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Design and application of a ranking system for the rapid assessment and selection of potential small-scale irrigation schemes

K. W. Nyamapfene[1] and A. J. Peacock[2]

[1]Agronomy Department, University of Fort Hare, P Bag X1314, Alice, RSA.
[2]Sir William Halcrow and Partners, Consulting Engineers.

In an attempt to provide a non-subjective parametric framework for the selection and priority treatment of irrigation schemes in the resettlement areas of Zimbabwe, a ranking system was designed and applied in the evaluation of 107 schemes in various parts of the country. The ranking scheme takes into consideration the relationships between various physical and socio-economic factors. The factors selected are then weighted and the rationale behind the weighting is discussed.

One of the main items on the agenda for action by the new Zimbabwe government that came to power in 1980 was the land issue, which had been one of the major demands in the war that led to independence. There was a class of mainly rural people who were either landless or had such poor land that they had to be provided with viable agricultural land. It was this consideration that led to a major resettlement programme initially intended to resettle 162 000 families over five years. This entailed the purchase of land from the predominantly white-owned commercial farming areas on a willing-seller–willing-buyer basis. A small amount of state land was also excised for this purpose.

Many of the farms thus purchased had some history of irrigation either as supplementary summer irrigation on the dry land or for the irrigation of a winter crop (the rains come in summer). Thus, at the time of purchase, many of the farms had considerable irrigation infrastructure both fixed and movable. In most cases where irrigation infrastructure had existed and had been in operation in the past, it was now not being used because it had been partly removed, or because it had fallen into disrepair or simply because the new settlers did not know how to use it. A range of water supply and irrigation systems existed from supplies based on a storage dam or weir, to run of river supplies, to boreholes and irrigation systems based on surface methods, to sprinklers.

It was as a result of the realization of the amount of capital tied up in this way and the potential for increasing the incomes of the settlers that government thought it necessary to investigate the general feasibility of, and scope for the rehabilitation of irrigation in the resettlement areas in general, and in particular, the potential for the rehabilitation of those schemes with considerable existing infrastructure.

The investigation covered all resettlement areas in Zimbabwe and resulted in the identification of 107 schemes of which 61 were Model A and the rest Model B or other. Model A comprises those schemes on which the people were settled on the basis of individual family holdings, five hectares in extent, while in Model B, settlers were organized into co-operatives to run a collective farm with each adult member of a family or unmarried individual participating as members.

In order to create a non-subjective, semi-quantitative framework for the evaluation of the schemes identified, it was decided to design a ranking system which would take into account the impact of both physical and

social factors on possible irrigation development.

The intention of the ranking system was to provide a quick, systematic and objective method of identifying the more promising schemes for further consideration and priority treatment. The system was developed in close consultation with the relevant government departments to ensure that it would reflect government policy as well as objective judgement of the factors to consider in the selection of priority schemes. The ranking system was also designed to take cognisance of the basic differences in the structure and management of Model A versus Model B schemes, without any pre-conceived ideas or bias as to the relative merits of either model.

Following their identification, the schemes were visited by a team comprising a socio-economist, soils specialist, an agronomist and an irrigation engineer. Data sheets were compiled for each scheme (Table 1) and an inventory of the schemes was prepared (Table 2). The schemes were then subjected to the ranking system.

Methodology

Following consultations among the team members, a draft questionnaire was drawn up and an initial test run was done on the first four schemes to test the sensitivity of the theoretical model, and modifications were made accordingly.

Two groups of factors were considered, Physical Factors and Socio-economic Factors, as shown on the ranking forms. The degree to which a particular factor was favoured was expressed by identifying the most appropriate description from a choice of four, a score of four points representing the most favoured factor and one point the least favoured. To produce an overall point score for ranking the schemes, point scores for the individual factors and characteristics were weighted in two stages. In the first stage, a weighted score was produced for each factor and totalled for the group of factors. In the second stage, the weighted score for each

group of factors was adjusted to reflect the relative importance of the group. Adjusted group scores were then combined into a single score for each scheme. From these a ranked list of schemes was prepared. The methodology is described below in more detail.

