Developing Small Dams and Social Capital in Yemen: Local Responses to External Assistance[1]

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Abstract

This paper examines six cases of small dam development along small seasonal rivers (wadi) in the rugged mountainous province of Al-Mahweet in north central Yemen. Development of small dams is a current priority of the Government of Yemen and various foreign donors. The government's objectives for small dam development are to recharge groundwater aquifers, create new irrigated area and provide sources of water for domestic uses.

The paper examines how external assistance effects local social responses of whether to invest, as groups, in further dam development, to construct water delivery systems and create rules for management. Most external assistance strategies are designed and managed in ways which discourage development of local "social capital" for dam development--even in cases where local people desire to develop small dams. Social capital tends to develop in cases where assistance is modest, dependent on matching local investment, or is unavailable.

The cases show that where the share of farmer investment in a dam project is dominant (such as in Al-Ma'mar and Saheb) the cost per ha and even cost per m3 of water storage created is significantly lower compared with projects dominated by government assistance. The cases suggest that external assistance produces high-cost projects and discourage local investment. The cases with high proportions of external assistance also have poorly developed rules for investment, water rights and O&M.

The author recommends that assistance strategies be reoriented to place highest priority on facilitating development of local institutions and social capital. External technical assistance should be designed to facilitate local initiatives and financial assistance should be provided to stimulate, not supplant, local investment capacity.[3]

Irrigated Agriculture in Yemen at a Crossroads

For many centuries the resilient people of the mountainous southwestern part of the Arabian peninsula have developed highly sustainable farming systems. They have developed indigenous methods of water harvesting, water spreading and constructing small dams and irrigation systems. Centuries of incremental exertion have resulted in spectacular terracing of numberless escarpments throughout the region.

But today the sustainability of irrigated agriculture in Yemen is under threat. It is apparent that irrigated agriculture in Yemen is rapidly approaching a state of crisis in at least five ways:

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[3] The study was conducted as part of a consulting mission for the FAO, Programme on Sustainable Water Resources Management, in December 1998 (Vermillion 1999). The author is indebted to the valuable assistance of Mr. Said Al-Shaybani in the field work.

- Already a very scarce resource in Yemen, the availability of water for agriculture is decreasing rapidly--due to overuse, drawdown of groundwater aquifers, increased competition for water and possible long-term trends of decreasing rainfall and desertification (5% per year);
- Yemen's ability to feed itself is eroding as growth in agricultural production is being outpaced by its very high population growth rate;
- Its meager exports and trade deficit are making it increasingly difficult for the country to import the substantial amount of food which is imported;
- Deforestation and deterioration of traditional terraces are creating increasing soil erosion and decreasing capacity of land to retain water;
- The proportion of the population whose livelihoods can be supported by irrigated agriculture is dropping while there is no corresponding increase in non-farming employment.

Increasing scarcity of water and agricultural land, combined with the inherent fragility and ruggedness of the environment, make effective management of natural resources the key challenge to the sustainability of agriculture in Yemen.

Yemen is an arid mountainous country of 16 million people, located in the southwestern part of the Arabian peninsula. Of its 55 million hectares (ha) of land area, only 2.9 million ha is cultivable, depending on availability of water. Only 1.1 million ha is actually cultivated (about 38% of the potentially cultivable area). Of the actual cultivated area, about 61% (671,000 ha) is rainfed only and 39% (429,000 ha) receives irrigation. 98,000 ha is under spate (or flash flood) irrigation. In addition to the cultivated area, approximately 16 million ha is considered rangelands and about 2.2 million ha is under agro-forestry.

Cereal crops, such as wheat, sorghum, maize, millet, and barley, occupy approximately 80% of the cultivated area. Irrigated areas have higher cropping intensities and more diversified cropping patterns which include cotton, vegetables, fruits (especially oranges, mango, dates and grapes), coffee, qat and tobacco, and grain crops. About 30% of water use for agriculture is for qat production.[4]

Yemen's total average annual renewable water supply is approximately 2.1 billion m^3. It is estimated that by the year 2010 the total annual demand for water will be about 3.3 billion, if current trends continue. Availability of water in Yemen is approximately 150 m^3 of water per capita per year, which is extremely low compared to the average for the Middle East and North Africa of 1,250 m^3 or the global average of 7,500 m^3. However, it is estimated that in Yemen 90% of the population have less than 90 m^3 per capita per year.

About 76% of the population live in rural areas. Agriculture employs more than 61% of the labor force and contributes 18% of the gross domestic product. But it is becoming more and more difficult for agriculture to provide this much support to the society and economy because of the exceptionally high population growth rate of 3.7% per annum and the advancing scarcity of water and land and environmental degradation. Per capita income was approximately US $260 in 1995, among the lowest in the world. Average life expectancy is 51 years. The infant mortality rate is 11.7%.

