Irrigation Renovations and Soil Reclamation Priorities For Inma

R.L. Tinsley[1]
Inma Irrigation, Water Management,
& Soil Reclamation Specialist

Introduction

The objective of this brief write-up is to provide some guidelines on how to proceed with irrigation renovations and soil reclamation programs once a community or irrigation command area (ICA) has been identified for a cluster value chain intervention. It could also provide some assistance to other PRTs not directly involved in Inma's cluster areas, and assist them in any renovations needed to optimize the irrigation and water management practices in their operational areas.

Canal & Drain Renovations

Primary and Secondary Canals

Perhaps it is a trivial statement but the beginning point of any irrigations renovations has to be with the canal network. If the water cannot flow, there can be no irrigation. Thus the highest priority of irrigation rehabilitation is getting the canal and drains functioning at a reasonable or optimal level of effectiveness, at least as far as delivering or removing water from the ICA. Canal/drainage networks are usually divided between the primary and secondary canals and drains, that convey water to or from the field canals and drains; and field canals and drains, that deliver or remove water from individual farms or fields. It is also possible for sunken canals associated with local lifting of water from field canal to field for the canals to partially double as drains.

The field canal diversions also represent the common point of division of administrative responsibility between Ministries of Water Resources as in Iraq or corresponding ministries of Water or Irrigation in other countries, and the Ministry of Agriculture. However, for practical purposes this represents the point where the farmers are expected to assume responsibility for the maintenance of the canals and drains, and assume control of the water distribution. It may also represent where the ownership of the irrigation system officially shifts from public to private sector. It is hoped that the MoWR and MOA in Iraq will accept these points of change of responsibility. Inma should not get involved in these policy issues but simply monitor how they develop and make any adjustment when necessary.

[1] The ideas contained in this paper are strictly the author who is solely responsible for the content. Some of these ideas may and probably are in contradiction to other Inma and USAID opinions. In such cases it hope they rational behind the opinions will be appreciated and lead to more comprehensive discussions and better overall programs.

Inma critical concern for the main and secondary canals and drains is to recognize that the cleaning and maintenance is a public sector activity for which Inma should not normally become involved beyond assuring an adequate flow of water into the ICAs Inma is concentrating on. Historically, the maintenance of main and secondary canals and drains has been undertaken directly by the MoWR or its predecessor the MOI. They own much of the excavators and other heavy equipment required to do this. However, like most public sector equipment, it is mostly in a poor state of repair and in desperate need for complete mechanical overhaul, or scraping. My recommendation it that the MoWR remain responsible for the canal maintenance, but it is done through private contractors, and the MoWR heavy equipment sold off for whatever value it can obtain, including exchanging it with potential private contractor for contracting x kms of canal work.

Beginning shortly after the conflict and continuing up to the present there has been a “make work” effort to manually clean the irrigation canals. I would like to see this completely reviewed and perhaps move to more commercial mechanical contracting of canal maintenance. I would venture that the manual cleaning is providing at mostly superficial cleaning that may remove the weeds, but does little to remove the accumulated sediment. Also, since this requires people to get into the water up to their chest, this is basically mostly drudgery, dirty, and unhealthy work that everyone is well aware can be easily mechanized and historically has been. If I were a young Iraq and asked to do this type of work I would think “these ‘*expletive deleted’* Infidel crusaders promised us work and this demeaning job is all they offer, it is better to join the insurgency and become a martyr chasing them out”. With the PDS food basket providing two-thirds the daily calorie requirements, there is really little incentive to accept this work and appreciate it. Thus, the canal cleaning make work program may be counter effective, and it might be better to shift back to mechanical contracting for canal maintenance. The public work effort might be better to think in terms of “meaningful work” instead of work for works sake.

One part of canal maintenance is the maintenance of the control structures that assure the water level is high enough for all the distribution and farm canals to receive their due entitlement of water. It is possible that some of the control structures are in such state of disrepair that water level in some reaches falls below the inlet of some distribution and farm canal outlets. This effectively eliminates the impacted canals from the irrigation system unless the farmers obtain pumps. This needs to be corrected to assure water is properly distributed. Also, high resolution remote imagery frequently show some major obstruction placed across the secondary canals. These often take the form of impromptu bridges or causeways with a limited number of pipes under the road to convey the water. However, most likely these will be a sufficient impediment to substantially reduce the flow. These need to be removed or replace with more permanent true bridge such as a prefabricated Bailey style bridge. It has to be accepted that the impromptu bridges were built for a reason, and to simply remove them will result in more impromptu bridge quickly replacing them.

