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Full Length Research Paper

Main-streaming participatory and cross-disciplinary approaches in animal science research in developing countries

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Conventional research approaches have lost considerable momentum after their astonishing achievements during the green revolution. The negative side of focusing rigorously on production improvement was eminent around 1980 and led to considerations of environmental, gender and equity aspects - making agricultural development much more complex than previously. In the search for new ways of addressing the persisting problems of food insecurity and malnutrition, new ways should be explored. Based on the experiences from three international, African research projects, the article argues the case of participatory action research and cross-disciplinarity as some of the key elements in future animal science research in developing countries. The benefits are outlined as well as the challenges for the researchers and the donor agencies.

Key words: Action research, agriculture, agro-forestry, animal science, cross-disciplinarity, developing countries, livestock systems, paradigms, participation, poverty.

INTRODUCTION

The need for change

In spite of the global trend of urbanisation, the majority of the world's population still lives in the rural areas, which serve as the source of most of the world's food. And in spite of decades of development aid and agricultural research as well as increased globalisation of food systems, there is still a pathetic (and in some places even increasing) state of poverty and food insecurity (Halberg et al., 2006; Knudsen et al., 2006). Even though yields

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List of abbreviations

ASPS- Agricultural Sector Programme Support; CNSF-Centre National de Semences Forestières; Danida-Danish International Development Assistance; DBL – Institute for Health Research and Development DIAS-Danish Institute of Agricultural Sciences; ENRECA - Programme for Enhancement of Research Capacity in Developing Countries; FAO-Food and Agriculture Organization; IA-Institute of Anthropology; IDS-International Development Studies; IRP-Improved Ruminant Production; KVL-Royal Veterinary and Agricultural University; LRSP-Livestock Systems Research Programme NARO-National Agricultural Research Organisation; PETREA- People, Trees and Agriculture; RandD-Research and Development ;

RasD-Research as Development; RfD-Research for Development; SUFR-Strategic Utilisation of Feed Resources for Small holder Dairy Production; UZ-University of Zimbabwe

of dairy cows, productivity in pig and broiler production have almost doubled over the last 40 years, this has mostly happened in the 'western' part of the world and in South East Asia. Most of the African agriculture[1] and large groups of smallholder farmers in other developing countries have been left out of this improvement (FAO, 2000). The gap between the most productive and least productive farming systems has increased twenty fold in the last 50 years. The reasons are many, e.g. poverty, population growth, low educational levels, limited access to knowledge of improved farming methods in combination with poor market linkages. Other important factors are wars, poor governance, climatic changes, epidemics and global trade imbalances, especially in agricultural products like food and textiles.

In areas with rapid economic growth, smallholder farmers are increasingly marginalised and out-competed (Delgado et al., 1999). The FAO (2003) foresee that many smallholder farmers will have limited possibilities for the purchase of manufactured fertilisers and livestock feeds due to their high costs relative to output prices, due to increased risks or simply due to unavailability. At the same time, there is an increasing demand for livestock products and this is projected to continue for the next several decades (Delgado et al., 1999; Rosegrant et al., 2001). This will open potential market opportunities for smallholder livestock farmers if they can find the link to the markets and produce at competitive prices and quality as well as meet the increasing bio-safety standards (Kristensen et al., 2004). Therefore it is highly relevant to conduct research on how to improve smallholders' livestock production using cheap and preferably locally available resources. However, many research institutions have been slow in responding to changes and are at present not adequately geared to address the prevailing development issues within livestock production in developing countries.

As it was recognised that agriculture production was multidimensional and intertwined with the socio-cultural context, research questions could no longer be properly addressed by using the traditional experimental and mono-disciplinary approaches. We contend that a new research paradigm is needed utilizing the potential of participatory action research and cross-disciplinary approaches.[2] The objective of this article is to contribute to further spreading of these ideas by presenting and discussing experiences obtained in three agricultural research collaboration projects in Africa.

Innovative research approaches: the trends

Participatory action research: ensuring relevance

The international breakthrough for a farmer-oriented approach came with the release of Robert Chamber's book, 'Rural Development. Putting the Last First' (1983). Within the area of farming systems research, the participatory approach means involvement of local farmers' and extension workers' knowledge and experience in problem identification, choice of solutions (typically technical or management oriented changes in the local farming systems) and adjustment of technology to local agro-ecological and socio-cultural conditions.

Action research[3] is an activity that aims at helping local people to solve an immediate, problematic situation and - at the same time - to build general knowledge through application of scientific methods (O´Brian, 1998). The aim is to move from the old Research and Development (R andD) paradigm (where the two activities were detached), via Research *for* Development (RfD) to a new Research *as* Development (RasD) paradigm (where the two activities are joined).

