Innovation in informal settings but in which direction? The case of small cotton farming systems in Argentina[*]

Valeria Arza[†] and Patrick van Zwanenberg[‡]

Abstract

Despite the size of the informal economy in low and middle income countries, and its significance for poorer households and communities, we understand little about innovation in such settings, and how it might best support marginalized households and communities. In this paper we compare two very different kinds of innovation in the same informal setting; that of small scale cotton production in north east Argentina. One involved the informal production and sale of copied genetically modified seeds, an innovation that fitted readily within an incumbent set of socio-technical practices concerned with intensive commodity crop production. The other involved new agro-ecological techniques; a radical departure from incumbent practices. We find both to be problematic, but for different reasons. The production and diffusion of copied genetically modified seeds resolved one problem for small farmers, but created others, and it could not address many additional problems that arise precisely because most aspects of the incumbent set of socio-technical practices are themselves problematic for small farmers. New agro-ecological production practices, on the other hand, addressed many more of the problems that arose from incumbent practices, but its success required wider institutional innovation, such as bridging finance, viable markets, and different inputs, that were far more difficult to create and sustain.

Keywords

Informal innovation; socio-technical trajectories; GM technologies; agro-ecology; cotton; Argentina

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[†] CONICET and CENIT/UNTREF, corresponding author, varza@fund-cenit.org.ar

[‡] CENIT/UNTREF

Section 1: Introduction

It is difficult to overstate the importance of the informal economy for peoples' employment and livelihoods in much of the world. In Argentina, a middle income economy, and the focus of this paper, one third of all workers were estimated to be making a living in the informal economy in 2012.[1] In lower income countries the proportions are far higher (Alter Chen, 2005). Following Cozzens and Sutz (2013, forthcoming) we use the phrase 'innovation in informal settings' to refer to innovation in those parts of the informal economy that intersect with the lives of marginalized households and communities. The focus is thus on marginalised people who earn their living in extra-legal/unregulated markets, and on the problem solving and knowledge generating activities that take place within those settings to create new artifacts, practices and services. Because of its 'bottom up' focus 'innovation in informal settings' shares much with the notion of 'grassroots innovation'.[2]

A number of factors underpin scholarly interest in innovation in informal settings. One is that despite the sheer scale of the informal economy, and its importance for the livelihoods of a very large proportion of the populations of middle and low income countries, we know relatively little about innovation in such settings. Mainstream innovation studies have tended historically to ignore what happens in informal settings. Development studies, on the other hand, whilst very much attentive to the informal sector, has usually paid little attention to innovation. We thus have little understanding of how innovation processes in informal settings differ from those in formal settings, which have been studies extensively, but there are very likely to be different dynamics at play. Such differences might, for example, be present in terms of the kinds and sources of knowledge that are utilised; the ways in which skills are obtained in the absence of formal learning institutions; and the difficulties of scaling up innovations (Kraemer Mbula and Wamae, 2010).

The different dynamics are also of interest to those concerned with 'inclusive development'. Might innovation in informal settings, for example, make relatively more use of, and value, local knowledge? Might it make a relatively greater contribution to learning and capability building amongst marginalized sectors of the population? (Johnson and Dahl Andersen, 2012). Closely linked to this interest in how innovation in informal settings might differ from more mainstream ones are questions about whether different *kinds* of innovation are likely to take place in informal settings. It particular, some commentators argue that where innovation is conducted by and with marginalized actors it is more likely to be better aimed (relative to mainstream innovation processes) at meeting the needs of those groups, solving local problems and creating livelihoods in those settings (Cozzens and Sutz, 2013, forthcoming, Leach et al., 2007, STEPS Centre, 2010).

For some activists and commentators 'bottom up' processes of innovation are potentially valuable not only because they might create novel spaces of production and consumption that address local needs and provide work. More ambitiously, they might also help empower people through the local development, design, ownership and control of technology and ultimately may help to challenge mainstream innovation agendas and development pathways (Fressoli et al., 2012). The issue here then is whether, and if so how, innovation in informal settings could help stimulate alternative *directions* of both technological *and* social change,

[1] http://www.lanacion.com.ar/1508611-el-gobierno-no-logra-disminuir-el-trabajo-informal-uno-de-cada-tres-empleados-esta-en-negro

[2] Cozzens and Sutz, 2013, forthcoming use the terms interchangeably.

as compared to innovations that occur in formal settings and that are undertaken by, and largely for, more privileged actors.

In this paper, we reflect on some issues concerning informal innovation processes and *directions* of technological and social change by discussing and comparing two rather different kinds of innovations in the same informal setting. The setting is that of small scale cotton production in northeast Argentina. One innovation in that setting involved organizational and product innovations to produce and sell copied versions of genetically modified (GM) seeds, which were then made available to farmers at low cost and on informal credit. The other innovation involved the development and diffusion of new cotton production practices based on agro-ecological principles. The two innovations differ markedly in many respects. We argue that in analyzing those differences, it is useful to consider the entire social and technological systems of production and consumption within which those innovations occurred, and to which they seek to contribute to and alter.

The next section outlines in more detail the analytical framework within which we address our two case studies. Section 3 then characterises the dominant agricultural commodity production-consumption regime in Argentina, identifying formal and informal players. Section 4 follows the same logic but specifically for cotton production. Sections 5 and 6 describe our two case studies. Section 7 compares both cases of informal innovation and Section 8 draws together some conclusions about the relation between informal innovation and inclusion.

The empirical evidence reviewed here was obtained in six participatory workshops with small-scale cotton farmers, held in July and September 2010 and in July 2011 in four cotton-growing localities in Chaco province (Pampa del Indio, Quitilipi, Villa Berthet and Sáenz Peña). About 20 people participated in each workshop, mainly small-scale farmers (cultivating less than 10 ha) but also some medium-sized farmers (areas of up to 100 ha), together with intermediaries, extension workers from the National Institute of Agricultural Technology (INTA) and local officials. The workshops, lasting roughly a day and a half each, were organized using participatory methodologies and aimed to identify productive practices, problems and potential solutions. In locations where agro-ecological farming exists, most agro-ecological farmers are neighbours of farmers producing with GM based technologies. They know each other and they experience common production and living conditions. A mix of them participated in the meetings we organised but we also talked to them separately.

The information collected through this method was complemented by twenty-nine in-depth interviews conducted between 2009 and 2011 with INTA agents, government representatives, representatives of farmer co-operatives, leader farmers from farmers' organization; and representatives of the seed industry both Chaco Province, and in Buenos Aires, and one workshop held in Buenos Aires with government officials, regulators and academics in 2012.

