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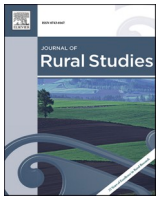

Can agrodealers be agents of sustainability transitions in agriculture? Reflections based on the expansion of biological inputs in Mexico

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ABSTRACT

Agrodealers are key players in providing technologies and support services to farmers. Nevertheless, they are generally perceived as reluctant, or at least inactive, in the transition to more sustainable practices. In this article, we examine their contribution to the expansion of biological inputs - biological control, biofertilizers, biostimulants - understood as a set of alternative technologies for reducing the consumption of chemical inputs. Based on a qualitative survey of agrodealers and various agricultural R&D stakeholders in Mexico's Bajío grain-production region, we show that they play a proactive role in the expansion of these technologies. Faced with a highly competitive environment, including these products in their portfolio enables them to differentiate themselves from their competitors, while continuing to promote the productivity and profitability of their crops to their customers. In some cases, they not only distribute the products of upstream industries, but also become producers themselves of the microorganisms they offer for sale. They are also actively involved in encouraging farmers to acquire and use these technologies, while striving to minimize the disruption that this may cause to their practices. To this end, they provide advice and support, and develop formulas for integrating biological inputs into technical packages that facilitate their adoption. These results call for a reconsideration of the role these actors could play in initiatives aimed at promoting sustainable technologies and practices for the agricultural sector.

1. Introduction

Sustainability transitions, considered as "multi-dimensional and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production" (Markard et al., 2012, p. 956), are underway in many sectors. Agriculture is definitely one of them, subject to intense scrutiny by many analysts (El Bilali, 2019). The terminology used to describe these transitions - and the agricultural models they aim to promote - is diverse, including concepts such as agroecology and regenerative agriculture (IPES-Food, 2022). Among the existing body of literature, research on transitions toward agroecology is arguably the most developed, and thus serves as a useful entry point for the discussion central to this article: the nature of the actors involved in sustainability transitions in agriculture. Agroecological transition involves indeed a wide range of actors (López-García et al., 2021). These include farmers (Coquil et al., 2018), and actors from agricultural research (Jones et al., 2022), rural extension services (Diesel and Miná Dias, 2016), states and their public policies (Gava et al., 2022), and the agricultural equipment (Salembier et al., 2020) or inputs industries (Konefal, 2015). However, one set of players is not, or only very marginally, taken into account, namely agrodealers, i.e., distributors located at the end of the agricultural inputs value chain, at the interface between input industries and farmers. While this generally reflects the scant importance accorded to them in studies of innovation and change in agriculture, it is nonetheless regrettable. Indeed, a large part of the driving force behind the sustainability transition lies in reducing the use of chemical inputs such as fertilizers (Jacobs et al., 2017) and pesticides (Goulet and Vinck, 2023), the very products that agrodealers market. Moreover, it has long been known that these agrodealers do more than simply sell products: they are also technical advisors guiding their customers' choices and practices (Wolf, 1995). In this article, we propose to address this gap by hypothesizing that agrodealers can be actors for change who participate in the sustainability transitions. This hypothesis is rather counter-intuitive, given

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that private actors associated with the production and sale of chemical inputs—led by the pesticide industry—are generally seen as obstacles to change (Jansen, 2017). To test this hypothesis, we focus in this article on how biological inputs— biological control, biofertilizers, biostimulants, based mainly on bacteria and microscopic fungi—enter the range of products sold by agrodealers, and how the latter contribute to the purchase and use of them by farmers. The aim is to understand how these actors contribute or not to the spread of alternative technologies that reduce the use of synthetic chemical inputs - the very inputs whose overuse has become increasingly problematic - and thereby support sustainability transitions.

Over the last ten years, the conditions leading to the emergence and expansion of biological inputs in agriculture have been relatively well documented. In particular, it has been shown how their rise to prominence within public agendas, industrial developments and farmers' practices has been less a matter of a fundamental rupture with the existing order of things than of a set of alignments enabling their gradual integration into the dominant sociotechnical regime built around chemical inputs (Goulet, 2021, 2022). Thus, the roles of public policy (Aulagnier, 2023), agricultural research (particularly in the field of microbiology (Goulet et al., 2025)), industry (Medina et al., 2023) and innovative farmers (Goulet, 2023) have been identified. But as in the more general literature on sustainability transitions in agriculture, agrodealers, the very people who are called upon to sell these biological inputs to farmers, constitute a blind spot. To test our hypothesis and study the role of agrodealers in the rise of biological inputs in the agricultural sector, we will base this article on the results of a survey conducted in central Mexico, in the grain-producing region of Bajío. This region, which is characterized by agricultural practices based on the intensive use of chemical inputs (Camargo Bonilla, 2024), is nevertheless witnessing an increase in the technological supply of biological inputs, like many other regions of Mexico (Chávez-Díaz et al., 2020; Zelaya-Molina et al., 2022). It is also characterized by a dense network of independent agrodealers, as well as those affiliated with diversified industrial groups, who are typically involved in activities such as selling inputs, collecting and marketing grain, and offering technical advice to farmers.

This article is organized as follows. Firstly, we review the literature on the role of agrodealers in interacting with farmers, and more broadly, on their role within the ecosystem of actors influencing technological dynamics in agriculture. Section 3 presents the materials and methods used in this research; Section 4 presents the results, in four steps. First, we show how and why agrodealers incorporate these alternative technologies into their product range. Second, we examine their role in selecting the technologies they distribute, particularly through their interactions with agricultural supply companies, including manufacturers and importers. Third, we highlight the significance of their function as advisors and influencers within rural communities. Fourth, we explore the rhetorical and practical strategies they employ to encourage farmers to adopt and use these technologies. Finally, we discuss these results and conclude by identifying avenues of research to take these findings further.

2. Agrodealers as agents of agricultural extension: a literature review

Compared with other players in agricultural development—public extension, research, farmers' groups and networks—agrodealers have been the subject of a relatively small body of work. It was only in the 1990s that their role, alongside that of independent crop consultants (Wolf, 1995), began to be considered and analyzed in industrialized countries, particularly in relation to the use of fertilizers and pesticides. More recently, since the 2010s, their influence and interaction with farmers in low- and middle-income countries have been documented. The focus on these countries can be explained by the fact that many of them have undergone decades of disinvestment in public extension systems, making the importance of agrodealers particularly prominent (Mengistie et al., 2016). In these contexts, often marked by a smallholders-based agrarian structure, agrodealers play multiple roles: while they are, of course, the gateway to inputs, they also buy crops, provide credit to farmers, and are local interlocutors on a daily basis for a wide range of issues (Aga, 2018). They are thus crucial players in rural extension (Sones et al., 2015). However, their technical knowledge of the various topics they cover is highly uneven and sometimes insufficient to properly support farmers. Based on this twofold observation—inevitable presence but weak skills—their integration into public policy initiatives in order to harmonize and improve their actions has been advocated (Hiralal Jana et al., 2014). In East Africa, for example, the activity of agrodealers has officially been considered as one of the levers for promoting the dissemination of technologies inherited from the Green Revolution. Nevertheless, their uneven geographical distribution, concentrated in territories where the demand for inputs is highest, limits their mobilization as key players in a planned and coordinated change (Odame and Muange, 2011; Rutsaert et al., 2021).

