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Review

Challenges encountered in conducting farmer-oriented livestock research among resource-limited farmers of Sub-Saharan Africa: A review

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Improvement of livestock productivity through on-farm research leads to the availability of animal protein and hence improved food security. On-farm research is associated with several challenges; chief of which is lack of initiative from the farmers participation. The objective of the review was to outline challenges faced by researchers as they conduct research on livestock in communal areas of Sub-Saharan Africa. On-farm research, however, is associated with several challenges; chief of which are lack of initiative from the farmers. Working in remote areas, culture, language barriers, high personal time of communication, risk of losing animals, lack of appropriate data analyses and administrative structures are some challenges that researchers should await as they plan to conduct on-farm studies. Efforts should be made to minimise the impact of these challenges to improve the quality of livestock research in communal areas and enhance rural development through livestock-based programmes.

Key words: Active farmer participation, on-farm research, poverty reduction.

INTRODUCTION

By 2050, the global population is projected to be 50% larger that at present (Alexandratos, 1999), resulting in the doubling of global food demand (David et al., 2002). Nearly 200 United Nations member states and at least 23 international organizations have collectively acknowledged such a challenge by setting up millennium development goals to be achieved by 2015, with the eradication of extreme poverty and hunger especially in the communal areas (Garforth et al., 2005) being one of the main goals. Poverty reduction could be accomplished by enhancing sustainable livestock productivity through, sustainable demand-driven research. To the resource-poor farmers, livestock provide meat, milk, eggs, wool, hides, manure, draught power and income from sales of the animals and their products. Animal food products, such as meat, milk and eggs raise the quality of the mainly cereal-based diets of poverty stricken livestock-keepers, because they provide readily digestible, high-quality protein and energy, as well as essential micronutrients (Kitalyi et al., 2005). Livestock manure fertilizes soils exhausted by continuous cropping. Draught animals permit land to be cultivated on time with less human drudgery and the easing of draught animals generates income for the resource-poor farmers. In some instances, draught animals are also used for transportation (Chimonyo et al., 2002). It, therefore, is imperative to improve livestock productivity in communal areas through on-farm livestock research with farmer participation (Pastures Network for Eastern and Southern Africa/African Research Network for Agricultural By-products (PANESA/ARNAB, 1990; Franzel et al., 2001). Improvement and hence sustainable livestock productivity will increase the availability of animal protein for consumption and sales of animals and their products for the betterment of the farmers' livelihoods.

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Involving farmers in research and development is one sustainable way to achieve the primary millennium goal. Conducting livestock research in communal areas, where over 65% communal farmers in Sub-Saharan Africa (Kitalyi et al., 2005) experience extreme poverty and hunger, uplifts the livelihoods and welfare of the actual beneficiaries, since most resource-poor farmers keep livestock which are valuable assets to them. On-farm research refers to trials conducted in farmers' fields or settings outside research stations, with the active involvement of the farmer (Ramachandran, 1993). It is a systematic approach of evolving and adopting technologies by the community members (Tan, 1985) or a process where farmers act as subjects who conduct investigations, measure and record the findings in collaboration with researchers in the designing and implementation of an experiment or monitoring programme (Ashby et al., 1987). This is for the benefit or improvement of farmer livelihoods. Farmers are also actively involved in the analysis, interpretation, communication and application of the results (Lawrence *e*t al., 2007; Engstrom et al., 2010). On-farm trials, therefore, generate realistic and relevant data for willing farmers to adopt the developed technologies (Ben and Smith, 2008) that are likely to lead to sustainable livestock production.

Resource-poor farmers have invaluable indigenous knowledge relevant to their local conditions (Barrios, 2008), which should be tapped. The farmers provide pertinent information concerning the citing of the studies before designing an experiment and/or trials (Bessette, 2004). Farmers can assist researchers by participating in the selection of willing individuals to incorporate into the study and, in provision of production practices in the area and possible threats to the study. Incorporation of farmers who are socially marginalized makes them realize that they are important as the value of their ideas and experience is confirmed, and such farmers are likely to remain committed (Burfisher, 2002) throughout the experimentation phase and beyond.

On-station research, on the other hand, attempts to significantly minimize experimental errors emanating from farm differences (due to social, cultural and economic factors as well as from soils and climatic influences) as a way of improving accuracy of the technological variable(s) under consideration. Controlled experiments however mask several of the real, on-farm factors that affect the response of the technology under test, prior to adoption by farmers. The major assumption made when conducting on-station research is that farmers will adopt the packaged technology from on-station trials regardless of other contributory factors to farmer situations (Franzel et al., 2001). It therefore entails that if farmer adoption of technologies is anticipated, on-farm research should be the tool of choice. Ben and Smith (2008) have argued that there is little point in using resources for testing and promoting a technique that farmers cannot adopt. In addition, the pluralistic approach brought about by the on-farm methodologies ensures that livestock based experiments are assessed within the complex and interrelated agricultural enterprises that the farmer is found in. This indicates that the performance of livestock is assessed in the real setting, thereby enhancing sustainability (Ikerd, 1993). Moreso, with problems of disseminating information due to shortages of extension officers, on-farm research becomes a research method of choice (Byerlee, 1996). There are, however, several challenges enshrined in on-farm livestock research. This paper describes challenges faced, offering solutions where possible, by researchers as they use on-farm research as a tool for research and development, largely among the resource poor. The paper is based on examples, cases and experiences encountered by researchers from Sub-Saharan Africa.