Ranking Form 1: Physical Factors
In assessing the physical suitability of the schemes, emphasis was placed on the ease of implementation and subsequent operation of the schemes. The philosophy behind this was to promote schemes which would not require complex design and preparation inputs and had existing infrastructure which could be quickly and effectively brought back into use, thus minimizing the burden on the government department responsible for implementation.

The assumption in all cases was that viable and successful irrigation had been carried out by the previous owners of the farms and that, therefore, the soils and topography were not likely to be constraints. However, a semi-detailed qualitative assessment of land suitability for each scheme was carried out.

Weighting procedure
Each of the factors on the ranking form was then assigned a weighting in relation to the other factors. The details of the rationale for the weighting procedures are given below and considered further in the 'discussion' section of this article.

A prime requisite of any scheme was that there should be a reliable and adequate supply of water. It was assumed that the existence of a water right on the property meant that a positive assessment had already been made in this regard and an allocation of water for agricultural purposes was assured. Based on the capacity of the dam or abstraction rights from river flow, the adequacy of supply was assessed using generalized rule-of-thumb estimates for water requirements for irrigated cropping.

Land factors
The suitability of the soils for irrigation was assessed together with topographic considerations in so far as they might

Table 1: Ranking Form 1; Physical Factors

Scheme Name:
Gross Arable Area:
Presently Irrigated Area:
Previously Irrigated Area:

Previous name of farm
Province:
Natural Region:

Factor	Characteristic	Rating			
		4	3	2	1
Water availability	Water rights	Final grant to hand	Provisional right awarded	Right applied for	No right and none applied for
	Adequacy of supply	Sufficient for full winter and summer irrigation on previously irrigated area	Sufficient for supplementary irrigation on area previously irrigated, but full irrigation on <100% but >50% of area.	Sufficient for supplementary on area previously irrigated but full irrigation on 50% of area.	Sufficient for supplementary irrigation only on previously irrigated area.
Ease of scheme implementation	Investigation survey and design requirements	Complete designs available for existing or proposed scheme	Topographic survey available, but no design	Existing sprinkler scheme with buried main lines, etc., but no design or survey.	Existing flood scheme but no design or survey.
	Rehabilitation measures	New pump, laterals and sprinklers, or rehabilitation of main canal only	New pump, main line laterals and sprinklers	Rehabilitation of headworks and main canal	Complete rehabilitation of flood scheme.
Power requirement + availability		Furrow scheme No power requirement	Electric pumping ZESA[1] on site	Electric pumping ZESA on farm or nearby.	No ZESA Diesel pumping.

1 implies connected to national power grid supplied by the Zimbabwe Electricity Supply Authority (ZESA)

Table 2: Ranking Form 2; Socio-economic Factors

Scheme Name: Previous Name of Farm:
Province: Natural Region:

Factor	Characteristic	Rating			
		4	3	2	1
Present dry-land farming achievement	Area planted per family (ha)	>5	>2.5 <5	>1,0<2,5	<1
	Relative maize yield	>120% of regional mean	>80 <120% of regional mean	>40<80% of regional mean	<40% of regional mean.
Willingness to irrigate		Successful attempt made to rehabilitate facilities on own initiative	Some use made of existing facilities	Request made for Agritex assistance to develop or rehabilitate facilities.	No initiative taken
Farming experience or training		Farmers present with arable farming experience (Model A), or previous commercial farming experience at Asst. Manager level or above	Holder of Agricultural diploma present as Coordinator or Adviser (Model B)	No management skills present (Model B).	Majority of participants have no previous farming experience (Models A & B)
Previous irrigation experience		Participant present with previous experience in irrigated farming at Asst. Manager level or above (Model B), or previous experience as an irrigator on a formal smallholder irrigation scheme (Model A).	Holder of Agricultural diploma present as Coordinator or Adviser	Majority of participants have irrigation experience at labourer level.	Majority of participants have no previous irrigation experience
Group organisation and cohesion	Model A	Registered irrigation co-op	Registered marketing and buying co-op or registered irrigation co-op	Unregistered marketing and buying co-op.	No attempt made to form co-op
	Model B	<5% annual membership turnover	>5% <10% annual membership turnover	>15% <30% annual membership turnover	>30% annual membership turnover.