Section 2: Socio-technological regimes, trajectories and the direction of informal innovation

Writing about grassroots innovation movements, Fressoli et al (2013) note how one dilemma for activists and actors is that the ambitious visions for informal 'bottom up' innovation processes, in which innovation activities challenge mainstream innovation agendas and development pathways, find it difficult to attend to a wider set of contextual social and

institutional constraints. These are concerned, in part, with the root social causes of marginalisation which innovation alone cannot easily confront. But the constraints also arise from the fact that the kinds of alternative technologies and practices developed in informal settings, and that are in principle more appropriate to marginalised peoples' needs and circumstances, may not 'fit' easily with the practices, knowledge and norms that characterise the mainstream institutions that are key to the long-term support of innovation, such as universities, firms, financial institutions and government departments. For example, university researchers, subject to institutional pressure to publish and patent their work, will not satisfy institutional measures of performance by supporting relatively non-novel (to the world), open source, innovation in informal settings. Likewise, the knowledge produced through government funded R&D programmes may not be relevant to the knowledge required by informal innovation initiatives. The standards and certification norms required for entry to mainstream product markets may be designed for large scale production units, rather than, say, a co-operative of small scale producers. And banks may be orientated towards dealing only with formal (and sufficiently well established) businesses that can provide collateral for loans.

In order to appreciate Fressoli et al's point here, it is useful to think about well-established working technologies as part of a wider set of aligned, mutually supporting institutional, social and technological components. Intensive commodity crop production technologies, for example, are not only a collection of key artefacts (such as seed varieties, chemical inputs and machines), but also the firms, public institutions and engineers that provide the underlying knowledge base and develop and sell the artefacts (and indeed their lobbying capacity and political power); the particular farming practices and the extension services that develop and promote these; the intermediate and end consumers and markets/practices that create demand for commodity crops (e.g. as feed for intensive animal rearing in Europe); and the rules and regulations that accompany the technological practice, such as over intellectual property. As emphasised in innovation studies and the sociology of technology, these different technical and social elements co-evolve and align over time in ways that create a technological system or 'socio-technical regime' that enables a technology or set of technologies to perform well (at least along some dimensions) (Rip and Kemp 1998).

One characteristic of such socio-technical regimes is that change tends to be incremental and path dependent (Dosi, 1982). Novelties tend to be those that fit well with established bodies of knowledge, existing industrial structures and firm routines, and existing infrastructure, which means that they are usually only minor modifications to existing ways of doing things. Radically alternative technologies or practices, by contrast, are at a disadvantage, in part because they lack the economies of scale and accumulated learning of incumbent technological practices, but also because they may find that the knowledge, markets, capabilities, skills, policy support and infrastructure required to develop the new technology or practice, and for it to perform well, do not exist (Smith et al., 2010). It is thus the presence of incumbent socio-technical regimes, and their characteristics, that often constrain bottom up or informal innovations that are attempting to challenge existing, and suggest alternative, development and innovation pathways.

And yet existing development and innovation pathways may well need challenging if informal innovative activities are to have any significant lasting influence on the livelihoods of marginalised communities. Consider, for example, the existing socio-technical regime of intensive agricultural commodity crop production. These have given rise to, and continues to shape, a technological trajectory of development and innovation that provides neither

products for local sale nor local consumption, nor employment for marginalised people, that draws on resources that marginalised communities do not possess or have access to (e.g. large tracts of land, advanced technical knowledge) and causes and exacerbates local environmental damage. As Chataway et al, (2013) emphasise, we often find that certain kinds of development pathways produce economic growth but at the same time increase poverty. This, they argue, is because mainstream socio-technical regimes, and the incremental path dependent trajectories of innovation and change that they give rise to, typically exclude marginalised people. As they put it:

> "One of the primary factors which explains why enhanced growth co-exists with, and indeed in some cases causes an increase in both absolute and relative poverty is the dominant trajectory of innovation. Its capital-intensive nature, its scale intensity, its dependence on high-quality networked infrastructure, its reliance on skilled labour and its product portfolio (producing products which meet the needs of the rich) all have the effect of disadvantaging the poor, both as consumers and producers. It also excludes large segments of the population in many countries from productive employment. Moreover, much contemporary technology is also destructive of the environment, not least in relation to its energy-intensity, and this has disproportionately harmful impacts on the global poor. Whilst innovation is only a partial contributor to the persistence of global poverty it is an important one, and one which is largely neglected in the theorisation of innovation" (Chataway et al 2013, p. 2)

The challenge then for 'bottom up' innovation processes that seek to achieve wider technological and social change is not just to create artefacts and technological practices that are more appropriate for, say, marginalised farmers, but to create and support *alternative* production and consumption systems, or regimes, in which such practices and artefacts can perform well (Thomas and Fressoli, 2011)

We shall illustrate this point empirically by comparing two radically different sets of innovations in the same informal setting of small scale cotton production in northeast Argentina. One set consisted of organizational and product innovations to produce and sell copied versions of genetically modified seeds, which were then made available to farmers at low cost and on informal credit. We characterize this as an innovation that fitted readily within, and that sought to marginally alter, the existing, well established, production-consumption regime for commodity crop production. It addressed only one of many problems faced by small farmers operating within that regime, namely their inability to afford new and access formal private GM seed markets.

The other innovation involved developing and diffusing new production practices based on agro-ecological principles. In contrast to the previous case it was designed to address multiple problems faced by small farmers, including those that arise as a *consequence* of the fact that farmers were operating within a dominant production-consumption regime within which mainstream innovation was focused on the problems faced by large commercial farmers. Novel agro-ecological production practices are best understood not as an incremental change within the *existing* commodity crop production-consumption regime, but rather an entirely different direction of linked technological and social change for small farmers. In order for the innovation to work, a new production-consumption regime needed to be *created.* Innovators in agro-ecological production not only needed to develop, demonstrate and diffuse new cotton production practices, but also contribute to the creation of new markets,

distribution infrastructure, finance, and a value chain stretching from Argentinean cotton fields to international garment retailers.

In what follows, after presenting the dominant regimen in agricultural and cotton production, we describe the two sets of innovations, including the problems and goals they were addressing, the processes by which they occurred, the role of intermediaries in trying to bring informal innovations into more formal settings, and the livelihood consequences of the innovations for small farmers. In the conclusions we draw out a number of arguments about the kinds of conditions under which informal innovation may or may not best support improvements in the livelihoods of marginalized actors.

