

Innovation and Development: Intensification / Disintensification Paradigms – Reflections from the French Experience

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Introduction¹

Intensification and the resulting specialisation of farms and regions are characteristics of the history of agricultural modernisation. It is an economic dynamic that results from private decisions made by farmers in order to respond to market incentives, in a context where the main agricultural markets were growing and stabilised. But it is also a dynamic fostered by the production and diffusion of knowledge and technologies through the diffusion of intensive models. These models are social constructions. The process of intensification starts off with the diffusion and implementation of generic technologies provided by industry upstream, and of scientific and technical knowledge produced by public research, para-governmental and professional R&D services and suppliers. The process was maintained by the productivity gains thus generated and sustained by collective action and public policies. In France, the period of modernisation that started in the 1960s, was characterised by an increase in the budget dedicated to research in agronomy, by a development of professional networks, and more generally, of technical consulting services provided to farmers. A sequential division of labour progressively emerged in the system of production and diffusion of technical knowledge. Thus, calling into question the intensification of agriculture comes down to calling into question this model of Research & Development.

No doubt today we can observe farmers' innovations corresponding with a downturn in the quantitative objective of maximizing the production per unit, actions which can be considered as disintensification processes. Generally, such an innovation is not an isolated action regarding a single factor, but implies associated issues. So, disintensification as intensification are concerning the production system as a whole. Disintensification appears as an alternative way to orient technological choices and to construct coherent production systems, at least at the level of one individual production unit.. New policies are designed so as to favour such an evolution of farming practices, expecting qualitative benefits from it, in particular with regard to ecological environment. The aim of this communication is to question the emergence of a paradigm of disintensification, as a consistent logic of innovation and as a collective development process.

Intensification can be considered as the result not only of economic mechanisms, but also of a logic of innovation that has guided private and public investments, at least during the so-called «productivist»

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1 This communication presents reflections based on the confrontation of socio-economic and agronomic researches carried out by the authors, respectively on farmers' skills, professional organisation, and technical and economical information systems (G. Allaire), and on cropping systems (mainly in a context of arable crop) (J. Boiffin), in a period of time from early 70's to late 90's. Both authors have an extensive experience of partnership with R&D and extension organisations in France. Because we have adopted a synthetic point of view in this temporary version of our communication, no bibliographical references are listed in the text. Previous papers of both authors, which are listed at the end of this document, contain references regarding the topics of the present paper.

era of agricultural growth. In light of this evolution, we put forward the hypothesis that a «disintensification» should also be based on a logic of innovation. Disintensification therefore necessitates instruments of economic policy that modify or counterbalance the mechanisms of specialisation, and a reversal of the innovation logic. We address logics of innovation related to intensification or to disintensification, by opposing both paradigms and the periods of time in which they emerge. Thus, we highlight the questions raised by the construction of a logic of disintensification. Indeed, a logic of innovation that takes into account multidimensional criteria requires other types of connections between research and development and between supply and demand channels.

This reversal of logic calls into question the role of private, collective² and public³ actors, as well as the organisation of R&D systems. We do not aim, in this article, to address all these issues, but we wish to provide elements of reflection for the analysis of R&D systems through three complementary insights: that concerning the technico-economic logic, that concerning the logics of innovation and finally that concerning the networks of actors. The three first sections analyse the paradigm of intensification and the third following examine the conditions of emergence of an alternative paradigm.

1. Intensification: a technical and economic logic

The more intensive agriculture is, the more units of physical factors are used per operational unit of land or of breeding (field, animal) and higher the physical output are (physical yield). As a macro process (intensification regarded at the level of a production chain or at the national or European levels), the intensification is a complex social process. To start the analysis of that process, we first define “*intensification*” as a management principle (or a convention of productivity) *oriented by the objective to increase yield by operational unit*. We call *paradigm of intensification* dynamics, including intensive technologies, consistent logic of innovation and R&D actors system, oriented by this principle.

Intensification can be expressed by economic ratios which indicate the importance of physical capital (or of other production factors than land) in the production process. Intensification generates productivity gains by exploiting ‘economies of scale’. Economies of scale are indirect consequences of the substitution of labour by capital, considering that this substitution permits efficient specialisation in the use of both land and labour. This analysis can be extended to the level of territory or of an economic system as a whole: the gains related to intensification are realised through processes of specialisation and sectoring of markets and functions..

