Journal of Cleaner Production 188 (2018) 698–707

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Farmer innovation system and government intervention: An empirical study of straw utilisation technology development and diffusion in China

Liyan Zhang [a], Bin Wu [b, *]

[a] Center for Innovation and Entrepreneurship, Tianjin University of Finance and Economics, Tianjin, China
[b] Nottingham University Business School, Nottingham, NG8 1BB, UK

ARTICLE INFO

Article history:
Available online 5 April 2018

Keywords:
Farmer innovation system (FIS)
Government intervention
Straw utilisation technology (SUT)
Rural China

ABSTRACT

In the context of rural sustainability in the developing world, a dilemma facing government intervention is to recognise and properly use local (or indigenous, practical) knowledge. This paper sheds new light on government intervention by introducing a farmer innovation system (FIS), which is initiated by farmer innovator(s) with participation or support from government agencies and other stakeholders for technology improvement and diffusion. In relation to different understandings, attitudes and approaches to farmer innovation, we argue that different government intervention may lead to different project designs and results. The complexity of government intervention in farmer innovation can be seen from an empirical study of the development and diffusion of straw utilisation technology (SUT) in rural China. By analysing and comparing two cases - one successful and one failed - we reveal two types of government intervention, and features and conditions of project success. The major limitation is identified as leaving out other actors such as local business partners and non-government agencies. We suggest a balanced account between farmer innovator(s), government intervention and innovation platform in future research.

1. Introduction

For rural development, agricultural innovation and environment protection in the developing world, there is a long debate on the nature and role of "state intervention". Having witnessed many human tragedies of the twentieth century (e.g. Great Leap Forward in China, collectivisation in Russia, compulsory collectivisation in African countries) caused by government's social engineering schemes, James Scott (1998) views state intervention as a process of extensive control over people and territory which leaves little space for other societal actors to play. Challenging such a dominant approach, nonetheless, there is a call for "beyond the state" (Li, 2005) or "the return of the state" (Cordoba and Jensen, 2014), to improve infrastructure and public services. A key and unsolved issue facing both schools of thought is how to recognise the value of local (traditional, indigenous or practical) knowledge, and identify by what channel or mechanism such knowledge can be integrated into current innovation systems or development programmes which are still overwhelmingly dominated by either governments or professionals (Gupta, 2012; Li, 2005).

This paper attempts to tackle this dilemma by focusing on the interfaces between local knowledge within grassroots innovators and "scientific" knowledge in the formal sector for better using and managing local resources, opportunities and overcoming local challenges. In this regard, farmer innovation system (FIS) is a useful concept for us to observe and analyse the communication, interaction and cooperation between farmer innovator(s), community members, external professionals, government and non-government agencies to improve rural environments and livelihood systems (QUNO, 2015).

In relation to the debate on state intervention, we attempt to examine the role of government intervention in farmer innovation diffusion in order to develop our understanding of the balance and interfaces between top-down government intervention and bottom-up development. The necessity and complexity of government intervention can be illustrated from China practices since its market-oriented reform in the 1980s with mixed results:

* Corresponding author. Nottingham University Business School, Nottingham, NG8 1BB, UK.
E-mail address: bin.wu@nottingham.ac.uk (B. Wu).

https://doi.org/10.1016/j.jclepro.2018.03.224
0959-6526/

successes and failures. Compared to a rich body of literature on government intervention on formal agricultural research and extension (Delman, 1991; Sun et al., 2014; Wang et al., 2016; Zhu, 2014), only a handful of researchers have paid attention to farmer innovation and government intervention (Gupta, 2012; Wu, 2003; Wu and Jules, 2004; Wu and Zhang, 2013).

This paper sheds new light on government intervention through a case of Straw Utilisation Technology (SUT) development and diffusion. This case is important because China is rich in terms of biomass resources including a variety of straw and agricultural processing residues, such as those of corn, rice, wheat, cotton, and oil-bearing crops. In theory, there is a total of 820 million tons of straw every year, of which approximately 690 million tons are available to collect. Currently, 350 million tons are used as fertilizer, and for animal feed, materials for food (e.g. mushroom plantation) and industrial (e.g. paper manufacturing) production per year, and the remaining 340 million tons can be transferred for the use of energy including biomass power generation, electricity, biogas, biomass fuel and bi-fuel ethanol which is equivalent to an amount of 170 million tons coal (Liu et al., 2008; SEB, 2012). Regarding the use of straw for energy production, furthermore, only 2.35% has been used in practice, leaving the vast majority (97.6%) unused (SEB, 2012).