Action research typically starts with a diagnostic phase involving relevant stakeholders in the analysis of the problematic situation and subsequent ideas for potential improvement are developed in collaboration with the stakeholders, and an action plan is made based on consensus within the stakeholder group in the farming systems researched. While the stakeholders implement the selected interventions, researchers help monitoring the systems in a planned and systematic way that ensures the best possibilities for interpretation of the results. Based on the researchers' and the stakeholders' observations, the first cycle ends with reflections on the outcomes of the interventions and a new description of the system. If the problems addressed are not entirely solved or other problems have arisen, a new cycle of problem identification, planning of interventions, action and observation and reflection is carried out (O´Brian, 1998; Wadsworth, 1998).

From a traditional research point of view, participatory action research has two major challenges:

[1] This includes animal husbandry, soils science, forestry, horticulture, aquaculture and natural resources management.

[2] The call for changes in research approach and methodology is by no means new. It was debated already in the 1970s as research questions within agriculture became increasingly more complex leading to an increased interest in 'farming systems research' approaches.

[3] Though the two concepts are closely interlinked, action research may or may not be participatory.

- The problem of personal involvement of the researcher in the process (Alrøe and Kristensen, 2002).
- The problem of generalisation of results (van de Fliert and Braun, 2002).

The former is based on the concern that the researcher is so involved in the change process that she/he can not keep an 'objective' perspective. The latter concern questions the ability to replicate the results. The fact that action research focuses on actual problems in their context (complex social and agronomic systems) is a challenge when trying to generalise, which is an important purpose of conventional science. However, several ways of generalising participatory action research can be mentioned. Defoer et al. (1998) try to generalise methodologies (e.g. how to use indigenous knowledge of soil fertility) and Gladwin et al. (2002) present a method to quantify farmers decision making vis-à-vis adoption of agro-forestry by establishing decision trees based on statistical testing. Kristensen et al. (1997) develop tools in relation to decision aids for advisors and models for researchers. Snapp et al. (2002) assess different types of inference from on-farm controlled experiments (e.g. comparing feeding levels, breeds or varieties). However, a detailed discussion of the pros and cons of case studies is beyond the scope of the present article.

In essence, participatory action research serves the main purpose of ensuring relevance to the smallholder farmers' day to day problems.

Cross-disciplinarity: providing better answers

Problems are usually multidimensional and interlinked. Pursuing solutions calls for application of combined methodologies as well as mobilisation of new areas of expertise and application of theoretical frameworks which transcend traditional professional boundaries.

Cross-disciplinarity is perceived as a cover term for different types of disciplinary collaboration. According to King and Brownell (1966), a discipline can be seen as a complex phenomenon with social as well as cognitive aspects, "a community, a network of communications, a tradition, a particular set of values and beliefs, a domain, a mode of enquiry, and a conceptual structure". Rosenfield (1992, 1351) distinguishes between three different levels of cross-disciplinary collaboration:

Level one

Multidisciplinary. Researchers work in parallel or sequentially from disciplinary-specific base to address common problem.

Level two

Interdisciplinary. Researchers work jointly but still from disciplinary-specific basis to address common problem.

Level three

Transdisciplinary. Researchers work jointly using shared conceptual framework drawing together disciplinary-specific theories, concepts, and approaches to address common problem.

When engaging in cross-disciplinary work, it is advisable from the onset to define the intended level of integration. Some of the research projects that claim to be interdisciplinary probably only reach the multidisciplinary level while truly transdisciplinary research is seldom seen. However, as pointed out by Aagaard-Hansen and Ouma (2002) there is a dynamic process within a (long-term) research project whereby the collaboration may gradually develop from multidisciplinarity to interdisciplinarity or maybe even transdisciplinarity.

A cross-disciplinary approach can provide more useful answers to the pertinent problems of the smallholder farmers because it applies a more holistic view. More-over, collaboration between different disciplines increases the possibility of raising new and innovative research questions and provision of cross-fertilisation in terms of methodologies and theories of direct academic benefit per se (Aagaard-Hansen, 2003; Gausset, 2004).

According to Aagaard-Hansen (2003), the challenges of cross-disciplinary work fall within two different domains: intra-project issues (relating to the individual scientists' different backgrounds leading to different perceptions of ontology, epistemology and research ethics), and extra-project factors referring to structural issues beyond the control of the individual project.[4]

In essence cross-disciplinary research serves two purposes, to provide more practically applicable results and / or to nurture more interesting research per se.

