PARTICIPATORY RESEARCH ON TECHNICAL INTERVENTIONS TO IMPROVE IRRIGATION PERFORMANCE: INFORMING PERCEPTIONS

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Abstract
Interviews were carried out with irrigators on commercial sugarcane irrigation schemes in Swaziland to seek their opinions on what would promote 'good irrigation'. Ranking methods were used to define good irrigation and allow irrigators to rank five technical interventions; altering furrow layouts, ensuring a correct flow to an area, improving canal type and equipment, changing the type of turnout and fixing leaks and spills. The results showed that a) irrigation planning addressing complex technical questions could be conducted in a participatory way, b) irrigators clearly perceived a hierarchy of needs, c) the hierarchy of needs was affected by exposure to different technical options, and that therefore, d) on irrigation schemes, research and policy based on participatory methods should be aware of the gaps in information available to users, researchers and planners, and proceed accordingly.
Keywords: Canal irrigation, irrigation technology, participatory research, performance.

1 Introduction

The debate regarding management of natural resources appears to favour participation: "Sustainable agriculture cannot succeed without the full participation and collective action of rural people and land managers [1]. Among many definitions, participation is 'involving users and communities in all stages of the development process to achieve sustained benefits' [2]. Examples of some of the stages are research, policy-setting, delivering services and evaluation of services. Considerable problems need to be overcome in each of these stages, particularly in terms of using and interpreting participatory methodologies, and seeing them as tools, not as 'recipes for success' [3]. Clearly balances have to be struck between methodologies and expectations, as well as

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between peoples' needs and wants, between their needs and what can be provided, and between perceptions of the actors involved.

This paper addresses the last kind of balance; between the perceptions of local users and 'expert outsiders' and specifically in the area where **gaps** in knowledge and perceptions might exist. It does so by examining the research stage when experts attempt to discover user's needs as contextualised within their local knowledge. A case study is employed to demonstrate that participatory research certainly gives outcomes with meaning for those involved, but which may not capture 'unknown' technical interventions which may have a far greater impact on irrigation performance.

The case study involves interviews with irrigators of commercial irrigation schemes. Although it could be argued that this is not applicable to the world of farmers, several important parallels apply. Firstly such organisations are attempting to raise productivity and reduce costs by motivating employees and giving them greater responsibility and this requires a participatory process. Secondly employed irrigators have similar perceptions of surface irrigation schemes as do farmers and farmer groups. These perceptions are of water at the lower levels of the system (e.g. tertiary and field outlet) and are determined by a lack of involvement in the management of the system, and by a lack of comparative experiences of other parts of the system or other irrigation systems altogether.

2 The case study

2.1 Introduction

Four large-scale surface irrigation schemes in the Swaziland lowveld were visited during the period 1995 to 1997 as a part of a research programme investigating differing approaches to irrigation design [4,5]. During that programme, the research asked the question, does the design of the system affect the way it is managed? For the sake of anonymity, these schemes are called, A, B, C and D. All four are similar in respect of climate, crop (sugarcane), soil type, topography, cropping calendar (a 12 month cycle) and generally speaking estate management. In terms of irrigation operation, similarities also occur; lined tertiary canals, use of both syphon and spile pipes, furrow irrigation using 1.5 metre wide furrows, and during peak demand periods constant secondary canal flows and rotational flows at the tertiary level.

However, important differences exist; schemes A, B and C are termed "type 1", characterised by a wide variety of tertiary turnout designs, and (as flow gauging determined) variable flow rates from one tertiary canal to another. Also on these schemes, flows are rotated loosely within the secondary area to wherever fields are driest. Scheme D is "type 2", having fixed, measured flows at the tertiary level, standard modular turnouts and long-crested weirs. Tertiary flows on these schemes rotate strictly within groups of fields as dictated by the hydromodule (l/sec/ha).

2.2 Interviews, questionnaires and questions

Interviews were carried out on the four schemes with a total of 37 irrigators using semi-structured group interviews. A questionnaire was developed to gain an understanding of how the irrigators perceived their responsibilities and tasks. The interviews were usually conducted in the open, close to fields with an interviewer, translator and approximately four to six irrigators. Irrigators were 'sampled' from several secondary systems within each scheme. The questionnaire consisted of open and closed questions, and time was allowed to follow new lines of inquiry. The final part of the questionnaire was devoted to a ranking exercise, called the "shopping list question", which is the focus of this paper.