The productivity gains related to intensification do not result from the replacement of (any) labour by just any capital. They are the result of the substitution of labour by what can be called a *technical capital*, which has several crucial properties. The «intensive» models are not only characterised by economic ratios, but also and essentially by knowledge and technologies⁴ that can be defined as «generic» in a double sense. First of all, they lead to the production of standard mass products. Whereas, in the old past, local markets were exhibiting a wide range of qualities and commercial networks were organized by the merchants, the modern intensive agriculture inscribed itself in a perspective of homogenisation of the production. That led to an ‘industrial’ conception of the product, defined by minimal standards such as bacteriological standards for the milk, alcohol content for wine ,

² By collective actors we refer for example to farmers unions and several other professional structures which, together, constitute professional networks.

³ Public research for example.

⁴ Or «models of production» as the actors of development call them.

specific weight for grain, etc. It is this type of generic product which, directly or indirectly, is the object of market organisation public policies (CAP). Secondly, they rest on *generic techniques* (industrial chemistry, mechanisation, automation, varietal selection, chemical protection of plants....) and on *generic technical knowledge* (experience plans to compare technical variants and to select those which unlock productivity). This knowledge is based on the generalised use of the experimental method that requires the breaking-up into factors of the processes of production, and which is related to the concept of limiting factor. Standardisation of products reduces market costs and generic techniques make possible to enlarge operational production unit, to standardize prescriptions and reduce technical communication costs. The ‘artificialisation’ of agronomy (modification and homogenisation of local conditions) completes and reinforces the logic of intensification. These evolutions generate systemic productivity gains.

Intensification directly concerns elementary practical technical systems (‘workshop’) or operational units which technology and activity resources are identified for. It is at this level that the principle of intensification operates, for example through the choice of crop variety and technical inputs. Technical innovation, at that level, rests on the breaking-up of the production into technical factors (research and correction of the limiting factors), in relation with generic technologies and problem solving procedures. The ‘farm’ is the economic entity that provides the means of production (land, capital, labour) to the unit and possibly, concurrently, to other units. It is at this level that the phenomenon of specialisation operates. The market permits the acquisition of the generic technologies and the selling of the production. At the market level, a farmer realises the benefit of specialisation by having access to inputs and commercialisation networks. Thus, the farms specialisation goes hand in hand with territories specialisation, which, again, does not mean that it is an automatic process: it is possible through the specialisation of the professional networks and of the industrial fabric of agro-food firms.

The dynamics of specialisation is conditioned by all sorts of ‘rigidities’ (fixed factors) and ‘indivisibilities’ which give rise to counter tendencies at the different levels. We distinguish three levels: the operational unit, the farm, the production basin. At unit level (workshop), technical rigidities are linked with materials capacities and skills scope. At farm level, organisational rigidities are related to the human and social capital endowments. At the territory level, rigidities appear in professional and market networks. Processes of intensification and specialisation operate through the transformation of these technical and organisational structures. Considering ‘rigidities’ is considering costs of flexibility. By mitigating these costs, the diffusion of generic resources releases these rigidities linked with resources heterogeneity.

Intensification is also related to an institutional context. The development of the intensification paradigm depends, on one hand, on the evolution of the family patrimonial strategies, on a minimum level of technical and accounting education, and as historians have shown, on the opening up of the farming communities. It depends, on the other hand, on public policies: not only the market organisation policies (which secure the anticipations of the economic actors) but also on the socio-structural agricultural policy (promoting the mobility of factors of production) and more generally on development policies which consist, in particular, in providing support to research and to the diffusion of knowledge as well as to professional education and training.

All in all, intensification, as a global process, is the result of a social logic, related to the values of «progress» or «modernity». Thus, many actors have been involved in the process of intensification. And if the desintensification process was to occur, it would also involve many actors.

2. Intensification: a logic of innovation

Provided there is no uncertainty concerning products definition, market outlets and performance criterions, intensification is a winning logic of industrial development: any technical progress such as described above, is guaranteed to lead to an increase of income at the farm level. It is a logic of innovation in a double sense: firstly it is a self reinforcing logic as soon as it is supported by the overall economic development (but there is no general economic law in favour of intensification...); and secondly, because it provides a path of professional development.

The intensification principle is a way of looking at things: breaking-up into activities, and then into technical factors. One cognitive issue regarding the logic of innovation is how the two sources of production knowledge are integrated, the first one being the experience of the professionals and the second one, the technical and scientific experiments. As we have seen, the intensification principle, through specialisation dynamics, is an integrative model. However, the spreading out of generic technologies and the diffusion of the intensification logic result from diffusion of both new materials and knowledge, which can only be diffused in a receptive and even proactive (i.e. generated by the farmers initiatives) environment. In this view, farmers are not only assumed to rationally react to intensification incentives, but also to be receptive and active to absorb and construct technical knowledge. Among the other processes rendering this proactive receptivity, there are processes of professionalization:

- The diffusion of basic technical and analytical accounting skills (according to normalisation of the professional capacity),
- The professional organisation and the diffusion of know-how (constitution and functioning of local professional groups and professional networks).