If we now turn our attention to their input sales activity per se, the importance of agrodealers is particularly understandable in view of the fact that the agricultural input supply chain relies heavily on intermediaries, with a limited number of companies producing inputs—in particular fertilizers and pesticides—but a plethora of retailers that is widely dispersed within rural areas (Kalaitzandonakes et al., 2003). This makes agrodealers an important focus for study at times of crisis (Goeb et al., 2020), such as the recent Covid-19 pandemic or the Russia-Ukraine war, which disrupted supply chains, increased energy costs, and thus significantly raised input costs for farmers. With regard to the technologies discussed in the literature, Rutsaert and Donovan (2020) recently highlighted the importance of agrodealers in low- and middle-income countries for the marketing of hybrid seeds. However, most of the work available deals with the sale and use of pesticides (Hiralal Jana et al., 2014). This dominance can be seen in the growing body of work on the problems of pesticide use in agriculture (Carvalho, 2006); indeed, it is by examining pesticide markets and usage practices that many recent studies have contributed to the literature on agrodealers. These studies show that agrodealers are often farmers' main source of information on pesticides (Okonya and Kroschel, 2015), particularly on the equipment used to apply them (Rother, 2018). In low- and middle-income countries, there is a general consensus concerning the low level of skills of agrodealers in guiding farmers towards good practices. Agrodealers are seen as providing very little advice during their interactions, simply relaying information present on labels, about active ingredients for instance (Staudacher et al., 2021). Not only do they fail to provide advice on good usage practices, they are themselves guilty of poor storage, hygiene, or repackaging practices (Lekei et al., 2014). They can also contribute to the disposal of defective or even banned products, whether in Africa (Haggblade et al., 2021) or in Latin America (Haj-Younes et al., 2015). These analyses also show that agrodealers are often poorly trained or not at all, and that very few of them have licenses or certificates of competence, even though these are compulsory in some countries (e.g. Uganda, (Tambo et al., 2024)). In addition to these findings on bad practices, agrodealers seem to pay little attention to the quantities used by farmers, insofar as they might encourage the sale of large volumes in order to maximize their sales (Aga, 2018). This subject of tensions and conflicts of interest between sales and advice has been addressed for some years in industrialized countries, where competition between pesticide advisory actors is at play (Compagnone and Simon, 2018), and where governments are increasingly committed to prohibiting the exercise of input sales and advice by a same operator (Sutherland and Labarthe, 2022).

On the basis of these observations, the capacity of agrodealers to take part in the dynamics of the sustainability transitions therefore seems quite limited. When it comes to levers for changing this situation, two pools of literature emerge. Firstly, agrodealers could be trained in good pesticide-management practices (Bhandari et al., 2018), or encouraged

to undergo certification (Mengistie et al., 2015), all within the framework of state-orchestrated operations. Such training and certification could be a lever for introducing alternative practices or technologies such as biocontrol to farmers (Schreinemachers et al., 2015; Tambo et al., 2024). It is around these technologies, moreover, that the second pool of literature concerning the levers for making agrodealers protagonists of the sustainability transitions is taking shape. Since the early 2010s, it has been consistently stressed, particularly in low- and middle-income countries, that agrodealers are not competent in the field of biocontrol, drastically lacking training in the use of these technologies (Diemer et al., 2020; Maina and Gowland-Mwangi, 2011; Ogutu et al., 2022). But there is also evidence of resistance on their part (Kadzamira et al., 2022), notably due to low demand from farmers, and therefore difficulty in achieving the levels of orders and stock that would enable them to achieve economies of scale and profits (Constantine et al., 2023).

This literature review provides us with several insights. First of all, most of the work available focuses on Africa and Asia, with very few contributions on Latin America. Most of it also deals with pesticides, and in some cases their alternatives; fertilizers are, with rare exceptions, outside its scope. Basically, agrodealers are described at best as unaware of good practice in the use of chemical inputs—with pesticides at the forefront—or of the functionality or existence of alternative technologies, and at worst as resistant to sustainability transitions that would run counter to their commercial interests. Nevertheless, beyond these very general observations, little or nothing is said in detail about how agrodealers can incorporate biological inputs—biological control, but also biofertilizers— into their portfolio. The same observation applies on how they interact with the companies producing biological inputs, and how they can convince farmers to use them. It is precisely these elements that we will document in the results presented in section 4.

3. Materials and methods

The results presented in this article are based on research conducted in Mexico in 2024 and 2025 in the Bajío grain-growing region of central Mexico. The aim of this research was to understand how agrodealers were - or were not - incorporating biological inputs into their range, and how they were or were not helping to lead their customers towards the use of these technologies. A total of 24 interviews were conducted.

Twelve (12) interviews were conducted with agrodealers at their premises, all of whom primarily sold seeds, fertilizers, and pesticides. These were exclusively retailers who did not import the inputs themselves. Ten of them also engaged in grain trading with their customers through a seasonal credit system: inputs were sold on credit at the beginning of the season, and the agrodealers were repaid when the crops were harvested and sold. Ten of the twelve agrodealers were self-employed, operating family businesses that they either founded themselves (n = 8) or inherited from their parents (n = 2), often managing one or more branch offices. Those who started their own businesses typically did so after working for several years as agricultural or mechanical engineers with input suppliers, seed companies, agricultural machinery firms, or occasionally on agricultural R&D projects funded by the Mexican state of Guanajuato or international cooperation agencies. The remaining two agrodealers were affiliated with larger entities: one with a diversified regional agro-industrial group, and the other with an irrigation water management organization that had expanded into input sales, technical advisory services, and grain collection. Beyond these twelve interviews with agrodealers, six (6) interviews were conducted with managers of four different regional companies that produced microbial-based biological inputs —biocontrol, biofertilizers and biostimulants — and marketed them to the agrodealers whom we interviewed. Finally, we interviewed six (6) regional or national agricultural research and development operators: two microbiology researchers, two technicians of rural extension and advisory services, and two technicians from a local technical demonstration center related to the national agency for farmers' credit, FIRA (Fideicomisos Instituidos en Relación con la Agricultura).