Section 3. Formal and informal agricultural production within Argentina's dominant agricultural regime

In the late 1970s, after years of relative stagnation, parts of Argentina's agricultural sector began to adopt the technological and institutional characteristics of large-scale, labour saving, input intensive production that had been pioneered by the USA and other major agricultural producers in the high income industrialised economies after the Second World War. Specifically, Argentinean governments sought to enhance the international competitiveness (and foreign currency earnings) of its agricultural economy by promoting specialisation in products in which it had comparative advantages (i.e. mainly those from the central Pampa region such as maize, wheat, sunflower, sorghum and soybean) and by adopting and adapting foreign production practices and machinery, designed to solve the production problems of relatively large farmers who could take advantage of economies of scale. Policy measures thus prioritized support for large farmers over small farmers, and the central Pampa region, where most export crops are produced, over other agricultural regions (Brieva, 2006, Manzanal, 2010). These processes pushed many smaller farming households out of agriculture altogether, and into the slums of the big cities, or into more informal and precarious forms of production, as markets for their traditional agricultural products disappeared, technical assistance and support declined,[3] and public infrastructure deteriorated.

A second wave of agricultural intensification began in the 1990s, triggered by a wider liberalization of the national economy. Reductions in tariffs and quantitative restrictions on imports, the availability of new technologies, and new organizational methods of agricultural production, led to further intensification in the use of fertilizers, agrochemicals, and machinery, primarily on the larger arable landholdings (Bisang and Gutman, 2003, Trigo et al., 2002). An important component of that technological intensification was the introduction of GM seeds in the mid-1990s. New machines and techniques accompanied the GM seeds as 'technological package' designed to increase farm productivity in specific export crops. The technological package involved organizational as well as technical innovations. In particular, the traditional model in which farmers exploit their own land, under their own risk, and control most of the production process, shifted to a contractual model in which entrepreneurs, who possessed machinery and knowledge, rented multiple extensions of land in order to produce crops (Bisang et al., 2008). These entrepreneurs were new stakeholders in

[3] Prior to the1970s there was a clear policy emphasis on education and if addressing other social needs of rural families, mostly carried out by the INTA extension service. Becerra *et al.*, 1997.

Argentinean agricultural production, as were the firms producing the new inputs and the machinery included in the GM-based technological package. Production of grains and oil seeds soared during the 1990s and 2000s, particularly of GM soya, and expanded into what were until then marginal areas for agricultural production.

Agricultural innovation during the 1990s was not designed to address the problems of the rural poor and it resulted in a rapid process of farm concentration and rural out-migration, with a third of all farms disappearing during that decade, and a sharp rise in median size (Trigo et al., 2002). Specialisation in soya production, which since the mid-2000s has represented over half of all Argentina's agricultural production,[4] and its extension into more marginal land, displacing other crops, or using land that was previously forested has had negative consequence for many marginalized farmers, operating informally. These include eviction from their land, where they have no clear property rights and a further reduction in the markets for alternative products grown by small farmers.

This process of technological change within a highly heterogeneous agricultural sector has contributed to an increase in the size of the informal rural economy. Amongst other things, regulatory changes during the 1990s have encouraged both the growth, and changes to the nature, of the informal agricultural sector, especially in relation to GM seeds. The very high costs of meeting bio-safety regulations have resulted in a concentration in the GM seed market, since neither INTA nor the domestic seed industry can afford to commercialise their own GM varieties.[5] The fact that very few firms operate in the GM seed sector has contributed to high seed prices for GM varieties. High seed prices have also been encouraged by the extension of patent rights to modified gene sequences. Traditionally, intellectual property rules for seed varieties (in Argentina and elsewhere) provided seed breeders with a monopoly on the commercial use of their seed varieties, whilst allowing competing seed firms to use those varieties as an initial source of germplasm for the purpose of creating new varieties. Those rules acknowledged the cumulative characteristic of knowledge and were designed to promote innovation. In the early 1990s, however, Argentina allowed the patenting of modified gene sequences which has meant that seed firms cannot use commercially registered GM seed varieties as a basis for further seed innovation, as is still possible with conventional varieties. As we describe below, for cotton at least,[6] this has mean that there are only a few varieties of GM cotton seeds available in the market, and only one firm supplying them, permitting relatively high prices to be set. This has encouraged a parallel informal market in copied GM seed.

[4] Data from Integrated System of Agricultural Information (SIIA) produced by the Ministry of Agriculture of Argentina, http://www.siia.gov.ar/.Last accessed August 2012.

[5] Estimates from other developing countries of the direct regulatory costs involved range from 100,000 to 4 million dollars, depending on the jurisdiction and crop-event combination, and on whether there already exists, for example food safety or composition data, as a result of prior applications in other countries Bayer *et al.*, 2010.

[6] The situation for GM soya (the most widely grown GM crop in Argentina) is very different because a patent for glyphosate tolerant soya was never granted to Monsanto in Argentina. As a consequence, the structure of the soybean seed sector is very different to that of cotton.

Section 4: The dominant cotton production regime in Argentina

Cotton production represents a relatively small proportion of Argentina's agricultural economy, but it is an important crop in the north east of the country. Cotton farms and farmers are heterogeneous. The majority of farms are small holdings where the crop is produced using family labour and with little mechanisation. Table 1 shows that in Chaco Province, which historically has accounted for two thirds of Argentina's cotton production, about 60% of the Province's cotton farms were less than 10 hectares in size. Typically, farms of that size are run by small subsistence farmers, producing vegetables and small animals for their own consumption using family labour, with cotton grown as a cash crop. Subsistence farmers are informal players in the sense that they often hold no (or have only weak) legal titles to the land that they farm, and they are not usually registered for tax purposes. Six percent of cotton farms in Chaco, on the other hand, were more than 100 hectares in size, and represented 50% of the land area cultivated with cotton. Those larger farms are usually mechanised, employ labour, diversify production and can take advantage of economies of scale. They are formal businesses on the whole.

Table 1: Chaco province: distribution of cotton farms by size, 2002

Size	Area in hectares	Percentage of farms	Area sown with cotton (percentage)
Small	0.1 to 10	60	9
Medium	10 to 100	34	41
Large	Over 100	6	50

Source: National Institute of Statistics and Censuses (INDEC), National Agricultural Census 2002.

GM cotton varieties, resistant to some insect pests, and tolerant to the herbicide glyphosate, first began to be sold commercially in 1998, by Genética Mandiyú (Monsanto) [7], the only firm to date that has developed and commercialised GM cotton varieties in Argentina. The large cotton farmers were the only group of cotton producers to whom Genética Mandiyú started to market its GM seed varieties, which cost four times as much as conventional cotton seeds (Qaim and de Janvry, 2005). In areas populated predominantly by small farmers, the GM seeds were not made available.

