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Species diversification in market-garden farms and consequences on crop management, labour organization and marketing at farm and territorial scales

Navarrete Mireille¹, Dupré Lucie², Lamine Claire¹, Marguerie Mathieu¹.

1 INRA Ecodeveloppement Unit, Site Agroparc, 84914 Avignon cedex 09 France

2 INRA SADAPT Unit, 65, avenue de Brandebourg, 94205 Ivry sur Seine cedex France

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Abstract

Most market-garden farms which converted to organic farming (OF) in the last decades are small and diversified. Larger farms are usually specialised on few vegetable species and frequently face technical and economic problems when they convert to OF. Diversifying production on medium and large farms may be a way to increase their sustainability because of larger crop rotations and varied marketing outlets. The increase in the number of species has various implications on farm management and sustainability, especially on labour organization and marketing. In this study we questioned how an acceptable degree in species diversification may be a potential lever to develop organic vegetable production. The study is based on multidisciplinary surveys carried out by sociologists and agronomists who compared market-garden farms in South East France varying in usable surface area and diversification degree. The article describes the various forms and dynamics of diversification either based on the increase in the number of vegetable species or on the combination of market-garden with arable crops, orchards or vineyards. The consequences are observed on (i) crop management (with a specific focus on the link between crop rotations and pest control), (ii) labour organization (especially knowledge and skills, division of tasks, use of hired labour) and (iii) marketing implications (with a specific focus on how collective marketing networks may be combined with individual short marketing chains). The results are analysed not only at farm level, but also at territorial level, as collective marketing initiatives, replacement services and cooperative use of agricultural equipments might be driving forces to facilitate the diversification process at farm level. The article concludes with theoretical considerations on the potential innovative organisations that could facilitate the transition to OF within the agrifood system.

I. Introduction

Various types of ecologically based agricultures are developing in Europe to face to society demands for more environmental practices and healthy products. Organic farming (OF) is developing but too slowly to reach consumers' demand for organic products especially for vegetables. As most market-garden farms which converted to OF in the last decades are small, diversified and engaged in local selling networks (82% of the market garden farms, Agence Bio 2010), a key issue to develop organic vegetable production at large scale would be to incite conversion of medium and large farms. Among the technical lock-in they have to face to, one is related to crop rotations. Organic farming principles encourage diversified crop rotations, which are considered as an efficient way for preventing from pests and fertility problems (Altieri, 1999). But medium and large farms are usually specialised on a few vegetable species and therefore frequently face technical and economic problems when they convert to OF. We assume that diversifying production such farms may be a way to increase their sustainability because of larger crop rotations and varied marketing outlets. This would prevent from the risk of conventionalisation of OF (Buck et al. 1997), i.e. when farming systems are designed more for economical than ecological principles.

We conducted a multidisciplinary study to understand how organic market-garden farms cope with crop diversification, and more specifically as regards the interactions between farming practices, marketing and labour. First, crop diversification is questioned by marketing issues. In previous studies, we showed that marketing strategy largely impacts the choice of species and hence crop rotations (Navarrete, 2009). Diversification is quite usual in farms selling through short channels, i.e. those delivering food directly from the producer to the consumer with maximum one middleman (Aubry and Chiffolleau, 2009). On the contrary, farmers involved in long channels are generally specialised in few vegetable species (Lamine et al., 2012). We analysed in this study how and why farmers use diversification as an agronomical lever or not depending on their marketing outlets. Second, we questioned how diversification reshapes farm labour (labour's value, skills and knowledge, help and cooperation). This issue is still underexplored in market-gardening (Dupré, 2011) while it appears as one of the key driving factor in OF (Jansen, 2000; Shreck et al., 2006; Rickson et al., 1999).

II. Methods

The case study: The PACA region (Provence Alpes Cote d'Azur) is the first French region for organic production with 10.5% of the usable agricultural land devoted to organics and rapidly increasing (Agence Bio 2010). The sample consisted in 31 farms combining market-garden productions with other typical production of the Mediterranean area (wine, olive, fruits and cereal crops) or cropping a large number of vegetable species (Evens, 2011; Marguerie, 2011). The farms sample correctly represented the regional population as regards surface devoted to vegetables (from 0.5 to 24 ha), farming systems and marketing channels. The beginning of the farming activity and the date of conversion were not taken into account to build the sample but analysed ex post.