The twelve agrodealers (12) interviewed were selected from the collaborative networks built by the International Maize and Wheat Improvement Center (CIMMYT, for its acronym in Spanish) within its Bajío Regional Hub (Camacho-Villa et al., 2016; Govaerts et al., 2021). Historically, interactions between CIMMYT and these agrodealers have primarily involved collaboration around the promotion of good fertilization practices between 2018 and 2024. Drawing on physical and chemical soil analyses, CIMMYT mapped the region's soils and provided recommendations on the precise composition of fertilizers to be used. It is important to note that throughout these collaborations, CIMMYT did not promote biological inputs, focusing instead on conventional mineral fertilizers microelements. Contacts with agrodealers were made by one of the agricultural engineers based in the region, who was also present at all the interviews and trips. This last point is of particular importance as the Bajío is one of the regions of the country most affected by organized crime—narcotraffic, smuggling, human trade—and each trip had to comply with strict security criteria. The choice of the other actors interviewed was made by a snowball method, according to the information gathered during the interviews with agrodealers.

All interviews were transcribed, primarily with the Whisper software, and secondly corrected manually. The most significant elements of each interviews were copied and gathered together in a single text document, and then aggregated under five thematic headings defined inductively, according to a grounded theory approach: the trajectories and training of agrodealers; the sanitary, pedoclimatic, and local political context of the bioinputs boom; advice practices, technical prescriptions, and sales to farmers; practices of validation of bioinputs before marketing; agrodealers' relations with bioinputs industries and their motivations for incorporating bioinputs into their portfolios. It should be noted that this research was carried out following a qualitative survey carried out between 2022 and 2023, based on some 30 interviews aimed at characterizing the innovation ecosystem supporting the development of biological inputs in the country. During this preliminary stage, we primarily interviewed stakeholders from public administrations and regulatory agencies, researchers, and national companies producing biological inputs. By asking these companies how they reached farmers, we were able to identify the key role of agrodealers as local retailers of these technologies.

4. Results

Agrodealers in the Bajío region are key players in the widespread use of biological alternatives to chemical inputs. Situated at the interface between input-producing or importing companies and farmers, their interactions with both strongly influence the technological trajectories of agriculture in the region.

4.1. Integrating biological inputs into technological portfolios: trajectories and motivations

In the Bajío region, agrodealers cater mainly to small- and medium-sized commercial farmers growing maize, wheat and barley on an average of 3.5 ha in two irrigated cycles per year. Most of their sales are in seeds, fertilizers and pesticides. The last ten years have been marked by the gradual incorporation of microorganism-based inputs, whether for plant nutrition or health, driven by sanitary or economic crises. In the early 2010s, for example, a major infestation of wheat by fusarium fungi led to catastrophic crop losses, and chemical fungicides were no longer of any use. Under the impetus of independent advisors and pioneering companies, agrodealers began to include commercial products based on fungi (*Trichoderma* spp.) and bacteria (*Bacillus* spp., *Rhizobium* spp.) in their portfolios, and these quickly became indispensable to growers. In the early 2020s, in the wake of the Covid pandemic and the Russia-Ukraine war, which caused a major rise in fertilizer costs,

agrodealers also turned their attention to microbial biofertilizers, with the idea of making chemical fertilizers more efficient by enhancing their solubility and absorption by plant roots.

The choice to incorporate these products is also part of an economic strategy: to differentiate themselves in a highly competitive local market, marked by an abundance of input retailers and a standardized technological offer of commodities. For some, specialized in the sale of seeds— and therefore concerned with a market active only once or twice a year, before sowing —it is also a question of diversifying with products sold over longer periods. In any case, all are involved in a process of continuous change and innovation, marketing different products whose performance is directly reflected in harvest volumes and growers' economic results. This is the case, for example, with fertilizers, where over the last ten years, the traditional base of NPK mixtures has been enriched with micronutrients, algae extracts and, more recently, microorganisms. As one agrodealer put it: "*every cycle we add something different to the mix, something that might work*". The challenge of this continuous improvement process is not only to win the loyalty of existing customers, but also to win over new ones by turning the plots and successes of the former into demonstration sites for the latter. Another agrodealer said:

> [The success of the clients] *is what keeps them coming back. And it's also what makes them bring other customers, because, for example, they come and tell you* [about a plot of land whose appearance demonstrates the success of a farmer]: *"Where Mr. Ramon sows, he got his fertilizer mix here.*"

4.2. Beyond distribution: selection of relevant technologies and interactions with upstream firms

This concrete and visible impact of technologies on crops —in other words their agronomic efficiency and validity— is not just a matter of expansion strategy and conquering new markets. In fact, it lies at the very heart of the choices made by agrodealers in the face of the recent boom in the national biological input industry. As the production of microorganisms requires fairly modest facilities and equipment, regional and national companies have proliferated, marketing products on a local scale without necessarily having sought or obtained official approval from the Federal Commission for the Protection against Sanitary Risk (Cofrepis, for its acronym in Spanish), that is responsible for issuing marketing authorizations. The agrodealers we met are receiving more and more visits to their facilities from these companies seeking to place their products. In this technologically uncertain world, agrodealers need to be sure of the efficacy of proposed products before incorporating them into their portfolio. To this end, they systematically test the products on their own plot—many of them are also involved in farming—or on those of their reference farmers. One agrodealer said:

> *We are the first ones to experiment everything that is going to be implemented* […] *we, as we also plant, see what works for us, what doesn't work, and what we can recommend.*

This need to ensure the validity of the technologies that they market is particularly understandable given the nature of the agrodealers' business model, which also involves collecting and marketing their customers' harvests. All those to whom we spoke stressed the importance of selling reliable technologies, not only to differentiate themselves from their competitors, but also and above all to ensure that their customers will be able to pay for them at the end of the season thanks to their harvest. One agrodealer said:

> *If I give a credit, the main person interested in that farmer doing well is me. Because I need to recover something.*

This selection operations realized by agrodealers make them particularly strategic interlocutors for upstream firms, who give them a real importance. Indeed, it is not only a question of convincing agrodealers that their products are the best one; it is also a question of training them, so that they are in the best position to explain to farmers how to use their products correctly. The storage and application conditions for microorganism-based products generally differ from those for chemical inputs, so there is a great deal at stake in enabling agrodealers to become experts in their prescriptions to farmers. They are therefore the focus of much attention, as the founder of a company marketing microorganism-based products explained:

> *We work with a type of distributors that we call "allies", who are much more than distributors. They are people with whom we are very close. We help them to train their own team. We train a lot of their team ourselves.*