[4] The leaves of the qat plant are a stimulant used mainly by Yemeni men.

Water policy and institutions

Partly due to political disturbances in recent years and the relatively weak position of the government relative to local bases of power, Yemen's water sector is in a rudimentary stage of development. As yet, there is no national water or irrigation law, policy, strategy or plan (although the government is in the process of developing these at present). The National Water Resources Authority (NWRA), which is charged with the responsibility to develop a water policy and strategy, and the General Directorate of Irrigation (GDI) are both new organizations and have critical shortages of skilled staff and resources. Without clear policies and strategies, their missions are still rather unclear.

At governate and district levels, MAI offices and irrigation departments are, in general, considerably over-staffed and have extremely inadequate budgets for operations and maintenance. They lack the capacity to avert rapid deterioration of irrigation schemes, to regulate over-extraction of groundwater or to plan small dam development according to basin level analysis and planning.

Strategic planning, some rehabilitation of irrigation infrastructure, training of staff and additional financing are needed. But it is clear that the challenges are greater than what can be accomplished merely through these conventional approaches. It is also apparent that crisis is looming close enough ahead that slow incremental change will not suffice.

Development of Small Dams in Yemen

The development of small dams in mountainous and hilly areas is a current priority of the Government of Yemen. The objectives most often stated for small dam development are to recharge groundwater aquifers, create new irrigated area and provide sources of water for domestic uses. There is a variety of programs, sources of funds and strategies currently being used to develop small dams.

The largest program is the Agriculture and Fisheries Production Promotion Fund (AFPPF), which has constructed about 300 small dams since the program began. The Fund's current annual expenditures for water structures (mainly small dams) is about YR 700 million (about US $5 million). This amount enables AFPPF to construct about 100 dams per year. The Fund has a waiting list of about 600 requests for small dam projects. The Fund receives such a large number of requests and pressures to build small dams that they have taken a decision to build only the dam, and not irrigation networks, so they can satisfy more requests to build dams.

Other sponsors of small dam development are the Ministry of Agriculture and Irrigation (MAI), the Social Development Fund, European Union and other bi-lateral donors. Each has its own strategy and terms and conditions for dealing with beneficiaries. None are guided by any national standards or development plans. The Social Development Fund allocates a set amount of money to governates, which allocate the funds among districts proportional to population. The districts in turn allocate SDF money to sub-districts. All the village heads in a sub-district meet and examine the needs

of all villages and they decide on priorities. If they don't agree, they divide the funds evenly among all villages, each receiving only a small amount. In this way the villagers are prompted to select the most important project. Also, they know what is the limited amount of funds available from external assistance. The SDF approaches engineers in the open market to make direct personal contracts, thus circumventing government agencies.

Small Dam Development in Al-Mahweet

The FAO study team conducted six rapid appraisal case studies of small dam development in Al-Mahweet province in order to determine:

- What factors induce or discourage investment by local beneficiaries in small dam development and operations and maintenance,
- What factors appear to lead to or inhibit improvements in agricultural productivity of small dam service areas, and
- What should be the role of participation of local people in the development and utilization of small dam projects.

The case study sites were selected to represent two types of small dams, those developed primarily by beneficiaries themselves and those developed primarily by the government. At each site group interviews were held with local people who were directly involved in development and management of the small dam. The dams were inspected to document their condition, size and setting. Staff from the MAI office in Mahweet were interviewed separately for additional information.

Case 1. Bait Abdullah dam, Shibam subdistrict

There are 120 farm families in the village. The total potential irrigable area is about 25 hectares. The long-term average rainfall in Bait Abdullah is 700-738 mm/yr. A wet year has about 1,000 mm and a dry year has 400 to 500 mm. The present cropping pattern in the area is wheat and barley, sorghum and maize (once per year) and if irrigated, they do alfalfa (45%) and vegetables such as garlic (45%) and onions (10%).

Several years ago a man from Bait Abdullah village started putting stones in the wadi to collect water for his family domestic water supply. About 25 years ago a technical team inspected the area and someone on the team said that this would be a suitable location for a small dam. Other villagers saw the small weir made by the man and said it shouldn't just be his dam but a village project.

The villagers sought help from the Ministry of Agriculture & Fisheries (MOAF) and the MOAF agreed to give them 1,000 bags of cement (1 bag = 50kgs). A team from the MOAF visited the site and decided to assist the village. But they informed the villagers that they would have to provide, at their own expense, all the rest of materials and all labor required. They informed them that no other assistance was available. So the villagers provided another 3,000 bags of cement. A total of 72 laborers, who were potential beneficiaries, worked on construction. Of 120 potential beneficiaries, 48 did not

join in to invest in the project for two reasons: 1) they didn't believe they could get enough water or that the project would be a success, or 2) they didn't have enough money. People could either contribute labor or pay the cost of labor for construction.