Data collection and analysis: The study was based on combined social and agronomical surveys to collect both (i) factual data to describe farming systems, farm functioning, labour organisation and marketing outlets, and (ii) the reasons expressed by farmers: part of the survey was based on open questions to help farmers to express their decisions. The farming systems and their relative importance were described, especially those with vegetable crops: number of species cropped, crop rotations, technical management. Marketing networks were identified as well as the percentage of vegetable sold in each of them. We collected information concerning the evolution of labour on the farm since the conversion (including both aspects of producing and marketing), in order to lead farmer to evaluate the quality of the work, its organization at farm level and the self-satisfaction at work. Farmers were then asked to point out works requirements referring to diversification (knowledge and skills, engines, equipment, hired and familial work). We finally questioned farmers about the main difficulties they had been faced to on the long term, before and since conversion to organics, and the solutions they had found to solve or at least to reduce these difficulties.

To analyze data, a farm typology was realized based on the surface area devoted to market-gardening and the number of vegetable cropped. Within each type, we characterized farming systems, marketing networks and labour organization and highlighted the link between these elements. Finally we identified various innovative organisations either at farm or territorial levels that could foster conversion to organic production even in medium and large farms.

III. Various degrees and forms of diversification and their implications at farm level

III.1 A typology based on 4 types of farm

Apart from vegetables, the most frequent crops were orchards, vineyards and cereals. Organics farms of the sample, as well as more generally those in South East France, almost never combine crop production and husbandry. The region is specialised in fruit and vegetable,

warm climate and sheltered crops enabling to supply northern urban areas in « primeurs ». The only animal activity consists in producing eggs or poultry for local sale, which guarantees a more stable income all year long and makes the farm more secure, but does not enable significant improvement as regards organic matter management.

The typology is based on the farm position along two axes: the number of vegetables cropped and the surface area devoted to market gardening (Fig1).

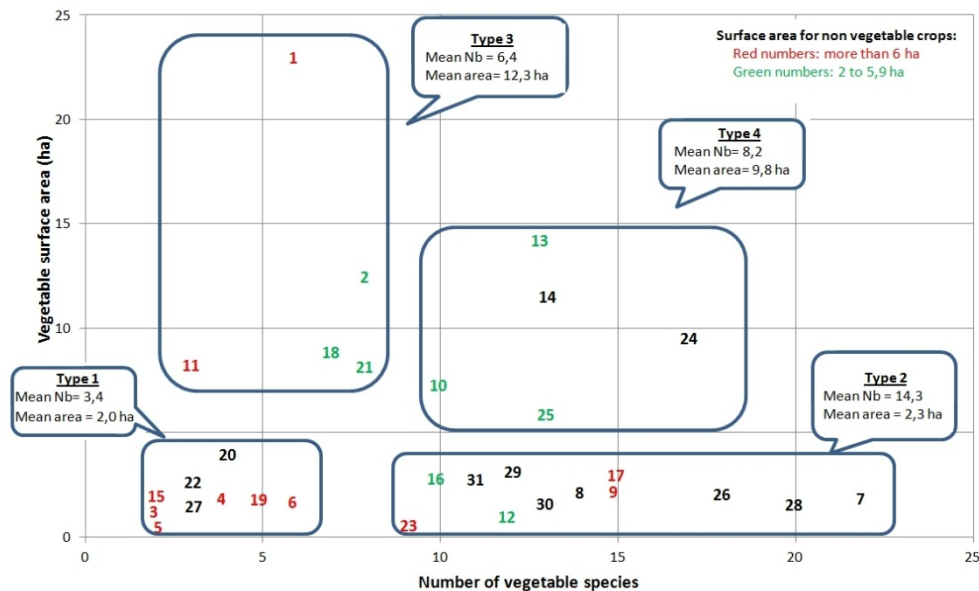


Fig1 : typology of diversification in the market-garden farms surveyed

Fourteen farms of the sample cropped a limited number of vegetables (3-8). Depending on the surface area under vegetables, two types were identified. Type 1 consisted in farms with a small surface area for vegetables, mainly in open-fields. Market-gardening was a minor activity compared to orchards, vineyards or cereal crops which represented more than 6 ha for 6 farms. The average age of farmers was 49 (from 37 to 59) and conversion took place after the mid 2000's except for 2 farms. Type 3 farms had a larger vegetable area (especially under shelters), however also cropped large amounts of fruit, grapes and/or cereals. Farmers had about the same age as in type 1, and were also the most experienced in farming and organics with an average of 19 years after conversion.