The complexity of SUT development and diffusion in rural China can be seen from the uneven process in research and application of semi-gasified stoves. Despite its great potential with clear benefits to both local and wider environments, it is difficult for individuals or commercial firms to initiate this process due to the heavy costs of collecting, transporting and storing straw. Government intervention (including financial subsidies) is important not only for farmer innovators to continue to develop and improve this technology, but also for other stakeholders, such as agribusiness firms and governmental and non-governmental agencies, to work together with farmer innovators and ensure wide dissemination and adoption.

In the past two decades or so, Chinese government has paid increasing attention to the efficient use of straw resources for the purposes of a cleaner sky, beautiful countryside and reduction of CO^2 emissions. A series of government campaigns and policies have been issued to stimulate the development and application of the SUT alongside the administrative prohibition of direct burning in the field (Sinton et al., 2004; Wang et al., 2016; Wang and Jiang, 2017; Hong et al., 2016). They include the promotion of new technologies such as straw return back to farmland, and straw-based power stations. Despite the above effort, there is a long way for China to go in full use of straw resources.

We consider the development and diffusion of SUT as a process of establishing and maintaining farmer innovation system, referring a process of innovation initiated by farmer innovators with participation or support by government and other stakeholders. Based on narratives of two cases of SUT development and diffusion, in particular, this paper aims to address the following questions: How did farmer innovator(s) initiate a process of SUT development and diffusion? What role have government agencies played in establishing and maintaining a FIS? What are variations of government intervention in terms of approaches and styles, leading to differences in SUT development and innovation diffusion?

This paper is organised as follows. The next section reviews the debates on state intervention and farmer innovation system. It is followed by research design and methodology for our fieldwork. In Section 4, we present two representative cases of government intervention: one successful and another a failure. Based upon empirical evidence, we discuss two types of government intervention, features of each type and the conditions of the successful intervention (Section 5), and draw our conclusion in Section 6.

2. Literature review: state intervention and the farmer innovation system

Reflecting the numerous case of failures in national strategies, campaigns or programmes in the twentieth century, the term *state intervention* has been coined in more or less negative terms and refers to such phenomena in which "[states] construct simplified models of the world that they would like to control and improve, yet improvement schemes fail in proportion to their effectiveness at preventing people from applying the everyday knowledge essential to human well-being" (Li, 2005: 383). As social engineering, according to Scott (1998: 4–5), state intervention consists of four elements: 1) "the administrative ordering of nature and society", 2) "a high-modernist ideology" and "legitimacy of science and technology"; 3) "an authoritarian state that is willing and able to use the full weight of its coercive power to bring these high-modernist designs into being", and 4) "a prostrate civil society that lacks the capacity to resist these plans". Whilst Scott's theory may be right in explaining why "certain schemes to improve the human condition" failed in planned economies such as Soviet Union and pre-reformed China, it could hardly reflect or explain the progress made by reformed China and other transitional countries where there is more space for business entrepreneurs, reformists and other non-state actors who could influence development planning and implementation.

Against the above simplified, unbalanced, and top-down approach to "state-society" or "power-resistance" relationship, there is a call for "beyond the state" or "return of the state" to rebalance between state and non-state stakeholders. Rejecting the claim of the state monopoly, for instance, Li (2005: 386) emphasises that "many improvement schemes are formed through an assemblage of objectives, knowledge, techniques, and practices of diverse provenance". Along similar lines, Cordoba and Jensen (2014: 482) argue that "state intervention cannot be analysed in isolation but must take into account the state's changing articulations with different forces in civil society, since power-relations within society influence the state and are in turn influenced by state power".

The key characteristics of state intervention, according to Scott (1998: 6), are legibility and simplification, which "exclude the fund of valuable knowledge embodied in local practices". Taking a Greek term *mētis*, he highlights the value of local or practical knowledge in settings that are "mutable, indeterminant (some facts are unknown), and particular" (Scott, 1998: 316). Whilst the mētis or local knowledge is necessary to a successful practice, a big challenge facing governmental and development agencies is the "relationship between scientific knowledge and practical knowledge" which is "part of a political struggle for institutional hegemony by experts and their institutions" (Scott, 1998: 311). As a result, whether or how to recognise the value of local knowledge, and bring it into development planning and implementation becomes a key for the success or failure of state intervention.

With a focus on the interfaces between local (practical) knowledge and scientific knowledge, perhaps, the literature on farmer innovation, diffusion and systems is most relevant. The term *farmer innovation* here refers to any technological invention or improvement made by rural people in order to cope with the complexity of local resource, ecological, economic and social conditions (Wu, 2003; Wu and Zhang, 2013). Farmer innovation is emphasised in the process of farmers' communication, interaction and cooperation in the search for, testing and development of new technologies (principles, methods, means, products and know-how) for their livelihood security. More importantly, it draws our attention to the existence and value of "local knowledge" (or traditional, indigenous knowledge), which is developed outside of