Genética Mandiyú offered GM seeds to large farmers as part of a wider technological package, knowledge of which was disseminated in part via on-farm technical advice by the firm and also by INTA extension agents. The technological package involved the herbicide glyphosate, growth regulators, fertilizers, and different production techniques. The latter included the sowing of cotton seeds using direct drilling techniques, which uses a machine to

[7]Genética Mandiyú had been created as a joint venture between Monsanto, the owner of the modified genes, Delta & Pine which had provided the cotton germplasm for some of the seed varieties (and which Monsanto subsequently purchased), and a local firm CIAGRO, which has a major seed distribution network in the north east of Argentina. In 2011 Monsanto Argentina acquired Genética Mandiyú.

insert the seeds directly into unploughed soil containing the residue of the previous crop, and simultaneous application of fertilizer and herbicide (the latter substitutes for tillage and discourages competition from other species). The new production techniques also involved sowing cotton in narrow rows 0.5 metres apart. Conventionally cotton was sown in rows 1 metre apart which facilitated manual harvest. The new practice of sowing in narrow rows was accompanied by use of a machine, called a stripper, to harvest the crop. The use of mechanical strippers was more cost effective, above a certain size, than relying on labour, or on the previous mechanised method of harvesting. INTA technicians also discovered that sowing in narrow rows produced better yields per hectare.

Although it is possible to adopt just some of its components, the full GM technology package (GM seeds plus other inputs and new production practices) requires a minimum scale to justify mechanization and technical training and the resources to finance the purchase of inputs. Large farmers, with economies of scale and access to capital, have largely adopted the full GM technology package in cotton production. Small farmers were not able to do so.

Conventional cotton seed varieties are bred exclusively by INTA. These used to be multiplied, distributed and sold by third parties under different types of agreements, but were virtually no longer available by the late 2000s. Although INTA continues to breed conventional cotton varieties, its agreements with third parties to multiply and market conventional varieties have diminished in number as many organisations exited from (or did not renew) their agreements. By 2011 there was only one farmer cooperative association producing INTA's conventional varieties in the institution's experimental fields and only one firm that had requested an INTA license for producing cotton seed. In Chaco, various sources now claim that conventional cotton seeds can no longer be found.

For small cotton farmers (whose main production characteristics are summarised in Box 1) the limited availability of conventional seed varieties, and the diffusion of a GM technological package that they could not afford, meant that that there were two main options: i) to manage within the dominant agricultural regime by obtaining copied GM seed and other low quality inputs in informal markets or ii) to try and produce cotton using alternative production practices. These options are described in the following two sections.

Box 1: Small farmers' production and living conditions in informal settings

Infrastructure: Most small-scale cotton-producing families live in shacks (very spartan rural dwellings with rough adobe walls, metal sheets, straw or similar products on the roof, and an earth floor), in overcrowded conditions, and only some have very recently gained access to rural electrification. They neither have piped drinking water, nor usually well water on their land.

Land ownership: They generally have fragile property rights over the land they farm and live in.

Production practices: Cotton yields are low mainly because cotton is severely affected by the boll weevil (a pest that is not controlled by GM technology). In addition, soils are degraded owing to deficient soil management practices (i.e. monoculture, lack of crop rotation, etc.). The technical assistance they receive is targeted on other crops and generally provided in the towns (in the form of informative meetings and other 'office' activities) or else in demonstration fields, but not in the farmer's own plots. In most cases, the land is worked exclusively by the family.

Commercialisation practices: The only crop grown commercially is cotton but small farmers are not registered with the tax department, since it is very difficult for them to make regular contributions, and even when sometimes they are exempted from payments, they do not trust exemptions to last and prefer to remain informal. However, informality partly explains their low profitability, since there are trapped with the intermediary (see below). They also produce vegetable, fruits and small animals for their own consumption. Surpluses of these products cannot normally be sold, because of a lack of nearby markets and also because they do not have formal registration, which does not allow them to sell these food products in public nearby entities such as schools.

Public support: Small farmers receive support from local public programmes that provide soil preparation services, along with seeds and fuel. In addition, farmers generally receive some form of public transfer, which accounts for a large proportion of total household income.

Section 5: Informal innovation within the dominant trajectory

5.1. Motivations and overall results

The high prices at which GM cotton seeds were made available (four times that of conventional seed) created strong incentives to informally multiply and sell copies of the new seeds, both to meet demand from medium size farmers at lower costs, but also to reach small farmers to whom the new seeds had not been marketed. The production of copied GM seeds required technical and, especially, organisational innovations, which were mainly undertaken by intermediaries. These were generally cotton cooperatives,[8] which, given their long standing and close relations with small farmers, soon realized the potential business opportunities. The technical innovations involved were related to the process of multiplying GM varieties which, as discussed below, involved several stages. The organisational innovations were particularly important to deal with informality, since cooperatives were not legally entitled to multiply GM seeds.

[8] These organisations had been set up and supported by the national government in the 1940s as a way to improve farmers' bargaining power in commercialisation chains. Traditionally, most farmers would have been members of a cooperative, but their role changed in the late 1970s, following political persecution of cooperative leaders by the then military dictatorship and declining state support for their original aims. Most of the old cooperatives became bureaucratic organisations led by some of the better-off amongst small to medium-size farmers (who were usually themselves part of the informal economy). We use the term intermediaries and cooperatives interchangeably.

The results of this endeavour were mixed. On the one hand, the innovations enabled small farmers to obtain access to GM seeds, a technological artifact they would not have otherwise been able to afford. The diffusion rate of copied GM seeds was astonishingly fast. In 2002 about 15% of cotton seeds sown in Argentina were GM varieties, but by 2010 almost 100% were GM, of which an estimated 84% had been produced informally (either re-used by farmers or copied and exchanged in informal markets). On the other hand, the performance of GM-based cotton production was poor for small farmers, especially in comparison with commercial GM-based cotton farming.[9] Although there are many reasons why that is so, several are due to the informal nature of both their own situations and the markets for copied GM seeds:

Firstly, small farmers are not able to choose the types of seed they buy from intermediaries; instead they take what is available. This is important because sources from both INTA and the provincial government have argued that that the informal seed production and multiplication activities of the intermediaries generate a mixture of genetic events, types and generations of seeds, and that these were often of dubious quality. Second, the informal nature of the markets for copied cotton seed means that small farmers do not receive technical assistance. Genética Mandiyú provides such assistance, as part of its 'customer service' strategy, but only to farmers who purchase certified seed. Private technicians also provide such services but only large farmers can afford it. Third, small farmers are in a weak position within informal input and output markets. Small farmers purchase seeds and other inputs on informal credit from intermediaries, and payback the loan, at high rates of interest, with part of their cotton harvest. In doing so they have little choice but to accept the price offered for their cotton by the intermediaries, which may have been lower than prices elsewhere. This is because i) they are in debt to the intermediary; ii) they face transport difficulties in reaching other markets; and iii) they can not sell their output in markets where tax registration is required, because they are not legally registered.