In this perspective, the role of professional skills oriented by the intensification logic must be highlighted. The process of productivist innovation in agriculture («the 1960s model », in France) has been based on the development of farmers' individual and collective skills which has enabled farms, not only to adopt innovative techniques, but also, for a good part, to design and develop them. From this point of view, the intensive models were jointly constructed from downstream industrial development, from research in agronomy and from the experience of operators in the fields or stables.

3. Intensification: A system of Research and Development

The innovation logic corresponding to intensification has been supported by an efficient system of Research and Development with a strong public research component and an equally strong professional component. The organisation of development rests on allocation of roles between public, para-governmental and professional institutions (co-operatives, R&D institutes or others). This mechanism is frequently described as corresponding to the stereotype of the «linear model of innovation», that is a « Research/ Research and Development/ Development» chain where «products» that are increasingly close to the technique or process used in real scale, are designed from the findings of research. But contrary to what the term «linear» suggests, this model is not unidirectional. Even in the context of intensification, it brings into play a double flow of information. The professional groups and networks, through which the intensive models are diffused, take part in their construction, if only by gathering technical information (reference networks). On the other hand, one can say that intensification gives a linear characteristic to the system inasmuch as it polarises the functioning of each segment, which gives coherence to the system as a whole: beyond rivalries between organisations, everyone «aims at the same target», that is towards an increase in physical productivity and the substitution of labour by capital.

The downstream-upstream segmentation of the process of innovation is not the only, nor even the main, type of segmentation to be considered. The agricultural Research & Development system is also segmented per production-transformation chain, discipline (partitioning between agronomy, phytopharmacology, animal production science, economy, nutrition...), institutions (public research, technical institutes, Chambers of Agriculture, specialised professional networks). Here again, this does not endanger the coherence of the overall functioning as long as the latter is polarised by intensification, which itself is closely related to the specialisation of activities.

This mechanism comprises two important interfaces, at the level of which are set up determinant processes which are either leading to innovation or hindering it.

- Between Research and R&D: Filtering and selective use of the research findings in order to evaluate or conceive new techniques or methods;
- Between R&D and development: adoption or rejection of inventions, construction of models of specialised production (or « models of farm development »).

Another major characteristic of the agricultural Research and Development system related to intensification is the predominance of empiricism. It can be schematised as one great mutual trial-and-error process where a multi-local and pluri-annual experimentation aimed to comparatively evaluate the new technical variants (see the mechanisms governing the registration in the official catalogue of the marketable seed varieties) is combined with the «real-scale» test that the integration of innovation into farms constitutes, and the results of which are information that are widely exchanged. When the intensification is designed and developed mainly empirically, public research can, in certain sectors, content itself with a role that consists more in supporting than in really creating the technical innovation: it is then solicited as a methodological aid for the evaluation of new techniques, or for the detection of limiting factors of productivity, rather than to invent new techniques and methods: this is the role of agro-suppliers.

4. Disintensification: a technical and economic logic?

Intensification having been referred to the increase of physical output, disintensification could be defined through the opposite objective. Intensification being considered as intrinsically related to a technical specialisation at unit, farm and territory levels, it is tempting to relate disintensification to a reversal of this logic of technical specialisation. This reversal must be envisaged at the three levels we have mentioned. The question is then to determine the processes of disintensification, to analyse their technico-economic coherence and to identify the skills and competences on which they depend.

If the dominant economic logic is intensification, the objective of reducing an activity output cannot reach economic efficiency if it is not associated with qualitative changes in the nature of resources and outputs. There are two possibilities for changing the efficiency conditions (and the efficiency convention): (i) to decrease the inputs costs more than the production value, through new combinations of factors, in particular by using more qualified internal workforce or external services; (ii) to valorise outputs qualities linked with less intensive techniques of production. Disintensification objective and processes come from the requalification (or reconception) of the objectives and resources at the different levels of the farm and of its environment.

Departing from the logic of intensification comes down to implementing more systemic logics. The principle of technical decomposition associates an input to a separable function (chemical cover to avoid pest attacks). On the contrary, if the option of input reduction is first taken (whatever the cause is), the

related function has to be reconsidered and, generally, this reconsideration concerns different levels of organisation. For instance, if the use of pesticides is to be reduced, the corresponding function (in this case, ensuring the health of plants) must be reassigned to all the other technical interventions. This technical function is then distributed throughout the crop system as a whole. This is why the term «integrated management» is used in this case. In general terms we can say that disintensification brings into play integrating capacities. This is equivalent to saying that the degrees of freedom or the margins to innovate lie more at the level of the production system as a whole than at the level of such and such a technical segment.