The villagers showed the site to the team from the MOAF and an experienced building construction man from the village committee suggested the width, height and location for the planned two weirs. The MOAF team agreed. It took about two years time for them to construct both weirs. They were built about 100 meters apart. The upper dam is small and the lower one is larger. There was no written agreement for cost sharing. The government only gave the group 1,000 bags of cement. The dams were made of stone, sand and cement.

After the dams were constructed, the villagers sent a delegation to the Al-Mahweet MAI office and requested financial assistance for getting two small pumps and a pipe to lift water for irrigation. They were given the pumps and pipe free of charge. By now they are running the pump for about 10 hours per day, all year round except when it rains. But these pumps are too small and can only irrigate 4.5 hectares as supplementary irrigation.

A small group of villagers who wanted to take silt from the storage area of the upper dam, joined together to build a stone terrace to keep the silt in a stony field above the dam. All those who built the stone terrace then began using this newly claimed land as a cooperative field. Anyone can take silt out of the tank to add to their top soil, and some do this. Siltation is not a major problem because the terrain is not steep upstream. Villagers believe the dams will last a long time. Water above the dams is also taken by women and girls in buckets for domestic use (drinking, washing, animals).

After the dams were built, farmers believed that their fields would need water at least once in 18 days, so they divided 72 members into 18 rotations of one day each. They calculated that four farms could be irrigated per day. A small diesel pump (15 hp with a 2" pipe outlet) was installed in 1994 by the Ministry of Agriculture and Water Resources (MAWR). The pump's capacity was 2.5 liters per second. Another small petrol pump was purchased by the farmer group. Until the end of 1998, there has been no problem with pump operation. Water is pumped uphill about 25 meters, then distributed in open earth canals. A significant amount of water is lost in conveyance. Beneficiaries are not inclined to purchase more pipe because the distance from the pump to the irrigated land is far. Farmers were optimistic that they could obtain more assistance from some other source so they decided to wait until they could obtain more assistance to purchase with credit more pipe and extend the distribution system.

The cost of water for founding members who invested in development of the project was YR100 per hour of water pumped. The cost for others who joined the group later was YR 200 per hour. The group adopted a rule that if the founding member has taken his share but wants more water, he must pay YR 200 per hour of extra water. Normally the pump is scheduled to run for eight hours per day but it can be operated another two hours if special requests are made. Money from the hourly charges for the pump is used for de-siltation (in addition to that taken voluntarily), fuel, oil and petrol for the pump, spare parts and pay for the salary of the pump operator.

After completion of the first phase (two dams, with two pumps) farmers began irrigating 4.5 ha. They removed silt from the storage reservoir to create topsoil to reclaim

small amounts of land in an expanding service area. The effect of irrigation from the small dams was to permit a second cultivation season.

Another effect was more easy access to water for domestic use. Before the project people in the area travelled as far as five kms to fetch water for domestic use. The total number of people from the village which use the water from the small dams is about 800, another 1,200 people from other villages also take water from it for domestic needs.

There have been no disputes between farmers over water. Farmers reported they were satisfied with the way the dam was built, but believe that they need more pumping capacity and that the sill of the lower dam should be increased in height. After the villagers saw the water repeatedly spilling over the lower dam, they wanted to raise the height of the weir to entrap more water. They sent a representative to the Al-Mahweet MAI office to request financial assistance. In 1996, district MAI office and passed on the request to the central MAI, which in turn referred the request to the AFPPF and the General Directorate of Irrigation. Eventually a team from GDI came to inspect the site and advised that the width of the wier needed to be increased, in addition to the height. The Al-Mahweet MAI office made the design at their own expense. They gave the design and proposal to the AFPPF. After one year, it was approved. Construction started in June 1998 under the supervision of the Al-Mahweet MAI office. Total contract time was eight months, but by December it appeared that it would not be completed on time due to flooding during the period of the contract.

The AFPPF offered to contribute to this second stage of development on a 50/50 share basis. But villagers argued that they had already built the first phase and that the AFPPF should consider the prior local investment and reduce the current share. The AFPPF agreed on a 70/30 share basis (30% by villagers). The 70% share from AFPPF includes contracts for labor and materials but is supposed to be only 70% of the work. Until December 1998 the villagers had not contributed any of their 30%. The contractor and sub-contractor are among beneficiaries from the village.