But the influence of agrodealers is not limited to that of a validator or conveyor belt of knowledge and technology from manufacturers to farmers. In fact, some of agrodealers do not hesitate to make suggestions to their suppliers on how to develop their products or range. For example, an agrodealer and several of his counterparts managed to convince a local seed company to inoculate its entire production with microorganisms, and persuaded a fertilizer importer to bring in certain types of biofertilizers from Canada in addition to his traditional orders for chemical fertilizers. After a few years of distributing their suppliers' microbial inputs, some agrodealers we interviewed go even further in questioning the distribution of tasks between manufacturers and distributors, taking the step of becoming microorganism producers themselves by teaming up with specialist companies or recruiting microbiologists. Four of the twelve agrodealers interviewed were already producing and marketing—or about to launch—their own range of microorganism-based products, in solid or liquid form. Their motivations were economic and logistical: no longer being dependent on their suppliers' distribution chains and being able to make higher margins on the products that they sell, while offering to their farmer customers lower prices than those offered by manufacturers, thus strengthening their competitiveness against other agrodealers.

4.3. Agrodealers as advisors and technical referees for farmers

Agrodealers can therefore be innovators, always on the lookout for new technologies to solve current problems and help them gain a share of the market. But with this in mind, it is also important to understand how they manage to steer farmers towards the purchase and use of biological inputs. As mentioned in the previous section, agrodealers are trained by upstream firms, and they systematically test new products on their own plot or on those of their reference farmers. These trials, albeit rudimentary, not only assure them of the new product's validity, but also provide training and demonstration support for their farmers customers. As with other players in the advisory and rural extension sectors, they organize extension events and meetings around these demonstration plots where biological inputs are tested. They also take videos and photos at these events that they then publish on their social networks. Many agrodealers also employ one or more technicians or agricultural engineers, whose job it is to run the trials and advise the farmers. One of them said:

> *I use my plot of land that I have from my dad. Then I invite them there, we do something. My engineer that I bring in the field, I also require him to put demonstrations. And show them that it is effective: "Look, how is it? Pictures before, pictures after."*

These advisory services are given on demonstration days, at their sales facilities at the time of transactions, or when visiting farmers' plots to answer any technical or agronomic doubts they may have. Another agrodealer pointed out:

> *We have an engineer, a technician there. He supervises the plots. Most of the farmers already know us there, and they tell me, "Listen, I have a plot like this, this is happening to me and we go and see it". We go and we recommend what to put there.*

Agrodealers' technical recommendations can cover a wide range of

subjects, and they can even design innovations that they then promote to their customers. This is the case, for example, with the adaptation of equipment to incorporate microorganisms into the soil at sowing time, such as a system that can be adapted to seed drills, developed by an agrodealer to deliver a liquid anti-fusarium product into the seed line. Such advice and services are not invoiced as such; rather, they are part of a service that includes both tangible and intangible components, without which the proper use of biological inputs cannot be guaranteed. And beyond these services, it is also the social capital that agrodealers possess within rural communities that creates a climate of trust and makes them important levers for the uptake of biological inputs. For the oldest or most important of these agrodealers, they are often local authorities, technical referees guaranteeing consistency and security for other farmers and for their customers. One agrodealer's employee said of the family that employs her:

> *They are well known for their crops, for everything. They are entrepreneurs, local, serious. Yes, they are seen as good farmers. They are the example of the other farmers. Sometimes, people tell me, "I want to buy the mix that* [agrodealer] *used in their fields." And that mix is here, it's not anywhere else. So, we sell it to them.*

4.4. Minimizing change: continuity narrative and technological packages

In addition to their personal reputation and the advice they provide, agrodealers steer farmers towards biological inputs through the way in which they shape – both in narrative and material terms - these technologies. Biological inputs, based on living beings rather than molecules, are disruptive technologies; their adoption could therefore frighten farmers who are reluctant to change their routines, unwilling to take risks, or insensitive to environmental arguments. To promote their sale and use, agrodealers —but also manufacturers of biological inputs— strive to present these in the same terms as those usually used for chemical inputs. One of them explained:

> *Let's measure ourselves in the same terms that you measure any pesticide, any fertilizer. It's going to work for you. You're going to harvest more per hectare. You will spend less. And later I will explain to you that it is biological* […] *we are never going to talk to the producer about the contamination of the planet and all this. That comes later, what we are going to talk about is the same thing that our customers talk about: you need productivity, profitability.*

This approach to commercial relations and technical recommendations is in line with the design of biological products, which is largely inspired by the design of chemical products so as to disrupt users' routines as little as possible. One manufacturer said: "*So what we did at the beginning was to make the products in such a way that it would be one kilo per hectare, per month".*

But beyond narratives or commercial presentations that minimize disruptions to farmers rationales, it is also the practical sales methods used by agrodealers, including their physical layouts, that play a role. Traditionally, agrodealers sale agricultural inputs in the form of technology packages. At the beginning of a growing season, farmers go to their agrodealers to buy seeds and all the inputs that they will need during the growing cycle, according to a plan prescribed by the agrodealers. One of them described this moment of prescription:

> *We attend them, and we give them the advice we can at that moment. We tell them: "ah, look, then you are going to plant this, this seed, this fertilizer and these agrochemicals". Maybe they don't take them at the moment. They take the seed and the fertilizer, the next day they come for the herbicide, and the day after tomorrow they come for the insecticide. But what do they take immediately? Seed and fertilizer. In season, they almost go hand in hand.*

This approach to selling and prescribing through standardized technology packages might lead one to believe that introducing new technologies would be particularly complex. But this is not the case. In fact, the two main components of the technology package just mentioned by our interlocutor above—seeds and fertilizers—are themselves each used as technology packages in which biological inputs are placed. First of all, thanks to seed treatment and inoculation processes, seeds are presented by agrodealers as a "Trojan horse"; when the seeds have not been previously inoculated by the manufacturer, agrodealers carry out this treatment themselves on their premises, by impregnating seeds with powders or liquids containing fungi or bacteria to combat fusariosis or to facilitate rooting and the absorption of mineral elements. To carry out this treatment, they use rotating tanks in which they mix seeds with biological inputs. So, when farmers buy seeds, they buy biological inputs by default. A similar process takes place with fertilizers: agrodealers add powders containing microorganisms to the already prepared NPK mixes, and then farmers apply them at sowing time or during the crop cycle. What makes these technology packages such black boxes, and underscores the importance of agrodealers, is that the latter sometimes don't even warn farmers of the presence of these microorganisms, again to minimize disruption to their routines. Two agrodealers stated, the first about inoculated seeds and the second about fertilizers mixes:

> *Some people don't know that. They just look at the fact that yes, it's good performance and it's cheap.*

> *Sometimes they don't even realize they are being used. The farmer doesn't know. But he says, "I did very well with that mix you sold me, what did you sell me" "Well, I sold you a mix."*

By making these mixes and technology packages on their own premises, agrodealers avoid having to recommend to farmers an additional product or operation that might discourage them from using biological inputs. In this way, they ensure that their customers are satisfied with their seeds and fertilizers. Likewise, microorganisms become doubly invisible: not only are they not identifiable to the naked eye, but they are also absent from the sales and advice discourse deployed by agrodealers. And this works, insofar as the production and marketing of these technology packages does not entail any additional costs for the farmers. Adding microorganisms to fertilizers means reducing the amount of nitrogen included in the mix by 15–20 %, which reduces its cost to the agrodealers. As one of them pointed out with regard to the seeds he inoculates, the challenge is once again to ensure their competitiveness with their customers:

> *I do not charge the customer more for the product. That is, I do not sell as a plus* [...] *mine will come with a product that will make my customers prefer my product, because it comes with this… And the difference is that I will give them for the same price.*

5. Discussion and conclusions

In this article, we put forward the hypothesis that agrodealers can play an active role in sustainability transitions. To test this, we drew on a qualitative survey of a sample of agrodealers in a grain-producing region of central Mexico. More specifically, we were interested in the ways in which agrodealers could contribute to the expansion of biological inputs—biocontrol, biofertilizers, biostimulants—as a set of alternative technologies for reducing the problematic consumption of chemical fertilizers and pesticides. The results of this survey confirm this hypothesis. Firstly, they show that agrodealers we interviewed play a proactive role in incorporating these biological inputs into their portfolios. They innovate in order to differentiate themselves from their competitors and to maximize their margins on the products that they offer for sale. Some even produce and market their own microorganism-based products. At the same time, they make a careful selection from among the diversity of products on offer, conducting their own tests to validate their efficacy. These agrodealers are also perceived as essential

interlocutors by the input industries, which are investing in their training. Our results then show that the agrodealers of our sample are actively committed to ensuring that their customers use these technologies, with different levers at their disposal. The advisory relationship that these agrodealers develop with farmers, based on a climate of trust and relying on their social standing, play an essential role in this respect. Furthermore, they strive to minimize the disruption that they could cause to their practices and customs, framing narratives and technological packages compatible with their routines. In summary, agrodealers play an active role in the expansion of biological inputs by changing some of their practices, and by influencing the practices of their suppliers and customers.

These findings prompt reflection through two key analytical lenses central to this article. First, our results clearly challenge existing literature on the role of agrodealers in advancing more sustainable agricultural practices. While previous studies do not explicitly address their contribution to sustainability transitions, they often portray agrodealers as obstacles to the broader adoption of best practices in input use - particularly pesticides (Aga, 2018; Staudacher et al., 2021; Haggblade et al., 2021) - and to the promotion of alternative technologies (Diemer et al., 2020; Maina and Gowland-Mwangi, 2011; Ogutu et al., 2022). In contrast, our research presents evidence that invites a reexamination of the role agrodealers can play in sustainability transitions and, more broadly, within agricultural knowledge and innovation systems (AKIS). The second point of discussion relates to the empirical approach we chose to study the role of agrodealers in sustainability transitions, namely the expansion of biological inputs. We started from the premise that reducing the use of chemical inputs is one of the pillars of these transitions, and that the introduction of alternative technologies is an important lever in this goal. Nevertheless, these alternative technologies are only one lever among several for reducing chemical input use and contributing to sustainability transitions (Vialatte et al., 2022). Proponents of agroecology - which, as we have seen in the introduction, has received particular attention in the literature on transitions - have long highlighted the contradiction between “simple” technological substitution and “true” sustainable agriculture (Rosset and Altieri, 1997). This contradiction has recently been vigorously revived in debates surrounding policies promoting biocontrol, which some view as advancing a watered-down version of agroecology (Aulagnier, 2023). While our results clearly demonstrate the role of agrodealers in promoting alternative technologies to chemical inputs, these findings must be considered in light of the type of transition they support. Within the field of sustainability transitions, this aligns with the scenario of a transition by technological substitution (Geels and Schot, 2007), a process characterized by the incorporation of technological innovations previously limited to peripheral niches, without major disruption to the incumbent sociotechnical regime and its actors. The promotion of these technologies with minimal changes to farmers’ practices (or even without their awareness, as we have observed), along with the continued centrality of agrodealers in the agricultural input value chain, are clear indicators of this scenario. Similarly, agrodealers’ investment in distributing or producing these inputs primarily to maintain or enhance their economic position in a competitive market contrasts sharply with the agroecological model, which advocates for emancipation from dependence on external inputs and their suppliers. In this case study on biological inputs, agrodealers are thus contributing to a certain type of sustainability transition, based on the absence of major disruptions to existing balances. The success of biological inputs is ultimately not surprising in light of the sociology of innovation and technology, and one of its adages: an innovation is all the more likely to be successful the more it fits into existing sociotechnical arrangements (Akrich et al., 2002). However, this does not prevent certain actors from contesting this type of transition, specifically by promoting alternative scenarios for the promotion of biological agricultural inputs. This is the case in Mexico and other countries in the Americas, through public policies that explicitly promote agroecology and aim to stimulate the production of biological inputs on farms by farmers in biofactories (Goulet et al., 2024).

There are several points for discussion regarding the specific case study chosen and the method used. Firstly, our survey focused on a particularly dynamic region in terms of agriculture, with a high density of agrodealers operating in a highly competitive and innovative market. This context may explain the distinctiveness of the results observed in relation to the existing literature, which points out challenges linked to the low density of agrodealers in certain regions (Odame and Muange, 2011). There may also be a bias in the profile of the agrodealers we interviewed. Agrodealers were selected because they had collaborated with CIMMYT in recent years on research and development projects aimed at promoting sustainable fertilization practices. As we mentioned in the methods section, CIMMYT never promoted biological inputs to them, allowing us to rule out direct influence on their perceptions of such technologies. Nonetheless, it is important to note that we were dealing with a segment of agrodealers who were relatively open-minded, receptive and well socialized to scientific innovations, and thus perhaps more inclined than others to adopt technological innovations such as biological inputs. That said, our previous research on the broader ecosystem of biological inputs in Mexico allows us to put this potential bias into perspective (Goulet et al., 2025). Indeed, it indicates that these technologies are gaining traction nationwide, fueled by a booming national industry that distributes its products primarily through agrodealers similar to those we surveyed. It is therefore reasonable to assume that a substantial proportion of agrodealers across the country - well beyond those who have interacted with CIMMYT - are now engaged in marketing these technologies.

