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Innovation Processes in Agro-Ecological Transitions in Developing Countries

Edited by
Ludovic Temple
Eveline M.F.W. Compaoré Sawadogo

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coordinated by
Dimitri Uzunidis

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Foreword

The different chapters in this book deal with a difficult problem that can be summarized as follows: “conventional” and modern agriculture in the second half of the 20th Century was based on a technical model using chemical inputs, mechanization and capital. Farms, which use these inputs at varying levels, could only “import” these techniques and inputs from large and increasingly monopolistic companies, acquiring them on the corresponding markets and following the recommendations attached to them. This has resulted in a form of technical dependence of agriculture on the upstream industrial sector and a dependence on reasoning from research institutions and dissemination of technical models.

In contrast, ecological intensification proposes to first intensify the natural functionalities of agroecosystems, which do not turn to industrial inputs as a first point of call. For farmers in developing countries, this is an interesting opportunity. However, ecological intensification is not easy to achieve. First of all, it is knowledge intensive. For example, reasoning in terms of food webs to control crop pests requires precise and sometimes complex knowledge, which is not the case in conventional agriculture where pesticides are used. It therefore requires a shift from situations where simple technical practices are applied to complex reasoning requiring training through observation, diagnosis, knowledge of different technical alternatives, monitoring and surveillance. Experience has shown that small-scale farmers quickly become familiar with this knowledge of how natural mechanisms work.

But these techniques are not given away for free. They are supplemented with conventional techniques, such as applying fertilizers where necessary, as "natural" methods are insufficient. In addition, ecological intensification comes with specific costs that can be high. This is particularly the case for ecological infrastructures such as, for example, establishing hedgerows, terraces, impluviums and more general improvements, which are all investments, and these investments are not limited by human labor. These are monetary costs.

It therefore appears that this new form of intensification presupposes a good understanding of ecology and good motivation from farmers to use it. This can only be done if they are convinced that it is in their own interest and if they freely agree to use the new techniques by appropriating them. This approach therefore contrasts with conventional extension, which has often placed farmers in a situation of dependence.

The studies that are presented here show how this change is taking place in practice on the ground. The authors are to be congratulated for having done this work of observation and analysis of experiments on a social phenomenon that is of primary importance for the farming agriculture based on agroecology.

Michel GRIFFON

Introduction

Innovation Processes in Agro-Ecological Transitions of Developing Countries

In this book, the core problem concerns the interactions between changes in innovation models, the institutional condition of production system greening and the social consequences. Six innovation processes are, analyzed in the agricultures of Burkina Faso, Cameroon, Haiti, Madagascar and Senegal, respectively. Chapter 7 analyzes the extent to which the lack of full agricultural policy explains the failure of technology transfer based on capital intensification. These situations converge to demonstrate that collaborative innovation models are particularly useful for development, as they adapt the studied processes to local needs. These models imply more commitment from public policy innovation in the agricultural sector, mainly food, in order to regulate the market and encourage funding of infrastructure and investment in production.

I.1. Introduction

The increase in global development inequalities, the questions raised due to the acceleration of climate change, new food crises and technical transitions in the fields of digital computing, energy, biotechnology, etc., all converge for a technological paradigm shift in the agricultural and food sector. The recognition of this in international political fora (World Bank, UNESCO, OECD, FAO, etc.) raises controversy about the economic and social model that it mobilizes and strengthens.

Chapter written by Ludovic TEMPLE and Eveline M.F.W. COMPAORÉ SAWADOGO.

The first model is based on the industrialization of production through the standardization of inputs that are used to produce agricultural and food goods. This is predominantly in OECD countries. It is partly due to technical progress in the postwar era in the fields of chemistry, motorization, genetics, etc. It is based on the search for economies of scale, on the concentration and specialization of farms and land, and is often associated with a modernist vision of capital intensification. It is mainly based on new techniques that implement scientific progress through the world's agro-chemical and agrifood companies. It requires agricultural policies that regulate market instabilities and the conditions for financing investment in production, which enable capital intensification [BOU 17]. In other words, within agriculture, it promotes the "developmentalist" myth that southern countries are catching up because of exogenous industry and technology transfers [COU 86]. Ultimately, it "artificializes" agriculture by "disembodying" it from its relationship with the land, climate and work (human and animal): hydroponics or the decerebration of animals. This model is highly efficient in terms of productivity or return on investment and underpins an innovation trajectory that is polarized by the intensification of production (more inputs and capital to replace labor and land). The emancipation of production from the natural and social ecosystem reduces the diversity of these ecosystems to a constraint that must be homogenized [VAN 09]. Huge fires in the dried-out bogs of Sumatra (Asia) producing acacia for the paper industry or even the dehumanization process of Chaco (South America) to produce soya are increasingly common place.