By December 1998, the farmers did not know how they were going to contribute the 30% and had no plan to do so. When asked why they did not contribute their labor free of charge, so it could be attributed towards their 30% share, they answered: 1) they did not have enough pocket money and 2) they were still hoping to get some more government assistance from another program to finish off the project, instead of contributing their share. The contractor reported that he would only complete his 70% share if the villagers paid him their 30% share. If not, he would leave it only 70% completed.

The beneficiaries did not include in their proposal to AFPPF financing for a larger pump and extended pipe network, which would be needed to extend the service area. They only included dam enlargement, because they new AFPPF would only provide assistance for the dam itself. But earlier in the year they made another proposal to MAI for the larger pump and pipe. They are still awaiting a response from the MAI.

The original lower dam was 3.3 meters wide at base, one meter of which was only two meters wide. The width at the top is 2.3 meters. The height is nine meters. After improvement it would be 9.8 meters thick at base and 13 meters high. Farmers believed that eight meters width was enough for the base and wanted to use the savings of material for the height, but the ID in Al-Mahweet disagreed. The storage capacity of the old dam was 24,000 m^3 and the improvement would make it 45,000 m^3.

The base of the upper dam is two meters thick with a height of 8 meters. The total capacity of the upper tank is 27,000 m^3. After improvement of the upper dam the base would be five meters thick with the same height. The farmers did not request to have the dam be made more thick but the MAI insisted on it for safety reasons, so it became part of the AFPPF project.

Farmers interviewed reported that the process of small dam development required too much time, too much waiting and a lot of political pressure and lobbying. It was complicated and they needed political connections in order to get the project. When the study team asked what the villagers would do if the government refused to provide any more assistance, they answered that they would have to just use a small pump or two, although they knew that this would not be sufficient. When asked what they would do if there would be future damage to the dams, they said they would repair that themselves because it would take too long to wait for assistance from the government. They said that any future costs of development or extension would be shared equally among the 18 shares. The 18 shares are divided into four shareholders each, for 72 founding members.

According to the MAI office, there are no problems with the design of the farmer-built weirs, except that the lower one was too narrow, being only 3.3 meters wide at the base, which raised questions about its safety. MAI officers agreed that the site was the best location for a dam for this village. However, they said there is a technically better site downstream (more narrow and economic to build and better storage capacity) but the downstream village had not requested it.

There appears to be a tendency for the people in this village to postpone their own investment if they think they can get external assistance within a year or two. They play off one fund against another, searching for the best terms. Sending village delegations to do political lobbying is an important part of the process.

Case 2. Bait Fakhar Ad-Den dam, At-Tawila sub-district

Bait Fakhar Ad-Den dam is located in At-Tawila sub-district, at an elevation of 2,960 meters elevation above sea level. The average landholding size on the irrigated land is only about .2 ha, without much variation in sizes among farmers. All water users are related in the same tribal group.

Two Yemeni brothers working in Saudi Arabia heard about the famous Marib dam in Yemen. After they returned to Yemen they visited Marib and decided to build a small dam in their home village. In 1987 they built a very small weir using stones and cement just to see how much water they could collect. At first they expected the water to be stored for only a short time but then saw that it stayed ponded for a long time. They decided to enlarge it and increased the sill height. They worked on the project in a small group of six farmers. They tried to persuade other villagers to join in and enlarge the dam further, but most did not believe they could capture enough water. They also lacked confidence that they could build a dam properly and many felt it would be too expensive. The small group finished the first phase of construction six months after starting.

During this period of construction the group organized themselves to rotate the work. Each day five men and their wives worked on the dam. The women poured and carried the cement. The sixth couple stayed at home and prepared food for the other five

families and sometimes watched small children. This was rotated each work day. The work was sometimes intermittent, since construction sometimes had to wait until the group raised enough money to purchase additional cement and materials and had time to do the work.

The next step was to build a second small weir downstream several meters from the original weir. They started diverting water to their fields via gravity pressure through two-inch metal pipe. They bought pipe a little at a time and tested levels and slope of different routes to determine which route would deliver water.

Four other families saw the benefit of the water and wanted to use it but the original group of six said there might not be enough water for all of them. The original group told the four families that they could build another weir about 100 meters distance upstream. The original group saw that water frequently overtopped the first weir, so they weren't concerned about having another weir upstream. As the second group of four was about begin building the upstream weir a team from a GTZ project visited the area, in December 1992. The team told them it was a good idea to build the weir and that the GTZ project had funds to help them. So the group of four joined the original group of 6 and GTZ provided them 800 sacks of cement (50 lbs. each) for the new, and third, weir. They also raised the height of the first weir and to build another small weir even further upstream about 50 meters (a fourth one).

