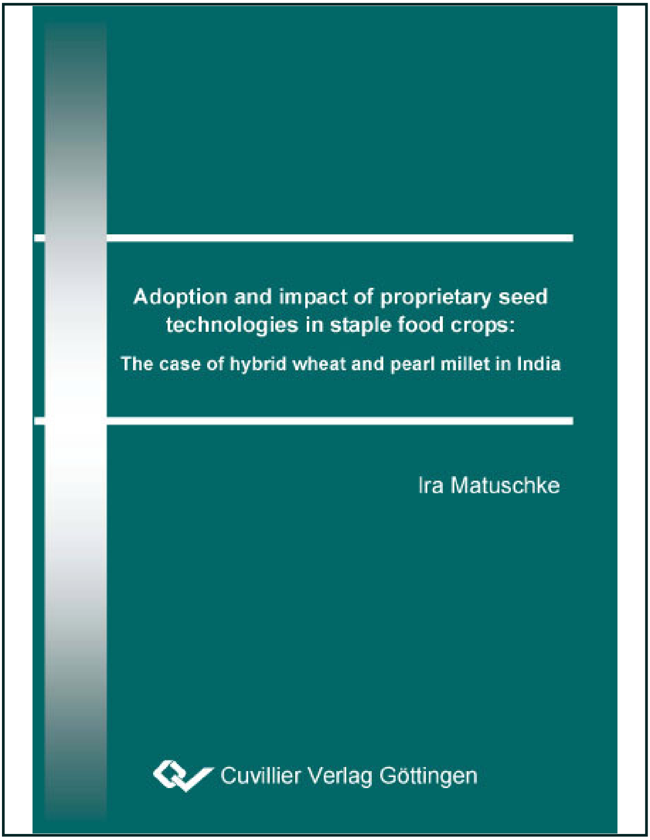
Ira Matuschke (Autor)

Adoption and impact of proprietary seed technologies in staple food crops: The case of hybrid wheat and pearl millet in India



https://cuvillier.de/de/shop/publications/1807

1 Introduction

Agricultural research in developing countries faces enormous challenges. The world population is expected to increase from 6 billion in 2000 to 7.5 billion in 2020 (Rosegrant et al., 2001), and this growth will mainly occur in developing countries. A concomitant rising demand for food stands against the background of decreasing areas of arable land, increasing water scarcity, growing environmental problems – particularly in high-potential areas – and stagnating yield growth in major food crops (Alston et al., 2001; Fan & Hazell, 2001; Leisinger et al., 2002; Haggui et al., 2006). Consequently, improving food production in developing countries will depend on productivity increases and the intensification of investments in marginal areas, rather than on mere area expansions. Moreover, not only the level but also the pattern of food demand is projected to change. For example, rising income levels are expected to shift dietary patterns towards an increased consumption of meat and cereals. Moreover, cereals will not only be demanded as direct food, but also as feed crop and possibly as sources for bioenergy. This necessitates yield improvements in forage and cereal crops, respectively (Rosegrant et al., 2001; OECD/FAO, 2005).

Increasing the scope for private investments in agricultural input markets, particularly in plant breeding, is seen as one approach to address these challenges. In fact, private investments in agricultural research and development (R&D) already rose considerably over the past two decades as a result of market liberalisation and economic restructuring policies in many developing countries. Scientific breakthroughs in plant biotechnology and the passage of intellectual property right legislations further spurred private investments. As a result, the framework within which agricultural research operates has started to shift gradually – from being publicly dominated to becoming increasingly privately driven; although these developments are more apparent in large developing countries than in smaller ones (Byerlee et al., 2002; Pardey & Alston, 2006). Private investments had a marked impact on many farmers in developing countries. For instance, Morris (2002, p. 201) found that the private sector “has demonstrated an impressive capacity to address farmers’ germplasm needs, develop improved cultivars in response to these needs, produce adequate quantities of high-quality seed and deliver that seed in a timely fashion”.

Among other factors, private sector investments depend critically on the availability and enforceability of exclusion mechanisms, which allow for the appropriation and subsequent re-investment of research benefits (Pray & Umali-Deininger, 1998). Exclusion mechanisms can be of legal or technical nature: legal exclusion mechanisms assign intellectual property rights (IPRs) to an inventor for a limited period of time, e.g. in the form of plant variety protection or patents (van Wijk et al., 1993). IPRs, however, were shown to have little impact on private investments in developing countries so far, because of their low enforceability (Tripp et al., 2007). For this reason, technical exclusion mechanisms, in the form of hybrid seed technologies, have been the main way of private sector investments.