LIMITATIONS OF ON-STATION RESEARCH AND THE EMERGENCE OF ON-FARM RESEARCH

In the 1950s and 1960s, the Agricultural Research Stations (ARS) and universities of many countries were using the transfer of technology (TOT) model as the standard in disseminating agricultural information. The model calls for delivery of research findings, after conducting on- station experiments, from scientists to the extension agent, who will, in turn, package the information for the farmer (Stroul et al., 2009). For example, livestock extension officers might focus on delivery of services such as artificial insemination, which might be their major priority, instead of conducting research on improved management practices as livestock farmers might be facing production practices and marketing constraints (Barton and Reynolds, 1996).

The Department of Veterinary Services, in most countries, has historically not undertaken extension advisory work, focusing instead on provision of emergency health care services. The services are offered by animal health assistants who are often insufficiently supported, and supervised by a veterinarian (Leonard, 2000). The TOT is a unidirectional process, associated with dissemination of findings from on-station experiments that leaves no room for communication, and makes the farmer the receiver and passive end-user of "the packaged wisdom". This means that researchers regard themselves as superior to the resource-poor farmers (Reij and Waters-Bayer, 2001). If the system was not adopted, the blame was on the farmer's resistance to change (Collinson, 2000; Blann et al., 2002), rather than the inappropriateness of the technology. It is this major weakness of on-station research that led to the emergence of on-farm research. The farmers should, therefore, be involved in generating the information they would use for sustained livestock production and hence improved farmer livelihoods.

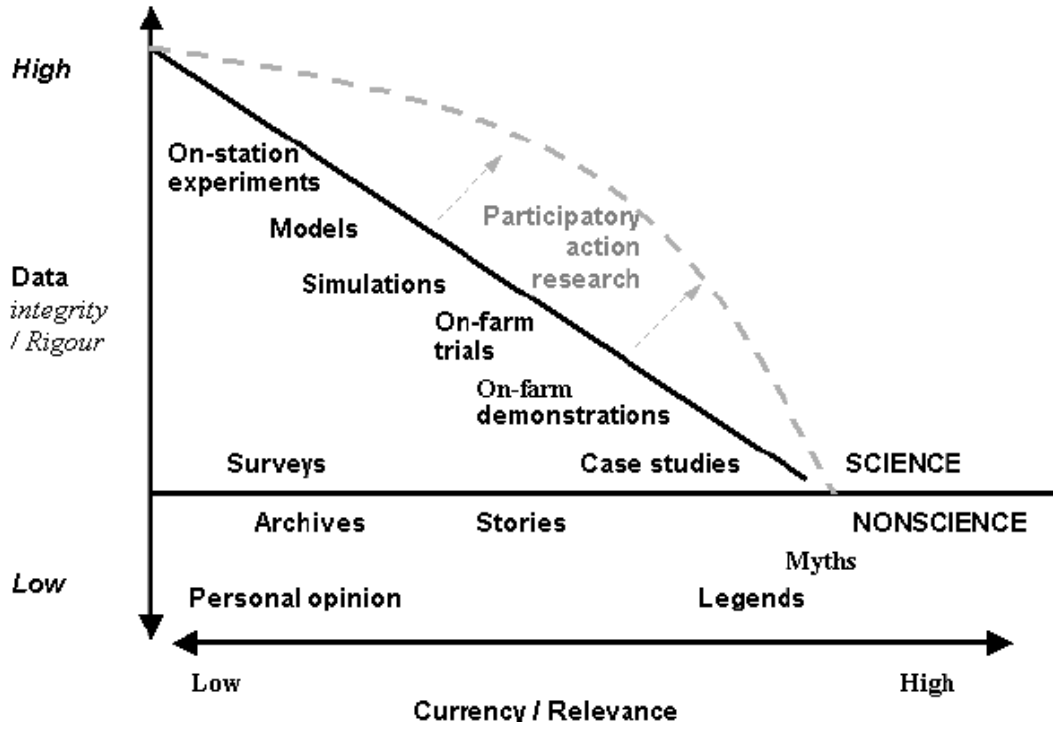

Figure 1. The effect of participatory action research on on-farm trials. Adapted from Crookston (1994).

In the 1970s and 1980s, non-adoption of technologies by farmers was attributed to constraints occurring on the farm (McGown, 2001; Gibbon, 2003; Killough, 2005). In the 1990s, some researchers realized that the non-adoption was because of the inappropriateness of the technologies to the farmers (Chambers et al., 1989), generated with the exclusion of the intended beneficiary; the farmer. In a notion against the TOT model, Castella *et al.* (1999) argued that farmers involved in communal livestock production act rationally within the context of their available resources and socio-economic objectives. This implies that farmers are economically efficient but are confronted with techniques that fail to consider their priorities, constraints, and available resources. Poor adoption of technologies by farmers led to the emergency of farmer participatory research, an approach that was meant to create technologies appropriate to the end users (farmers).

