From technology development and transfer

to development-oriented and action research :

new context, new issues and new partnerships for FSR-E approaches.

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Summary

Farming system research approaches and methodologies have emerged as a way to provide solutions to problems that could not be addressed through conventional "discipline-oriented" analyses. In a first stage, they were mainly used (i) to facilitate the transfer of technologies that had been previously designed and tested in experimental research centres and (ii) to assess the impact of such transfer.

However, such application often faces limits, as they seldom allow to address properly the whole range of problems faced by the stakeholders under new and evolving circumstances. Moreover, the results often do not match neither the expectations created nor the facilities used.

First is the need to shift from technology transfer to decision making support. This implies in analysing stakeholders' practices in order to understand their strategies and the technical, economic and social factors that influence their decision. The challenge is then to provide them with relevant and adapted information that can impact on decision making process.

There is also a need to recognise new researchable issues derived from an analysis of the problems faced by stakeholders. In addition to practices analysis already mentioned, issues like marketing chains, dynamics of rural space at local government level or organisations for managing collective resources should be paid attention.

There is finally a need to build up new partnerships, in order to address these issues in a participatory and more efficient manner and to satisfy expectations of rural stakeholders.

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1. Between globalisation and local identity : new challenges for development.

The agricultural sector in the SADC region is evolving very quickly. Democratisation and political stability obtained during the past years in most countries have increased the importance of this process, which can be characterised as a process of intensification of the flows of capital, products, people and information. Changes in international and cross-border trade patterns represent the most visible and discussed issue, but there are in fact diversified in-depth re-organisations resulting from on-going globalisation.

This process is amplified by the withdrawal of State responsibilities and resources from most of its usual duties in the rural development process (markets' regulations, pricing control, supply services, schemes' management, subsidies and incentives, *etc*). Further to this, the transfer of national responsibilities and resources to local Governments often accompanies this withdrawal.

The role of the private sector, local organisations, local authorities and Non Governmental Organisations –NGOs- is then promoted as a way to support such an evolution. Relationships are developing between stakeholders that were not used to exchange information and products and to work with each other. New informal networks are developing on the basis of common interest and initiative.

As a result, one can observe an increasing complexity of relationships related to agriculture production and marketing in each and every locality, involving a

multiplicity of stakeholders acting at different levels and pursuing each of them different objectives. These relationships rely on new organisation patterns set up between local stakeholders, but also on the development of networks involving far distant institutions and individuals. It implies new rules, practices and flows and results in the multiplicity and tangle of hierarchised organisation patterns.

The penetration of urban products and life style in rural areas and the problems faced to market agricultural products raise concerns related to the loss of local identities in a global and uniform environment.

Economic integration is often looked upon as a way to promote comparative advantages and local identity of agricultural products. It strongly depends on the set-up of new local stakeholders' networks and territorialities and on the local answers and activities that might be developed to address the problems and opportunities related to globalisation. It is argued that new developments in participatory approaches and information technologies offer opportunities to address these concerns.

The needs for rural development are also becoming more complex, because of the multifunctional character of agriculture and land (Swanepoel & Stroebel, 1999). The increase in food production and food security through the improvement of productivity in both large and small-scale sectors is no longer the only issue that agricultural research and extension should look at. The competitiveness and quality of agricultural products, labour employment and income generation, equity and gender awareness, environmental concerns and

management of natural resources also need to be taken into consideration (SACCAR, 1999).

2. From technology development and transfer to development oriented research

Without disregarding the success of the *green revolution* for certain crops and in certain places (Northern America, Europe, irrigated areas in Asia…), the failure to extend it has provoked the question as to why research and development have had relatively little success in generating and disseminating technologies in a wider range of situations. Although some impressive advances had been realised in some developing countries, there are many areas where agricultural research is failing to make a satisfactory contribution to increases in agricultural productivity (Mettrick, 1993).

Specifically about small-scale farming in developing countries, the insufficient taking into account of real activities, production conditions, practices and strategies of the local stakeholders appears to be one of the main factors explaining these problems. Many “improved technologies”, although technically sound, are not relevant to the objectives, socio-economic circumstances or even to the agri-climatic conditions of small-scale holders.