Two logics of integration are still possible. On one hand, a more integrated management at the workshop level seems to imply more cognitive labour and more abstract knowledge but also more specialized in a domain. On the other hand, if disintensification process comes from the objective of valorisation, this objective goes down to the operational level involving specific knowledge. Because disintensification objectives are related to some qualitative objectives, which can refer to a plurality of efficiency criterions, we cannot offer a simple definition of the principle of disintensification. What can be said on such a principle is that the distribution of the functions on a higher level of organisation questions the principle of separability of specialized functions. Indeed, reasoning on a more complex level requires taking into account contextual specificities of this level, than it implies reasoning about the treatment of the plot within the framework of the whole cultivation system, the farming system in the exploitation, or the exploitation in the territory. Taking in account global issues requires taking into account the specificities of the farm organisation and competences, and the local specific opportunities and constraints. While the intensification was a logic of “genericisation” and specialisation of the resources, the reversal of this paradigm of innovation rests on the expression of the diversity at different levels.

Generally, from the technical point of view, the need for a systemic and multifunctional innovation emerges. Innovations can then no longer be evaluated in a simple manner: taken individually, hardy varieties are disqualified; it is through their combination with other techniques that their interest is enhanced. Innovations dedicated to non-productive functions must also be introduced (for example, water purification, waste storage, etc). From the economic point of view, in general, the activities of agricultural production can no longer be only considered as the production of basic food products of standard quality. The practices and places of production are likely to endow the final product with additional value. The collective integrating capacities are not exclusively technical. They are also economic and are defined in particular by the capacity to seize the opportunities related to the demand for quality of agriculture.

More generally still, new objects of innovation are emerging. It is the case, in particular, with regards to territorial management. A great number of environmental functions can only be managed through the collective management of territories that are larger than the farm itself, and which do not correspond to the administrative or holdings boundaries, and which imply a wide range of stakeholders. With regard to this type of problem, technologies, trouble-shooting tools and above all the mechanisms of co-ordination are far from perfected and a wide range of new references needs to be established. Innovation must then be less empirical, and more closely related to scientific knowledge and research. The use of “insurance-related” techniques (such as a systematic pesticidal treatment) can only be reduced by keeping up with and gaining a more comprehensive knowledge of the functioning of agro-eco-systems.

In the case of phytosanitaries, for example, the development of integrated protection requires progress in epidemiology and in physiology of ill plants. The management of environmental functions is not based on the same reference systems as the management of the functions of crop production. In this case, the

traditional experimentation process («all things being equal») is impossible. It cannot, for example, be applied to the management of catchment basins. The trial-and-error approach by the practitioner himself is quasi impossible: the nitrate, nitrous oxide, the carbon sequestered on soil or oxidised by carbon dioxide, are not only invisible but are also difficult to measure. It is therefore necessary to use intermediary indicators. Trouble-shooting or assessment tools and prescriptions must be based on the modelisation of the phenomena that is validated by in situ observations rather than through classical experimental approach. And these tools themselves must be integrated in actors' negotiations and plans, which is a complex process as it implies the integration of various objectives in the knowledge systems.

5. New context, new logics and new actors of innovation

Whether the intensification comes to a halt or continues, when the objectives of innovation shift towards quality and «multifunctionality» related to public goods the linear representation of innovation is no longer tenable. This shift in innovation regimes is related to the fact that the demand has become more proactive. This is expressed in particular in changes in consumption patterns, and a tendency by consumers to give more importance to aspects of safety and aesthetics.

The breaking out of the linear model of innovation occurs at research level and at farm level, which in both cases implies the involvement of many more partners than in the past. On the one hand, research becomes both more diversified and the setting up of finalised research programmes is increasingly complex. On the other, the orientation of development is as much based on the understanding of what happens qualitatively with regards to consumption and territories, as with what happens on the production side. This leads one to consider innovation as a process that goes through several networks.

This evolution of the processes of innovation - which implies a greater number of actors and therefore heterogeneous knowledge – can be seen through the conceptions that the representatives of the farming profession have of progress. Without abandoning the intensive models of production chains, professionals mentioned «diversification» as early as the 1980s. And in 1989, the minutes of the General Assembly of the ANDA⁵ mentioned the «end of the development models ». Today, certain territorialised mechanisms of transfer of technology bear witness to this evolution (GIS⁶ in the Alpes du Nord region or AGROTRANSFERT in the Picardie region).