Unfortunately in present day Iraq when installing control structures or repairing pumping stations, it is necessary to consider security. When considering security it might be best to carefully consider where the vested interest is in protecting or destroying the control structure or pumps. Most likely the damage to these facilities was done, not so much to invectively vandalize

them as to get the extra water they would allow, as the decline in the canal conditions reduced the flow and someone received insufficient water. Thus the vested interest in a pumping station is with those farmer and large landholders below the pumps, while the vested interest in a control structure that lifts water would be back upstream of the control and the farmers and large landholders prior to the structure. These respective large landholders should be given the mandate to organize any needed security.

Also, given the tendency to use canals for disposing of all kinds of trash including animal carcasses and occasional corpuses, it would be desirable to also install trash removal equipment prior to any control structures or mid-canal pumping stations. These could be similar to those used by the Salt River Project in Phoenix, Arizona to protect their control and diversion structures.

Where possible while renovating the water control structures and pumping stations install measuring devises with imbedded staff gages. While the less rigid water entitlements in Iraq do not require in-depth measurement, they are good for evaluating the overall operations of the canal network, at least up to the distribution canals. When possible the measuring devices should be free flowing without any submergence so that they can be easily read from a single staff gage. If submergence is a problem farmers can be very sensitive about the restriction in the measuring flume. They tend to think the restrictions are reducing the flow of water and then vandalism them. This can sometimes be overcome with the broad crested weir or Repogle Weir. This restricts from the bottom with the only thing visible to the beneficiaries is the small jump in the water surface. The make it more acceptable and less likely to be vandalized.

Finally, since much of the access to the ICA will be via paths and roadways adjacent to the canal, and much of the restriction to access is caused by erosion around the field canal inlets, during the rehabilitation of the secondary canal the roads adjacent to the canal will also be rehabilitated. As much as possible the sediment removed from the canal can be used for this purpose.

Farm Canals & Drains

Field canals and drains are those watercourses that convey water from the secondary canal to the individual fields and remove excess water from the fields into the secondary drains. The excess water could be either surface water or subsurface seepage. In some case when lifting is required to get water from the field canal to the individual field the field canal can partially serve as both delivery canal and drain. Most field canal in surface irrigation system similar to those in Iraq are free flowing with no control gates at the inlet from the secondary canal. The main control is the size of the opening which is often no more than a pipe which in hydraulic terms is an open orifice. The diameter of the pipe is normally roughly adjusted to the area commended by the field canal. However, as individual pirate water from the main canal, frequently additional pipes are added to assure extra water for the field canal and area it serves. Where necessary such extra pipes should be removed. While this may not be ideal according to western irrigation standards, given the complexity and diversity of crops produced, the time spread in crop management, the ownership/tenure structure that serve it, and the limited communication possible this could represent the optimal operational efficiency. Adding gates for farmers to

control would have little if any impact as there is a tendency for farmers to open the gates and just leave them open 365 days a year as they never know who might also be irrigating.

The farm canals and drains have historically been left to the farmers to maintain and operate. This is appropriate because of the physical proximity, and the benefits go directly to the farmers involved and no one else. The usual mechanism promoted by development projects for managing farm canals and drains are Water Users Associations (WUA). WUA are intended as an association of the users along a field canal that should have sufficient vested and mutual interested in the operation and maintenance of the canal. The expectation is that they will work together to jointly maintain and operate the canal, often with each individual expected to maintain the canal adjacent to their lands.

They are based on the private ditch companies that developed most of the irrigation in the Western US. However, the ditch companies are backed by a rigid legal system of strict water rights that are enforced through the “water courts” dedicated exclusively to hear water litigation. This also make it an expensive irrigation system to operate and even more expensive to litigate any disputes. In the absence of these legal water rights the WUA are a very fragile organizations that rarely survive the end of donor facilitation. They require 100% continued active participation of all water users sharing a canal. Unlike the cooperative system that can tolerate substantial side-selling and still continue retain a functional shell that can be promoted as functioning, with WUAs it only takes 1 user to break with established procedures for the whole WUA to collapse. The underlying assumption for WUAs is that everyone will equally accept the operational and abide by it. Unfortunately, usually there will be someone on the canal that for whatever reason feels he as some priority right over his neighbor and will routinely break with established WUA procedures. After all they only have to look at the pirating of water from the secondary canal as justification.