Production of new technologies is a necessary, but not a sufficient condition for improving sustainably rural livelihoods. Since the 1980’s, serious questions have been raised about the economic, social and ecological constraints linked to green revolution technologies. They refer to unsatisfactory conditions of technology

transfer and market and to the undesirable social and environmental impact of these technologies. To address the challenges of rural development, a shift is therefore needed to adapt research practices.

Resulting from this evidence, new concepts and approaches for conducting research have emerged. Among them are the system approach in the 1970's and the eco-regionality in the 1980's. However, they have essentially been applied to technology development and transfer at farm level. They aimed at improving the adoption by farmers of new technologies validated in experimental stations, by taking into account socio-economic constraints and the environmental impact of these technologies. But the role of technology development and transfer as one of the various factors among others that impact on the development of the agricultural sector has rarely been questioned by agricultural research.

Eco-regionality has for example been a useful concept for researchers to deal with the diversity of natural resources, by offering a basis for stratification that could prevent to take into consideration every diverse situation. Nevertheless, it has not been used to analyse the mechanisms of evolution of agricultural production by considering not only the natural resources base but also social and economic issues.

More recently, the use of participatory approaches has developed as a way to better identify the farmers' needs. It is then generally assumed that these approaches can facilitate the identification of adequate technologies to be delivered by research and that farming system research (FSR) could solve problems related to further transfer.

However, such a strictly diffusionist approach is facing limits related to the poor dialogue between scientists dealing with each of these areas, to upstream difficulty for transforming local demands into national or regional priorities for research and to downstream application of FSR limited to particular local areas.

Three shifts are proposed to move from technology development and transfer to development oriented research and to address the whole range of problems faced by the stakeholders of the agricultural sector :

- to shift from technology transfer to decision making support ;
- to recognise new researchable issues derived from an analysis of the problems faced by stakeholders ; and,
- to build up new partnerships, in order to address these issues in a participatory and more efficient manner and to satisfy expectations from rural stakeholders.

3. The shift from technology transfer to decision making support

Agronomic research, extension services, training operations, etc., have always had as a principal purpose the establishment of basis for technical change in agriculture. For researchers, the experimental station was, for a long time, a privileged, if not exclusive, place for the development of new technical models which were then transferred to farmers (the so-called top-down approach).

Everything seemed to be proceeding by itself : experimental agronomic research was responsible for the development of progressive technical models with

extension plans to ensure the transfer to the farmers, who would adopt them. However, the panorama became progressively blurred. In fact, most of the time in the small-scale farming conditions, the new technologies were not adopted as it was expected and the results obtained by farmers were not up to expectations. After having attributed these relative setbacks as much to the farmers' lack of technique as to imperfections in extension organisations and methods, a part of the agricultural research community called into question the validity of its technical models, and therefore its processes. The controlled environment of the experimental field and the laboratory could not effectively validate these models alone. The technical approach was revealing its limits, and agronomists were realising that the "agriculturally possible" does not often match the "agronomically desirable" (Le Gal & Milleville, 1994).

It therefore appeared necessary that the agronomists get closer to the farmers, not only to understand the reasons for the gaps, but also to design proposals to adapt technical changes to specific situations. The farm became in this way a key level for inquiry, as much for identifying the farmers' objectives into a hierarchy as for assessing (i) the availability of production factors, (ii) the organisational, technical and economic decision-making rules (decision and information system, Landais & Deffontaines, 1990), and (iii) their effects and efficiency with regard to overall farm operation (operating system, Landais & Deffontaines, 1990).

The farmer's technical system has therefore become a major subject for research. Analysing farmers' practices and decisions refers to identifying the

modes and methods that they use to manage their resources, crops and livestock (Perret, 1999b).

The major idea underlying this shift is that researchers should not only provide farmers with norms or technologies (even though adapted or technically sound) but also with information regarding their own performance, possible changes and the environment. This information is then used by the beneficiary as input for decision-making process. Such an approach directly refers to the analysis of current practices and strategies (action models, knowledge models, Landais & Deffontaines, 1990 ; Papy, 1994). It aims at formulating scenarios, events or trends likely to occur in order to stimulate problem solving.