A second economic model [SOU 14] underpins an agriculture that is based on family production methods. It still dominates agriculture in developing countries and is based on social structures of production, which are considered to be diverse in terms of their historical roots. It challenges and calls upon the capacities of science and technology to accompany this diversity, which is a resource for innovation. This intensification, which is sometimes described as an ecological one [GRI 02], prioritizes the exploitation potential of natural and social ecosystems by hybridizing scientific research knowledge and knowledge bases of localized rural societies. Ultimately, this model refers to permaculture or other forms of organic farming that are based on the self-production of inputs.

These two "stylized" models coexist in the differing agrarian realities in the North and the South. They compete for resources: land, water, labor, knowledge, finance or in securing support for public policies for innovation

and research. In some situations, these models are complementary. Thus, they converge in recognizing the inadequacy of the diffusionist linear innovation model for the conception of invention through scientific research and its transfer from the laboratory to global agriculture [MEY 16]. This convergence is reflected in the growing importance of a system-wide reference framework for innovation analysis in innovation and research policies, which can alternatively be mobilized to improve the use of biotechnologies or to support innovation derived from the tacit knowledge of rural societies [TOU 15].

This special book takes a look at different innovation situations. The connections highlight how the transition from a linear diffusionist model to a systemic collaborative model intensifies agricultural production in a sustainable manner. The trajectories of agricultural innovations mentioned in the first five chapters are mainly based on improved achievement of ecological potentialities in the mobilization of environmental resources (human and non-human) due to the networking between innovation stakeholders. They show that it is possible to improve food security through ecological intensification and capacity-building for agricultural innovation in developing countries. Chapter 6 argues in favor of strengthening the capital intensification of production. It analyzes how the incompleteness of agricultural policies, which is linked to the disengagement of states in regulating product markets and making financial investments, explains current technological inertia in the considered context.

I.2. The determinants of ecological intensification

In Burkina Faso, based on the technological promises of reducing pesticides through the diffusion of Genetically Modified Organism (GMOs) by an agro-chemical firm, Eveline Compaoré Sawadogo (Chapter 2) shows how the lobbies linked to globalized investments in GMOs create institutional conditions for the extension of Bt cotton. She analyzes how emancipating the precautionary principles and not taking into account stakeholders' expectations contributes to the failure of the innovation process. She questions the negative social consequences of such a trajectory of Bt cotton.

Looking at the development conditions for Jatropha cultivation to produce energy in Burkina Faso, Salif Derra and Ludovic Temple (Chapter 3) extend this questioning. They show how structuring research and

entrepreneurial investments in the bioenergy sector instigates technological dynamics in response to needs defined by industrial countries. However, they underline how it can also feed a variety of possible technological models, some of which can meet localized needs (under certain conditions).

In Madagascar, Eric Penot *et al*. (Chapter 4) question how the diffusionist model of a new agro-ecological cropping system (SCV) reinforces its effectiveness through a development project by integrating farmers' participation into the evaluation and experimentation mechanisms. However, the results point to low adoption rates and partial adoption mechanisms of these techniques. They question the future sustainability of these adoptions in terms of their ability to integrate the complexity of institutional and organizational variables that, beyond individual scales, structure the coordination of collective community or professional action.

In Côte d'Ivoire, Euphrasie Angbo-Kouakou *et al*. (Chapter 1) show how a "South–South" technology transfer based on new disease-resistant plantain banana hybrids (which potentially reduce pesticide use) mobilizes participatory multi-stakeholder assessment schemes. These schemes solidify a collaborative innovation model. They generate collective adaptations of the relationships between research and farmers. These experimental platforms adapt the technology transfer offer to the needs of different stakeholders in the localized value chains.

