Data Management, Analysis and Report Writing for a Field Based Irrigation Resource Inventory

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INTRODUCTION

This paper outlines several objectives and potential uses for an irrigation resource inventory. It uses an example from the country of Nepal to focus on the development of inventory methods that would meet differing needs at several levels within irrigation, planning and policy agencies of the government. While the primary objective is to identify farmer-managed irrigation systems and specific information about each, it is proposed that an irrigation resource inventory go beyond that. It is suggested that the inventory process be used to tap farmer knowledge and experience of their local environment to identify opportunities for augmenting the irrigation supply to their existing systems and to get farmer suggestions concerning constructing entirely new systems.

INVENTORY PURPOSE AND USE

Information about irrigated agriculture at the local level, where farmer-managed irrigation systems are of critical importance, is lacking in many countries. Land capability maps, topographic maps, cadastral maps and aerial photos exist but do not explicitly identify farmer-managed irrigation systems because their small size farmer canals do not show up on most maps and aerial photos. Though land use maps indicate irrigated area, the fact that there are multiple, often interrelated but distinctly different systems serving the area is missing. Cadastral maps are used to identify land ownership and have sufficient detail to show irrigated area but information about irrigation was seldom explicitly collected and again there is no differentiation among systems in an irrigated area.

While farmers have built and operated irrigation systems for many generations, the modern development era of the past five decades has tended to overlook their accomplishments. New systems are sometimes proposed and have frequently been built that overlay existing ones with the expectation that they will be technically more efficient. Some are successful but many are plagued with management problems. Maintenance budgets cannot be met and the rules essential for operation -- allocating of the irrigation supply among users, irrigation distribution procedures, resource mobilization and management of conflicts -- have lost their local under pinnings.

In the past decade the failure of expected output from investment in construction of new systems together with improved information about the extent of farmer-managed irrigation has caused a shift in irrigation investment emphasis. Increasingly programs are designed to provide assistance for improving and expanding farmer systems. Though farmer systems are now recognized as an important resource, there is not sufficient information available about individual systems to identify the type of site specific support that would be most useful. In a mountainous area like the Himalayan foothills in Nepal, for example, it is not uncommon to have several hundred irrigation systems in one watershed. Though it is known that there are many systems, without identification of each system and its unique problems it is not possible to identify priorities for the scarce resources available for assisting these systems.

In countries where support services are being set up or assistance programs established for farmer-managed irrigation systems, the primary purpose for an irrigation resource inventory is to prepare accessible information about the current status of each system. Collecting information for such an inventory must be based on field visits to the systems and offers an unique opportunity to systematically tap the farmers' information on further irrigation development potential in their micro areas.

The use of an irrigation resource inventory can be outlined as follows:

Policy Needs

- To provide an accessible, enduring record of all irrigation infrastructure in a watershed in a format that can be sorted at will for different purposes and needs and that can be updated easily.
- To supply input for preparing an overall irrigation development strategy that does not overlook existing resources.
- To use for setting priorities for investment in the irrigation subsector that identifies cost-effective opportunities for increasing food production (for example, the priority might be to first assist systems with available land and water resources for expansion of irrigation to new area in order to benefit families that may not have irrigated land).

Project Implementation Needs

- To determine water allocation among systems in a watershed.
- To select among candidates systems for assistance in order to match policy strategy (for example, expansion of irrigation to unirrigated land, intensification of cropping, or reliability of irrigation service, etc.)
- To provide first level identification of system deficiency (physical deficiency, management ability, labor and other resource mobilization, etc.)
- To provide first level identification of system institutions and experience which can be used to expand, intensify and improve irrigated agriculture or that need to be modified if expansion is desired.
- To establish implementation priority that allows effective supervision.

Research Needs

- To identify systems to use for demonstrating good irrigation management practices that can be used as sites for farmer-to-farmer training.

- To identify and classify problems that require research attention.

PROBLEMS

An irrigation resource inventory will only be useful if the field data collection is done with sufficient accuracy that analysis will yield the desired results (garbage in/garbage out). There are many pitfalls in accomplishing this. Field data collection will be hard physical work that is nearly impossible to supervise. It will be costly to train teams and support them in the field. Data handling will be a mammoth task which will require continued support.

In many ways this is analogous to building and operating a public library. It sounds like a good idea, one can raise money to initiate it, but funding to continue maintenance and effective operation depends upon the public's perceived value of the facility. Without proper initial cataloguing and continual correct shelving of books the library becomes useless. Over time as new additions are not entered, the system becomes dated and holdings inaccessible. If an irrigation resource inventory collects data that is not entered by a systematic procedure and properly maintained and updated, it will also become useless.