Seventeen farms of the sample had a much diversified vegetable production, with 10 to 22 species, in open fields and under shelters. Type 2 farms had a small surface area under vegetable and few shelters. Half of them cropped only vegetables and the other combined with fruit and grapes. Cereal crops were very rare (only 2 farms out of 12). Except 2 cases, conversion very quickly followed the beginning of agricultural activity or was simultaneous to it. Farmers were a bit younger (average 41, and half of them under 40). Type 4 farms cropped vegetables on larger areas (about 10 ha), some orchards and hardly no cereals. They started market gardening in the 1980's, but converted after a long while.

We now analyse successively the case of farms having a specialised and diversified vegetable production as regard farm management, labour and marketing outlets.

III.2 Farms specialised in few market-garden productions (types 1 and 3)

In specialized farms, the vegetable species cropped mainly belonged to 3 plant families: Solanaceae, Cucurbitaceae and Brassicaceae. The crop return time, that is the period between two successive plantings of the same species on the same plot, was very short (each year or one year upon 2) and largely shorter than what plant pathologists advise (for instance, about 3-4 years for *Sclerotinia* which is responsible for lettuce drop). Moreover, soil pathogens such as root-knot nematodes (*Meloidogyne* genus) are hosted both in Cucurbitaceae and Solanaceae, and the actual crop rotations largely increase their development in sheltered Mediterranean crops. Cropping cereals on the same area as vegetable is an opportunity to reduce disease risks, as the major diseases on vegetables are not hosted by cereals. Six out of seven farms of Types 1 and 3 cropped cereals on the same area. But this was impossible when only part of the usable area was irrigated. In that case, farmers gave priority to vegetables on the irrigable part and cereals were pushed back on dry areas and never cropped in vegetable rotations.

Another frequent alternative consisted in green manure (9 farms out of 14). The aim was first to improve soil functioning and structure, but also to create a cycle break for soil borne pests by selecting non host species (mainly *Sorghum* under shelter, cereal crops and legumes in open field). Some species were also used specifically against one particular pathogen, such as *Phacelia* or Brassicaceae against root-knot nematodes. Green manure crops, lasting 1 to 3 months, could be easily introduced in these specialized farms thanks to free plots available for their cropping.

On the farms cropping few vegetables, crop management did not differ drastically from conventional production, except banning chemical treatments. Most farmers replaced them by biological ones, since several antagonists are available especially for sheltered crops, following the *Substitution* paradigm (Hill and Mc Rae, 1996). Anyway even if they are considered as specialised in our sample, some farmers indicated that a slight diversification occurred during conversion. Therefore they experienced a more complex organization of crops and labour. They now estimate that this situation often generates more stress because non-chemical treatments require being very rigorous. Farmers from Type 3 could take advantage of the larger area devoted to vegetables, and especially shelters, that allowed them to standardize their production, and as a consequence labour. These farmers did not use mutual help; work being always realised by hired seasonal workers (from 2 to 15). On the contrary, the other diversified type rarely used permanent hired workers; the farms rather benefited from a familial work force (wives, daughters, retired father...).

Several types of marketing were observed in the sample (Fig. 2). When involved in long channels, farmers first sold vegetables either to wholesalers or to a cooperative organization. The short channels consisted in supplying local open-air markets, box schemes, on-farm selling, local retailers or local catering (especially for supplying schools or restaurants). Type 1 farms sold about 68% of their vegetable production to local retailers or box scheme providers that they could complement. Yet, they could benefit from higher prices thanks to the reduction in the number of middlemen, which was all the more important as they had small quantities to sell. Farms of Type 1 could not sell directly to consumer because they had too few vegetables; they could not afford selling on long channels either, which require larger amounts of products. Some farms combined short and long channels which reconciled the capacity of long chains for selling large amounts of products and the higher prices offered by short channels.