influence the irrigation system to be recommended. Greater weight was placed on those combinations which favoured a low-input system, for example, furrow rather than sprinkler irrigation.

Ease of scheme implementation
It was recognized that participants in the scheme would find it difficult to arrange for the investigation, survey and design of the schemes, because of their general lack of technical and management skills. As there is a shortage of irrigation specialists within existing government departments to assist in this task, schemes for which designs had already been prepared by government departments or by the commercial suppliers of irrigation equipment were favoured over those for which there had been no preparation.

Similarly, schemes which required a minimum degree of organizational input from government departments for the provision or construction of irrigation infrastracture were favoured over those which might have required the mobilization of earth-moving plant and construction gangs.

Power requirement and availability
The unavailability of electricity from the national grid to a pumping scheme was seen to be a major constraint as the scheme would then have to depend on diesel fuel. This was regarded as unattractive because of high cost, unreliability of fuel supplies and difficulty of maintenance of the engine.

Ranking Form 2: Socio-Economic Factors

Rationale
The design of the ranking form for socio-economic factors is shown in Table 2. This group of factors was intended to highlight groups which showed a high degree of cohesion and organization (formal and informal) and which had participants with the experience and willingness to manage the scheme once it had been rehabilitated. It was also intended to reflect any infrastructural constraints which existed,

such as lack of draught power or access to markets.

Present dry-land farming achievement
For this factor, weighting was to favour those schemes where the participants had made maximum use of the arable land available to them and had the greatest planted area per family, based on average yields for the previous season. One season was preferred to an average of two or more seasons in order to standardize this parameter since some families had been on the land for only one season and the previous season had been a 'normal' one with regard to rainfall.

Willingness to irrigate
This factor was intended to reflect the interest of farmers in irrigation development, and favoured those schemes where participants had taken some initiative in developing or rehabilitating irrigation infrastructure. This may sound like a strange consideration but in fact, there were many groups who, for various reasons, had no desire to irrigate. The point score categories shown in Table 2 are self-explanatory.

Farming experience or training
Here, the scoring was intended to disfavour schemes where participants had little or no previous experience of arable farming. The point score categories shown on Table 2 reflects the difference in management skills required for Model A and Model B schemes.

Previous irrigation experience
It was recognized that irrigation often creates an additional management burden on farmers. Therefore, previous irrigation experience at an appropriate level was favoured.

Group organization and cohesion
This factor was considered to be particularly important for Model B schemes where, quite often, there was a high turnover of membership, resulting in a general weakening of the management structure, and sometimes of morale and, therefore, performance.

Borrowing record

This factor was introduced in order to give some indication of the prospects for resettlement-scheme farmers to borrow from the National Farm Irrigation Fund which was created to encourage farmers to borrow on comparatively easy terms to finance irrigation development. This factor was considered important since many farmers in the communal area from which many of the settlers came were willing to irrigate but often quoted the unavailability of funds for acquisition of initial inputs as a major limiting factor.

Draught power

No distinction was made between animal and mechanical draught power, importance being attached to the availability and effective use of either.

Marketing

Assuming that scheme participants would all grow either high-value perishables or low-value grains, depending on the market, point score categories for this factor were intended to indicate the distance to the nearest marketing point, for example, Grain Marketing Board depot, a rural service centre or a growth point.