Gillespie et al. (2007) reported that unfamiliarity and non-applicability of the technologies advocated for and high cost of inputs required were the major reasons for non-adoption by communal cattle producers. In another study by PANESA/ARNAB (1990), communal farmers failed to adopt a technology of improving the utilization of crop residues in feeding livestock, which had been developed on-station, citing lack of cash to buy inputs, lack of appropriate equipment and low quantities of crop residues as the main reasons. These authors concluded that it is imperative to conduct on-farm research to appreciate farmers' problems and constraints. Acceptability of a technology also depends on its feasibility from the farmers' perceptive and its value to them. Constraints such as labor bottlenecks, that are usually cited when farmers attach low value to an activity, disappear when the farmers' perceptions of the value of the technology is high (Franzel et al., 2001).

Although on-station experiments are associated with high scientific rigor, they have low relevance (Figure 1) with regard to how the information is used in reality (Crookston, 1994). Figure 1 also indicates that on-farm trials have moderate scientific rigor and relevance that can both be improved with active farmer participation, indicating the relevance of having farmers as stakeholders in trials. Advantages of on-farm research include realistic input-output data; willingness of farmers to adopt developed technologies, and enhanced sustainability of the adopted technologies (Franzel et al., 2001). As research is conducted on the actual sites, developed technologies are applicable to the farmers and there is elimination of genotype by environment interaction on the response variable under investigation or improvement compared to when technologies are developed from a different environment. In addition, the goal of sustainable agriculture is to maximize the net benefits that society receives from agricultural production of food and this could be accomplished when farmers on their farms, are guided by researchers (Byerlee, 1996).

On-farm trials are also important for obtaining realistic

input-output data for financial analysis. Financial analyses conducted on on-station experiments are usually different from what prevails on farm, for instance whilst tractors might be used on-station, hoes and oxen will be used on farm. Sensitivity analyses can be conducted to assess the effect of changes in key parameters such as input-output coefficients, the discount rate, or prices of inputs and outputs (Franzel et al., 2001). Despite the advantages associated with on-farm studies, there are several challenges researchers encounter when conducting on-farm research on livestock. It is crucial to comprehend these challenges for enhancement of efficiency of sustainable research with the farmers' involvement.

CHALLENGES ASSOCIATED WITH ON-FARM RESEARCH

Livestock researchers planning to make use of on-farm trials as a research tool need to be aware that potential challenges await them in the implementation of their research. Impediments can be encountered that can distract collection of quality data or can lead to discontinuation of trials with huge potential to alleviate poverty. The major challenges to be faced relate to the cooperation by the farmers, communication barriers, administrative challenges and difficulties in publishing articles based on such data. The challenges discussed here have not been ranked since the nature and extent of challenges vary with researchers, project objectives, study sites, and from one country to another (Sutherland, 2001).

Co-operation by farmers

While an investigating team (scientists and/or researchers, extension officers and farmers) may have reached an agreement on how a study should proceed, host farmers could change or neglect a planned methodology due to farming pressures, a change of attitude or a lack of perceived benefit in the study thereby reducing the sustainability of the research benefits. Some of the farmers might choose to withdraw from the activity. For example, most farmers in the communal production systems expect to receive incentives and quick rewards for their involvement or use of their animals.

In one on-farm study in Namibia, after realizing that results were important to the researcher, farmers demanded high payment for her labor. This created a potentially unsustainable precedent relating to rewarding farmers with other farmers demanding payment. The project staff, with the intervention of the chief, had to call for a meeting to explain the objectives of the research (Sutherland, 2001). It is imperative, therefore, to start research with honest explanations of the trials giving the farmers an option to decline the offer to participate if the research is to be sustainable. Researchers should not commit themselves to what cannot be fulfilled (Mutsaers, 1997). Instead, they should ensure that farmers continue to show interest in the trials because of the skills development and knowledge involved, and not because of immediate benefits in form of tokens. According to Rees et al. (1999) in another on-farm study in Kenya, researchers experienced some negative effects when farmers who were motivated by hand-outs continuously asked for more of the tokens.

Trials that require longer periods of data collection, such as involving reproductive performance of cows usually end up with a few farmers participating (Nqeno, 2008). Marufu (2008), when assessing the contribution of cattle to household incomes and consumption in the Eastern Cape Province, the initial cattle sample size was 115. At the end of the trial, 12 months later, only 23 were left, with the majority of the treatment combinations being empty or with one animal (Marufu, 2008). The researcher had to shift his focus onto other issues. On-farm participative trials, like other trials, require the development of protocols which ensures the investigating team that the trial will proceed as planned. This is critical if a positive cost benefit analysis from on-farm trial work is to be achieved (Petheram and Johnson, 2006). If the researcher is to carry out several measurements on one farm, there might be need to increase the number of assistants, if the budget allows. Farmers might lose interest if the researcher is going to be on one farm for a long time since these farmers might need to attend to other activities. Rumosa et al. (2009) had to reduce the number of goats from which they collected samples from eight to four per household since farmers felt that the researchers were on each household for longer than the farmers could tolerate. Mapiye et al. (2010) also faced problems towards the end of their research when farmers, who were supposed to take animals to the dip tank at the end of every month, decided to stay at home citing long contact hours with the researchers. It is in this regard that researchers should collect only data pertinent to the experiment's objectives. In addition, it would be wise to conduct other experiments, such as surveys, during the non-cropping season when farmers are less busy.