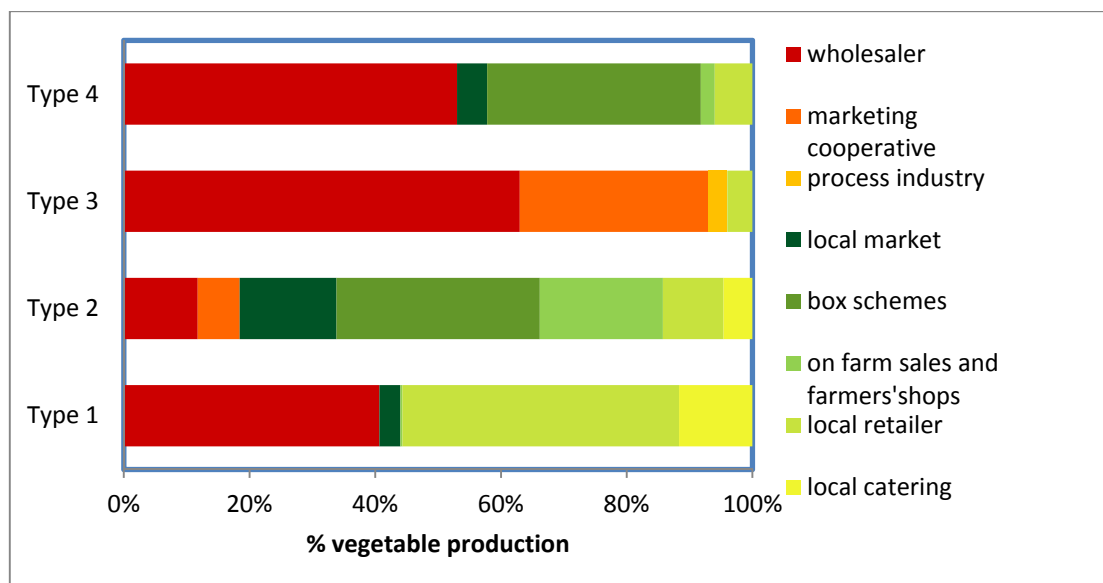


Fig 2: Relationship between the diversification degree in the market-gardening and the marketing networks

Farms belonging to Type 3 were also specialized, but cropped larger surface areas. They were mainly involved in long marketing channels, combining several sellers to increase their financial security: several wholesalers and co-operative organizations (respectively 63% and 30% of the production) ; the first operator has the advantage of requiring less work with regard to packaging vegetable. Only 10% of the production was sold locally, mainly for few vegetables very expensive and seasonal (for example aspergus and mangetout pea in April).

In both Types 1 and 3, non-vegetable cropping was important. Fruits were generally sold to the same operators as vegetables; cereals and grapes were sold via specific channels (wine or cereal cooperatives).

III.3 Diversified vegetable production farms (types 2 and 4)

As farms of Types 2 and 4 cropped 10 to 22 vegetable species, they could afford larger crop rotations with a return time quite long (2 or 3 years). But they hardly had any cereals on their land (only 3 farms out of 17).

In Type 2 where the land devoted to vegetable is limited, growers rarely used green manure (only 5 out of 17) or soil solarisation, which takes place for 2-3 months during summer. The reasons were that their land was rarely available for it in summer, or they did not have enough time to sow, water, cut and bury the green manure. They also considered that alternative techniques were not necessary because there was enough diversity in vegetable species to avoid the development of pathogens.

As regards labor, a major point was that a large diversification creates a high complexity for the growers who, for the largest part of them, converted after a very short experience in conventional gardening. That means that they had not elaborated yet a very proper and structured system in conventional farming and were quite open to largely rebuild their farming systems, possibly up to a large system *Redesign* (according to Hill and Mc Rae's grid, 1996). Obviously, farmers insisted on the fact that diversification increased work but no one declared to be hardly overwhelmed (one of the 11 farmers even declared to feel comfortable at work). For all, the main difficulty refers to the cropping organization and crop calendar that needs a long experience before being efficient and stabilized (Salmona 1982). Diversification also

requires an everyday presence on plots in order to observe vegetables and if necessary to bring a relevant and quick technical response to every problem. It also means that the farmer shares his working time in many different tasks every day, and has to acquire a very large range of skills and knowledge. In particular most farmers considered that the irrigation is one of the tasks that cannot be done by anyone else except themselves for at least two reasons: first, the simultaneous presence of several crops on a same piece of land makes irrigation pretty complex and second, it allows the farmer to personally watch over the crops, and hence does constitute a very strategic activity. Farmers belonging to the second type mainly rely on occasional workers, and more often on neighbours' or friends' help. Being quite recently involved in gardening but most often on a familial farm they take over, they benefit from a strong socio-professional network and help, but are not yet able to face financially hired labour.