First-stage weighting

Physical factors

Five physical factors were considered (Table 1). In the first stage of weighting, a maximum of 100 points was allocated. Thus if any scheme was marked in column 4 (i.e. 4 points were scored) for each of the five factors, the application of the weighting would result in a total of 100 points (that is 25 x 4).

The weighting factors selected in Table 3 were intended to reflect the relative importance of each of the factors. As can be seen, more importance was attached to water availability and power requirement/ availability than the other factors combined.

Table 3: First-stage weighting for physical factors

Factor	Weighting
1. Water availability Water Right	2.8
2. Water availability Adequacy of supply	9.0
3. Ease of scheme implementation Investigation survey and design	4.1
4. Ease of scheme implementation Rehabilitation measures	2.8
5. Power requirement and availability	6.3
	25.0

Socio-economic factors

Nine socio-economic factors were considered and weighted. As was the case for the physical factors, 100 points were allocated.

The weighting factors are given in Table 4, from which it can be seen that prime importance was attached to previous irrigation experience and willingness to irrigate.

Second-stage weighting

Point scores for physical and socio-economic factors were then adjusted by factors of 0,4 and 0,6 respectively, to give a total point score of 100 for each scheme. This was intended to reflect a view, which experience suggested, that for the purpose of rapid screening of projects the importance of socio-

Table 4: First-stage weightings for socio-economic factors

Factor	Weighting
6. Present dryland farming achievement Area planted per family	2.0
7. Present dryland farming achievement Relative maize yield	3.0
8. Willingness to irrigate	3.5
9. Farming experience and training	2.5
10. Previous irrigation experience	4.5
11. Group organization and cohesiveness	3.0
12. Borrowing record	2.5
13. Draught power	1.0
14. Marketing	3.0
	25.0

economic factors outweighs the importance of physical factors.

Discussion

With regard to the physical factors, it was generally found that, after the availability of adequate water, the ability to transmit the water was the next important factor to be considered as there were numerous cases where a more-than-adequate water source was present but irrigation was not being carried out because the farmers had not been able to raise the relatively large sum of money required for them either to be connected to the national electricity power grid or to purchase diesel fuel for pumping. Very often too, power may have been available and pumps may have been inherited in a state of slight disrepair but there may have been no appreciation of the capital value of such equipment and no technical know-how as to the nature of their malfunction and the best way to go about getting them repaired. Hence water availability and power requirement and availability are weighted considerably higher than the other factors. It was because of the importance of the power factor and the problems emanating from lack of know-how that, among the social factors, previous irrigation experience was also weighted heavily.

Farms not within reasonable proximity of the national grid or where farmers, for one reason or another, had to rely on diesel power were rated low. This was so because use of electric motors for pumping is less costly than use of diesel engines and is, on the whole, more reliable because most peasant farmers do not have reliable transport of their own or facilities for the bulk storage of diesel to guarantee against the disruption of pumping.

Ease of scheme implementation was largely dependent upon the extent to which there was infrastructure and upon the state of repair of the equipment constituting such infrastructure. Some schemes had considerable infrastructure which had been left to degrade because of lack of motivation, know-how or, in some cases, lack of interest in irrigation as some farmers were only settled some time after the purchase of the farm and interest in irrigation was not one of the criteria for selecting people to be resettled.

Among the socio-economic factors, four merit special consideration. The first is 'previous irrigation experience' which is given the most weight. It was clear after the first few interviews that, in those cases where such experience did not exist, willingness to irrigate was also low or if the settlers were willing, they very often underestimated the financial and other implications of such a commitment. Experience also affected their appreciation of the capital value of any existing infrastructure and, therefore, the way in which they looked after it.

A second factor, dry-land farming performance (factors 6 and 7), was found to be a good indicator of the levels of motivation and management. This was particularly so in the case of the Model B schemes where problems of management were evidently a very important factor. Dry-land farming performance was, in the case of Model B schemes, closely related to group organization and cohesion (factor 11). Where factor 11 was poor, ratings for factors 6 and 7 were invariably also low.