Besides direct disagreements between the researchers and farmers on research methodologies and logistics, there might be in-fights in the selected communities in most communal areas where arguments are raised on the criteria used when selecting participating individuals or communities. In some cases, the situation is worsened when the chief or headman does not have the livestock species required and is excluded from the trial. In a study by Nqeno (2008), the headman did not have cattle yet his people had the breed that the researcher required. The headman reluctantly allowed the researchers to conduct research in his area. He, however, was not very

supportive when decisions such as erecting a dip tank in his area where suggested since he did not benefit from the dip directly. It, therefore, is imperative for the researchers to explain to the farmers the randomization and selection criteria used in identifying farmers to work with. Researchers should bear in mind that farmers vary widely in terms of income, resources and attitudes. This entails that all these aspects should be catered for as research is being conducted. When the wealthier farmers are often the ones who show greatest interest in trials, conclusions arrived at can have narrow applicability within the area. In addition, with animal health trials, it can be very difficult to get farmers to cooperate and assign animals to the control (untreated) group or there might be bias when farmers choose which animals are to be in which treatment group.

It is crucial to understand circumstances and interests of the farmers. The research should be planned early, with involvement of traditional leaders, extension workers and the farmers. It must be noted that in instances where there are institutional problems in the community, the research is derailed. A community meeting to discuss objectives and select participants (seek consent of farmers) is mandatory if, at all, the research is to be sustainable. In some adaptive research in Zambia, Sutherland (1987) observed that when farmers had not been consulted adequately, they would either sabotage a specific experiment or the whole trial. If, for example, a researcher decides to challenge farmers' goats with a particular helminth but does not indicate to the farmers that they will be compensated if their infected goats die or that the goats will be treated when they get infected, the farmers are likely to decline the offer to participate in the trial or transfer their goats to neighboring villages.

It also is fundamental to characterize farming systems before conducting the trial. In a study in Uganda, under the auspices of Action Aid Uganda (AAU), researchers later on realized that they had paid insufficient attention to characterization of the farming systems (Salmon and Martin, 1997). In the latter stages of the trial, they tried to retrieve information on characterization of the farming systems. The knowledge gaps that existed before they characterized the farming systems indicated to them that a systematic survey on the farming systems should be the starting point of research in on-farm trials (Salmon and Martin, 1997). Researches on livestock require baseline information which will allow the researchers to be familiar with the knowledge gaps which can be used to formulate research objectives.

It is necessary to hold a planning workshop so as to identify issues, develop research questions, explain objectives of the research to the farmers and work out the best methodology to answer the set questions with appropriate rigor for the specific situation (Lawrence et al., 2007) and predict whether the research will be sustainable or not. The frequency of visits, methods of data collection and protocols to be followed (such as ear tagging and blood collection) need to be clarified and communicated to the farmers before trials commence. Farmers get discouraged if they do not understand the experimental objectives and processes. They also get disillusioned if a lot of data is collected but very little information is given back to the community (Sutherland, 2001). Poorly timed meetings that clash with other important farm activities can also hinder the progress of trials. Such hurdles are likely to demotivate farmers who might not be receptive to future on-farm research in the same areas.

The role of each stakeholder should be clear. In a study by Rumosa et al. (2010), the role of the farmers was to record events occurring to their goat flocks for 12 months whilst for Mapiye et al. (2010), farmers were expected to take cattle to the dip tank. In the event that the researcher is dealing with animals that need to be released for grazing, getting at the farmer's homestead early will ensure that measurements are taken before animals are let out. Farmers lose interest if they are not updated on the findings by the researcher. Giving farmers feedback as soon as meaningful data is obtained will keep the farmers committed and informed. A lack or response from researchers causes disillusionment among farmers whose expectations might have been raised (Salmon and Martin, 1997).

With trials that extend over prolonged periods, farmers tend to lose interest and are more likely to switch their animals to a better treatment group. This challenge is common with improvements which take long to take effect, for instance crossbreeding trials, are likely to be of less interest to the farmers. In addition, supplementary feeding trials are within this challenge. In another experience, where farmers were asked to separate an identified heifer from their herd to provide it with a feed in a provided container, the majority of the farmers switched the animals, after realizing that those that had been provided with supplementary feed for over four weeks had started to show evidence of improved body condition (International Livestock Centre for Africa (ILCA), 1990). Researchers had to modify the objective of the experiment to suit the new development. If conducting a feeding trial, purchased supplements, which are used in the trial, may not always be available on a continuing basis. As a result, the technology tested on-farm will have a limited period of applicability and will, therefore, be unsustainable. It is, therefore, crucial to test technologies that are feasible to the farmers, even after the researchers have moved away from the study area.