The knowledge that is necessary for innovation (and that is generated by the processes of innovation) comes from several fronts: science, of course, but also production, markets and users. It is generated by what may be called innovation networks.

In studies on innovation, the linear models of innovation driven by technology and that of innovation pulled by demand have been replaced by models that combine both aspects, but which have also rejected the idea of sequential flows of information. Nowadays, the processes of innovation are seen as complex, non-linear and with two-way exchanges. More fundamentally, innovation in firms is today considered as a network driven process. And this is all the more true when innovation concerns the management of a whole chain, to solve environmental questions for example and more generally to solve systemic issues. This also applies in the farming and agro-food world.

⁵ National Association for Agricultural Development.

⁶ Groupement d'Intérêt Scientifique (≈ Group for the development of scientific interest).

A network of innovation can be defined as a network of agents and structures that have specific functions in the process of generation, transformation, evaluation of knowledge, and where are developed integrating capacities making it possible to create new services (produce new qualities or provide solutions to collective or public issues such as environmental questions). The farming world has been able to generate many professional networks, a certain number of which may be qualified as specialised networks of innovation. In today's context, one of the key questions is that of their opening up to the non-farming world: Faced with the issues we have just mentioned, the actors of innovation represent social categories other than just the farming and agro-food categories, and occupations that do not exclusively concern production, transformation and distribution. They can be institutions, in particular territorial collectivities, but also associations of users (users of rural space, of recreational resources, forest, rivers...) and of citizens who feel concerned about issues related to public health or the environment (associations of consumers, environmentalists...).

Any reorientation of the process of innovation, and disintensification in particular, must be examined by taking into account this new context. Disintensification cannot be implemented by reversing the functioning of earlier networks, or even by replacing them with networks that are new but built on a similar model. It can only become a true logic of innovation if it is part of this movement of diversification, of opening up, and all in all of network re-creation.

6. What systems of research and development are necessary for disintensification?

Assuming that disintensification proves viable as a technico-economic logic, it cannot be implemented as a logic of innovation in a framework that is shaped for and by intensification. A certain number of changes are required.

A first critical point concerns skills and competencies: In the face of the technical and economic challenges of disintensification, the current system not only «does not know how to», but cannot decide who must be in charge of the technical co-ordination when the issues affect several categories of actors and emerge simultaneously at different scales. In other words, the question raised is that of the existence of integrating capacities and of where they can be found, particularly when issues are related to space and environmental management.

The second critical point is the structuring of the global system: firstly it is necessary to determine the specific roles and functions of the different institutions and organisations constituting the R&D system and to adapt them to the objects of innovation involved by disintensification: systems of culture, systems of production, functional spatial entities in terms of hydrology, ecology, territories... But the most challenging problem is that of interfaces. When the system as a whole is no longer polarised in a simple way nor driven by the common force of intensification, there is a risk that these interfaces will become insurmountable barriers. Among other scenarios, the hypothesis of a complete atomisation of the development resulting from a regional decentralisation (or privatisation) of its financing, cannot be excluded. The pro-active reconstitution of a more dynamic and less discontinuous interface between public Research and Research & Development is of the utmost importance in order to deal with certain problems which the current system is not equipped to solve. These interfaces must play a role that is almost the reverse of the role they play at present: they must generate mutual requests of collaboration, common projects and new instruments rather than filter and limit the role and authority of each group of actors. This vision is not the result of an idealistic principle of shared labour; it results from the reconstruction of research and development objects which is related to the emergence of new entities of action and decision-making, and new networks of innovation. The integrated phytosanitary protection,

or integrated management of catchment basins, remain to be invented. And their invention in the short or medium term will only be possible if the «integrators» - i.e. farmers on the one hand, and the actors of territorial management on the other - closely interact with research; because it is this integration itself which is, at least partly, an object of innovation and research. If this does not occur, disintensification might remain purely virtual or based on more or less ideological conjectures based for example, upon on acts of faith in the virtue of hedges, grass, the biology of soil, and of nature in general.

Calling into question the structuring of the research & development system, *leads to a third critical point: that of the modes of governance and of the regulation of agriculture and society relationship.* Disintensification in itself, does not guarantee that the social legitimacy of agricultural activities will increase or be regained. We cannot exclude the possibility that certain paths to disintensification might lead to an increase in the opposition to public aid, while other paths might justify it. If, whatever its orientation, a logic of innovation remained under the exclusive control of agriculture professionals, it is doubtful that it would ever inspire trust from other social actors. In other words, the concept of disintensification does not make it possible, in itself, to trigger an evolution of the agricultural research and development system that would contribute to the development of a sustainable agriculture.

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