In Senegal, on the topic of market gardening, Patrick Dugué *et al*., (Chapter 6) show how spatial proximity between different agro-industrial and family production methods can lead to innovation processes for small producers. In the observed situation, they favor the pooling of experimental and learning capacities, which allows for the adoption of new industrial innovations (thermal or electric pumps) for drip irrigation. This adoption model is coupled with other innovation processes that are more based on natural and cognitive local resources, for example the fertilization of crops or optimal valorization of land (crop associations). The hybridization of knowledge bases between professional organizations, civil society (NGOs with an organic farming model), businesses and research are at the root of these innovation mechanisms, combining different technical artefacts with local knowledge.

In Haiti, James Boyer and Ludovic Temple (Chapter 5) analyze how a linear diffusionist innovation model has been transformed into an open and

collaborative model of long-term production of yams. They highlight how this transformation needs to be created and strengthened through positive synergies between adoption mechanisms, the autonomous greening of the innovation process, and the socioeconomic impacts at a macroeconomic level.

Jean-Marc Boussard (Chapter 7) emphasizes the need to increase the availability and accessibility of agricultural production in order to meet the needs of population growth. By mobilizing the contribution of the agricultural production economy, he identifies the need to increase the productivity of the land and the labor it conditions for capital investment. This capital investment can take different forms: infrastructure, mechanization, use of technical inputs or mobilization of new knowledge. It remains governed by agricultural policies, which secure access to credit and regulate agricultural and food markets.

These six chapters provide cross-disciplinary knowledge of the results that illustrate a coevolution between the adaptation of agricultural innovation models and technological trajectories, which lead to a greening of agronomic practices in the intertropical agriculture of developing countries. All these case studies confirm the growing practice of participatory research, which creates interactions between stakeholders. These practices are more or less inclusive of local and non-local stakeholders depending on the phase of the process: design, experimentation, dissemination. In some cases, implementing a diffusionist model is a minor adjustment that barely modifies the linear dimension of the technology transfer governed by agro-chemical companies or researchers that are exogenous to rural societies. This results in costly failures for local populations and partial adoptions that are not stable. In other cases, the tools implemented (innovation platforms) modify the initial linear pattern of technology transfer by creating feedback loops. Finally, in yet other situations, the explicit implementation of collaborative innovation models during all phases of the process reinforces the endogenous innovation capacity of farmers in self-production of inputs. In these latter situations, the mechanisms for adopting innovation are faster, which breaks with the linear model. There can be two outcomes relative to the situations mentioned above: an increase in yield and productivity or an improvement in the innovation capacity of farmers through control of their own resources.

I.3. Conclusion

In terms of greening of production, some case studies have shown that innovation processes which reduce labor hardship (irrigation, *in vivo* seeding multiplication) allow for better involvement of farmers in the adoption and dissemination of technologies. With regard to innovations that are based on technology transfer, new varieties exist, crop systems to reduce pesticides developed in industrialized countries (SCV) and capital-intensive agricultural practices (new varieties including GMOs, chemical fertilizers). These produce divergent results depending on the institutional and political contexts. The chapter by Boussard explains the failures of capital intensification in the productivist model due to the inadequacy of agricultural policies to secure credit access conditions and reduce market instability. Risk aversion is highlighted as a major variable for investment in production. However, it does not question the compatibility of both this model and intensification technologies with the diversity of socioeconomic conditions for production and the specific nature of local needs. In general, all the innovation situations considered here concern family-run farms. The example of Senegal, however, reveals an explicit complementarity between different economic models of production organization.

The innovation situations referred to in this book differ in terms of the level of involvement of the various stakeholders in innovation processes, but they also depend on the role played by institutional incentives provided by public policies. They challenge the mechanisms and methodologies [TEM 16] that allow sub-Saharan Africa to accompany the transition from linear technology transfer models to collaborative innovation models. Although the results are contextual in each case, the fact that they converge shows how these collaborative models reinforce the effectiveness of innovation processes with respect to better connectivity between the agronomic research activity and its usefulness in inclusive development. Innovation and research policies that focus on the public good relative to local societal expectations are a necessity in the fragile institutional context of developing countries.

I.4. Bibliography

[BOU 17] BOUSSARD J.M., *Les prix agricoles*, L'Harmattan, Paris, 2017.