Continuous supply of free inputs to the farmers during the experimental period makes it doubtful whether the farmers will continue to use the technology when they have to purchase the inputs themselves. If farmers see no concrete benefits resulting from their participation in the trial, they tend to start regarding regular sampling as an inconvenience which has no real purpose and often refuse to continue to cooperate. That might be common

with collection of blood samples for trypanosomiasis detection. This might be deemed unpopular precisely because it does not lead to any immediate benefits. Therefore, education of farmers is crucial so that they are aware on how and when they will benefit from the research.

High personal time of communication

It is crucial and equally important for both researchers and farmers to be completely committed to the work. The researchers have to continuously be friendly to the farmers to keep them committed to the trial. Farmers have to be constantly reminded that they are part of the research and that they are the major beneficiaries of the findings from the trial. The attitude and commitment of farmers is vital to the success and sustainability of on-farm research since the approach is associated with extra work for some farmers, and can take up some of their time at critical periods of the year such as at planting and harvesting times (Collins et al., 2001). Farmers that perceive the benefit to the group and the wider community do not mind doing the extra work. Similarly, farmers that appreciate the value of collecting accurate data from the site and believe in the need to do this over a number of years generally have the most successful sites. This leads ultimately to the development of more relevant approaches.

Communication barriers

Communication barriers can be categorised into cultural, language and physical.

Cultural barriers

Local customs, habits and taboos are some of the cultural aspects that can pose significant obstacles in on-farm research activities. It is important to be sensitive and respectful to local cultural traditions and protocols (Sutherland, 2001). In most cases they derail progress, for instance, in some places no women are allowed in livestock pens (Clark, 2008). If researchers arrive at a homestead when males are not around during that particular time, then no data collection will take place. This has a great impact on cattle, sheep and goat researches. For instance, in the Eastern Cape Province of South Africa, chickens and pigs are largely managed and run by women (Mwale and Masika, 2009). In addition, no women are found at homesteads on Thursdays as it is called a Women's day. It implies that if researchers cannot find women at a homestead then no useful information will be gathered. Under such cases, pigs and chickens are the livestock species affected most. Farm visits should, thus be conducted on other days besides Thursdays. On Saturdays, if there is a funeral service, no one will be available for data collection as farmers will be involved in the funeral service activities (Clark, 2008).

In other instances, cattle are meant for men only. Cattle mean status, wealth, power and the ability to buy wives. Frequently, Zulu chiefs would be buried in their cattle kraals. In such instances, women may have little/no knowledge on cattle management hence aspects to be gathered might be inaccurate or remarkably insufficient. In addition, people differ culturally on how and when they hold their weddings and funeral services. The researcher, therefore, has to be well versed on how such events are conducted for easy planning of the research activities because if the study area is far, then researchers may travel in vain and may need to reorganize. It is always important to involve the extension workers within the study area and to communicate first before the research team travels to the research site to avoid travelling in vain.

To overcome the effects of culture on on-farm research, some researchers spend more time living in the communities among local farmers, organizing and participating in social activities in the communities. According to Magrath (1993), a team of three project staff stayed for a week in each of seven villages that were to be used for a study, observing farmers' practices and culture. Their stay did not just help on learning the farmers' culture but also helped in gaining trust and confidence in the farmers. The researchers also gathered some information by observation and discussions with the farmers in the evening (Magrath, 1993). This can make an immense difference for the researchers in understanding the community and for the community to understand and know better those researchers (Bessette, 2004). Visiting the village elders and collecting information from different groups is also an important practice. The research team should consider itself as a group of guests in the farmers' environment, respecting the culture of the village whilst avoiding sensitive and political issues which might derail their agenda (Mutsaers, 1997).

Language barriers

On-farm research brings producers and scientists together to come up with a common research agenda. The approach attempts to build a scientific dialogue and to establish a peer relationship between farmers and scientists, rather than using a "customer-provider" model. The approach is certainly associated with language and protocol barriers. Language barriers are mainly associated with farmers' non-understanding of questionnaires not written in local language (Goma et al., 2001). The barrier needs to be overcome, with the view that there are equal opportunities for learning and information exchange between farmers and researchers. Researchers,

therefore, have to understand the terminologies that farmers use. Moreso, researchers and students from other districts, regions or countries may not be conversant with the local languages and hence have to diligently ensure that they converse with farmers and develop good rapport to work effectively; otherwise incorrect information may be collected or the scientist may totally fail to gather the required information. In addition, non-local researchers and student can collaborate with local researchers and/or students to enhance the learning skills for the local language of the study area. The local language should be the main medium of communication. Where researchers fail completely to communicate in the local languages, interpreters may be used. Interpretation, however, reduces the chances of effective dialoguing and being inquisitive. To enhance farmer's understanding, use of diagramming or simple and sketchy maps helps with a high magnitude in participatory research. Diagrams and maps provide an easy, accessible and broadly recognizable tool for communication (Goma et al., 2001).