As a consequence of these and other factors, the profitability gap between commercial (large) and small farmers is likely to have widened since the introduction of GM technologies in the late 1990s (Arza et al., 2012), thus putting pressure on small farmers to sell their land. Although there are no recent official figures on farm concentration trends,[10] nor on population movements to and from rural areas,[11] there is a widespread perception among small-scale farmers, INTA agents and government representatives, and amongst farmers' organizations and academics, that the sale of small farms and a rural exodus is taking place.[12] There is certainly a discourse claiming that cotton cannot be profitable for small-scale farmers among some groups within the provincial government and INTA. Most small farmers

[9] According to our fieldwork, estimates of the yields obtained from small farmers' GM-based cotton production practices, are in the order of 1000 kg per hectare, three times lower than the yields that INTA has reported (2900 kg in average) based on using the full formal GM-based technological package (Elena de Bianconi, 2011), and which only larger farmers have adopted.

[10] The most recent data come from the 2002 agricultural census

[11] The most recent data for the Chaco region date from 2001 and show that the number of farms decreased by 21% between 1988 and 2002. Moreover, while the rural population in the province amounted to 53% in 1970, it only represented 17% in 2001.

[12]. See the media article by Aranda, 2011. Valenzuela and Scavo, 2009 describes the resistance by small-scale farmers to the concentration that has resulted from the expansion of the agricultural business model in the Chaco. Other authors, in contrast, claim that concentration, although considerable, has not to do with the diffusion of GM seeds in particular but reflects a global process of intensification of production under the productivist paradigm (Trigo and Cap, 2006)

disagree with these views, however. Not only do they have a cultural link to cotton, but it is hard for them to find markets for alternative products, whereas cotton is a cash-crop. Accordingly, small-scale farmer organizations do not generally advocate abandoning the crop but fight instead to defend their land.[13]

5.2. The intermediaries in their role as innovators

Cooperatives had the technical capacity and knowledge to copy seeds informally since many of them had been legal seed multipliers of INTA's conventional varieties in the past and therefore had experience in seed production. Moreover, their long experience in the cotton business facilitates their access to key infrastructure. Many own cotton gins (machines that separate cotton fiber from seed) or have strong connections to gin owners. They also have access to storage facilities and transport.

The technical process of producing copied GM seeds is graphed in Figure 1 and involves the following stages: i) obtaining seeds for reproduction; ii) delinting (the separation of the downy fuzz, known as linters, that still adheres to the seeds, and which requires mechanical, heat or acid treatment) and the treatment of the seeds with fungicides; iii) replanting of the seeds; iv) ginning the crude cotton and recovery of the next generation of the seeds; v) packing the seeds for sale.

Figure 1: Stages in the technical process of producing copied GM seeds and main actors involved

activity	**i** obtaining seeds for reproduction	**ii** delinting	**iii** replanting of the seeds	**iv** ginning	**v** packing and sale
performing actor	cooperatives from farmers	third parties	cooperative leaders	cooperatives or other gin owners	cooperatives or other intermediaries

Stage i) was easily satisfied by recovering seeds from farmers' raw cotton during the ginning process. These seeds then required delinting and fungicide application, i.e. stage ii), a process usually outsourced to third parties. From time to time informal seed producers bought a proportion of original seeds (first multiplication, or F_1) from Genética Mandiyú for stage i) in order to maintain seed purity and therefore improve the quality of the multiplied seeds they subsequently sell. In this case stage ii) is not necessarily because it is performed by Genetica Mandiyú.

Stage iii) is performed by cooperative leaders and some other farmers in whom they trust. F_1 seeds in particular were handed to especially selected farmers with whom the cooperatives have made an (informal) agreement to ensure effective multiplication, total recuperation of the multiplied seeds, and confidence in their identify. Such agreements were less typical where other third parties multiplied farmers' recovered seeds.

[13] Social movements have expressed their concern about this situation, such as the Multisector Forum for Chaco Lands (foroporlatierrachaco.blogspot.com/).

Stages iv) and v) were also performed by the cooperatives. Some were more responsible than others, and made efforts to identify seeds from different generations and to test and monitor seed quality from time to time. However, accurate identification and tests for seed quality could not be assured, in part because cooperatives have a largely captive market amongst small farmers and therefore little incentive to ensure seeds are of good quality, and because seeds were normally sold unlabeled to small farmers. In practice, this unlabelled seed copies might, for example, be several multiplications of the F_1 seed, and it may or may not be what it purports to be. The seed may be non-transgenic but sold as herbicide resistant, or it may be a mixture of herbicide tolerant and insect resistant varieties, but sold as only herbicide tolerant.

As well as the technical capacity to produce copied GM seeds cooperatives entering into the business of *informal* seed production and sale needed to develop new managerial skills to deal effectively with informality. In particular, organizational innovation was also required a) to avoid being monitored by the regulatory body responsible for both seed quality and for protecting seed firms' intellectual property rights and b) to establish a relation with the formal breeder, who had to remain unaware of their informal activity, in order to buy F1 seeds and services such as delinting, and to obtain access to technical knowledge about how to use GM seeds (so as to then be able to inform farmers).

The institution responsible for controlling seed quality in formal markets, known as INASE (National Institute of Seeds), has almost negligible influence on the informal seed businesses serving small scale cotton farmers. This is primarily a matter of resource constraints, and poor regulatory design, which reflects an institutional failure to appreciate the circumstances of small-scale cotton production (van Zwanenberg et al., 2012). However, it also relates to informal players ability to avoid inspection. Many cooperatives had been registered as seed multipliers when, in the past, they had multiplied INTA seeds as a formal activity. However, they intentionally cancelled their registered status (or did not renew it) in order to avoid inspection: "If you do not exist, they do not inspect you" as one intermediary told us. In fact, INASE can only monitor those organizations formally registered as seed producers.

Another demonstration of informal players' organisational efforts to deal with informality is evident in how they managed their relations with the formal breeder, Genética Mandiyú. In our interviews, which took place in 2010, some intermediaries were faced with the decision of whether or not to sign an agreement with Genética Mandiyú which the latter had launched two years earlier in order to try and formalize the informal market. That agreement authorized a number of stakeholders, many of which were the types of intermediaries we describe in this section, to purchase original seed (normally subsidized by the Provincial government), multiply it, and sell it formally, paying Genética Mandiyú a portion of the income for each bag obtained in the multiplication process.[14] The agreement also meant that Genética Mandiyú would retain the right to monitor and control the multiplication process.[15]

[14] According to information from Genética Mandiyú, the price of a sack of original seeds of the "stacked" event was about $200. The payment was around $45 per sack multiplied, including the delinting service (the process in which the seed is cleaned, removing the linter or fluff and making it more effective for sowing) by Genética Mandiyú.

[15] As a result of the agreement, Genética Mandiyú's share of the GM seed market (i.e. the proportion of certified seed used by farmers) had grown from 8% in 2008 to 16% in 2009.