The work was done intermittently and incrementally, as their labor and money became available. After they organized themselves into a group of ten families and began receiving water, they arranged to do the work by either having each family provide their labor directly or by hiring someone to do their share.

After the first weir was built up to several meters in height, some additional families wanted to join the group by paying shares in the capital cost of contruction up to that time. But the original group of 10 refused and decided that they would sell water to the "late-comers" at the rate of YR 200 per hour of water service, whereas the original group of ten would pay only YR 100 per hour of service.

In December 1994, some of the farmers went to the MAI office in Al-Mahweet to ask for technical and financial support for further development of the dams and irrigation networks. They had heard that there were assistance programs for dam development.

The width of the first dam was only 1.5 meters at the top and five meters at the bottom. They started with a bottom width of only one meter and they expanded the width incrementally, as they raised the height. They eventually raised it to 18 meters height. An engineer from the MAI district office in Mahweet visited the site and said it was too narrow and should be widened. The MAI made a study and found it would cost about YR 22.5 million to widen it sufficiently and would give a total storage capacity of about 68,000 m3. The total storage capacity before the fifth weir was 45,000 m3. After the fifth weir is completed, MAI estimates total capacity will be 96,000 m3. They said if they built a fifth weir several meters upstream from the first weir, which was in a narrower and more suitable place, it would yield a total storage capacity of 73,800 m3 for both weirs and would cost only YR 16 million. The fifth weir would submerge the second weir and would reduce the storage capacity of the first weir to only 1,800 m3. This seemed to imply that if the local people had had technical support they would not have built the first or third weirs where they did.

After this the farmers heard about AFPPF and submitted an application for assistance for the proposed fifth weir to AFPPF, suggesting a 50/50 share basis. The farmers intend to have their previous investment counted towards their 50% share. Farmers said if their new contribution was 20% of YR 16 million they could do their part in less than a year, in kind. If their share of new investment would have to be more than 20% they would need more time.

All husbands of the 10 families were working in Saudi Arabia and several of them returned to Yemen (*before* the gulf war in the early1990s) when they heard about the benefit of the dam. Some returned to Saudi Arabia to make more money to send back to their village to support continued construction of the dams. When the construction was developed to the point where they had enough water to irrigated their lands all ten decided to stay in Yemen because of the opportunity brought by the new irrigation.

The original shareholders were the first to reclaim land, obtaining about 1 ha from open-access village land. When they saw the benefits of their work they wanted to extend it. The village stopped them and decided to allocate all potential reclaimable land equally among villagers. After negotiation, the shareholders were given a limited amount of additional land and the rest was given to non-shareholders of the project.

In 1988 the group started installing the pipe network. They purchased 500 pieces of galvanized metal pipe (6 meters each for a total of 3,000 meters) at the amount of YR 200 per piece (which is worth more than YR 2,000 in 1998 YRs). Two years later they purchased 200 more pieces and in the mid 1990's they purchased another 300 pieces. All pipe was purchased by only the original 10 shareholder families. They continue to develop the network by trial and error testing of the highest elevations which can be irrigated downstream and the maximum extent of irrigated area. It is apparent that if the group had received some technical advice, they could have developed the same area or more with much less pipe. There is a 50-meter plastic hose connected to the end of the galvanized pipe to direct water to different fields, with a valve at the end of all pipes.

The original 10 shareholders each receive eight hours of water every 16 days. Water is rotated between original shareholders and non-shareholders every other day. For the most water intensive crops, farmers report that they can irrigate 250 sq meters in one hour or one-fifth of a hectare in eight hours. Any time of the year water can be made available for up to 12 hours in a day. The extra four hours can be used for emergencies or special requests. Shareholders pay YR 200 per hour for water during the reserve time (i.e., the extra four-hour period). Non-shareholders pay YR 200 per hour for both normal scheduled time and reserve time. Farmers apply water in different amounts and for different lengths of time depending on crop water requirements. Some fields don't need water every 16 days, some need it every eight days. Farmers often trade unused time with other farmers in exchange to get water on a day which is not their normal day.

The original 10 shareholders agreed that five of the original shareholders would take water from the lower dam and the other five from the upper dam. They constructed one main conveyance pipe which divides into several branches below. They put a pipe from the upper dam coming down to just below the lower one to join a single pipe coming down from the lower dam. Two valves just below the lower dam enable farmers to take water either from the upper dam or from the lower dam. They rotate water extraction between the upper and lower dams every other day, according to the agreed water use rights pertaining to each dam.

After the prospective AFPPF dam is constructed, the older upper dam will become submerged and villagers intend to take water together from the new and first dam in equal shares. The 10 shareholders divided the water rights among themselves equally according to their share of investment not share of land area used by each. They plan to invest equally in the total required beneficiary's share of the AFPPF dam.