The null hypothesis was that there is no difference between the irrigators' understanding of factors affecting performance dependent on the type of irrigation scheme. The alternative hypothesis is that there is a difference between the irrigators' understanding of factors affecting performance dependent on the type of irrigation scheme. In other words, the alternative hypothesis is that the ranking of factors by irrigators is contingent on the design and operation of the scheme.

The shopping list question was "what would you like to fix or keep so that you can irrigate well and get round in time before cane stress shows?" The question was asked in a number of ways and ended up with presenting the irrigators with five choices of interventions that might improve their irrigation. Irrigators were asked to discuss and rank them from 1 (most important) to 5 (least important). The five choices were:

1. *Layouts and furrow lengths*: improve layouts to reduce number of feeder furrows (which are small in-field feeder furrows leading off from the concrete side canal to irrigate small portions of fields), ensure high ridges of soil so breakouts of water from one furrow to another are minimised, and change furrow length where too long or too short by altering the width of the field (an imaginary situation).
2. *Flow to area groups*: ensure that the right flow can supply the right area, otherwise known as correct leadstream cycling groups.
3. *Canal type*: change the canal type which includes altering the diameter of the spile or syphon pipes, changing to spiles or syphons, improving head control in the tertiary canal by adding more checkboards or by altering the design of head control.
4. *Turnout type*: improve the design of turnout, or change to another design, either to reduce leaks, or to make it easier to operate or to add flow measurement.
5. *Leaks, spills and flow rate*: alter the flow rate, either by changing the tertiary turnout, or increase the flow by reducing leaks and spills.

To test differences in irrigators beliefs, 2 x 5 contingency tables were drawn up so that Pearson's Chi-squared (χ^2) test could be used. Excel spreadsheets were used to enter ranked classes of answers, calculate expected frequencies and the chi-squared statistic, which was compared to a critical χ^2 statistic for a 95% level of confidence.

2.3 Results

Irrigators showed a high level of responsibility towards their jobs; irrigating as well as possible within the constraints set by the design and operation of the canal and field systems. They were concerned about cane stress and well-understood that summer was the critical time for achieving "good" irrigation. The ranking question took time to discuss but in the end the irrigators appeared sure about their responses.

Table 1 gives the results of the ranking of irrigators to improve irrigation on type 1 schemes and table 2 gives the results for the same exercise for the type 2 scheme (D). In both tables, five columns represent the five technical choices. The numbers in the columns are the frequency count of the rank of importance by the respondents. For example in table 1, on type 1 schemes, 13 out of 20 irrigators ranked furrow layouts as being the most important, and in table 2, 11 out of 17 irrigators ranked layouts as being the most important. At the bottom of each table, the mean response is calculated to show the order of ranking (in brackets) of each of the five interventions.

Table 1. Responses to questions about perceptions on means to improve irrigation for type 1 schemes

	Layouts	Flow to area groups	Canal type	Turnout type	Flow rate
Count of rank 1's	13	0	4	1	4
Count of rank 2's	4	4	0	4	7
Count of rank 3's	3	0	5	4	7
Count of rank 4's	0	7	10	1	2
Count of rank 5's	0	9	1	10	0
Mean (and order)	1.5 (1)	4.0 (5)	3.2 (3)	3.8 (4)	2.4 (2)
Total number	20	20	20	20	20

Table 2. Responses to questions about perceptions on means to improve irrigation for type 2 schemes

	Layouts	Flow to area groups	Canal type	Turnout type	Flow rate
Count of rank 1's	11	6	0	0	0
Count of rank 2's	6	11	0	0	0
Count of rank 3's	0	0	11	0	6
Count of rank 4's	0	0	6	0	11
Count of rank 5's	0	0	0	17	0
Mean (and order)	1.4 (1)	1.6 (2)	3.2 (3)	5.0 (5)	3.8 (4)
Total number	17	17	17	17	17

The frequency counts of each rank were used to test differences between the two types of schemes for the five factors. The outcome of each test is discussed in order:

1. *Layouts*: both types of irrigators, those on type 1 and type 2 schemes, ranked this intervention very highly, with 100% of irrigators putting it in the top three. The calculated chi-squared ($\chi 2$) statistic (3.345) was less than the critical value (9.49), and so there is no significant difference between the two types of irrigation system.
2. *Flow to area groups*: nearly 50% of the type 1 irrigators ranked this the least important (number 5), whereas 100% of the 17 type 2 irrigators put this in the top two most important slots. The statistical test, with a χ^2 of 25.189, greater than 9.49, indicates a significant difference at the 95% probability level.
3. *Canal type*: although the spread of answers is noticeable with the type 1 irrigators, with some ranking this most important, 50% of them ranked it number 4. When compared against the type 2 irrigators who placed this in either rank 3 or rank 4, this was found not to be a significant difference.
4. *Turnout type*: the range of answers was large for the type 1 irrigators, placing this across all five positions of order. This contrasts with the type 2 irrigators who placed these all within the lowest rank. It was found that was a significant difference at the 95% probability level (χ^2 value = 11.648).

5. *Leaks, spills and flow rate*: 90% of the type 1 irrigators systems ranked this in the top three, whereas the majority of type 2 irrigators placed this in rank 4. This difference was found to be significant (χ^2 = 17.177).

With the exception of the need to improve layouts, an intervention which both sets of irrigators ranked highly, and the choice regarding canal types, an option both irrigators ranked in the middle, significant differences arose for three other interventions. Type 1 irrigators did not rank the correct flow to area highly, reflecting their lack of experience of this type of operation whereas type 2 irrigators who understand the operation of the leadstream cycling, ranked highly a correct flow for a group of fields. Their knowledge of this comes their experience of difficulties when the flow is too low for the area, or when the area is too large for the cycled flow.

Type 1 irrigators with experience of variable gates felt they would see some benefit if "better gates" were introduced, thought it is not clear what. This "turnout" intervention was dismissed by the type 2 irrigators with experience of modular gates.

Type 1 irrigators ranked more highly the need to fix leaks and ensure the right flow rate than type 2 irrigators. However, this may be more a reflection of the priorities of the type 2 irrigators rather than differences in leakage rate. Observations indicated that differences in leakage between the schemes were roughly similar and leaks were not great due to the use of lined canals placed within clay to clay loams soils.

In summary, type 1 irrigators ranked the interventions in the following order of priority; layouts; flow rate and leaks, canal type; turnout type and correct flow to area groups. The type 2 irrigators ordered them; layouts, correct flow to area; canal type, flow rate and leaks; and turnout type. It seems that on the evidence collected, the null hypothesis can be rejected and the alternative hypothesis can be accepted and say that on the whole there are significant differences in understanding of the factors affecting irrigation depending on the local technology and operation of the system.

3 Discussion on participatory research

Three main issues arise from this case study; inherent benefits in the participatory process; solving problems according to a hierarchy of needs; and the paradox of how to deal with technological options unknown to both researcher and user. Firstly, there can be no doubt that inherent 'first order' benefits occur via the participatory process; summarised by the words 'talking and listening' which includes expressing views, understanding another's view, accepting and encouraging, all of which help to 'generate alliances', an 'enduring value of PRA' (Jeanrenaud and Jeanrenaud, quoted in [3]). At the end of the interview sessions in Swaziland there was certainly a feeling of problems having been well aired, and of acknowledgement of those problems.

On the second issue, it is possible to respond to the perceived hierarchy of needs with interventions in the same order presented by the users. Responding is an important part of the process that begins with talking and listening, adding benefits besides solving the technical problems such as building trust, increasing motivation, and enriching future research cycles. Such benefits are termed here 'second order'.

The third issue is about known and unknown knowledge of both researcher and user. Unknown knowledge, or gaps, may be very important in terms of omitting significant interventions from a programme or influencing the order in which interventions are tackled. Although it may be argued that order of events is secondary to process, the omission of important factors affecting the performance of irrigation is a more serious matter. To discuss this further, four classes of experience or knowledge interchange between users and researchers are proposed, shown in table 3.