Beyond the will to get closer to farmers' practices, and in order to build up a renewed advice function, the mere observation of practices is not sufficient. During the 15 past years, detailed studies have been carried out on crop management, maintenance of soil suitability, on livestock management, cash flow management and land management (Papy, 1994). However, researchers soon felt themselves that they were not addressing adequately the problem and that a simple analysis of practices was not sufficient to provide a full understanding of technical farmers' choices. For example, climate variations, operational variations from one year to the next are such that it is sometimes difficult to detect a guiding principle. Obviously the farmer can often give explanations, but obtaining them retrospectively is not easy. Would it not be better to pinpoint all the solutions that were open to him/her at a given time t, and the reasons why he/she chose certain solutions rather than others ? If this is

indeed the case, then the decision-making process needs to be studied in the sense given by Sebillotte and Soler (1990), *i.e.* the process leading to a choice for which the underlying cognitive procedures are not studied, but which researchers try to express in the form of rules (action models).

This process, recognised as a sort of “driving force” for the practices, has become in its turn a subject of research (Papy, 1994). Preliminary work in this respect, carried out on cash crop systems, is being extended to more complex systems : livestock farms or mixed crop-livestock farming. For extension/advice purposes, they tend to focus on farms’ specific sectors, i.e. irrigation, labour force management (Perret & Le Gal, 1999).

This implies a major step forward, as the external operator investigates decision-making situations involving the role-player and attempt to reconstruct them through modelling.

Since the early 1990s, many works were carried out on the decision-making process, reviewed by Papy (1994). The way farmers build up their decisions and their practices has now a conceptual framework. Recent works give a renewed methodological frame to support the shift to decision-making support, at least at farm level.

This relies on the assumption that the information to transfer a technology should not be provided to the beneficiary as a normative recommendation, rather as a useful input for his/her own decision making process. This implies a specific packaging of the information based on the main criteria used by him/her to choose between different technical possibilities.

Typological and zoning methods allow spreading the benefit of these works to community or small region levels by modelling the inner diversity of local situations or the diversity faced from one place to another (Lhopitallier *et al.*, 1999 ; Perret, 1999b).

4. To recognise new researchable issues

Many decisions of fundamental importance to agricultural production are not taken at farm level. For agricultural research, recognition of this has lead to identify two main activity areas: (i) technology development and transfer at farm level, taking into account socio-economic constraints at both farm level and the environment; (ii) assessment of policies and of their impact to provide elements for policy-makers at national level. However, these two areas have remained disconnected.

There is in fact a continuum between them. For example, to analyse and improve cattle feeding, one might have to consider, not as constraints but as research and development issues, the organisation of extension and input delivery systems at regional and local level, the management of grazing areas (fences, access, stocking rate, etc) at the village level, the practices of the farmers according to the available resources at the household level, the feeding practices and their nutritional consequences at the herd and at the animal level.

There is therefore a scientific challenge in integrating these two areas when addressing research and development issues and for taking into account other stakeholders' needs and practices than the only farmers' and policy makers'

ones. Development oriented research has to recognise as subjects of investigation not only the production technology at farm level, but also issues whose analysis can provide stakeholders with operational elements for decision making. Among others, one can identify:

- The management of common productive resources :

The management of common productive resources results from a co-ordination process between different stakeholders, whose objectives are to mobilise, develop, share, maintain or renew equipment or information, financial and natural resources. Analysis of this process and of the decision making related mechanisms are of fundamental importance to ensure an optimal allocation of the resources, as well as their sustainability. This can apply to multi-use spatial entities, in which multi-users can compete and/or collaborate, such as communal areas where the appropriation of forestry products, fruits, water resources for domestic or irrigation purposes can lead to conflicts (Lasbennes, 1999 ; Perret & Le Gal, 1999). This can apply as well to a particular common good, such as soil fertility, indigenous knowledge, water resource, etc, whose renewal may be threatened or developed. As far as sustainability of agricultural development is concerned, the impact of rural transformations on the status and the evolution of natural resources are of particular importance.

- The organisation of marketing process :

The organisation of marketing process relies on a co-ordination process between farmers, processors, traders and policy makers, whose interests can be complementary or competitive. Implications on the productive process at farm

level on the one hand, on food security on the other hand are of fundamental importance. Processing technologies and industrial research, local organisations for marketing and supply of farm inputs, infrastructure, cross-border trade regulation and legislation are among important researchable issues that can modify the organisation of the marketing process or the management of input delivery chains.