Three Cases: Exploring New Ways

In the following, three case studies will provide a basis for

[4] The 'extra-project' challenges, which often hamper efforts to work cross-disciplinary, relate to levels beyond the influence of individual researchers and projects. These are contextual and usually constraining factors such as organisational structures of institutions of higher education, career structures and donor agencies' ability to assess and evaluate cross-disciplinary research proposals as well as their readiness to pay for the additional cost and time entailed by cross-disciplinarity (Becher and Trowler, 2001; Aagaard-Hansen, 2003).

further discussion of challenges and benefits of participatory action research and cross-disciplinary collaboration. The three case studies were all implemented in Africa and were funded by the Developmental Research Council in the Danish International Development Assistance (Danida). In 2002 a workshop was held in Arusha, Tanzania, where researchers from the three projects met to discuss their experiences. The following presentation and analysis draws heavily on discussions and results from this workshop (Larsen et al., 2002).

"Improved ruminant production" (IRP) in Zimbabwe (1990-2000)[5]

Institutions involved

Department of Animal Science, University of Zimbabwe (UZ), Harare, Zimbabwe
Department of Animal Science and Animal Health, The Royal Veterinary and Agricultural University (KVL), Copenhagen, Denmark
Danish Institute of Agricultural Sciences (DIAS), Tjele, Denmark

Objectives

The general objective was to improve livestock production and productivity of communal land in Zimbabwe**.**
The specific objectives were to:

- Support projects in the communal areas in Zimbabwe with the aim of improving livestock productivity
- Provide assistance from KVL/DIAS to postgraduate training in Zimbabwe and opposite
- Provide short term training of UZ staff in Denmark
- Provide assistance from KVL/DIAS in establishing research facilities at UZ Mutually to give seminars at the involved institutions, on topics related to animal science and production
- Support publication and the distribution in the communal areas of the knowledge gained through the research cooperation

[5] The project was one of the first projects funded through Danida's Programme for Enhancement of Research Capacity in Developing Countries (ENRECA). The goal of this programme is to strengthen the research capacity of developing countries aiming at (i) supporting research of significance for social and economic development, (ii) improving the capacity for utilizing the results of international research, and (iii) improve the quality and the relevance for the surrounding society of teaching at the universities.

Background and implementation process

In 1990 Zimbabwe had only experienced ten years of independence and the research focus as well as the course curriculum of UZ (reflecting a traditional positivistic and reductionistic scientific worldview) was still to a large degree oriented towards the large commercial and predominantly white owned agricultural production sector. At KVL, radical changes in the approach to teaching were taking place during late 1980s and early 1990s. During this period the university went from a classical lecturing curriculum to more problem-based learning giving a greater responsibility to the students for their own learning process. In spite of this development, research at KVL was still mainly based on traditional approaches.

The research focus during the initial phase (1990-93) of IRP was primarily supply driven and farmers, when involved, played a rather passive role as 'technology testers'. The research was mono-disciplinary and mainly concentrated on nitrogen metabolism and cattle feed evaluation reflecting the focus of the research team. This initial phase was a learning period for all the involved institutions and scientists. During the first phase the farmers were not too happy with the role they had been given. Therefore, more active involvement of farmers, especially in the farming system part of the research, was initiated. During the second phase (1994-97), the research agenda was broadened considerably to include milk production, draught power, reproduction and also farming system research - the reason for this mainly being the inclusion of new students and scientists both in Denmark and Zimbabwe. Also links to other activities in the region was strengthened in this phase, especially Sokoine University of Agriculture in Morogoro, Tanzania, where KVL had been involved in institutional capacity building during the 1980s. In addition, links were made to other livestock oriented ENRECA projects. Gradually the project became more participatory, action oriented and cross-disciplinary than in first phase.

In the third phase (1998-2000) research moved from being primarily supply-driven to much more demand-driven. At the same time the farming system approach came more into focus. Farmers themselves initiated research committees in the different research sites. Through improved dialogue, farmers revealed that among other things poultry and small ruminants were higher priority for them than cattle feeding.

Central participatory and cross-disciplinary lessons learnt

It took time to change attitudes and behaviours of the involved scientists towards accepting that a system-oriented approach presupposes formation of cross-disciplenary research teams, and that true participation of farm-

ers is a prerequisite for conducting relevant applied research. The changes in attitudes and research approaches were seen to be at least as important as the production enhancement achieved by the project.

Despite enhanced dialog with the farmers throughout the project's lifetime, it is still questionable if the change in focus also brought an adequate change in level of participation from all actors. Thus, the change of research focus following the participatory approaches was not followed by a similar change in the involvement of research expertise and establishment of cross-disciplinary teams. The core scientist group remained the same throughout the project with overlapping competences. Funding did not allow involving additional scientists and none of those already involved in the project were interested in leaving to give room for new profiles. Only on the students' (MSc and PhD) side, there were new profiles like system researchers and agro-economists engaged.