Physical barriers

Many communal areas are located in mountainous areas, where roads are bad and the land is very steep. To use a tractor or other machinery on most of these farms is next to impossible. Therefore, most farmers rely on beasts of burden such as oxen and donkeys to tend their fields, and horses to herd their cattle, sheep and goats. Steeper fields are used as pastures for livestock, but there are still many fields on steep hills. The hills and bad roads also make transportation of farmers' products difficult. Of the 35 330 km of roads in Costa Rica, for example, only 8 km are paved. During the rainy season of May to November, the long stretches of unpaved roads would be a challenge to negotiate (The World Fact Book, 2000). Almost all roads leading to remote communities in Southern Africa are not tarred and largely inaccessible. Researchers should be prepared to traverse difficult terrain, leave home early and return late and hold interviews and collect relevant data at a time convenient to the local people. In a study by Rumosa et al. (2009), researchers had to travel during the night so that they would get to the research site, which was about 600 km from the college, early in the morning before farmers let out their goats. In a study by Sutherland (1987) in communal areas in Zambia, after realizing that homesteads were scattered around a geographical area which complicated collection of meaningful data, researchers ended up clustering trials in different provinces.

Unacquainted farmers

Most farmers are illiterate and therefore, need capacity building to avoid problems and inaccuracy when the research requires them to keep records. It is mandatory that farmers understand the importance of record keeping. This ensures that, even when the researchers withdraw from the study area, the farmers will continue with the practice. Where the elders have problems with recording, involving school children is helpful as they will assist their parents/guardians in keeping correct and accurate records. The research team may also purchase bicycles and employ some resident assistants who can move around homesteads monitoring and keeping proper records for the team, in the absence of the researchers. At times, farmers may fail to understand some questionnaires written particularly in English (Goma et al., 2001) and other non-local languages. To avoid this, the questionnaires have to be written in the local language, school children should assist with the reading of the questionnaire and assistants and extension officers who are well versed with the local language can help in interpreting the questionnaire during the time of information gathering.

Farmers may have little scientific knowledge base on participation in a research and this could be an impediment of the research leading to inaccuracy collection of irrelevant data and misconception of the research objectives at large. Subsequently, continued on-farm research and its invaluable benefits will be hampered. In-depth diagnostic and descriptive research is necessary prior to a long-term experimental program. A strong parallel programme of technology-testing with farmers is needed to ease the scientific knowledge base of farmers (Scherr, 1991).

Gender of farmers

It is fundamental to pay particular attention to the issue of gender since social roles and responsibilities of men and women are different. Men and women have different needs, problems, skills and knowledge (Croxton and Murwira, 1997). The degree of access to resources and of participation in trials may also be gender related. In most settings, women are often barred from village meetings, or if they are admitted, they do not always have the right to speak (Bessette, 2004). In such instances, in areas like the Eastern Cape Province, pigs and chickens researches are more adversely affected compared with researches working with ruminant animals; man's livestock species. Female researchers might not be comfortable to discuss reproduction in animals when interviewing male respondents yet this might be a critical constraint to animal production in a particular setting. There, also, is a distinction between the roles and needs of younger and older women, or between older men and young people's perceptions of the same problem. This results in different levels of contribution, in research, for the different classes. It is

important to consider such aspects and researchers need to learn how to establish communication, in all settings, with both men and women and the different age groups. It implies that researchers should understand that the project team gender composition will influence its operational effectiveness especially when discussing gender-sensitive issues (Sutherland, 2001).

Administrative challenges

Working in remote areas

Most researchers, motivated by the need to collect quality data in a relatively short period of time, prefer to conduct research on livestock in those areas that are well endowed in terms of both human and natural resources and where the rural infrastructure is already developed. Farmers in such areas might become research-fatigued, especially if they do not get feedback or any kind of benefits from the researchers. There is need to conduct research also in the remote areas if sustainability of livestock found in such areas is to be achieved. Research sites should, however, be carefully chosen with special considerations to history of the site and research in question. Trade-offs may also be needed between the extent to which locations are representative on one hand, and the time, resources and cost required to work with them on the other hand (Sutherland, 2001). Mutsaers (1997) recommends use of clustered instead of scattered sites. The author further recommends that sites should be within 5 km from each other allowing a days' travel by field staff on bicycles. Costs incurred might be for accommodating field assistants, high cost of fuel, and hiring of appropriate cars, which might be costly. A tent might be used instead of accommodating assistants in a hotel. It would also be worthwhile to build a house that can be used by researchers when they visit a site. This becomes imperative when the research being carried out in those sites is extensive (Mutsaers, 1997). Assistants might be drawn from the villages, and even the farmers themselves, in which the researchers will be working in. Some researchers opt to sleep and eat with the farmers. Apart from trying to convince the farmers that researchers value them, this has an advantage of allowing discussion early in the mornings and late in the evenings when the farmers are less busy.