To be successful WUAs need to be come as close to the legal rights system of the US, without getting into the more costly aspects. This mean being fully aware of the communal vested interest which implies that, yes it is in the community’s best interest to have a functioning canal. And, also the individual vested interest which reverses once and individual outlet is past. That is individually a water user wants the canal maintained in front of his inlet, but not past his inlet. Once past his inlet the weeds and sediment in the canal will cause “backflow” that will provide him extra water beyond what he would otherwise obtain. Thus, it is unrealistic to expect farmers to maintain the canal adjacent to their holding, as commonly expected. They have more vested interest in the canal above their outlet and would be far more willing to maintain the canal in front of their inlet and holding, but need a clear right to do so. Thus, for WUA to have a better chance of success it will be necessary to provide:

1. As clear a statement as possible on water entitlement.
2. A clear statement of right to intervene either as a group or individually, particularly to intervene in front of their inlet to remove weeds and sediment, prevent overtopping, plug any leaks in the canal bank and close any informal bank cuts.
3. A clearly well established mechanism of recourse back to the scheme management to settle any disputes that arise in the operation of the canal.

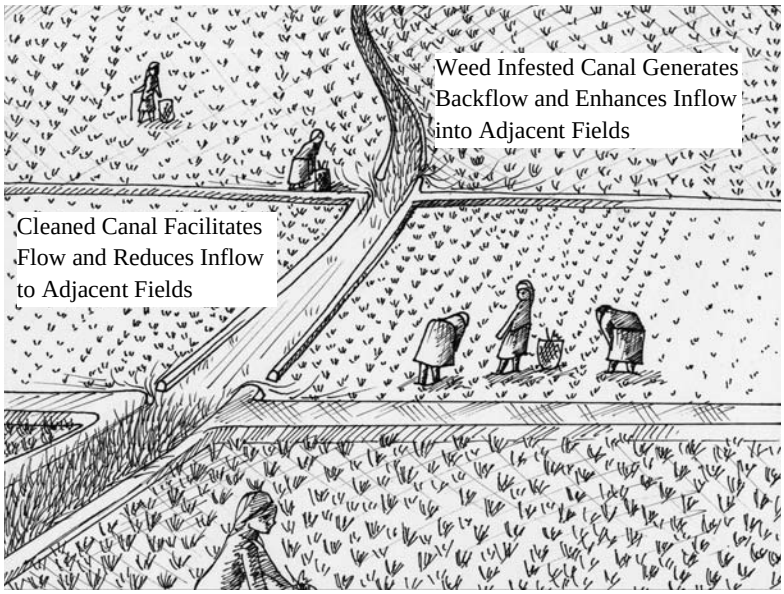

Fig. Illustration of how weeding adjacent to irrigation canals will reduce inflow to owners fields while increasing inflow to downstream neighbors

It would also be good to invest in concrete outlets for each field fully equipped with flash boards so water can be either diverted into a field or allowed to flow past. This will better assure everyone receives their due allocation of water. Such outlets should replace the simple canal cuts that are most often used to guide water into a field that should now be subject to closure by the downstream users. Finally, formal tail escape should be installed as needed to assure water levels in the lower reaches of the canal are adequate to serve lower fields and the water leaving the area is non-erosive, and any roadways along the drains are protected.

Canal Operations

In countries like Iraq with public irrigation system managed by the respective Ministries of Irrigation or MoWR, the end users have little influence over the overall operations of the main and secondary canals. This is done be edict from the Ministry based on some idealized crop calendar master plan of the crops expected to be produced in the area. This may be continuous flow as in Pakistan or rotational flow as it Egypt. In neither case is the normal 8 week spread in basic crop establishment factored in. It is a crude operational procedure but really the best available. To even attempt a demand based system as in the US would be administratively impossible, and prohibitively expensive relative to any potential returns. The biggest problem would the unbiased communications needs, even with the wide scale use of cell phone communication. There are means of determining the aggregate demands in a system and use that as a planning tool for subsequent year's management. It can be evaluated but most likely

not until later stages in the project[2]. In Iraq the canal operations are continuously affected by power shortage and pump breakdowns. This reduces the reliability of the irrigation deliveries for which the most logical and rational response by the farmers it to irrigate when water is available even if this is earlier than desired, even when reducing the opportunities to downstream neighbors to irrigate.

Application Efficiency

Once the canals and drains are functioning effectively, the next priority would be to increase the application efficiency. This will mostly involve land leveling. However, this may have only a limited virtually non-measurable impact on the water applied or the operations of the canal. That is because the division of the field into small irrigation basins to a large extent mitigates the water management problems associated with non-precisely leveled fields (± 2 cm), and limited water flows to push the wetting front across the field. These small basins can be as small as 10 x 15 m in total field size of 0.5 ha as shown in the figure below. These small irrigation basins are usually temporary and the bunds surrounding them remove and reconstructed each time the field is cultivated. This requires considerable extra mostly manual time and effort to manage the fields, and hinders tractor mechanization once the bunds around the individual basins are formed. The mechanization that would be most affected would be seed drills and weeding cultivation. Land preparation and harvesting would be less affected because land preparation takes place before the bunds are built and at harvesting it no longer matters and the machinery can simple run over the bunds.