"People, trees and agriculture" (PETREA), Burkina Faso and Tanzania (2001-2005)

Institutions involved

Centre National de Semences Forestières (CNSF), Ouagadougou, Burkina Faso Faculty of Forestry and Nature Conservation, Sokoine University, Morogoro, Tanzania Centre for Forest, Landscape and Planning and Department of Animal Science and Animal Health, Royal Veterinary and Agricultural University (KVL), Copenhagen, Denmark Institute of Anthropology (IA), University of Copenhagen, Copenhagen, Denmark International Development Studies (IDS), Roskilde University, Roskilde, Denmark

Objectives

The development objective was to secure and improve the livelihood of rural people in the selected countries in Africa by adding to their agricultural production in a sustainable manner through increased use of trees and shrubs. The specific objectives were to:

- Contribute to an increased understanding of rural people's utilisation of trees and shrubs in specific localities in the selected countries
- Develop and test locally adapted techniques and strategies of how to bring trees and shrubs into wider use by rural people according to their needs and priorities
- Strengthen the Danish resource base by promoting an interdisciplinary approach to research in people, trees and agriculture

Background and implementation process

From its outset, PETREA was defined as an action research project and was planned to be conducted in cross-disciplinary teams mixing natural and social scientists and involving Burkinabe, Tanzanian and Danish researchers. It had a strong participatory focus and the ambition to work in close collaboration with local farmers.

The project consisted of two phases. The first phase (2001-2002) aimed at identifying opportunities and constraints for improving the use of tree products, and the second phase (2003-2005) at designing solutions to identified constraints. A third phase to test the suggested solutions was never implemented due to changes in Danida's priorities and lack of funds.

During the first phase a number of different data recording methods were applied reflecting the various disciplines' research traditions and their focus on different dimensions of the overall theme. A number of interviews were carried out including tree ranking exercises. Other data recording included the collection of manure and establishment of botanical inventories in order to evaluate the feeding of livestock. The many participating disciplines were reflected in the very high number of different data recording methods covering the same topic, namely the types of trees and shrubs being the most important in the villages. Cross-disciplinarity was attempted in the data-recording phase by co-ordinating the schedules so that socio-economists and natural scientists were present in the villages in the same weeks and had daily discussions of methods and results.

During the second phase, some researchers started devising solutions to the needs and problems identified during the first phase. In Burkina Faso, after presenting the result of the first phase, they were also asked to address problems that no researcher felt qualified to study, such as the problem of commercialising mango and cashew. As the first phase had been very short, and as new researchers were integrated in the team, most participants continued to study or get more knowledge on identifying needs and problems. However, some never reached the point where they felt confident to suggest and try some solutions. If the first phase was characterised by common fieldwork of the whole team and intensive cross-disciplinary discussions, the second phase was characterised by fieldwork in smaller groups or solitary, partly because of the difficulty to organise common fieldwork of bigger groups, and partly because of the variety of problems that had to be addressed. In addition, scientists focused on the problems that were closer to their own field of expertise.

Central participatory and cross-disciplinary lessons learnt

The teams of researchers met a number of challenges

due to the participatory and cross-disciplinary ambitions. An initial challenge was to agree on how much information could be assumed from previous mono-disciplinary studies, and how important it was to start from scratch without any prejudice. Moreover, the level of involvement of local African scientific partners (with a traditional mono-disciplinary background) in determining the direction of the research was discussed. Different strategies were applied. In Burkina Faso, the team started afresh to identify tree needs with a variety of methods. In Tanzania, however, the research was more in line with existing experiments on tree boundary planting.

Research design constituted another area of discussion. Should researchers make detailed research plans before going in the field, running the risk that these would be ill-suited to local needs, or is it acceptable to go 'unprepared' but 'open-minded' into the field and improvise, considering the local context? To avoid conflicts, a tacit agreement developed that each researcher should prepare her/his research as she/he wished and that it would be judged on its results. This led to a certain overlap in research, but it also allowed researchers to triangulate their data.

Researchers differed in commitment regarding practical application of research findings. Some scientists preferred to limit their contribution to fundamental research. Others made suggestions, but did not commit themselves to try them in the field, running thereby the classic risk of making 'top-down' advices that were ill adapted to the local context. Yet others tried to turn their suggestions into practice, and to test them in the field in order to be able to gain first-hand knowledge of the feasibility of their solutions. An important lesson learned was that the more researchers commit themselves to work together with the farmers to solve their problems, the easier it was to work in cross-disciplinary teams; and the more 'participatory' their research would be, the more it resonated with local needs. Yet, the lack of commitment or the uneasiness of some researchers to engage in action research and be accountable to local farmers led to a slow drifting apart of the different researchers, who engaged increasingly in mono-disciplinary research which was difficult to integrate in a holistic vision to solve problems.