Most researches in South Africa are funded for a maximum of three years, forcing researchers to collect data as quickly as they can, which could be difficult to achieve if a remote area has been chosen as one of the research sites. In some cases, a three-year, or at times, one year, project is a very short timescale for any meaningful participatory research (Morton et al., 2002). This scenario affects mainly researchers dealing with cattle improvement practices. The 3-year time period also gives little incentives for researchers to develop extension materials and liaison with extension services. Hence, it is imperative to co-ordinate with donors, and universities to address these constraints. Researchers might want to work in sites where rapport has been established by other researchers already, mainly in developed communal areas. This might assist in reducing the amount of time required to establish a meaningful relationship with the farmers.

Institutional challenges

Researchers should be assured that funds are available on time. Involvement of finance personnel from the beginning assists in avoiding disappointments and enhances timely disbursement of cash. The researchers also have to clearly explain and highlight the need and the importance of research to finance personnel in research institutions and universities to create a good working environment and appreciated co-operation. A healthy partnership between the farmer and project facilitation, the technical staff and institutional organizations is vital to the success of the research. All parties should understand the balance between practical operation of the site, accurate data collection and on-time financial support, and take into account each others' requirements in achieving the research goals. This approach requires active institutional collaboration, for the achievement of the set goals by the researchers (Scherr, 1991). For example, in some universities, it is difficult to get an advance allowance to use in the field. All incomes to researchers are paid at the end of the month and are, at times, taxable. The consequence is that researchers, in most cases, have to use their personal funds, which they might not be having, to finance research and then get reimbursed later. Although difficult to solve, such challenges can be minimized by establishing a research fund in each faculty or school.

In most cases, if research is conducted on-farm, the analysis, interpretation and dissemination is usually done by the researcher who in most cases is interested in having a qualification (in form of a degree/dissertation) or publications in refereed journals or books which the farmers do not have access to or cannot comprehend. This implies that farmers rarely get any feedback or it isnin a form that is inappropriate for them. This signifies that researchers might also be to blame as they might just be interested in accommodating themselves in hotels, moving around with expensive hired cars, obtaining higher qualifications without focusing on the impact of research output for the farmers. This entails that researchers should change their attitudes and see to it that both the researcher and the farmer benefit from the research thereby increasing the sustainability of research and hence its benefits to the farmers in the same areas. This can be accomplished by holding workshops to explain simplified research results and/or make fliers and

fact sheets written in local languages that can be useful and distributed to farmers at dips or in schools.

Difficulties in publishing information from on-farm trials

Articles on on-farm researches are not easy to publish as reviewers often refer to such studies as “rare studies” (Martin and Sherington, 1997) that are of insignificant importance. An appraisal of 2000 edition of African Journal of Agricultural Research, for example, found out that of more than 50 journals addressing agronomy research, only two articles had employed on-farm research. The pertinent issue is whether lack of successful on-farm research has forgone research rigor (and publication opportunity) in order to gain relevance (Carberry, 2001). It is imperative to encourage agricultural science journals to publish systems studies. The initiative by the Australian Journal of Experimental Agriculture to publish a special issue on extension practices should be applauded (Anderson, 2000). There should be flexibility in the criterion of excellence of a publication is its contribution to scientific rigor, but to whether new practices have spread among the resource-poor or not (Chambers and Ghildyal, 1985). It is also imperative to develop reward structures favoring on-farm experiments where researchers can be assessed against and rewarded for realized benefits in addition to attributes such as publication record and peer review (Gibbons et al., 1994). The main emphasis should not be a shift in the rigor but a widening of the scope of journals.

Weather

The weather might be an obstacle making it difficult for researchers to carry out investigations. Researchers have to be prepared for rain, snow, wind and heat and other vagaries of weather by having appropriate clothing. This might be expensive if many assistants are involved. There also is need to consider weather forecasting before visiting the study area, otherwise all the activities might be adversely affected and/or may fail to be undertaken. Rumosa et al. (2009) used Matatiele, a Northeastern area of South Africa as their site of study. This area experiences low temperature from June to August with high chances of being snowy. The researchers had to consider the weather forecast before visiting farmers in those areas.

Complications in data analyses

The local people have extensive knowledge of their environments and, their identification of problems and solutions is both skilful and topical (Goma et al., 2001). Consequently, it is ideal for researchers to work closely with farmers or communities for long periods of time to determine conditions, evaluate perceptions and preferences, and share knowledge. Nonetheless, with participatory processes, more descriptive and broader knowledge is generated than scientific information. Such knowledge is normally difficult to analyze (Lawrence et al., 2007) but is mainly and appropriately useful for the planning of future research.

Farmers vary in their ability to manage livestock, and this can confound trial results. This makes it difficult to replicate studies and interpret research outputs. Blocking trials on the basis of differences in management can overcome this problem if sufficient animals within the same age, sex and productive class can be obtained on each farm for each treatment. When this is not possible, similar animals have to be obtained from many more farmers. Researchers should, however, note that the more widely dispersed the population, the more difficult it is to supervise the trial.