An inventory is an ideal application for a computerized database. Information management and presentation would be enhanced by use of a geographical information system (GIS). Initial capital costs for this are reasonable. However, continued operation and maintenance of the database (and the associated software and hardware particularly for GIS) is dependent upon trained operators. Training must continue so that the turnover of staff can be accommodated.

ALTERNATIVES

There appear to be formidable problems in making and maintaining an effective irrigation resource inventory. It is an exciting idea with a lot of appeal that can easily bog down when the initial support is withdrawn. However, I do not see any viable alternatives for achieving the things listed above without collecting information in the field. Presently most of the work done in collecting information on a project basis gets lost or becomes inaccessible when projects terminate.

Information about existing irrigation infrastructure in a country could be handles in the same way as land ownership. While incentive for maintaining land title records are multiple (taxation and ownership to name two) the returns to an irrigation inventory are much more indirect (in this sense census may be a better analogy than land records). The choice is to whether to muddle along as at present or to do serious, systematic and expensive work to improve policy and management decisions. In the long-run it needs to be determined which will cost the most.

IMPLEMENTATION

The implementation procedure proposed here is based on experience in Nepal. It is assumed that each stream and river has multiple diversions built by farmers. It is also assumed that while some systems have received prior assistance from a government agency, many have never been visited and are not on any agency list of existing systems. Finally, systems will only be visited one time since access requires extended walking.

The approach for collecting field information proposed here is to prepare a detailed questionnaire to be used by a team that interviews farmers in each system. The questions should be based on the experience and information available from past research on farmer-managed systems. If little information is available, a series of rapid appraisal studies should be used to generate the first questionnaire. The reason for moving away from open-ended questioning so useful in a research setting to specific questions developed from research results is to allow numerical, yes/no, or coded answers that can be sorted by computer. While narrative descriptions may be needed, it will be kept to a minimum. This can be done by revising the question list as necessary. Narrative description is impossible to sort and classify effectively in a computerized database.

In the field, the team will meet with farmers and walk along the canal from the diversion through the command area. In addition to the information on the questionnaire, the team will need to make a sketch of the system layout and command area. This must be referenced on the best available topographic map and aerial photo. For larger systems, area can be estimated from the map or photo for comparison with farmer reports of command area size and area for irrigation expansion.

Data Collection

Coded forms need to be developed to allow entry of field information on the form in a format that can be directly keyed into a computer database without recording. This requires several iterations of testing and modification. Criteria are needed for the field team to use in determining the type of existing systems and area to exclude from the data base. For example, in many small basins there are springs or systems in valley bottoms that allow individual or small groups of farmers to irrigate without much effort and which have no potential for further development. These could be marked on the map or aerial photo but the normal question routine may not be followed depending on the selection criteria. Estimation of area irrigated and number of farmers served should be noted even for systems where formal interviews are not done, to allow full and systematic coverage.

After development and completion of testing of the field data techniques, field enumerators need to be trained. In the training process undoubtedly additional refinement of techniques, will be necessary.

Development of Data Handling

A computerized database system should be established to manage the field data. The database software chosen must be evaluated carefully to assure that analysis and reporting capabilities are in line with desired results. If possible the software should be compatible with statistical and GIS packages. Development of the data base requires careful conceptualization of the desired output -- types of queries that will be done and reports to be generated -- in order to match input and file management options.

It will be important to establish a data entry procedure that matches the coded questionnaire. It would be useful if data entry could be done on a laptop computer in the field. Capacity to print a simple report in the field would make verification by the field team easier and allow immediate correction or addition of missing data. It would also allow a copy of the data to be left with the farmers as a record of what they have helped assemble and for them to use in preparation of requests for assistance. Data analysis, sorting and report generation will not be necessary in the field.

Data Analysis

A number of criteria or conditions for sorting and ranking systems are suggestions below. Others needs to be added as experience is gained with the field situation, data handling and analysis options, and procedures and needs.

Water Resource Criteria. 1) Extent to which water is available in the source for system expansion in each cropping season[1] in an existing system; 2) Possibility for augmentation of the water supply from a new source to an existing system; and 3) Underutilized water resource available for developing area not presently irrigated.

Land Resource Criteria. 1) Land area irrigated in one crop season but is fallow in other each year, i.e., the potential for increasing the cropping intensity; and 2) Cultivated or cultivable land area not presently irrigated that lies in the hydraulic command of an irrigation water source.