Farms of Type 4, whose vegetable surfaces were larger and sometimes had land reserves, could afford to lengthen the intercrop period and to crop green manure (3 farms out of 5). Sometimes they even suppressed one commercial crop on a particular plot from time to time as fallow land. The design of crop rotations was much easier than in Type 2 with smaller surface areas: the return time was about 4-5 years in open field, shorter under shelter because surface area is limiting. Shelters allowed them to employ hired workers, seasonal and all year workers - they all admitted that diversification requires more organization and work, but the work being more diversified becomes also a more rewarding and pleasant work, as pointed by Tovey (1997).

In Types 2 and 4, crop rotations were rarely chosen for agronomical reasons, but rather for marketing ones: most of the farms were engaged in short channels, which was considered as a way to remain consistent with organic's values, on an ethical point of view. Direct selling was a way (i) to reach high vegetable prices; (ii) to stabilize farm income, especially with box schemes; (iii) to provide money throughout the year whereas in specialized long-channel farms cash inflow was very season-dependent.

Direct selling also contributes to a professional proudness and helps farmers to better cope with their additional work on the farm. This acknowledgement is pointed out as necessary to go on. But direct selling needs a lot of time and a very good work organization in which wives or daughters are often involved. The rhythms and the nature of direct selling have also to be taken into account. For example, open air market is only possible when farmers are quite close from it; otherwise they would spend more money and time than what they could earn. Direct selling may also be a problem because only small amounts of vegetable can be sold through this way and it needs to manage unsold vegetable (usually by developing an on-farm processing activity). In that way, it can be pretty uncertain.

For that reason, some farmers prefer to choose box schemes because this organization relies on regularity (one box each week), secured income (annual contract with consumers), and farm work can be structured more easily. As it requires a large diversity in products all year long in order to build boxes with at least 5 or 6 vegetables each week, crop organization is strictly planned throughout the year to supply consumers during the longest possible period (non only thanks to the combination of species, but also for each species, with several planting dates and/or cultivars). Combining crops in open field and under shelters also contributes to enlarging the harvesting period. This high complexity explains why inexperienced farmers have difficulty in box schemes and prefer direct selling networks less constraining, such as open air market or on farm selling, where they don't have to contract with consumers.

In Type 2, where area devoted to vegetables is limited, farmers were nearly specialized in short channels (82%) and combined several outlets (box schemes, open air market, on farm selling, local retailers). Box schemes represented 25% of the amount of vegetables sold. Quite often, farmers also cropped one particular vegetable in larger quantity for a wholesaler having tight relationships with him (3 farms out of 12), which increases farm security.

Unlike in Type 2, farms of Type 4 produced larger amounts of vegetable and could not afford to only supply short channels, except 2 of them which combined 2-3 box schemes. Thus 53% of the products were sold to wholesalers. But what is surprising is that diversification was not always used as an agronomical lever. In most farms, the land was divided in two parts, one very diversified dedicated to short channels and the other cropped with few vegetables, destined to wholesalers. One of the reasons is that the cultivars for wholesalers or export are specific (long shelf life, ability for transportation, uniformity of colours...) whereas other criteria are preferred for short channels (diversified colors and tasty cultivars). This resulted in reducing the room for manoeuvre for using crop rotation as an agronomical way to prevent soil borne pathogens.

IV. Discussion : innovative organisations at farm and territorial levels

As a discussion, we'd like now to address the sustainability of specialized and diversified market garden farms we studied, considering agronomic, economic and sociologic levels, as OF movement claims. We'll discuss results concerning diversified farms more precisely since they are more likely to fit with the 3 dimensions of sustainability.