The intermediaries we talked to were considering whether or not to participate in those agreements. On the one hand, signing the agreement meant they could be privately monitored. On the other hand, they would get access to good quality seeds which would improve the quality of the seeds they produced informally (and wished to continue producing). One of the cooperatives we interviewed argued that although the agreement did not appear to be beneficial for them, they might nevertheless enter because there might not be another way to access F_1 seeds without becoming suspected of being an informal seed producer once the agreement was launched. They added that in any case they would always find a way to produce informally some proportion of the seed they sold.

In sum, the most important challenge faced by innovators (intermediaries) producing GM copied seeds was how to deal with informality, and the most successful players were those that managed it better in terms of avoiding the risks of being monitored by public or private entities, and in terms of their success in being themselves guarantors of the quality of seeds that they sold.

Section 6: Informal innovation in a different socio-technical direction: agro-ecological cotton production

6.1. Motivations and overall results

Agro-ecology is the application of ecological principles to the design and management of agro-ecosystems (Altieri, 1995). It is a holistic approach that aims to protect crops and improve productivity by relying on ecological interactions and synergies between biological components within the farm rather than requiring external inputs (e.g. it does not use agrochemicals). For this reason, it is especially suitable for small farmers, who lack resources to buy inputs. Agro-ecological production constitutes a radical alternative to high input industrial agricultural practices.

The production of agro-ecological cotton in Argentina dates back to 2004 when an agronomist, and activist for agro-ecological production, was hired as a consultant by the Ministry of Social Welfare. He was asked to provide technical support for a civil association called *Unión Campesina* based in Chaco, formed by around 1000 peasant families mainly from the indigenous Qom community who had been producing cotton based on their own local knowledge and practices.

Those practices were traditional, low-input, and technical efforts were required to systematise them and to combine them with other technical knowledge so as to create an agro-ecological technical protocol. Moreover, there was also the need to create a new market for the differentiated product. Therefore, as in the case with copied GM seeds, innovation for producing agro-ecological cotton was both technical and organizational.

Results were mixed but in the opposite sense than our previous case. On the one hand, diffusion rates were negative over time. When the project began in 2004 there were 320 participating farmers, but by the time of our fieldwork in 2010 the project was contracting and only 50 agro-ecological farmers remained. On the other hand, the project performance was highly promising for small farmers. They managed to produce better quality cotton, the farmers involved obtained higher financial rewards than similar farmers operating in the informal GM cotton system, and production rules were respectful of other important values (e.g. gender equity, no child labour; environmental performance).

In 2008/2009 90% of agro-ecological farmers obtained yields in the range of 1200 kg/ha to 2900 kg/ha, whilst some very small farms obtained a maximum yield of 3900 kg/ha. This contrasts with estimates of 1000 kg/ha for farmers of similar size producing informal GM cotton.

Table 2 compares the main performance characteristics of both socio-technical practices, including an estimate of the equivalent workday salary. This estimate is derived by dividing the revenue associated with growing cotton on a plot of 1.5 ha net of direct costs (inputs) over labour demand. Taking a conservative figure for yields, agro-ecological farmers received twice for their work than farmers operating in the established system of informal GM cotton. The negative diffusion rate for the project is thus surprising, and the reasons for this are discussed in subsection 6.2 and Section 7.

Table 2: Comparing yields, cotton quality and profitability of small farmers in agro-ecological and informal GM systems, in 2009/2008

	Agro-ecological system	Informal GM system
Cultivated area (ha)	<10	<10
Yields (kg/ha)	1200	1000
% of fiber	40	30
Fiber quality (most bales), from A (high) to F (low)	C	D
Average price 2006-2009 (AR$/kg)	2.1	0.95
Average income for 1,5 cultivated ha (AR$)	3780	1425
Direct costs (without labour costs) per ha (AR$)	140	267
Gross margin for 1,5 cultivated ha (AR$)	3570	1024.5
Workers/days for 1,5 cultivated ha	60	48
Equivalent day wage for cotton production (AR$)	**59.5**	**21.3**

Source: own elaboration based on information provided by the Agrecological Cooperative and also information obtained in participatory workshops with farmers in 2010 and 2011

6.2. A network of innovative actors with intermediaries at the core

Innovation in agro-ecological cotton production was network-based. There were several actors participating: indigenous communities that provided their knowledge of pre-Hispanic practices of production; science and technology organizations such as INTA and the UNL

(*Universidad Nacional del Litoral*) that provided technical and synthetizing knowledge to create a technical protocol; local agro-ecological organisations with previous experience with this type of practice; NGOs such as the Institute of Popular Culture and the Institute for Social Development and social movements such as the Latin-American Agro-ecological Movement (MAELA) that provided political support for the creation and expansion of agro-ecological systems; a network of actors for the social economy that created an integrated value chain in the textile industry; and, finally, an international network of fair trade organisations.

Two intermediaries took charge of the project locally: the consultant mentioned previously, who became the president of the newly formed Agrecological Cooperative known as CAL (*Cooperativa Agroecológica del Litoral*) and another activist with connections to the international fair trade network. In 2005 they formed the Solidarity Textile Chain (STC) with other actors from the social economy within the domestic textile industry. The STC integrated all stages involved in the production and commercialisation of cotton T-shirts, based on agro-ecological and fair trade principles. The STC project is quite unique in Argentina since it is the only organisation that has been able to certify fair trade cotton at the International Fair Trade Association.

As previously noted, the project required both technical and organisational innovations. On the technical side, the challenge was one of producing a differentiated product, whose quality had to be stabilised and guaranteed. This was fairly successful. In order to do so, the project developed a technical protocol for fair trade agro-ecological practice, described in Box 2. This involved assistance from INTA and UNL, and local agro-ecological cooperatives.[16] The protocol was quite demanding and it involves a series of very specific productive practices that needed to be followed by farmers that wanted to operate within the STC. The intermediaries were responsible for training, diffusion and subsequent monitoring and certification of these practices. The results, in terms of cotton quality and productivity were very good, as summarised previously in Table 2.

[16]More specifically, we refer to the project "Agro-biodiversity in productive systems of family farmers" run by the Research Center for Family Agriculture (CIPAF) from INTA and other agro-ecological cooperatives with experience in the market of agro-ecological products (but none on cotton) especially the Agro-ecological Group *"Las Tres Colonias"* with more than 15 years of experience in agro-ecological production.

Box 2: Technical protocol for producing agro-ecological fair-trade cotton

Agro-ecological practices

- Cotton is grown in small farms of no more than three hectares.
- "Curtains" around the whole farm are advisable to protect it from the wind.
- Rotation is sought to be as long as possible: ideally, cotton is expected to return to the same lot after three years.
- Cotton is never grown in monocultures; it must be combined with at least two other crops. The greater the diversity of crops, the less the incidence of pest and diseases is.
- They must progressively decrease tillage and add organic matter to soils.
- The soil must be kept as covered as possible and only vertical tilling or superficial labours are made.
- *P*ests are not fought with the use of chemical insecticides but the model relies instead on the correct plant nutrition -own to healthier soils- and in the action of natural enemies.
- The model allows for the use of natural fertilizers
- Weed control is manual and between one and two hoeings are performed. This is the reason why agro-ecological production requires more labour than the industrial model, which saves labour using herbicide tolerated by the GM plant.
- Harvest is also done manually using white cotton bags.