In conclusion, we would like to refer to analytical angles that our survey did not explore, but which constitute avenues for future research and development actions. Firstly, it would be relevant to extend such a survey to the farmers who are customers of these agrodealers, so as to understand the role played by the latter in their experience of using biological inputs. While elements are already known about farmers’ motivations for adopting these technologies (Abdollahzadeh et al., 2016), the influence of agrodealers in this area remains poorly described. Secondly, it would be relevant to broaden the scope of the actors considered to be agrodealers to include independent consultants and advisors (Botha et al., 2008), some of whom include in their activities the distribution of biological inputs on behalf of the companies that produce them. Through training sessions and a commission-based remuneration system, bioinputs production companies are making increasing use of these operators, who may not have their own business premises, but are more mobile and able to make contact with farmers in remote areas. Now that the role of these independent operators in recommending practices that are less intensive in chemical inputs has been demonstrated (Pedersen et al., 2019), it would be useful to better understand their role in the promotion of biological inputs, and more broadly, in the evolution of input sales models. Finally, on an operational level, these results and perspectives invite us to rethink the role that agrodealers could play within agricultural development actions in favor of sustainability transitions. Policies aimed at training agrodealers and raising their awareness of the challenges of sustainable agricultural practices could make it possible to draw on these existing players, who have so far had little or no involvement in actions taken by public authorities.

CRediT authorship contribution statement

Frédéric Goulet: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ramiro Ortega Landa:** Writing – review & editing, Investigation, Funding acquisition. **Francisco Buenrostro:** Writing – review & editing, Resources, Investigation. **Simon Fonteyne:** Writing – review & editing, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have influence the work reported in this article.

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Data availability

Data will be made available on request.

References

Abdollahzadeh, G., Sharifzadeh, M.S., Damalas, C.A., 2016. Motivations for adopting biological control among Iranian rice farmers. Crop Prot. 80, 42–50. https://doi.org/10.1016/j.cropro.2015.10.021.

Aga, A., 2018. Merchants of knowledge: petty retail and differentiation without consolidation among farmers in Maharashtra, India. J. Agrar. Change 18 (3), 658–676. https://doi.org/10.1111/joac.12249.

Akrich, M., Callon, M., Latour, B., 2002. The key to success in innovation. Part 1: the art of intressement. Int. J. Innovat. Manag. 6 (2), 187–206. https://doi.org/10.1142/S1363919602000550.

Aulagnier, A., 2023. Substitution policies as a categorization process. Making biological alternatives a solution for the French national pesticide reduction plan. Environ. Sci. Pol. 146, 37–46. https://doi.org/10.1016/j.envsci.2023.04.006.

Bhandari, G., Atreya, K., Yang, X., Fan, L., Geissen, V., 2018. Factors affecting pesticide safety behaviour: the perceptions of Nepalese farmers and retailers. Sci. Total Environ. 631–632, 1560–1571. https://doi.org/10.1016/j.scitotenv.2018.03.144.

Botha, N., Coutts, J., Roth, H., 2008. The role of agricultural consultants in New Zealand in environmental extension. J. Agric. Educ. Ext. 14 (2), 125–138. https://doi.org/10.1080/13892240802019147.

Camacho-Villa, T.C., Almekinders, C., Hellin, J., Martinez-Cruz, T.E., Rendon-Medel, R., Guevara-Hernández, F., Beuchelt, T.D., Govaerts, B., 2016. The evolution of the MasAgro hubs: responsiveness and serendipity as drivers of agricultural innovation in a dynamic and heterogeneous context. J. Agric. Educ. Ext. 22 (5), 455–470. https://doi.org/10.1080/1389224X.2016.1227091.

Camargo Bonilla, Y., 2024. El desarrollo agrario del Bajío, una visión regional de largo plazo: tendencias y transiciones. Oficio. Revista de historia e interdisciplina 19, 207–227. https://doi.org/10.15174/orhi.vi19.11.

Carvalho, F.P., 2006. Agriculture, pesticides, food security and food safety. Environ. Sci. Pol. 9 (7), 685–692. https://doi.org/10.1016/j.envsci.2006.08.002.

Chávez-Díaz, I.F., Zelaya Molina, L.X., Cruz Cárdenas, C.I., Rojas Anaya, E., Ruíz Ramírez, S., de los Santos Villalobos, S., 2020. Consideraciones Sobre El Uso De Biofertilizantes Como Alternativa Agro- biotecnológica Sostenible Para La Seguridad Alimentaria En México. Revista Mexicana De Ciencias Agrícolas 11 (6), 1423–1436. https://doi.org/10.29312/remexca.v11i6.2492.

Compagnone, C., Simon, B., 2018. Cooperation and competition among agricultural advisory service providers. The case of pesticides use. J. Rural Stud. 59, 10–20. https://doi.org/10.1016/j.jrurstud.2018.01.006.

Constantine, K., Makale, F., Mugambi, I., Rware, H., Chacha, D., Lowry, A., Rwomushana, I., Williams, F., 2023. Smallholder farmers' knowledge, attitudes and practices towards biological control of papaya mealybug in Kenya. CABI Agric. Biosci. 4 (1), 18. https://doi.org/10.1186/s43170-023-00161-7.

Coquil, X., Cerf, M., Auricoste, C., Joannon, A., Barcellini, F., Cayre, P., Chizallet, M., Dedieu, B., Hostiou, N., Hellec, F., Lusson, J.-M., Olry, P., Omon, B., Prost, L., 2018. Questioning the work of farmers, advisors, teachers and researchers in agro-ecological transition. A review. Agron. Sustain. Dev. 38 (5), 47. https://doi.org/10.1007/s13593-018-0524-4.

Diemer, N., Staudacher, P., Atuhaire, A., Fuhrimann, S., Inauen, J., 2020. Smallholder farmers' information behavior differs for organic versus conventional pest management strategies: a qualitative study in Uganda. J. Clean. Prod. 257, 120465. https://doi.org/10.1016/j.jclepro.2020.120465.

Diesel, V., Miná Dias, M., 2016. The Brazilian experience with agroecological extension: a critical analysis of reform in a pluralistic extension system. J. Agric. Educ. Ext. 22 (5), 415–433. https://doi.org/10.1080/1389224X.2016.1227058.

El Bilali, H., 2019. The multi-level perspective in research on sustainability transitions in agriculture and food systems: a systematic review. Agriculture 9 (4), 74. https://www.mdpi.com/2077-0472/9/4/74.