"Strategic utilisation of feed resources for smallholder dairy production" (SUFR) in Uganda (2000-2002).

Institutions involved

Department of Animal Science (DAS), Faculty of Agriculture, Makarere University, Kampala, Uganda Namulonge Research Station, National Agricultural Research Organisation (NARO), Ministry of Agriculture, Uganda Livestock Systems Research Programme (LSRP), Agricultural Sector Programme Support (ASPS), Danida Danish Institute of Agricultural Sciences (DIAS), Foulum, Denmark

Objectives

The development objective of the 'Livestock Systems Research Programme' (LSRP) was to increase productivity and income that smallholders, both men and women, derive from environmentally sustainable agricultural production. The immediate objective was to develop appropriate technologies adapted to Ugandan agricultural production for improved animal husbandry management, animal nutrition and animal health. The specific objectives were to:

- Characterise smallholder dairy production systems
- Verify feed inadequacies (identified through district diagnostic survey of 1999)
- Improve the feed resource base
- Provide models for replication

Background and implementation process

Danida included the LSRP as part of the first phase of the ASPS in Uganda. The idea was to build capacity in farming systems oriented research and competences of on-farm research methodology within the existing livestock research institutions in Uganda. The project on small holder dairy production systems was one of the first atempts of the NARO researchers to carry out action research based on farm studies. The NARO staff in collaboration with local extension staff carried out the main part of the research whereas Danish researchers contributed with technical and methodological expertise. The project had a strong element of research capacity strengthening.

An initial problem identification phase led to a focus on the lack of feed for the dry season where milk prices are high (Mubiru et al., 2001). After consultation with local extension workers and farmers, it was agreed that the project should aim at finding solutions for improving the feeding in the dry season suitable for use by the smallholders and that this testing should be done on a number of small farms in Masaka. Farmer involvement was seen as crucial and a number of farms were selected for testing each of four interventions including the use of intercropping elephant grass and legumes for improved protein supply.

The participatory approach consisted of involvement of farmers in the problem identification process, selection of interventions and assessment and evaluation of the tested technologies. This approach ensured that inappropriate technologies could be filtered out at an early stage and it facilitated a rapid adaptation process for the propo-

sed interventions and led to a rapid detection of unforeseen problems.

Central participatory and cross-disciplinary lessons learnt

The project included a feedback workshop with the farmers commenting on results, lessons learnt and – not least – what problems they would like the project to solve in the future (Mubiru et al., 2002). The results of the project increased knowledge among farmers (e.g. record keeping and management) and led to more interaction between farmers and extension officers and researchers as well as among farmers themselves.

An independent assessment of LSRP (Laker and Bashasha, 2004) found that the participating farmers evaluated the smallholder dairy project positively and were happy with the results even though not all the proposed changes were economically attractive from farmers' point of view.

Another cycle of planning and interventions would have been preferable in order to fully utilise the results, but this was not feasible at the time.

The project was cross-disciplinary from the onset, involving fodder production agronomists and specialists in livestock production and feeding. The fact that these researchers worked together in the problem identification phase and visited farms together was one of the reasons for the identification of appropriate technologies that were feasible from both agronomic and livestock science viewpoints. In particular, the use of simple farm level models integrating the different disciplinary knowledge (in this case the potential fodder production and the fodder needs and resulting milk production integrated in a spreadsheet) helped to create a mutual cross-disciplinary understanding of the most relevant interventions. However, the project would have benefited from closer collaboration with socio-economists and marketing specialists, who might have helped to test other marketing strategies and the economic importance and limitations of the proposed interventions. In the process, the researchers were conscious about the challenge of generalizing participatory action research.[6]

The project was followed up by two separate projects, one which continued the specific research in appropriate fodder production technologies (Kabirizi et al., 2004), and one which focused more on comparison of different small-holder dairy systems and their economic and nutrient accounts (Halberg et al., 2004).

Challenges and benefits

All three cases provide examples of the challenges and benefits experienced as researchers with mono-disciplinary backgrounds engage in cross-disciplinarity and participatory action projects. Put simply, we contend that these two approaches pose a number of challenges during the various stages of the research process, whereas the potential additional benefits appear mainly as outcomes of the research projects in terms of solutions to practical problems and/or innovative research findings. The main points are summarized below (Table 1).