Fair Trade practices

- Cotton price is discussed among CAL members and must be agreed before planting
- CAL must provide technical assistance and training
- inputs must be financed by CAL
- equal gender opportunities in working conditions and rewards must be ensured
- child labour is prohibited
- attempts should be made to continuously improve environmental standards .

Organisational innovation, on the other hand, was more challenging for the project and ultimately less successful. The project needed to face two important managerial challenges.

First, since no market existed for the differentiated cotton product, the project needed to create one. It achieved this by forming links with the fair-trade textile market. This was key for the economic success of the project. On average for the period 2006-2009 cotton prices were just over 60 % higher for agro-ecological production in contrast to cotton produced with the informal GM system (see Table 2). Although several factors explained this difference

(e.g. higher cotton quality, and lower intermediation and transport costs) the main difference in price was explained by obtaining access to fair trade markets.[17]

Second, since the fair trade market was for textile final products, a further organisational challenge involved the integration of all production stages in the textile chain (i.e. from on-farm cotton production, through initial and subsequent processing, to production of cotton garments). Integration was highly demanding and required the building of political support through active dissemination and persuasion strategies in order to create a network of actors committed to the initiative. Most of those actors came from the social economy sector and were directly committed to the project (e.g. a 'recovered' garment manufacturing factory that had been taken over by its workforce following bankruptcy in the wake of the 2001 economic crisis). Yet not all actors were directly committed, notably, the spinning process which was carried out by large private companies.

The activities involved in organising the network were too demanding given STC resources. In 2010 the STC staff consisted of three people, responsible for: training farmers; monitoring compliance with the protocol; disseminating and promoting agro-ecological production; seeking funding sources that did not exist in the formal banking system; and creating and/or linking to networks of national and international actors whose support was central to building and sustaining the initiative.

The binding constraint was the long lapse of time between cotton cultivation and selling finished T-shirts to retailers. This was around 14 months–which, according to the intermediaries could have been reduced to 9 months with more effective management. The intermediaries argued that they needed three times more working capital than they had available to pay farmers for cotton at harvest time.[18] As a result agro-ecological farmers had to wait well after they had harvested their cotton to get paid, and they could not do so since they were in urgent need of cash. Consequently, some farmers started to sell their agro-ecological cotton (or at least part of) to local intermediaries which, of course, did not value the differentiated nature of their product. This in turn discouraged the farmers from following the agro-ecological protocol the following season.

Section 7: Discussion: case comparison

The previous sections have described the main characteristics of cases of informal innovation within two very different trajectories of agricultural socio-technical practice. An economically significant and institutional embedded set of practices characterized by intensifying use of inputs and capital in agriculture production as a means to increase factor productivity and profitability. And an alternative institutionally far weaker trajectory of agro-ecological production characterized by reliance on on-farm synergies low use of external inputs, and just social practices, as a means of achieving social and environmental agricultural sustainability.

[17] The intermediaries said it was not difficult to maintain the price difference, since there is always international demand for fair trade cotton products. In fact, international brands buying the T-shirts earn much more in this product line than in their normal business.

[18] The lack of access to formal credit was a challenge difficult to overcome for STC since the conventional financial infrastructure requires profitability and collateral conditions which are not consistent with this type of enterprise.

The main characteristics of our case studies of informal innovation within those two trajectories are quite different, as summarized in Table 3. Firstly, motivations for the innovations match the underlying values characteristic of each trajectory. In the case of informal GM cotton the motivation was to obtain access -at lower cost- to a technology that may increase productivity. Strategies to produce and sell the copied GM seeds were designed by individual actors. In the case of agro-ecological production, the motivation was to increase the value added of production activities carried out by peasant families. Strategies to do so involved a network of actors, led by intermediaries rooted in social movements. The knowledge base on which each of these innovations relied also differed. Agro-ecological production drew from a syncretic knowledge base combining technical with indigenous knowledge with efforts to codify that knowledge whilst informal GM cotton relied on the experience and tacit knowledge of innovative actors who made efforts to adapt foreign technologies to local needs.

The technical features of each innovative production system also differed, again in ways that resembled those of their underlying trajectories. Whilst agro-ecological production avoided the use of off-farm inputs and intensified the use of labour, making it more complex, informal GM cotton production used off-farm inputs aimed at simplifying and replacing labour. As a consequence, agro-ecological production worked better at a small scale whilst informal GM cotton production did so at a large scale. The ways in which environmental dynamics were exploited also differed: agro-ecological production sought to understand the synergies of different components of the ecosystem in order to take better advantage of those components, whilst GM cotton production sought to master techniques to make production of one of those components more efficient.

The socio-economic aspects of each innovative production system systems were the most divergent. Firstly, the relation between intermediaries and farmers was hierarchical in the informal GM cotton production system (i.e. famers were captured by intermediaries to whom they were indebted) and structured by market relations (i.e. intermediaries were maximizing their own business). By contrast, agro-ecological cotton production was not concerned with maximising the income of the intermediaries. Cotton production was just one stage in an integrated value chain inspired by fair-trade principles, and farmers and intermediaries negotiated production and commercialisation conditions, including the price they would receive for raw cotton.

Secondly, informal GM cotton production functioned relatively smoothly within the dominant socio-technical regime of intensive commodity crop production: it made use of existing infrastructure and markets, and the innovative informal practices were either supported or consented to by formal actors. For example, the provincial government distributed copied GM seeds as part of its production subsidy programmes designed for small farmers; the formal seed breeder, Genética Mandiyú, pushed for the creation of a private agreement to be signed by intermediaries to control (and to obtain further benefits from) the informal market in GM seeds; INTA designed complementary technologies for the use of copied GM seeds such as machinery that could be used by small farmers for harvesting cotton. By contrast, the agro-ecological initiative needed to not only create its own market, but their novel practices were also sometimes undermined by incumbent socio-technical practices characteristic of intensive cotton production, mainly as a result of contamination of conventional seeds with GM material, and propaganda (information plus distribution of free GM seeds). This required extra efforts to i) create infrastructure (i.e. ginning machinery, storage facilities, transport, etc.) in order to avoid risks of contamination and ii) to build

political support based on dissemination and persuasion strategies to mitigate the temptation of some farmers to return to the established practices.