- The local government planning process :

In a general context of decentralisation, Local Governments are each times more assuming responsibilities in terms of policy planning and resource allocation. Yet, most of them have not experienced such a process. Moreover, this is a level where intermediate methods can apply, between top-down planning at national level and participatory approaches at local level. There is a challenge for designing and validating methods that can promote planning of agricultural development, through the implementation of reliable and relevant information systems and the support to mediation process (Lhopitallier *et al*., 1999).

5. To build up new partnerships and new relationships between partners

The new situation that farmers have to face challenges research and development practicioners, as they are asked to develop negotiating and decision-making support for emerging managers. The new stake is to manage the change required for sustainable development. This relies on 3 key-concepts : action, modelling and information.

A research focusing on intervention, action and participation

Technology generation or market forces are not enough to bring about this change. It necessarily requires facilitation of collective learning and negotiated agreement (Jiggins & Roling, 1997). These needs led recently to the emergence of the concept of *action-research*, adapted from diverse disciplines (health, education) to agriculture and rural development. The main principles of these approaches are described in table 1. *Action-research*, as defined by Liu (1994) combines :

- the convergence of a will for change and a research intention,
- the dual nature of the objective, problem solving and knowledge generation (with local and generic scope),
- an ongoing long-term joint project between researchers, development practicioners and users, and,
- a common ethical framework negotiated and accepted by all stakeholders.

Several previous experience show that projects inspired by action-research can efficiently support local development (Valleyrand, 1994 , Perret & Le Gal, 1999) and that original information can derive from the analysis of the changes induced by the intervention itself (Caron, 1998). The tricky and essential point is to implement properly the participation of local stakeholders, not only in the surveys but also during recurrent and interactive workshops (information sharing, discussions about scenarios, solutions seeking…).

A recent trend in management-oriented research is to proceed through direct "intervention" within the targeted organisations. *Intervention-research* means that the researcher is no longer an external observer, analysing managerial processes, then prescribing possible improvements. He/she is actually embarked in a common work with the actors of the organisation (Moisdon, 1997). The prescription dimension takes part of an inner process in which control, strategy, piloting, ongoing learning… are central.

Table 1. Bottom-up approach and action-research : definition of the responsibilities for each participant. (from Perret, 1999a).

Role-players : Phases :	Farmers	Researchers	Development practitioners
Diagnosis	Expression of needs, problems, knowledge models (know-how, representations) Exchanges between farmers	Collection, re-formulation of problems into questions, demand analysis though specific tools, collection of available data (scientific knowledge, generic references)	Expression of knowledge of the situation, collection of available data (local references)
Production of information	Participation to on farm experiments, surveys, feedback of results, role of validation	Proposals of methods, set up of experiments, surveys, sampling, additional labs/station experiments	Contribution to sampling processes, experiment setting-up and monitoring, role of validation
Management of information	Enrichment of the information systems, of the knowledge models, sharing with the socio-cultural and professional environment, diffusion of knowledge	Storage of data, production of generic knowledge, models, methods, sharing with the international scientific community	Local knowledge and references, sharing with professional environment, capacity building, diffusion of knowledge and methods

Modelling and simulation as a support to decision-making and action

The second main idea is to promote modelling and simulation. Even though often seen as computer and high-technology oriented, participatory simulation of scenarios with stakeholders proved to be powerful means :

(i) to enhance local participation during the data collection phase ;

(ii) to share information and to give equal access to information to all stakeholders ;

(iii) to create a common basis for discussion and negotiation ;

(iv) to boost collective learning and pro-activity through scenarios ; and,

(v) to create and adapt tools as support for decision-making, as it aims at answering questions as to “what would happen if… ?”.

Negotiations, then decisions about individual (crops, cropping systems) and collective issues (maintenance organisation, water distribution, water tariff and modes of payment, etc) need to be implemented and supported. Modelling is a way to gather information, to create a common representation on a subject. Simulation can help testing and finding out solutions, being proactive (Perret & Legal, 1999). It thus relies on a shift of paradigm by attributing to modelling prospective rather than predictive functions (Godart *&* Legay, 1992). According to the authors, it is actually impossible to look for predictivity when the subject or its environment are not enough stabilised so that known laws can apply to their future. This is particularly true in situations where “*the knowledge of possible evolutions and the prediction of the ones to occur induce actions aiming at transforming in advance the reality through a change in the way the actors represent themselves their future and their possible actions*”.