Clearly, regardless of how high the scores were for the three factors above, there was no likelihood of irrigation taking place if there was no willingness to irrigate. Therefore factor 8 was given considerable weighting.

A striking feature which emerged from the pre-ranking reconnaissance investigation was that a considerable number of schemes required only minimal capital investment and expertise to rehabilitate them, a fact which most of the settlers were not aware of. There was a general but understandable lack of appreciation on the part of the settlers of the capital value of the inherited infrastructure. Moreover, the relatively minor technical skills required to initiate rehabilitation were not available to the settlers, or they were not aware of the availability of skills or the finances required, notwithstanding the considerable activities of non-governmental organizations in these areas.

For example, on some schemes, it was found that there was an existing dam, pumps, transformer, pipeline and a buried distribution network, but no sprinkler lines. In this case it would be relatively easy to approach one or more of the several commercial irrigation suppliers for a free design and quotation for the equipment required, information which could then be used for an application to the fund established for the purpose.

Another typical example is the case of schemes which were gravity-fed from an existing dam through a system of canals and had night storage dams and a furrow irrigation system. Quite often on such schemes, irrigation was not taking place only because the canals were in a state of minor disrepair and the settlers did not have any idea how to manage the simple repair operations required.

Thus, bearing in mind the lack of know-how, although considerable weight was placed on water availability and the ease with which rehabilitation could be achieved, it was also necessary to consider the socio-economic aspects of farmer interest and previous irrigation experience as well as their previous dry-land farming experience.

Conclusion

The ranking system described in this paper was found to be a quick, useful and cost-effective method for non-subjective, parametric preliminary evaluation of the potential of small-scale irrigation projects. It is hoped that the information presented here can also serve as a useful basis for the development of comprehensive evaluation methodology which can be used for rapid preliminary planning, especially where computer processing of data is possible. It should be noted, however, that the ranking system developed was not intended to replace the more traditional approach of pre-investment study, only to identify quickly and objectively those schemes which should be chosen first for the more detailed treatment.

Inevitably, such a system suffers from some defects, including a possible failure to take all relevant socio-economic factors into account. For example, in the case of Model A schemes, there may be a need to move families from their already allocated plots so that all participants in the scheme may be given smaller irrigated plots. However, in a situation where planners are faced with a very large number of potential schemes from which to choose, the problem of selection is immense, unless some means is available for a quick assessment. The system devised does draw attention to the more promising schemes and it is hoped that this would lead to more detailed consideration of all relevant factors and constraints at a later stage.

ACKNOWLEDGEMENTS

APPENDIX 1: INVENTORY FORM

Inventory No:
Scheme:
Previous farm name
Province/District
Location (1: 50000 Map No)
Total farm area
Agro-climatic data
Natural Region
Mean annual rainfall
Mean annual pan evaporation
Altitude
Soil and land capability
Types
Irrigation suitability
Soils
Topography
Erosion hazard
Conservation required.

Water availability
Source
Name of river
Water Right

Irrigation infrastructure
Pumping equipment

Conveyance to field edge
Night storage
Distribution system
ZESA availability
Rehabilitation measures required
Investigatory survey and design requirements

Agricultural background
Arable area
Previously cleared
Cultivated area
Land capability class
Presently planted area
Irrigable area
Area previously irrigated
Area presently irrigated
Main crops: Summer
                Winter
Present dry-land yield
Crops to be irrigated if scheme rehabilitated

Socio-economic data
DERUDE[2] model
Number of members or family size
Farming experience and training
Irrigation experience
Willingness to irrigate
Present use of credit
Willingness to borrow for irrigation scheme
Turnover of settlers on farm
Draught power used: Cattle
                     Others
Market for potentially irrigable crops
Group organization and cohesion.

2 Department of Rural Development