Research on hybrid seed technologies started as early as in 1908 when the hybrid vigour in maize was discovered (Banga & Banga, 1998). Hybrids were shown to be generally higher yielding than open-pollinated varieties (OPVs) due to the exploitation of the hybrid vigour. This vigour, however, gets lost in the second generation of planting. This unintentional feature of hybrid seed technologies requires farmers to buy fresh seeds on a regular basis in order to sustain stable yields. This in turn attracted private investments at later stages, because it allows for the appropriation of research investments.

The area under hybrids rose considerably over the past decades. Today maize hybrids cover more than 50% of the total maize area in countries like Argentina, Brazil and Kenya. Rice hybrids are reported to take up 50% of the rice area in China; and in India hybrids of cotton are covering more than 50% of the total cotton area (Pingali, 2001; World Bank, 2006). The area under proprietary seed technologies is expected to increase further if transgenic crops gain more hold in developing countries and innovations become available that are currently in the private R&D pipeline, e.g. water-saving or drought-tolerant crops.

Nonetheless, private investments in agricultural R&D and, associated with this, the increasing diffusion of proprietary seed technologies stirred massive concerns about the socio-economic ramifications they may entail. In related debates, which are often led on an emotional basis, numerous criticisms are brought forward. These criticisms will be discussed in detail in the following analyses. Yet, the main argument centres on the question whether or not farmers, who are operating under marginal conditions, are able to access and benefit from proprietary seed technologies.

This concern is understandable given the fact that private sector investments tend to be directed towards commercial crops that are primarily cultivated by large-scale farmers in high-potential areas, e.g. in areas with assured irrigation or good market infrastructures. If marginal farmers are bypassed by modern innovations, a situation may evolve in which productivity growth is socially and spatially inequitable. In addition, differentiated technology access bears the risk that the diffusion of innovations could slow down (Srinivasan & Jha, 2002). Such scenarios are highly undesirable from a social point of view, and, if valid, would necessitate reconsidering policies that stimulate private sector investments in developing countries.

The actual experience, however, is not that bleak. Numerous studies showed that farmers in developing countries benefit from proprietary seed technologies even if they are protected by legal or technical means (e.g. Smale, 1995; Heisey et al., 1998; Morris, 1998; Tripp & Pal, 1998; Zeller et al., 1998, Ismael et al., 2002; Qaim &

Matuschke, 2005). Yet the fact that the results available from studies are not fully conclusive and that most of the related research so far focused on crops cultivated on a commercial basis warrants further analysis.

This study contributes to the debate by analysing the adoption and impact of proprietary seed technologies in staple food crops in India. The objectives are twofold: First, I aim to establish the determinants of the adoption of hybrid wheat and hybrid pearl millet. Both crops are of prime importance to India's food security and are cultivated on a semi-subsistence basis in the study region, the state of Maharastra in the semi-arid tropics. Second, I address concerns raised with respect to proprietary seed technologies by analysing whether adopting farmers, particularly smallholders, benefit from cultivating hybrid crops and how cultivation benefits are allocated between farmers and seed-producing companies. Basis of the analyses are two data sets that are the result of a household survey I carried out in Maharashtra in 2004. Both data sets contain extensive information on the adoption of hybrid wheat and hybrid pearl millet. In total, the data sets comprise information on 284 wheat and 266 pearl millet farmers, respectively. These datasets are analysed econometrically and with other statistical tools.

The findings of this study may stimulate discussions in numerous directions. Many developing country governments are currently drafting or implementing plant variety protection (PVP) legislations; and there are great uncertainties of how far-reaching these legislations should be. Stricter legislations are expected to encourage private sector investments, but they are feared to restrict farmers in their access to seeds. This study may contribute to the discussion on PVP legislations by providing a constructive empirical background. Moreover, given tightened government budgets a discussion on how far the public sector should withdraw from agricultural R&D evolved over the past years (Jaffe & Srivastava, 1994). If the private sector is able to address farmers' needs, then a partial public sector retreat could be a possible consequence. The results of this study could help to address this question. Finally, an essential element to productivity growth in rural areas is the uptake and diffusion of productivity-enhancing innovations. The results drawn from the analyses could support policy-makers who are envisioning strategies to increase the adoption and diffusion of innovations in seeds.