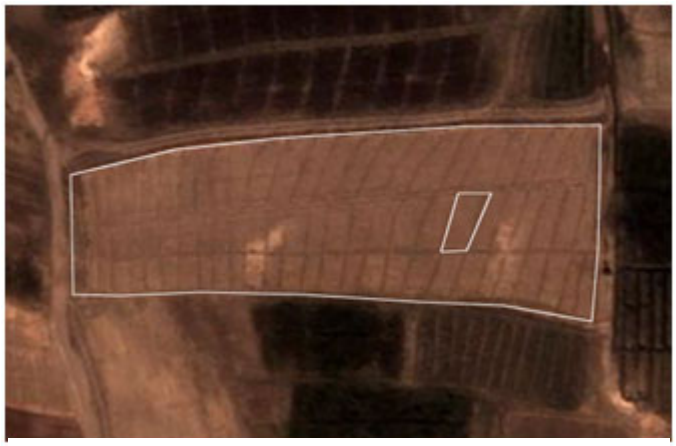

Fig. This field has overall dimensions of 150 x 47 m and represents a total area of 0.75 ha, the irrigation basin measures 19 x 6 m.

However, the bunds also consumes a substantial percent of the land area, but because the border effects surrounding each basin has a considerable lesser impact on total yields as full canopy crops will bridge the bunds. Thus the main advantage of leveling fields would be

[2] A method for determining water requirements based on farmers' aggregate demand and water lose over the tail escape is provide in the Chapter 8 Smallholder Irrigation of the text Developing Smallholder Agriculture: A Global Perspective. This chapter is available in the project library.

reducing the number of irrigation basin and save labor both in managing the water and other mid-season crop management activities. It will also lead to more uniform yields across the fields. Once leveled the basin size will be determined by the flow of water available to push a wetting front across the field. This could still be insufficient of effective tractor based mechanization.

However, leveling can be a tricky business. For small fields of one donum or less the only way to level the fields is by hand, basically from the farmers memory of where the high and low spots are located and moving soil from the high point to the low point. It typically takes a couple years to do this but eventually it can be fairly effective. In larger field between 2 and perhaps 20 donum the only way to effectively level them is with lasers leveling equipment. This can be very challenging as for the laser equipment to be economically effectively used it needs to have a single source tower serving several target scrapers. This can only be done while the fields are fallow. Thus the challenge is to get sufficient fields, possible of different ownership or tenure, fallow at the same time in order to independently level each. Also, working in field of 2 to 10 donum is fairly inefficient for tractors as the amount of time spent turning and backing into corners grows quickly. The estimated loss in operating efficiency in fields this size is 20%. Even so it is possible to level several 2 to 4 donum fields in a half day. However, with all the challenges in working in fields of this limited size, the laser leveling may not be economical as a commercial support service and have to be subsidized. It will also take several years to get all the fields in the community level as the fallow opportunities will be staggered. Once fields are more than 20 donum, the laser leveling efficiency increases to the point where it should be a commercially viable agri-business support service. Leveling is something that often has an initial fairly large effort that has to be followed every 3 or 4 years with a quick touch-up application.

Precision Irrigation Scheduling

Precision irrigation scheduling based on detailed ET estimations is an area that should have the lowest priority. It is the area in which the technology has vastly exceeded its importance and few US farmers have enough operational flexibility to make effective use of the ET estimates readily available from different climatic websites. This is an area where it is not reasonable to expect the Iraq water users with his much less well defined water entitlement and much less precise delivery system to be more precise than their US colleagues. For surface irrigation systems it is virtually impossible to accommodate this level of precise information. In Iraq and similar countries the canal operations usually make this impossible other than for an individual field demonstration. Trying to integrate that down a farm canal, with the typical 8 weeks spread in crop management, is virtually impossible and not worth the effort. For this reason the agriculture climatic stations envisioned in the ARDI project will most like receive few requests for information just as their sister station in Texas and Colorado receive few requests. Thus the procurement of such stations should be given low priority. A more effective use of the time and effort would be to evaluate the return flows and get them conjunctively integrate back into the main distribution system. It might also be possible to adjust some of the flow into the canals based on the simple aggregate demand analysis and monitoring tail escape flows as mentioned above.