Institutional/ Participation Criteria. 1) Water rights among systems diverting water from a given stream, i.e. will there be conflict if more water is diverted by a particular system; 2) Water rights (irrigation allocation) within an existing system that determines water property rights and potential for system expansion. The question or issue here is whether the present irrigation users have a mechanism or are willing to create a method for adding additional water users to their system and give them clearly identified rights and responsibilities for being members and using water from the system; and 3) Extent to which lack of organization limits farmers' ability to improve the system on their own.

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1 In some areas, at high altitudes for example, only one crop can be grown each year because of temperature factors. In other areas two crops can be grown and in others crops can be grown all year which, depending upon the community, often translates into three cereal crops each year. The cropping season refers to the duration of one particular crop in a specific location. Thus, in an area where crops can be grown all year and the local practice is (or could be) to grow three crops each year there would be three cropping seasons. Water availability relative to land resources and irrigation practices such as water rights, might be different in each cropping season.

Physical System Criteria. 1) Extent to which physical system (the building structures would rectify) problems limit available water delivery and constrain expansion of irrigated area or intensification of cropping pattern; and 2) Degree to which physical system maintenance costs limit expansion of irrigated area or crop intensification[2] or threaten sustainability of the system.

Agricultural/ Production Criteria. 1) Extent to which crop selection could be used to manage a scarce water resource; and 2) Degree of subsistence or market orientation of the existing irrigation users.

Output Requirements

A multitude of possibilities exist for analysis and report generation. The two main levels of interest are at the local or implementation agency level and the other at the central or planning agency level. The needs of the two are somewhat different.

Local Level. The objective at the local level could be to sort and rank systems by degree of potential for increasing food production if given assistance. Such a ranking needs to consider secondary criteria, such as willingness to allow new irrigators to gain water rights, likely conflict over water among systems, etc., for establishing the priority for giving assistance to systems. This list can then be used to select priority systems for assistance. It allows grouping of systems for assistance to enable intensive supervision of the inputs supplied.

The database can also be used to record assistance and enable rapid access to the status of projects underway and completed, provided such information is collected and entered regularly.

Central Level. At the central level the database information will allow compilation of detailed statistics on area irrigated and the potential for expansion of irrigated area in different cropping seasons. This will enable planning or investment for assistance.

Report Generation

The nature and structure of the database will depend on the type of analysis and reports that are needed. A sample profile report is given below. Detailed reports need to be catalogued for easy reference. Identification of several possible sorting criteria permits preparation of lists of systems that fall into different pertinent categories to consider for assistance (system profile report notes). Flexibility in viewing report information before printing will be important.

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2 If the cropping pattern is one crop per year for a given field in an environment where two or three would be possible, intensification of the cropping pattern means adding additional crops per year to the field.

Documentation

To enable others to understand the rationale and strategy behind the approach used in the questionnaire and software development, there should be full documentation. This should include changes made in the framework after conceptualization. This will facilitate reporting the cost of development and show the evolution of thinking as new information becomes available.

The final step in development of data management will be preparation of an operational manual. The purpose of the manual will be both as a reference and to facilitate training the persons that will need to implement and access the system when it is introduced.

REPORT SCENARIOS

SYSTEM PROFILE

SYSTEM LISTING

By Panchayat and Ward

By Watershed

SYSTEM RANKING

By Irrigable Area Expansion Potential

By Crop Intensification Potential

By Potential for Increased Food Production

By Maintenance Reduction Potential

IRRIGATED AREA AND PRODUCTION ESTIMATES

System Profile Report Notes

1. Table 1 is a prototype of a System Profile Report which could be generated from a database with data supplied from the accompanying questionnaire. A great deal of effort went to making it all fit on one page. The Dhading Development Project in Nepal has compiled an inventory of all existing systems in Dhading District. They found about 3000 systems in one district. A one page summary as suggested by this proposed format would still require 3000 pages. Just a one line listing would require approximately 3000/60 lines per page = 50 pages.

2. "Present" and "potential" area irrigated by each crop is an important way to assess potential benefits from future assistance. "Present" refers to the existing practice and "potential" to the expected level if assistance were given. The potential level would consider both land and water resource availability including the possibility of augmenting the water source if feasible.

3. Water availability assessment indicator value categories are:

   - A abundant compared to need
   - C constrained compared to need (this could be either due to physical or management problems)
   - L limited supply even if managed well

4. Water distribution: R = rotation, C = continuous