The three research projects differ as to how participatory action research approaches and cross-disciplinarity were applied. From the outset the IRP project in Zimbabwe was mono-disciplinarily planned, but during the implementation a demand for action research and cross-disciplinarity emerged. The PETREA case was explicitly designed to rely on such approaches, though the there was a trend towards mono-disciplinary research. From the start the SUFR project in Uganda involved some degree of cross-disciplinarity, and action research was stressed in terms of on-farm experimentation.

Challenges

Problem identification and project planning

The three projects had different aspirations as to the level of local involvement in the planning. The IRP case shows an example where the 'problem-owners' were increasingly involved in defining the research problem as the project adopted a farming systems perspective and farmers' participation was enhanced through research committees. This development, which was possible due to the long time span of the project and flexibility of some of the researchers, was perceived to enhance project relevance and lead to more applicable results. The PETREA project shows how 'local needs' may constitute may constitute a significant challenge to cross-disciplinary research, for instance whether villagers should tell researchers what to study, and if they should be allowed to decide that some

[6] Different dimensions of generalisation were achieved in the LSRP in Uganda (Kimmins et al., 2004): (i) up-scaling and spreading of new inputs (e.g. new poultry breeds and vaccines); (ii) up-scaling and dissemination of generic systems (e.g. introducing new zero grazed goat keeping including stables and feed supply strategies); (iii) generalising technical solutions for specific types of livestock systems (e.g. the applicability of using maize Stover and lablab feeding in zero-grazed dairy systems through farmers leaflets, etc.); (iv) generalising working methods and improved daily farm management (e.g. simple ways to observe livestock health status and assessing the needs for treatment); (v) improving scientific knowledge regarding the biological, technical and socio-economical characteristics of smallholder livestock systems (e.g. the degree of diseases, the profitability of different interventions, etc.).

Table 1. Main trends of participatory action research and cross-disciplinary aspects in the three cases.

		IRP (Zimbabwe)	PETREA (Burkina Faso & Tanzania)	SUFR (Uganda)
Participation	**Time line**	Introduced gradually	From start	From start involvement in initial problem analysis and subsequent in choice of intervention
	Challenges Problem identification and project planning Project implementation	The research focus changed following demands expressed through participatory approaches. Similar changes in the involvement of research expertise were only partly achieved	Conflict of interests in local community Need for researchers to engage in local community. Conflict of interests between research and development interests	Research focus strongly influenced by the initial livestock feeding viewpoint among the participating researchers Involving farmers in selecting methods to test and still get publishable and balanced results
	Benefits	It became a more mutual learning process and collaboration with farmers greatly improved. More relevant improvements developed in breeding and feeding Researchers learned new skills	Research driven by farmers' needs and wishes. But phase 3 (application of results) was never funded	Increased knowledge of farmers and collaboration with extension workers. Improved feeding products. Increased enthusiasm among farmers. Farmers' experiences and problems addressed during the research process, more rapid adaptation
Cross-disciplinarity	**Time line**	Started mono-disciplinary, later wish to establish cross-disciplinarity only materialised on student side (not scientist)	From start, between social and natural science	From start, between agronomists and livestock specialists (gender aspects included but specialists not well integrated)
	Challenges Problem identification and project planning Project implementation	The old team of scientists did not want to leave to give room for new disciplines. No budget for adding more disciplines	Many, from design of study to ways of doing fieldwork and devising solutions Time consuming	Problematic issues interpreted from narrow viewpoint of crop-livestock interaction Little extra expertise was included during the project implementation even though more disciplines were needed (specialists in marketing and economy)
	Benefits	Improved ability to meet the broader priorities of farmers. Researchers learned new skills	Holistic approach, avoiding common disciplinary prejudices.	Improved mutual understanding between livestock and agronomy researchers

researchers were unnecessary, and ask them to be replaced by other people specialised in topics that were more useful for local needs. The fact that the disciplinary composition of the PETREA team was chosen in Denmark before the project started precluded this possibility. The PETREA team has drawn the attention to the definition of the term 'community'. Could the chief or the village council legitimately take decisions for the rest of the village? Could researchers build their research on the apparent consensus attained in a village meeting attended by 5% of villagers? Since migrants and women were seldom represented in such institutions, the PETREA researchers adopted participatory methods to ensure talking to all interest groups. But this raised another type of problem, as differentiating different local interests meant getting involved in local power struggles between existing social groups (Gausset, 2005; Gausset et al., 2005).