Let's first examine farmers cropping few vegetable crops that converted to organic farming without enlarging significantly their vegetable crop rotations. Hence their cropping systems are quite risky on a sanitary point of view because the crop rotations are too narrow even if they introduce green manure or cereal crops in rotation. Once soils are contaminated by pests, they hardly have any ways to control them in organic farming (Collange et al., 2011), except moving crops away from the contaminated plots. As market-garden crops represent a low percentage of the total usable surface area, this is usually possible, provided that the land is irrigated. As most farms also crop cereals, fruits or grapes, the technical and economic risks are spread over several productions and several marketing networks, in accordance with Zander (2008). Considering the social sustainability of farms of Type 1, we observed that the system was mainly based on familial task force, as well as in Germany (Jansen, 2000), which is ambiguous on a social point of view: on the one hand, it does increase its vulnerability (because of the evolution of the family unit) and on the other hand it may constitute one of its strength, familial workers being rather more flexible concerning work rhythms.

Let's now question the sustainability for diversified market garden farms. As shown above, diversification offers the opportunity to prevent from some soil borne diseases, even if the succession in crops is more organized for marketing reasons than for controlling pests. Moreover in diversified farms, the technical risks are spread over several crops. Hence a possible failure in irrigation, fertilization or pest control of one particular crop is counterbalanced by other crops. That is probably why in France a large part of farmers who start organic farming nowadays are involved in short marketing channels (Lamine, 2011). In diversified farms, work intensity does increase, and so does hardness of everyday tasks, but this situation is quite well balanced with work satisfaction to run the farm throughout a more interesting and challenging work as pointed in previous studies (Rickson et al. 1999; Paturel 2010). Professional identity and social acknowledgment (particularly in case of direct selling) are also much more grateful. On an economic point of view, such farms appear to be quite secure, because the diversity in products may compensate for the great variability of prices often observed in long channels.

But as indicated above, such diversified systems are very complex. Therefore farmers often try to simplify crop management and farm functioning. As several species are cropped simultaneously on a same plot, they do not adapt water or fertilizer amounts to each crop; they sometimes renounce to a particular treatment when it is not adapted to the next crop (Marguerie, 2011). Farmers also delegated some defined tasks to workers or to agricultural enterprises (tillage, plant nursing) (Jean 2011). And finally, they sometimes reduce the number of species cropped (without ever reaching that of non diversified farms). In that case, farmer's choice refers to agronomic, economic and labor constraints: species that require too much work are often excluded (strawberry, spinaches, peas, lentil...), so are those for which special equipment is needed (leek or potatoes). Moreover the search for simplification is probably one of the reasons explaining why the combination between husbandry and vegetable production was so rarely observed. This process of simplification and sometimes reduction of diversification has also been observed by Lamine (2011) in another production area, in order to simplify cropping patterns and labor organization. It was usually in relation with an extension of their surfaces and development of mechanization. But if such a transition does secure OF and guarantees the social durability of the farm, we wonder about its long term efficiency as far as the agronomic level is concerned.

V. Conclusion

We observed some innovative organization forms at the farm's scale and at the territorial scale, some of them relying on one main principle consisting in combining different activities and outlets, in order to spread risks and incomes.

Diversified farmers widely develop what Zander (2008) calls the "horizontal diversification", relying on the combination of perennial and annual cultures. Respecting to marketing channels, we also observed another kind of association: between long and short channels which is a good way to adapt the marketing outlets to the effective quality produced on the farm and to secure outlets and incomes. But depending on farm constraints, it is sometimes difficult or impossible to build such combinations at the farm level. The collective scale may provide new room for manoeuvre to overtake farm lock-in.

At the territorial level, some collective dynamics have been observed, based on exchanges or coordination. Except for the exchange of engines between farmers (limited because of the same agricultural calendar that leads farmers rather to resort to an equipment cooperative), farmers sometimes share a hired worker (through an employers' group for example). Even if it has been quite rare till here, they could also exchange plots of land for a few years in order to improve the rotation possibilities. At least, when belonging to the same professional or commercial organization, they are involved in economic and agronomic regulations, in which each farmer defines his own production relatively not only to his own constraints, but also to the market needs and the other farmers' productions.

As a coming reflection, we suggest addressing the innovative organization forms in OF relatively to the assets and the limits of a territory which agricultural vocation is so specialized as the one we studied. In order to better understand under which conditions these innovations are possible, it seems more than ever necessary to carefully analyze the very complex interactions between sociological, agronomic and economic elements, which only if put together, can open to a more sustainable organic farming.

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