Before the land was irrigated, farmers cultivated wheat and maize. After the project they cultivated potatoes, lentils, tomatoes, garlic and apple and olive trees. They continue to plant wheat and maize on rainfed land. Some non-shareholder beneficiaries have multi-season crops like alfalfa, which is cut every 20 days and grows again. These farmers obtain two or three-year agreements for water allocations. They experimented with cultivating tomatoes and qat but the crops were not successful so they continue to try other crops.

Before each season, the non-shareholding farmers who want water for the coming season go to the senior, elder man of the initial two families (the "water leader") who constructed the first dam. (He is not a village headman.) They tell him how much land they want to irrigate for what crops and ask for an allocation of so many hours per 16 days (or per 8 days). The water leader then makes the time allocations. Sometimes the requests exceed the available time and some have to wait till the following season for a water allocation. Non-shareholders sometimes must rotate water use permits among themselves between seasons.

At the end of an allocation period, the user must turn off his valve, if he is the last user of the day. If there is another user that day, it is the duty of the next user to turn off the other valve and turn on his own valve. In the morning the user goes up to the lower dam and turns off the valve for the dam which was supplying water on the previous day and opens the valve for the dam which is to supply water for his day.

If there is rainfall and irrigation is being used as a supplemental supply, all 22 ha. can be irrigated. Depending on what crops are in the field, roughly 14 ha. can be irrigated solely by the irrigation system. Of this amount about 55% of the land is owned by the 10 shareholders.

Money collected for the water service charge is distributed equally to the 10 shareholders, after costs of irrigation are paid for. These costs include: 1) repair of pipes, 2) de-silting of the dam and 3) purchase of more pipe to extend the system. In kharif season (which lasts about 90 days), approximately YR 135,000 is collected for the water charge. Farmers empty the dam every two or three years for de-silting. They flush the silt in to the wadi.

By 1998 there were 22 families or 102 farmers (roughly five persons per family, including men and women) with parcels of land irrigated by the dams. Ten of the 22 are the original capital shareholders and 12 buy and use water as beneficiaries. The total service area is 21 ha. About 2.5 ha of the 21 is new farm land from land reclamation, done by transporting new top soil to rock area which was potentially irrigable. The cost of soil was about YR 500 per 8 m^3. It cost YR 700 to rent a loader to take soil and put it into the truck and YR 1,000 per truck load, for a total of YR 2,200 per truck load. A villager supplied the truck (but has not yet been paid in full). They made the top soil 35 cm in depth. It took 1,130 truck loads to transport soil from five kms away. Land reclamation cost about YR 1.4 million per ha (US $9,800).

Before the first dam was built, only one of the shareholder families had one cow. After the dam, each shareholder family has three to five cows and non-shareholder families have two to three cows. Farmers claim that they can grow more alfalfa as a result of the dam. Before the dam the villagers had to travel 10 kms to obtain water for domestic use. They could not carry enough water for animals. After the dams, they report that they have more straw from corn or other crops for animal feed. Before the dam, the main limiting factors for raising livestock were not money, but lack of feed and water for animals.

Farmers were not accustomed to such intensive cropping before the dam. One effect of crop intensification is emergence of new plant diseases. The wheat is being effected by yellow rust and garlic is being attacked by a reddish rust. So farmers recently made a plan to rotate crops and change the variety of wheat.

We can see that in Bait Fakhar Ad-Den the extensive amount of initial local group investment in dam development involved a parallel development of organization and arrangements for financing irrigation and distributing water. Original investors preferred to restrict their founding status to the initial 10 families and grant access to water to others on the basis of higher payment per unit of water. This protected their prior water rights and created two classes of members.

Case 3. Al-Ma'mar Dam, Bait Al-Ma'mar village, At-Tawila sub-district

In 1990 a group of farmers in Bait Al-Ma'mar village got the idea to build a dam. They visited Bait-Fakr Ad-Den and saw the benefits of those dams. After several meetings and discussions they identified whom the beneficiaries and shareholders would be. There were 16 shareholders in 1990. This expanded to 25 shareholders at the time of construction, in 1992. The dam was constructed in four months time. The shareholders hired laborers to build the dam. Some representatives sought technical advice from the MAI office in Mahweet and staff from the MAI visited the site and examined the proposed site. They agreed it was a suitable location. Dam construction cost about YR 2.5 million (or YR 100,000 per share). The district MAI office gave the villagers 350 sacks of cement and farmers contributed another 150 sacks, for a total of 500. The dam was built six meters thick at the bottom, 1.2 meters thick at the top and 14 meters high. The dam is six meters wide at the bottom and 22 meters wide at the top.

