension services and farm advisory companies, could leverage the potential of crowdsourcing for both agricultural research and farming applications. This paper coins the term of farmsourcing as a professional crowdsourcing strategy in farming activities and provides a source of recommendations and inspirations for future collaborative actions in agricultural crowdsourcing.

Contents

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1. Introduction

First coined in 2006 by J. Howe, the editor of the *Wired* magazine (Howe, 2006), the term crowdsourcing rapidly gained public uses in the social milieux of the internet and blogospheres. Crowdsourcing was associated (but not defined) by Howe as a new organisational form inspired by online firms such as Amazon.com using the crowd or online communities as a way to outsource several tasks. David Brabham, after a comprehensive work of literature review (Brabham, 2008, 2012, 2013) proposed to define crowdsourcing scientifically as... "(...) an online, distributed problem-solving and production model that leverages the collective intelligence of online communities to serve specific organizational goals" (Brabham, 2013, p. xix). According to Brabham, the specificity of crowdsourcing lies in the topical sharing of responsibilities between an organization (typically a firm) and an online community; between "a bottom-up, open, creative process [and] a top-down organizational goals" (Brabham, 2013, p. xv). In this sense, crowdsourcing practices are situated under the control of the institution (being an administration, an academic community, a corporate firm, ...), i.e., the one that manages the activity and defines its objectives, or purposes. As a result, according to Brabham, open sources software or common-based peer productions such as Wikipedia should not be labelled crowdsourcing initiatives as the locus of control is in the hand of the online community.

The term "crowdsourcing" was progressively assigned to many scientific and operational initiatives aimed at collecting contributions from a large group of people. In scientific research, outstanding initiatives based on crowdsourcing managed to yield significant scientific outputs (Franzoni and Sauermann, 2014) such as the project "Foldit", where contributors can help, through the gamification of a scientific task, to improve the understanding of the structure of proteins. This project currently gathers nearly 200,000 contributors, has resulted in a number of publications in top journals and has inspired dozens of similar crowdsourcing initiatives in biomedical research (Belden et al., 2015). Often denominated as community-based monitoring, citizen sensing, or citizen monitoring, the majority of crowdsourcing initiatives aim at collecting environmental and wildlife observations by volunteers (Roy et al., 2012). Besides this major field of application, crowdsourcing initiatives were reported in the fields of astronomy (Raddick et al., 2010), meteorology (Muller et al., 2015), cartography (Heipke, 2010), mathematics (Cranshaw and Kittur, 2011) and human health (Ranard et al., 2014). These initiatives, in relation with the concept of citizen science, have gained an increasing interest in the scientific community not only for the potential outcomes that crowdsourcing-based projects may bring to the researcher's field of interest but also for studying crowdsourcing as a scientific object per se (Wiggins and Crowston, 2011; Franzoni and Sauermann, 2014). Although the use of volunteering contributions in the scientific research area originates well before the internet era (Koerten and van den Besselaar, 2014), current crowdsourcing initiatives are always mediated by internet platforms. Other ICT tools such as mobile phones considerably foster the development of citizen sensing initiatives. The quality of the inputs collected through crowdsourcing is a major point of discussions in several projects (e.g., Muller et al., 2015), as well as the data quality procedures that are needed to improve the quality of the inputs (Allahbakhsh et al., 2013). Some authors claim that "higher quality information can be derived from vast amounts of low quality data" (De Longueville, 2016), which is related to the so-called "big data" paradigm. Several studies further investigated the profiles of the contributors to crowdsourcing initiatives (e.g., Newman et al., 2012; Neis and Zielstra, 2014; Ranard et al., 2014) and their motivations (e.g., Raddick et al., 2010; Reed et al., 2013; Koerten and van den Besselaar, 2014; Nov et al., 2014).

Large-scale, successful projects such as the ones developed in environmental monitoring are still lacking in the agriculture sector. It is sometimes argued that farmers may be reluctant to use new ICT tools such as crowdsourcing applications. However, specific applications are increasingly adopted when the tools are relevant and meet their current practices, e.g., weather forecasts on a mobile application. More complex ICT tools such as precision agriculture applications are also increasingly used (GNSS, 2015), in both industrialized and developing countries (USAID, 2013). This trend is supported by the facts that mobile phones are used worldwide and mobile connectivity is increasing to reach complete spatial coverage in many rural areas.

Although not always denominated as crowdsourcing, there is a long tradition of setting participatory approaches in research and development projects in agriculture, attempting to facilitate the farmers-researchers interactions or to simply collect and aggregate agricultural information from farmers (van Etten, 2011). Dissemination of research and development knowledge in agriculture is often organized by national or regional agricultural agencies or structures, also known as extension services, or by farm consultants from private companies, which all aim to transfer scientific knowledge and new technologies to farmers. However, a gap remains between scientists and farmers. Scientists may not understand or even know the farmer needs. In addition, many project outputs fail to meet the farmers' fields or needs, even if research outputs are pertinent. More recently, there was a receding