In the SUFR case, initial problem analysis was based on consultation with local extension workers and farmers. Although this approach may not be perceived as high-profile participation, the subsequent on-farm involvement and obtained results were evaluated positively by farmers. During the problem identification phase some of the farmers had also pointed to other problems in their farming activities, especially the poor market access and the unstable prices. The agronomists and livestock researchers 'interpreted' this problematic issue into a question about improving milk production in the dry season, where prices were higher, using fodder conservation. This made the problem researchable from their viewpoint and expertise. While this was entirely relevant and provided some sustainable solutions, this focus did not in reality address the marketing problems involving economists or other marketing specialists in the research. A truly cross-disciplinary effort would have needed extra resources, which were not foreseen in project budget.

There is a need to involve the poorest farmers in the research process in a realistic way, not least in the problem identification phase. The general experience in the three projects was that the majority of farmers could not set research priorities on their own, but could prioritise their needs with assistance from researchers or extension workers. Their involvement could come through a process like the one described for action research in the SUFR project and some of the sub-studies of IRP.

Project implementation

From all three cases it is obvious that working within a participatory and cross-disciplinary project is a time consuming and conflictive endeavour.

In IRP, the idea of working participatory was not so difficult to accept for the involved scientists because they clearly saw the need for learning from the farmers and other stakeholders. In the first phase farmers seemed at times obstructive to the research activities planned and executed by the scientists, either because farmers did not understand the purpose or did not feel that it was in their interest. Gradually involving the farmers more actively and already in the planning process cleared a lot the frustration away and led to a shift in research focus more in line with farmers' priorities. Although that let to a poorer match between the involved scientists' competences and the actual research agenda, no changes happened in a team of scientists involved. Instead the mismatch was partly compensated by involving both Danish and Zimbabwean students with different research backgrounds and disciplines. Due to the phased nature of the project, there was opportunity for making change in the core team of scientists to better reflect the multi-dimensional nature of the on-farm research. However, the original team of scientists wanted to continue as a team which left very little financial and intellectual room for new scientist from different disciplines to join in as full team members. Contact was made to other scientists, but the openness to changes was too limited to be attractive. The flexibility and ability to work outside the frame in order to understand the complexity of the problems and target research better to the 'farmers' needs were somewhat limited in the final stages of the research project due to the mono-disciplinary character of project management team.

The PETREA project had to be implemented within a relatively short time with *a priori* defined team of researchers. In short term, phase-funded projects like the PETREA, researchers have an incentive to demonstrate the vital necessity of precisely their discipline in the later phases of the project. During the data collection in the PETREA project schedules were co-ordinated so that socio-economists and natural scientists were present in the villages in the same weeks and had daily discussions of methods and results. This approach was seen as fundamental to enhance integration between scientists and is highly recommended (Gausset et al., 2003; Gausset, 2004). The PETREA project experienced difficulties in establishing a common database with access for all participants including the local researchers. Issues of data rights should be dealt with before starting the data recording.

In PETREA it was assumed that focusing on a common problem and common solutions would force scientists to collaborate with one another to understand a complex reality and would force them to collaborate with local smallholder farmers to address real problems in a useful way. In practice, lack of commitment to and difficulties associated with action research led to different researchers increasingly engaging in mono-disciplinary research. Because all project resources were bound (divided among participants) at the beginning of the project, it was difficult to change the balance between disciplines (or introduce new relevant disciplines) in the second phase. This has partly to do with the demands from the donor for

very detailed research plans at the outset of the project, which was not compatible with the participatory and explorative approach attempted in PETREA.

In PETREA, the researchers discussed to which extent the researchers should have developed full fledged protocols before going to the field. This is a concrete example of the challenge of harmonizing different disciplinary methodologies, but also of the potential benefits in terms of data triangulation.

The cross-disciplinary design of PETREA led to a situation where the effort of simply co-ordinating the different researchers' field studies and combine the results was immense. This left few resources to involve the local stakeholders in the overall problem definitions and selection of interventions to be tested and it points to the importance and complexity of project management.

The evaluation conducted within SUFR (Laker and Bashasha, 2004) identified a number of factors which supported the sustainability of the efforts. The farmers were involved fully in the implementation of the project, and there was a discernible feeling of ownership. The research area and subsequent interventions were high priority to most of the farmers. New knowledge built upon indigenous knowledge that the farmers already had. District production officials were involved in the selection of the project site and the beneficiaries. On the negative side some of the 'control farmers' did not fully understand why they were involved in the project.

Benefits

A critical point in applied research is to ensure adequate reporting back to 'problem-owners'. In IRP the dissemination was initially mainly in terms of published scientific articles and changes in university curricula. By end of the second phase, the results were presented to and validated through discussed with farmers, while involvement of the extension service was low. Sustainability was not obtained due to the political instability and later chaos in Zimbabwe following the land reform process which coincided with the last phase of the project. In IRP the approach went from using farmers as 'technology testers', over being in passive dialogue to changing the research priorities to follow farmers' needs. A more long-term dissemination took place when the Zimbabwean, former Ph.D. students took up senior positions in the national agricultural research and education system in Zimbabwe. It can be said that the IRP project went from a Research and Development (R and D) approach to a Research for Development (RfD) approach, but never reached nor intended to reach the Research as Development (RasD) approach.