Before they constructed the dam, farmers used about 80 pumps (2 hp each) to lift water from the wadi to their farms. The pumps were installed when the floods came. Prior to construction the villagers thought that the dam would save them about 50% of the cost of O&M, because they would no longer have to pump groundwater. After the dam was built they no longer pump from the wadi directly, but some occasionally pump water out of open dug wells. There were five tubewells with 19-hp pumps in the irrigated area. Farmers pump water out of the dam reservoir with the single 24-hp pump which has an average discharge rate of 6.25 l/s.

During construction they made concrete manually without cement mixers so the quality of the concrete was inferior. They did not cut the rock and smoothen it on both sides of the ravine where the dam was placed so there is some seepage on the sides and the dam is not as strong and safe as it should be.

The group established a cooperative society committee which included a board of directors with a chairman, according to the national law for cooperative societies (Law 18, 1994). The committee nominated society members by common consensus. Farmers received a 24-hp pump from the AFPPF, after they requested one from the Minister of Agriculture, when he made a visit to the area. For the local share of the cost sharing agreement, the village supplied and installed the pipes between the dam and a small feeder reservoir. Water is pumped about 30 meters up to a feeder reservoir and from there is distributed to fields via gravity pressure 3" galvanized pipe and open channels (through a hard rock mountain area). Pipes for conveyance to the fields were paid for by the shareholders.

The dam supplies water to the land of 75 family farms. There are 25 shares, each of which has one to four persons who own it (or part of it). It is possible to arrange irrigation intervals in gaps of every 12 to 16 days. The more frequent the interval the higher the cost of water. Each share gets a 6-hour irrigation period, divided among the holders of that share. At first they thought the irrigation interval should be 16 days so they started with 16 shares, but more people wanted irrigation so they increased it to 25 shares. The irrigation time is six hours per share but the pump operates for 12 hours per day so water can be conveyed to two shareholdings per day. If the number of users who request water for a season is high, the water charge rate goes up. The rate varies between YR 250 and YR400 per hour, depending on the level of demand and seasonal costs for maintenance and repair.

The committee collects the water charge from farmers upon delivery of water. One member of the committee keeps the money in his house until the end of the season. At the end of the season the committee generally allocates between YR 100,000 and YR 150,000 for O&M costs for the next season. The rest is distributed among shareholders according to how many shares each obtained during capital investment in dam development. The cost of each share was about YR 100,000 (in 1992 prices).

During Seif season in 1998 (March – June), the cooperative pumped water out of the dam reservoir for a total of 1,800 hours at the chargeable rate of YR 400 per hour. About 33,000 m3 of water was extracted from the reservoir, which has a total storage capacity of 40,000 m3. About 63 ha can be irrigated from this dam from supplemental irrigation, if there is normal or above-normal rainfall. When there is no rainfall, about 45 ha can be irrigated from the dam as the sole source of water. About 400 sq meters of land can be irrigated per hour.

After the dam became functional, farmers started cultivating garlic, onions, tomatoes, potatoes, cucumbers and some apple trees. After the dam, farmers were able to reduce the hours of tubewell or dug well pumping, which reduced their cost of production. Farmers are now shifting to qat, which needs much less labor, less fertilizer and less water but can still result in a good valuable crop. As yet, there are no diseases for qat and it is highly profitable. Farmers now cultivate 50% of the land in qat and 50% in food crops. The area planted in qat is still expanding each season.

The cooperative did not build a flushing escape for silt and the reservoir is silting up. They broke a hole in the dam about two years ago for flushing silt but this took about one month of work. So now they intend to install a large concrete pipe for flushing and will just cement it shut when they are not flushing. They need to flush silt once in two years. Their main purpose for removing the silt is to increase the dam capacity. However,

in December 1998, farmers estimated there were about 6,000 square meters of topsoil (5 meters deep or 30,000 m3) inside the reservoir. They intend to remove and use it to reclaim land or add to topsoil on farms, but they do not yet have the equipment and funds to do it.

Before the dam the water table was about 210 meters below the surface. After the dam was completed farmers reduced the number of tubewell pipes by 6 sections, making the wells 18 meters less deep. Farmers reported that this could be reduced even further. The hand dug open wells were dry before the dam and now they obtain water in the open wells on a seasonal basis. Sometimes they are full.

Farmers interviewed suggested that the process of obtaining financial and technical assistance should be decentralized to the district level so they would not have to go to Sana'a to settle questions or take decisions about dam projects. Farmers reported that they could afford to provide about 20% of the total cost of further investments in dam and irrigation development.