It also has to be recognized that farmers normally will not excessively or deliberately abuse the irrigation system, and most of the sub-optimal irrigation practices are out of their direct control. Farmers in most cases will irrigate within ± 1 or at most 2 irrigations from the recommendations number of irrigations. Also, they will apply only enough water to push the wetting front across the field and then quit. However, this will often mean they are applying a minimum of 10 cm against a soil water deficit of only 7.5 cm. The 7.5 cm represent the soil water deficit when the plant will start to show yield sacrificing stress, and the 10 cm minimum application is determined by the flow of water reaching their field and the size of the field the wetting front must be pushed across. Some of this apparent excessive application is really needed for salt leaching. The saving grace that prevents farmers from abusing the irrigation system and applying more water than what is physically necessary is the amount of labor required to manage the water with all the small irrigation basins and the backlog of work in other parts of the farm.

Soil Reclamation

Soil reclamation in Iraq is considered to be almost exclusive salinity reclamation. However the extent of the problem is uncertain. It is proclaimed to be a major problem affecting large tracks of irrigated land. However, Google Earth searches of the irrigated land do not confirm this. Rather the saline affected soils appear more as isolated inclusion in what otherwise appear as productive fields. Thus the extent may be overestimate. Also, with Inma primary interest in developing agri-businesses most of the ICAs selected for commodity cluster promotion are expected to have only minimal salinity problems. This has to be to avoid diverting major part of the project resources to tangential activity.

Furthermore, it is thought that most of the salinity problems are the result of the repair and maintenance problems with the irrigation system, which reduce the water available for irrigation and resulted in sufficient surface evaporation to allow salts to accumulate on the surface with the capillary rise of water being evaporated. Since the problem most likely started with the disrepair of the irrigation system any effort to reclamation the soils will depend on the repair and return of the irrigation system to an effective and optimal design. This would include both the canals to deliver water and the drains to remove the excess water and salts.

Once the irrigation drainage system is functioning it is possible to consider reclamation processes. This requires either scraping the accumulated salts crusts and removing them from the field, or leaching them through the soil. Scraping a salt crust really requires accumulated crust of 2 cm or more which is rarely found. Leaching means apply excessive irrigation water to dissolve the salts and force them through the soil profile and out into the drains. This can require substantial amounts of water, which may best be done in winter when the ET rates are lowest and there is usually ample water in the canals. During this time it is possible to produce either salt tolerant crops or salt reclamation crops. An example of salt tolerant crop would be barley. It can grow in soils with reasonable high salt concentrations provide the irrigations are frequent and heavy, so the plant does not become moisture stress and shift the soil moisture gradient in favor of salts returning to the surface. Salt tolerant crops normally do little to actually remove salts from the soil. Salt reclamation crops are those crops that actually force salts out of the soil. The most common of these is paddy rice, provides there is a plentiful supply of good

irrigation water. When there is sufficient water to keep the paddies fully flooded for the entire season both a hydraulic and density gradient will push the salts out in what is basically a 6 month steady state infiltrometer. In the northern Nile Delta rice is produce primarily as a salt suppression crop. During a single rice season the salinity can be decrease by 30%.

It is possible though not expected to have some saline affected soil with poor internal drainage and high water tables. These soils may require tile drains. If these are incurred the necessary tile drains will be installed.

Summary

As Inma proceeds in working on irrigation rehabilitation in the designated Irrigation Command Areas the priority will be first to make certain the water is flowing. Thus the highest priority is to work down the system starting with the primary or secondary canal to clean weeds and sediments, remove obstructions and renovate the pumping stations and control structures. Once sufficient water is following in the main or secondary canal, focus should shift to the field canal and assuring the inlet structures and tail escapes are improved even if they are not equipped with gates, also install individual control structures at each field inlet. This is also the time to start working with farmers on how to maintain and operate the field canal with due consideration for changing vested interest as each inlet is passed. With the water flowing all the way to the farm, it is possible to consider improving the application efficiency and uniformity. This would involve land leveling which can be a challenging task to have sufficient fields concurrently fallow for economical use of laser leveling equipment, but that is the only effective means with field > 2 domum. The lowest priority would be irrigation scheduling as this is usually not practical as most surface irrigation system do offer sufficient flexibility to take advantage of this level of precise information. The same applies for most US farmers even when highly promoted by irrigation professionals. The soil reclamation is also the lowest priority because once the canals are working effectively most of it within the ICAs will automatically be reclaimed. Those not could then receive individual attention.