The PETREA experienced problems with the reporting of findings of the first phase back to the stakeholders in order to get their feedback in time to influence on the second phase. Lack of clear distribution of responsibility and resources as well as the late and weak involvement of the local researchers were seen as major reasons. In PETREA there were different attitudes to how much the scientists should engage themselves in the change processes. Some scientists preferred to limit their contribution to fundamental research. Others made suggestions, but did not commit themselves to try them in the field. Yet others tried to turn their suggestions into practice, and to test them in the field in order to be able to gain first-hand knowledge of their feasibility. Thus, the project encompassed the whole range from RandD to RasD. It is important that project priorities and researcher obligations be clearly negotiated at the outset.

The assessment of SUFR highlighted the fear that the technologies would not spread among new farmers due to lack of extension staff and difficulties in procuring the legume seeds for the crop mixtures (Lasker and Bashasha, 2004) - challenges that might be taken up by the strategy for improved farmer extension in Uganda[7]. In SUFR the researchers became very involved with the specific farmers and solving their problems and only in the second project phase were generalised results achieved. In SUFR there was a commitment to RasD, which led to some of the positive results for the participating farmers (such as better overall management).This also points to the tension inherent in (participatory) action research between solving concrete local problem and the need to generalise the findings for use by others later with the aim of developing well functioning technologies (Kimmins et al., 2004). Involving extension workers directly in the research process, as in SUFR, increase the likelihood of dissemination and spread of results.

In general, participatory action research and cross-disciplinarity is relatively time consuming. This also applies to the dissemination of results. In the PETREA case the lack of funding for a third phase led to failure to implement some of the developed solutions. Also in SUFR the time frame constituted a limitation to proper generalise results and ensure dissemination.

In both IRP and PETREA it was stressed that it was to a significant degree a learning process for the involved researchers on how to organise and benefit from cross-disciplinary collaboration. The PETREA project indicated that these personal and professional competences can only be developed through practice.

[7] This could also have been attained using participatory extension efforts such as farmer groups either as local organisations or in the form of farmer livestock schools, where farmers meet regularly to discuss and learn to observe and evaluate their systems and thereby start to raise their own questions to investigate (Minjau et al., 2003).

The way forward: towards a new paradigm

When successful, participatory action research and cross-disciplinary provide significant benefits. The research questions are relevant to the small-holder farmers and the research team composition provides a higher chance of getting useful answers. In addition the presence of a mix of disciplines may nurture a more inspiring and innovative research environment. However, the approach also entails several challenges. Below we list the main points as seen from researchers' and donors' perspective**.**

Challenges for the researchers

For researchers to plan and conduct cross-disciplinarity and participatory action research it is important that:

- The 'rules of the game' for being part of the project be negotiated and agreed upon up front.
- It should be recognised that involvement in cross-disciplinarity and participatory methodologies demand an open and flexible attitude and willingness to transcend traditional professional boundaries in terms of methodologies, paradigms and disciplinary ideologies.
- It should be recognised that cross-disciplinarity and participatory methodologies are very time consuming.
- Projects should be designed in a flexible way allowing for shifts in focus, disciplines and participants as the project evolves.
- Research managers should strive to create a conducive project environment, where information flows freely and the researchers can interact in all phases.
- It may be useful to liaise with a senior colleague who has experience with such kind of research and who may serve as a facilitator.

Challenges for the donors

For donor agencies to facilitate such projects, we recommend the following:

- The donor should be prepared to allocate the necessary additional funds and time to allow the researchers to conduct the projects successfully. This applies to all phases of the research projects.
- The donors should be prepared to accept proposals which are less detailed and pre-determined than usually required. Otherwise genuine involvement of 'problem owners' and establishment of a well-functioning cross-disciplinary team may be hampered.
- Venturing into this field entails a certain amount of risk taking in the sense that such projects are relatively more complex and difficult. On the other hands the benefits of a successful project are relatively larger.
- The donor agency should have access to appropriate evaluation competence in the selection and evaluation phases.

It is our hope that practitioners, researchers and research institutions within the field of animal science research in developing countries will take up the challenge and engage themselves in this demanding but rewarding field, and that the donors will appreciate the special circumstances related to these projects and adapt their demands accordingly. We contend that this will lead to research findings which are both more interesting and more useful. And we believe that it will provide an important contribution to ameliorate the prospects of small-holder farmers and thereby food insecurity.

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