Gava, O., Povellato, A., Galioto, F., Pražan, J., Schwarz, G., Quero, A.L., Iragui, U.Y., Massa, C.A., Zīlāns, A., Carolus, J., 2022. Policy instruments to support agroecological transitions in Europe. EuroChoices 21 (3), 13–20. https://doi.org/10.1111/1746-692X.12367.

Geels, F.W., Schot, J., 2007. Typology of sociotechnical transition pathways. Res. Pol. 36 (3), 399–417. https://doi.org/10.1016/j.respol.2007.01.003.

Govaerts, B., Negra, C., Camacho Villa, T.C., Chavez Suarez, X., Espinosa, A.D., Fonteyne, S., et al., 2021. One CGIAR and the integrated Agri-food systems initiative: from short-termism to transformation of the world's food systems. PLoS One 16 (6), e0252832. https://doi.org/10.1371/journal.pone.0252832.

Goeb, J., Boughton, D., Maredia, M.K., Zu, A.M., Nang Lun Kham, S., 2020. Monitoring the impact of COVID-19 in Myanmar: Agricultural input retailers. June 2020 survey round (Myanmar SSP Policy Note 15, Issue.

Goulet, F., 2021. Characterizing alignments in socio-technical transitions. Lessons from agricultural bio-inputs in Brazil. Technol. Soc. 65, 101580. https://doi.org/10.1016/j.techsoc.2021.101580.

Goulet, F., 2022. The role of alternative technologies in the enactment of (dis) continuities. In: Koretsky, Z., Stegmaier, P., Turnheim, B., van Lente, H. (Eds.), Technologies in Decline: Socio-Technical Approaches to Discontinuation and Destabilisation. Routledge, pp. 167–184. https://doi.org/10.4324/9781003213642-7.

Goulet, F., 2023. On-farm agricultural inputs and changing boundaries: innovations around production of microorganisms in Brazil. J. Rural Stud. 101, 103070. https://doi.org/10.1016/j.jrurstud.2023.103070.

Goulet, F., Fonteyne, S., Ridaura, S.L., Niederle, P., Odjo, S., Schneider, S., Verhulst, N., Van Loon, J., 2025. The emergence of microbiological inputs and the challenging laboratorisation of agriculture: lessons from Brazil and Mexico. Agric. Hum. Val. 42 (1), 369–381. https://doi.org/10.1007/s10460-024-10614-y.

Goulet, F., Guerrero Poveda, D., Odjo, S., 2024. Biofactories: new models for production and access to agricultural inputs in Latin America. Perspective (64), 1–4. https://doi.org/10.19182/perspective/37599.

Goulet, F., Vinck, D., 2023. New Horizons for Innovation Studies: Doing Without, Doing with less. Edward Elgar Publishing. https://doi.org/10.4337/9781803925554.

Haggblade, S., Diarra, A., Jiang, W., Assima, A., Keita, N., Traore, A., Traore, M., 2021. Fraudulent pesticides in West Africa: a quality assessment of glyphosate products in Mali. Int. J. Pest Manag. 67 (1), 32–45. https://doi.org/10.1080/09670874.2019.1668076.

Haj-Younes, J., Huici, O., Jørs, E., 2015. Sale, storage and use of legal, illegal and obsolete pesticides in Bolivia. Cogent Food Agric. 1 (1), 1008860. https://doi.org/10.1080/23311932.2015.1008860.

Hiralal Jana, H.J., Adhikary, M., Basu, D., 2014. Agricultural input retailers and their role in extension. Environ. Ecol. 32 (2), 582–589.

IPES-Food, 2022. Agroecology, Regenerative Agriculture, and Nature-based Solutions: Competing Framings of Food System Sustainabilityin Global Policy and Funding Spaces. IDS & IPES-Food.

Jacobs, B., Cordell, D., Chin, J., Rowe, H., 2017. Towards phosphorus sustainability in North America: a model for transformational change. Environ. Sci. Pol. 77, 151–159. https://doi.org/10.1016/j.envsci.2017.08.009.

Jansen, K., 2017. Business conflict and risk regulation: understanding the influence of the pesticide industry. Glob. Environ. Polit. 17 (4), 48–66. https://doi.org/10.1162/GLEP_a_00427.

Jones, S.K., Bergamini, N., Beggi, F., Lesueur, D., Vinceti, B., Bailey, A., DeClerck, F.A., Estrada-Carmona, N., Fadda, C., Hainzelin, E.M., Hunter, D., Kettle, C., Kihara, J., Jika, A.K.N., Pulleman, M., Remans, R., Termote, C., Fremout, T., Thomas, E., Quintero, M., 2022. Research strategies to catalyze agroecological transitions in low- and middle-income countries. Sustain. Sci. 17 (6), 2557–2577. https://doi.org/10.1007/s11625-022-01163-6.

Kadzamira, M.A.T.J., Chaudhary, M., Williams, F., Dutta, N.K., 2022. A non-linear approach to the establishment of local biological control agent production units: a case study of fall armyworm in Bangladesh. CABI Agric. Biosci. 3 (1), 48. https://doi.org/10.1186/s43170-022-00115-5.

Kalaitzandonakes, N., Kaufman, J., Wang, X., 2003. Firm entry through e-commerce in the U.S. agricultural input distribution industry. J. Chain Netw. Sci. 3 (2), 123–133. https://doi.org/10.3920/JCNS2003.x035.

Konefal, J., 2015. Governing sustainability transitions: multi-stakeholder initiatives and regime change in United States agriculture. Sustainability 7 (1), 612–633. https://www.mdpi.com/2071-1050/7/1/612.

Lekei, E.E., Ngowi, A.V., London, L., 2014. Pesticide retailers' knowledge and handling practices in selected towns of Tanzania. Environ. Health 13 (1), 79. https://doi.org/10.1186/1476-069X-13-79.

López-García, D., Cuéllar-Padilla, M., de Azevedo Olival, A., Laranjeira, N.P., Méndez, V. E., Peredo y Parada, S., Barbosa, C.A., Barrera Salas, C., Caswell, M., Cohen, R., Correro-Humanes, A., García-García, V., Gliessman, S.R., Pomar-León, A., Sastre-Morató, A., Tendero-Acín, G., 2021. Building agroecology with people. Challenges of participatory methods to deepen on the agroecological transition in different contexts. J. Rural Stud. 83, 257–267. https://doi.org/10.1016/j.jrurstud.2021.02.003.

Maina, S.W., Gowland-Mwangi, J., 2011. The effectiveness of agro-dealers in enhancing dissemination and adoption of the "push pull" technology among smallholder farmers in Western Kenya. Probl. Educ. 21st Century 33, 118.

Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. Res. Pol. 41 (6), 955–967. https://doi.org/10.1016/j.respol.2012.02.013.

Medina, G.d.S., Rotondo, R., Rodríguez, G.R., 2023. Agricultural bio-inputs as an innovative area of opportunity for agro-industrial growth in developing countries: lessons from Argentina. World 4 (4), 709–725. https://www.mdpi.com/2673-4060/4/4/45.

Mengistie, B.T., Mol, A.P.J., Oosterveer, P., 2016. Private environmental governance in the Ethiopian pesticide supply chain: importation, distribution and use. NJAS - Wageningen J. Life Sci. 76 (1), 65–73. https://doi.org/10.1016/j.njas.2015.11.005.

Mengistie, B.T., Mol, A.P.J., Oosterveer, P., Simane, B., 2015. Information, motivation and resources: the missing elements in agricultural pesticide policy implementation in Ethiopia. Int. J. Agric. Sustain. 13 (3), 240–256. https://doi.org/10.1080/14735903.2014.959330.

Odame, H., Muange, E., 2011. Can agro-dealers deliver the green revolution in Kenya? IDS Bull. 42 (4), 78–89. https://doi.org/10.1111/j.1759-5436.2011.00238.x.

Ogutu, F., Muriithi, B.W., Mshenga, P.M., Khamis, F.M., Mohamed, S.A., Ndlela, S., 2022. Agro-dealers' knowledge, perception, and willingness to stock a fungal-based biopesticide (ICIPE 20) for management of tuta absoluta in Kenya. Agriculture 12 (2), 180. https://www.mdpi.com/2077-0472/12/2/180.

Okonya, J.S., Kroschel, J., 2015. A cross-sectional study of pesticide use and knowledge of smallholder potato farmers in Uganda. BioMed Res. Int. 2015 (1), 759049. https://doi.org/10.1155/2015/759049.

Pedersen, A.B., Nielsen, H.Ø., Christensen, T., Ørum, J.E., Martinsen, L., 2019. Are independent agricultural advisors more oriented towards recommending reduced pesticide use than supplier-affiliated advisors? J. Environ. Manag. 242, 507–514. https://doi.org/10.1016/j.jenvman.2019.04.091.

Rosset, P.M., Altieri, M.A., 1997. Agroecology versus input substitution: a fundamental contradiction of sustainable agriculture. Soc. Nat. Resour. 10 (3), 283–295. https://doi.org/10.1080/08941929709381027.

Rother, H.-A., 2018. Pesticide labels: protecting liability or health? – unpacking "misuse" of pesticides. Curr. Opin. Environ. Sci. Health 4, 10–15. https://doi.org/10.1016/j.coesh.2018.02.004.

Rutsaert, P., Chamberlin, J., Oluoch, K.O.a., Kitoto, V.O., Donovan, J., 2021. The geography of agricultural input markets in rural Tanzania. Food Secur. 13 (6), 1379–1391. https://doi.org/10.1007/s12571-021-01181-9.

Rutsaert, P., Donovan, J., 2020. Sticking with the old seed: input value chains and the challenges to deliver genetic gains to smallholder maize farmers. Outlook Agric. 49 (1), 39–49. https://doi.org/10.1177/0030727019900520.

Salembier, C., Segrestin, B., Sinoir, N., Templier, J., Weil, B., Meynard, J.-M., 2020. Design of equipment for agroecology: coupled innovation processes led by farmer-designers. Agric. Syst. 183, 102856. https://doi.org/10.1016/j.agsy.2020.102856.

Schreinemachers, P., Afari-Sefa, V., Heng, C.H., Dung, P.T.M., Praneetvatakul, S., Srinivasan, R., 2015. Safe and sustainable crop protection in Southeast Asia: status, challenges and policy options. Environ. Sci. Pol. 54, 357–366. https://doi.org/10.1016/j.envsci.2015.07.017.

Sones, K., Oduor, G., Watiti, J., Romney, D., 2015. Communicating with smallholder farming families - a review with a focus on agro-dealers and youth as intermediaries in Sub-Saharan Africa. CABI Rev. 1–6. https://doi.org/10.1079/pavsnnr201510030.

Staudacher, P., Brugger, C., Winkler, M.S., Stamm, C., Farnham, A., Mubeezi, R., Eggen, R.I.L., Günther, I., 2021. What agro-input dealers know, sell and say to smallholder farmers about pesticides: a mystery shopping and KAP analysis in Uganda. Environ. Health 20 (1), 100. https://doi.org/10.1186/s12940-021-00775-2.

Sutherland, L.-A., Labarthe, P., 2022. Should 'impartial' advice be a priority of European agricultural and rural policies? EuroChoices 21 (1), 15–22. https://doi.org/10.1111/1746-692X.12348.

Tambo, J.A., Holmes, K.A., Aliamo, C., Mbugua, F., Alokit, C., Muzira, F., Byamugisha, A., Mwambu, P., 2024. The role of agro-input dealer certification in promoting sustainable pest control: insights from Uganda. Int. J. Agric. Sustain. 22 (1), 2299181. https://doi.org/10.1080/14735903.2023.2299181.

Vialatte, A., Tibi, A., Alignier, A., Angeon, V., Bedoussac, L., Bohan, D.A., Bougherara, D., Carpentier, A., Castagneyrol, B., Cordeau, S., Courtois, P., Deguine, J.-P., Enjalbert, J., Fabre, F., Féménia, F., Fréville, H., Goulet, F., Grateau, R., Grimonprez, B., Martinet, V., 2022. Chapter four - promoting crop pest control by plant diversification in agricultural landscapes: a conceptual framework for analysing feedback loops between agro-ecological and socio-economic effects. In: Bohan, D.A., Dumbrell, A.J., Vanbergen, A.J. (Eds.), Advances in Ecological Research, vol. 65. Academic Press, pp. 133–165. https://doi.org/10.1016/bs.aecr.2021.10.004.

Wolf, S., 1995. Cropping systems and conservation policy: the roles of agrichemical dealers and independent crop consultants. J. Soil Water Conserv. 50 (3), 263–270. https://doi.org/10.1080/00224561.1995.12456961.

Zelaya-Molina, L.X., Chávez-Díaz, I.F., de los Santos-Villalobos, S., Cruz-Cárdenas, C.I., Ruíz-Ramírez, S., Rojas-Anaya, E., 2022. Control biológico De Plagas En La Agricultura Mexicana. Revista Mexicana De Ciencias Agrícolas 13 (27), 69–79. https://doi.org/10.29312/remexca.v13i27.3251.