Moreover, the idea is more to identify and to discuss the possible scenarios that might occur than to supply the stakeholders with fixed norms or technologies (Moisdon, 1997).

Information system as a background tool

The information issue crosses all components of research and development, as it is necessary for diagnosis, monitoring, modelling and simulation. This information bears different functions and status. It would be the way to memorise, to represent and to share various information (maps, database) within the action-research process. It may be used for monitoring, assessment and control purposes by the management organisation. The research team also may use it for modelling and extrapolation purposes (see table 1.).

6. Conclusion: a renewed role for research

Agricultural research can no longer claim its desirable contribution to development and, in the same time, satisfy itself from the production of technology, assuming that the efficiency of technology transfer depends upon factors that are not within its control, thus making researchers too comfortably justify their failures. This is of particular importance when situations are complex, such as places where farmers are not only depending on agricultural activities to make their livelihoods, where increases in production and productivity strongly depend on socio-economic constraints alleviation and where social or ecological sustainability is threatened.

The role of agricultural research is to translate and formulate into scientifically researchable issues questions arising from development problems. To address this challenge, the integration of technical, social, economic and spatial dimensions of the production process is necessary.

In addition to technology development and transfer, there is a need to produce knowledge and information regarding agrarian situations, production process and mechanisms for social, economic and technical transformation, conditions and pathways for technological changes and support. This confers to development oriented research three inter-related functions:

- An **analysis function**, through diagnosis of agrarian situations and of technical, economic, social and spatial factors which give rise to changes and through the production of models;
- An **experimentation function**, through testing of technical (off and on-farm), economic and organisational innovations, with the objective of producing knowledge regarding possible changes of the production process. Results should be related to experimental protocols and to the specific conditions of experimentation to deliver information and methods that can be used by extensionists and farmers after adapting them to their needs.
- A **planning function** to support stakeholders' decision making in order to help them to design, implement and follow-up technical and economic individual and collective "projects". This function includes: (i) the production and delivery of information regarding the current situation and possible

changes (diagnosis, mobilisation of available technical and economic information); (ii) the facilitating of stakeholders dialogue and creativity in order to design collective and public action to take place, thus promoting contractual relationship between private and public stakeholders; (iii) the monitoring of the activities and their impact through the production of references, in order to adapt/readapt the activities on a permanent basis.

Inter-disciplinarity is a necessary mode of organisation of development oriented research. Research has to consider, through system approach, different levels of social and spatial organisation and the interactions between them, from macro- to micro scale, namely:

- the regional and national scale (SADC, country, Province, large watershed, etc), at the level of which it is possible to analyse or promote policies and planning, infrastructures implementation, market organisation, demographic and migration patterns, and to organise public and private support services;
- the local scale (village, small watershed, etc), which is relevant to understand the production, consumption and marketing patterns, the mechanisms of common resources management (land allocation, grazing areas, water and wood resources, etc) and to plan and test possible interventions;
- the household level, at which the main economic and technical decisions are taken as far as agricultural production is concerned; it is relevant for

understanding the rationale of economic and technical choices by considering the whole farming system, and for testing innovations;

- the plot (or the herd) level (by extension the plant or the animal), at which it is possible to analyse and modify the technical and biological mechanisms of production.

From one level to the other, there are strong linkages: what is observed or promoted at one level is not independent of what is happening at the other. As a consequence, a specific issue can be dealt with at various levels. Nevertheless, it is impossible to define *a priori* the levels of organisation that are consistent and meaningful to explain and understand stakeholders' behaviours and practices and to design new activities (Caron, 1998; Caron *et al*., 1998). The analysis of the stakeholders' networks, their principles of organisation and their evolution is a first step to the identification of the relevant levels to consider, which might be undertaken by the study of changes along the time.

At each of the relevant levels, diversity and complexity are key elements. To design and test relevant innovations, it is necessary to understand the way stakeholders take their decisions to manage resources in order to reach their objectives (Landais & Deffontaines, 1990). This is the path by which research can produce operational information, which is not normative, but used as input by stakeholders in making their decisions.

There is finally a need to derive from local analysis and intervention information that can be used in other places and at other levels in order to satisfy expectations of rural development stakeholders to benefit from research

investment. The modelling of the knowledge acquired locally should in the future provide frameworks to address this challenge.

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