The remainder of this study is organised as follows. Chapter 2 gives a comprehensive overview of the transformation processes that agricultural R&D faced over the past two decades. The analysis is set within the framework of a seed system, which is defined as comprising all activities that influence the research, development and distribution of seeds (Pray & Ramaswami, 1991). Within this framework, the economics of public and private sector investments in agricultural R&D are discussed, a glimpse on the role of proprietary seed technologies in global seed markets is provided and the risks associated with proprietary seeds are debated. Finally, the last section of chapter 2 provides a short outlook on the likely challenges that agricultural researchers will face as privatisation in agricultural input markets continues. Every chapter concludes with a summary of findings.

Chapter 3 sets the stage for the empirical analyses. The first part reviews analytical approaches to adoption analysis and thereby differentiates between micro and macro level studies of adoption. Since the adoption analyses are carried out at the farm-level, a greater emphasis is laid on the theoretical foundations of micro level studies. The chapter proceeds by giving an overview of India's seed system, which is one of the most complex and vivid seed systems in the developing world (Pal & Byerlee, 2006). The Indian seed industry experienced considerable privatisation efforts in the past two decades. It, therefore, offers a particular interesting background to this study. The next section explains why hybrid wheat and pearl millet were chosen as research crops.

Hybrid wheat was launched in the Indian market in 2001, and seeds are currently solely produced by the Maharashtra Hybrid Seed

Company (Mahyco). Even though adoption rates tripled over the past six years, the area cultivated with hybrid wheat is low: Mahyco reported an area of about 62,000 acres under hybrid wheat in 2006, which corresponds to 0.1% of the Indian wheat area. What is striking, however, is that the company’s marketing focus is not on the irrigated wheat states of northern India, but on states in the semi-arid tropics where wheat is primarily grown for home consumption. Pearl millet hybrids, on the other hand, constitute an interesting contrast to hybrid wheat, because pearl millet was one of the earliest available hybrid crops in India. Launched in 1965 by the public sector, pearl millet hybrids spread quickly; and presently about 60% of the Indian pearl millet area is sown to hybrid seeds. Private investments in pearl millet R&D increased considerably over the past two decades. Already in the late 1980s they were estimated to be at the same level as public sector investment (Pray et al., 1991). The final section of chapter 3 elaborates on the specifics of data collection in the state of Maharashtra.

Chapter 4 analyses the adoption and impact of hybrid wheat. Adoption probit and Tobit models are employed to determine what factors significantly influence the adoption and adoption intensity of hybrid wheat. Moreover, the chapter examines the impact of hybrid wheat cultivation on farm income and the allocation of benefits between farmers and seed-producing companies. In addition, as farmers consider the price of hybrid wheat a major barrier to adoption, contingent valuation methods are utilised to determine the farmers’ willingness to pay for hybrid wheat seeds.

Chapter 5 examines the adoption and impact of hybrid pearl millet. The fact that pearl millet hybrids have been marketed for the past four decades allows for the application of duration analysis techniques to determine not only why a farmer adopted, but also at what time (Fuglie & Kascak, 2001; Dadi et al., 2004). In this way, concerns that private technologies could hamper the diffusion of innovations are addressed. As duration analysis techniques have been rarely applied in an agricultural context and require the collection of specific data, the first part of chapter 5 elaborates on the theoretical foundations of duration analysis before proceeding to the regression results. The second part of the chapter considers the impact of hybrid pearl millet cultivation on farm income and the allocation of benefits between farmers and seed-producing companies.

Farmers' information networks are shown to have a significant and positive impact on adoption in most regression set-ups. For this reason, chapter 6 assesses the role of social networks in the adoption process more specifically. Using comprehensive data on farmers' networks, the analysis is able to crystallise the impact of individual networks on adoption as opposed to village level networks that were often analysed so far. Based on the rich information collected, the chapter also demonstrates whether endogenous or exogenous network effects are more relevant to an individual's adoption decision. An endogenous effect is hereby defined as the effect that the *behaviour* of a network member has on adoption; whereas an exogenous effect is the effect that the *characteristics* of a network member have on adoption. Chapter 7 gives a synopsis of the chapter conclusions, discusses wider policy implications and outlines further research requirements.