According to Riley and Fielding (2001), some participatory studies generate data that can be analyzed statistically although their multidisciplinary structure, inherent data variability and, often small sample sizes make them complex to design, analyze and interpret. In some cases, the data produced has not been immediately relevant to the farmers reducing the sustainability of research since those farmers are likely to turn away any future researchers. Thus, regular monitoring is essential with on-farm approach. Also, farmers’ findings can be, to a limited extent, correlated with formal research findings because different criteria and rules are used by farmers and scientists. Instead, farmer methodologies and findings should complement the scientific ones and more focused research strategies. This enhances accuracy and ease of data analysis and interpretation. Inclusion of a biometrician from the beginning of the experiment (Johnston et al., 2003), coupled with collection of quality data, is essential if meaningful results are to be obtained and computed easily. Statistical analysis of data after the experiment is designed and completed cannot overcome a poor experimental design. Adequate project supervision by either the farmer or the project staff is crucial in ensuring that the potential for error is reduced.

In most cases, designs and locations of the study sites are poorly planned and, replication and randomization of treatments is absent, which later causes confounding of results. Treatment effects are also masked by covariates such as slope and variability in soil type, vegetation type, climatic patterns and livestock breeds in a particular area (Collins et al., 2001) and they should, therefore, be considered in the designs. This causes problems when interpreting the results implying the need for good trial designs and layout. In particular, group members consider the need for replication in on-farm trials after the problems encountered in interpreting data from non

replicated sites. Overall, researchers should aim at reducing complexity of experimental designs.

One of the challenges of on-farm research and long-term experiments (especially when working with cattle and goats) is the risk of losing animals. This is mainly caused by farmers withdrawing from the trial, sales, slaughters, deaths (both farmers and animals) or farmer relocation. Sale of few animals is unlikely to introduce bias into the results of the trial and affect the inferences made, unless the disposal of an animal has a relationship with a particular treatment effect (e.g. if in a feeding trial, treated animals were sold because they were in better condition than control animals) (ILCA, 1990). Researchers should, therefore, be prepared to lose animals along the way. If this is not guarded against, data analysis becomes difficult and complex and some scientists fail to finish the experiment and/or to achieve the initially set goals. It is fundamental to use large samples in the beginning, so as to cater for contingencies arising from animals exiting the flock or herd. The extreme case of lose of animals is when the whole herd/flock is wiped out by diseases such as Newcastle, for poultry and Foot and Mouth disease for ruminants or African swine fever for pigs. One student from the University of Fort Hare had to change the study site after pigs were culled due to an outbreak of Classical Swine Fever (Eastern Cape Provincial Government, Department of Agriculture, 2008). It is necessary to be flexible and consider such losses before the experiment commences. In some cases, it is imperative to start with a higher number of both animals and farmers as some might be lost on the way.

Farmers can also opt to move animals across treatments if they detect that a particular treatment is having a relatively beneficial effect. A trial on the efficacy of antihelmintics by researchers in villages in Okavango, Namibia was discontinued after farmers who were in the placebo treatment did not bother bringing their animals for dosing (Sutherland, 2001). In another trial on draught animal implements, the trial went well until farmers were asked to take care of the implements when some farmers decided to personalize them leading to discontinuity of the trial (Matsaert et al., 1997). One way of circumventing the movement of animal across treatments is by making use of ear tags and ensuring that farmers understand the objectives of the trial(s). There may also be cases when researchers unconsciously pass on their expectations to the participating farmers, who then give more attention to a particular group of animals so that a management effect rather than a treatment effect is recorded. The researchers should try and guard against inducing such biases. It should be appreciated that with appropriate management controls and statistical designs, on-farm trials are an increasingly valuable research tool (Engstrom et al., 2010).

The integrity of the data requires monitoring every time data is collected so that if need arises, corrective measures as instituted before it is too late when any remedy might be impossible. Checking of data integrity might be accomplished by recording the same information in two different ways. For instance, the researcher might record daily sow feed intake at the farrowing crate and total weight of lactation feed delivered to the unit. In addition, where researchers expect farmers to do some recordings, the on-farm experiments should not be complicated. A small number of treatments, usually a control and an experimental treatment, allow the maximal number of replications per treatment within the number of animals available for the experiment. Treatments that are easy to implement are more likely to be imposed willingly and accurately by the farmers. If the treatments are not imposed properly, resulting data is meaningless (Aaron, 2001).

CONCLUSIONS

On-farm trials have several benefits that pertain to sustainability of livestock production and research, provided they are managed tactfully and farmers are encouraged to consider themselves as major stakeholders. The great value of participatory studies is in the shared evaluation, monitoring and education approaches that will encourage local agricultural practices to advance appropriately for the farmers and their locations. It is ideal for researchers to work closely, over periods of time, with farmers or communities to determine conditions, evaluate perceptions and preferences and share knowledge. Albeit on-farm trials are appropriate for the end result of the farmers, they are associated with many challenges, and cannot replace on-station trials but the two should be intermarried. In addition, it is important that farmer participation be acknowledged by way of patenting exceptional technologies originating from them.

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