Table 3. Framework of knowledge interchange between users and researchers on a particular subject

		Researcher's knowledge of the subject			
		Yes		No	
		Actor/process	Effect	Actor/process	Effect
User's knowledge of a subject	Yes	User (U)	can agree	User (U)	gauges & teaches
		Researcher (R)	can agree	Researcher (R)	can learn
		Direction of learning (and class no.)	$U \Leftrightarrow R$ (1)	Direction of learning (and class no.)	$U \Rightarrow R$ (2)
	No	User (U)	can learn can	User (U)	restricted learning
		Researcher (R)	gauges & teaches	Researcher (R)	restricted learning
		Direction of learning (and class no.)	$U \Leftarrow R$ (3)	Direction of learning (and class no.)	$U \neq R$ (4)

It should be understood that the teaching and learning as described in table 3 is additional to the first order benefits inherent to the participatory process. The knowledge interchange is of specific interventions intended to improve the performance of users and of irrigation. Referring to table 3, class 1 in the top left is where both researcher and user know about a proposed intervention. The second kind, top right, is where the user has knowledge of an intervention, which researcher does not know about. Here, the user passes knowledge to the researcher. The third class is where the researcher has knowledge of an intervention which the user does not, and where the flow of knowledge is from researcher to user. The fourth class is where both user and researcher do not have knowledge of a particular intervention.

The four kinds of perceptions are exemplified by reference to the case study. A class one interchange happened when the researcher who knew about leadstream cycling found agreement as to its importance with type 2 irrigators. A class two interchange might have happened if a researcher without experience of leadstream cycling was introduced to it by irrigators from type 2 irrigation schemes. A class three interchange happened when the researcher familiar with the idea of leadstream cycling introduced the irrigators on type 1 schemes to the idea of leadstream cycling (though this was not followed up). A class four interchange might have occurred if another researcher not acquainted with leadstream cycling had visited the type 1 irrigation schemes which the irrigators did not reveal through lack of experience.

In summary, this third issue acknowledges that errors in ranking might occur. This opens up the possibility of different orders of interventions which may be better reflections of what is required (measured by impact, rather than by perception). If these

more effective interventions can be found then these might be called third order benefits to the participatory process.

4 Lessons for participatory research on irrigation technology and design

The discussion above examines the possibility that neither the user nor the researcher might know about interventions which may be relevant and significant to a particular context. Recent research on participation of farmers in the design process covers issues such as canal alignment through farmer's land or changes of turnout design from divisors to orifices [8]. Resolving unsuitable irrigation engineering need not be reason enough to demonstrate the worth of participatory process (beyond first order benefits of alliance building, and second order benefits of prioritised problem-removal) since these may be good examples of class 1 or class 2 interchanges of knowledge where the user or both parties readily understand the problem.

In the literature, contrasts are made between of top-down, non-participatory design by bureaucratic engineers and bottom-up farmer-participatory design by other types of engineers [7]. Although there is demand for participatory engineers, the implication is that farmer design is enlightened and bound to succeed. However, one has to question how participation will deliver answers to complex questions of water management on large-scale schemes, some of which are, by the nature of their complexity, are likely to fall within class 3 interchanges which may be seen as top-down and therefore unsuitable, or within class 4 type interchanges where neither party knows the answers. This paradox is more acute for irrigation when we think of how difficult it appears for experts to transfer best-practices amongst each other, and how farmers, who tend to be fixed to one locale, cannot through the market-place know other designs and operation. In particular, participatory design with farmers who have recently moved out of rainfed agriculture is open to question.

5 Conclusions

Research on four irrigation schemes in Swaziland revealed that irrigators' perceptions of irrigation technology were related to contexts that they were working in. Although the interviews provided results, the question must be asked what do these opinions mean for researchers who seek answers beyond the rewards of the participatory process. The following conclusions can be made:

- irrigation planning tackling quite complex technical questions can be conducted in a participatory way with users of irrigation schemes because users of irrigation schemes readily perceive a hierarchy of needs;
- those perceptions are informed by comparisons they may make within their geographical area or timeline of technology and operation;
- those perceptions are constrained by a lack of experience and comparison with other areas of technology and operational types;

- solving priority needs may reveal further needs, which in turn need to be solved, which is an acceptable manner of progressing;
- these perceptions may not occur in the same order as in their real impact on irrigation performance;
- research and policy based on participatory methods should be aware of the levels of information available to both users and planners. Perhaps the chief implication is to promote comparative experiences, as Meijers says; "attention should be paid to broadening the designers' frame of reference as well as the users' in order to come to a more effective interaction." [9]. If participation is to raise performance then it cannot not, as a primarily social science tool, ignore the effort required to address complex technical and water management issues. This is particularly so when the technical elements of large-scale network canal systems become so interwoven and hidden within the irrigation scheme's considerable social dimensions.

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