Table 3: Main characteristics of informal innovation along different socio-technical trajectories

		Informal innovation in	
		Informal GM cotton	**Agro-ecological cotton**
Innovation features	Main feature	Stealth innovation	Inclusive innovation
	Type of innovator	Actor-based	Network-based
	Main innovative goal	Profitability	Social and environmental sustainability
	knowledge source for innovation	Experience, learning by doing, tacit	Syncretic: indigenous + technical, codified
Production system: technical features	Scale	Scale-dependent	Works better at small scale
	Inputs	Off-farm	On-farm
	Use of labour	Reduced	Intensified and complexified
	Relation with the environment	To exploit one component	To exploit synergy of components
Production system: socio-economic features	Infrastructure	Available	Non-available
	Market	Available	Non-available
	Relation between intermediaries and farmers	Vertical	Horizontal
	International participants	No	Yes
	Integrated in value chain	No	Yes
	Political support (public and private)	Moderate	Little
Innovative outputs	Diffusion	Wide	Narrow
	Profitability for small farmer	Unfair	Fair
	Empowerment of small farmers	No	Yes
	Differentiated product	No	Yes
	Promote production diversification	No	Yes

These distinct value, technical and socio-economic characteristics of each innovative initiative gave rise to different impacts. Informal GM production, based on copied seeds, was successful in terms of diffusion rates but did not perform well in small scale agriculture. By contrast, the agro-ecological project did not consolidate as an emergent alternative production system and exhibited negative diffusion rates but it did manage to (at least) double the profitability of small cotton farmers participating in the project for five consecutive seasons. For a range of, social and environmental criteria, the agro-ecological innovation also exhibited superior performance relative to informal GM production: it improved environmental sustainability (in contrast to contamination and soil degradation); it enabled product diversification (in contrast to monoculture); it reduced of health risks; and it fostered

gender and social inclusion; farmers' empowerment and self-esteem; and the creation of novel social and institutional networks.

Section 8: Conclusions

By contrasting these two cases we have argued that the potential of informal innovation to better address the problems of marginalized actors and to improve their likelihoods depends to a considerable extent on the normative, socio-economic and technical characteristics of the broader production-consumption systems, and associated trajectories of socio-technical practice, within which those innovations are situated and which they seek to contribute to. To conclude we make a number of broader arguments:

First, it is unwise to assume that just because innovation is taking place in informal systems, and involving informal players, it will be better aimed at, and offer more adequate solutions to, the problems experienced by marginalised people. Informal settings, as with their more formal counterparts, involve multiple actors, with different interests and resources, and who experience problems differently. The local politics of informal innovation processes -just as in more formal settings- is central to questions about whose problems get addressed and how. The fact that innovation is taking place in extra-legal circumstances and not in more formal settings may even exacerbate the marginalised position of weaker actors, given the lack of legal protection and state oversight. In our case of copied GM innovations, relatively powerful co-operative owners created a market in copied seed, and whilst this innovation provided access to new seeds for small farmers, it created additional, and arguably more severe problems as a result of the fact that small farmers had shifted from operating in semi-formal conventional seed markets to entirely informal and illegal GM markets (such as problems of poor seed quality and uncertain seed identity, and lack of technical support). Furthermore, informal farmers bargaining power *vis à vis* intermediaries was further reduced; they became more vulnerable as input purchasers because they had to obtain a larger variety of inputs and could only do so in the informal market with its intrinsic risks regarding product quality.

Second, innovation in informal settings may even undermine inclusive development when it takes place within an incumbent regime of socio-technical practice that is itself problematic for informal actors. This is largely because innovation within an incumbent regime is likely to maintain several of the characteristics of pre-existing but problematic practices. In our case study, informal GM cotton seed production allowed access to GM seeds, but did nothing to alter small farmers' inability to adopt most of the practices associated with large scale commercial farming which require capital, scale and clear land ownership rights, and their consequent relative disadvantages in producing cotton. And yet, informal innovation within an incumbent regime is likely to be easier than innovation that seeks to create alternative sets of technical and social practices, where there is a need to also create markets, enrol institutional support, and so on. The former is facilitated by several pre-existing elements of support (e.g. existing institutions and markets) and since informality tends to imply low-entry cost advantages, this may help, as in our case study of informal GM seed production and sale, ensure wide, and systematic diffusion of the outcomes of informal innovation.

Third, innovation in informal settings that attempt to generate ways of providing radically alternative practices and products, in the sense that they promote and attempt to create novel socio-technical regime like practices and technologies that better meet marginalized peoples' problems and aspirations, confront a familiar dilemma. To succeed, such alternatives must cope with various kinds of institutional, market and infrastructural selection pressures that tend to favour incumbent ways of providing goods and services. Our case of agro-ecological innovation illustrates that dilemma. Agro-ecological cotton production is in many ways more appropriate to small scale farming, increasing productivity and farm incomes, providing for on-farm crop diversity, reducing pesticide poisoning risks, discouraging child labour, and so on. Conversion of small scale cotton production along agro-ecological lines is in itself risky, but its wider success requires customers, distribution channels, and product markets, that were far more difficult to create and sustain.

Fourth, the difficulties confronting informal innovation initiatives that are attempting to create and contribute to alternative sets of socio-technical practices may not only be restricted to the fact that the existing social and institutional elements of support for agricultural practice (e.g. credit markets, output markets, technical assistance, subsidies, etc.) were all orientated towards supporting the incumbent set of socio-technical practices. At the same time, incumbent socio-technical practices may actually conflict with and undermine the creation of path breaking alternatives. In our case, some of the obstacles to the emergence and robustness of alternative agro-ecological practices, were precisely the incumbent socio-technical practices. These caused contamination, with GM events, of the conventional seed used in agro-ecological practices, produced an on-going rural exodus, and gave rise to government-supported pro-GM campaigns, which undermined the alternative initiative.

Finally, the role played by intermediaries -as actors that might help promote social inclusion- may also depend on the underlying characteristics of the socio-technical regime. In both our cases there were intermediaries that attempted to bring the informal innovative activities into a more formal setting. However, in the case of the incumbent set of socio-technical practices orientated towards commercial commodity crop production, intermediaries promoted the same kind of vertical relation as formal actors would themselves have done: they were motivated by their self-interest to take advantage of existent opportunities (i.e. there was a latent market for copied GM seeds) and they continued to marginalize informal actors to achieve that goal. In contrast, in the case of our alternative trajectory, which was characterized in part by general values of inclusion and empowerment, intermediaries sought to actively change the power dynamics in favour of informal farmers. Within this system the relations between actors (whether formal, informal, or intermediaries) are conceived of as relations between equals. In this case, therefore, the role of the intermediary may help to balance the power relation between informal and formal actors, as the normative view in the literature of informal innovation would expect (Guha-Khasnobis et al., 2006).

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