Case 4. Sahib dam, Al-Khyat village, At-Tawila sub-district

After the Al-Ma'mar dam was completed, the members of the dam cooperative committee decided to form a regional committee to promote dam construction in other wadis in the area. This was also considered a business enterprise. They selected five potential sites. Sahib was the first one selected. The committee selected Sahib dam first from among the other prospective sites because it had the largest estimated potential service area, the largest number of villagers who would be effected and the lowest cost of construction per unit of service area.

The cooperative submitted a request for the project to the district MAI office in April 1995. The district office did the design in August 1995. Construction began in October 1995 and finished in January 1997. The study showed a depth of soil at the dam base of three meters but during construction it was found that the actual depth was 14 meters. This caused a delay in getting approval for the cost of additional excavation. The original projected cost of construction was YR 14 million and the actual total cost was YR 18 million, paid on a 50/50 basis between AFPPF and farmers. The cooperative provided equipment, materials and labor for their 50% share and they also became the contractor for construction. As the contractor, the cooperative was given the payment for 50% of the cost from the AFPPF.

The Sahib dam is eight meters thick at the base, 2.5 meters thick at the top and 19.5 meters high. The length at the top is 65.5 meters. The MAI thinks the dam is unsafe. According to the MAI, those who designed it were not adequately trained in civil engineering and dam design, but after studying more they realized it was not strong enough. As with the other dams, it is masonry (stone and cement) using local material. The total capacity of the reservoir is about 80,000 m3 but this will increase to 120,000 m3 after the silt is removed from the dam reservoir. Two openings have been installed for flushing silt.

Beneficiaries of the dam include people from five villages and included some of the shareholders from the Ma'mar dam project and dam cooperative committee. Members of the regional dam cooperative are all regional shareholders. The cooperative

intends to recover its 50% investment in Sahib dam from sale of water from Sahib dam to beneficiaries. Everyone, shareholders and non-shareholders, will pay the same price for water. The cooperative shareholders and all beneficiaries from the five villages agreed in 1995 that all future revenue from the sale of water would first be used to cover the costs of operations and maintenance (O&M). Funds remaining after costs would be shared on the basis of 75% to the cooperative shareholders and 25% to all water users from the five villages.

The cooperative finished the dam and is now waiting to install a pump and conveyance pipe network. They are trying to get funds from the government to finance the costs. The cooperative has a representative from each of the five villages. The sub-district MAI office also has a representative on the Sahib dam development committee. The representatives from the five villages meet together to decide water distribution. If there is some dispute which they have difficulty in settling, the representative from the sub-district MAI office would be invited to help resolve the dispute.

The study team asked members of the cooperative committee why they did not include both the dam and the distribution network in the same project proposal. They said that they needed all these components, but saw from the Ma'mar dam that the MAI office was only going to provide some cement. So they assumed that the government could not provide enough assistance to include both the dam and conveyance network. They felt that they would not be able to contribute their share for all this amount at one time. AFPPF informed them that it was not according to their policy to include the distribution network in small dam development.

At present, the cooperative committee is looking for other sources of funds for the pump and conveyance network. Until now (nearly two years after completion of the dam) they have still not yet made use of the dam. When asked what they will do if they can not obtain additional assistance from the government, they responded that they will use small, lower-cost pumps. They knew that these would be an efficient way to extract water and thereby would not be able to make full use of the available water. Until December 1998, farmers were not using any small pumps at all.

The estimated number of potential water users for Sahib dam is about 400 farmers (including all family farm workers). The estimated irrigable area is approximately 16 ha. Members of the cooperative calculated that the main irrigation interval should be 18.5 days, based on an estimate that each village would need an irrigation turn of about 3.5 days each. Farmers said they intended to learn how to develop and manage the pump and conveyance and water distribution by visiting Ma'mar and seeing how they do it there.

The Agricultural Development Bank of Yemen charges between 7% to 12% service charge for purchase of such things as pumps or pipes on credit. So the farmers decided to look for other sources of grant assistance. The farmers intend to build additional small dams upstream to collect silt. No downstream water users have complained about having less water after the dam was constructed. In fact farmers report that the springs downstream are getting more water after the dam.

Farmers are growing wheat, barley and maize. After they start irrigating from the dam they intend to introduce vegetables. Farmers said they need some extension support from the government about improved seeds, how to use the irrigation system and distribute water, best periods for planting crops and rotating crops and recommended types of pesticides and methods of application.

When asked what the cooperative would do if there is damage to the dam, they said if there are small cracks or damages they would make the repairs themselves. But if there is large damage then the government should help them with that. They intend to use the water only for irrigation.

Case 5. Al-Makik Dam, Hobah village, At-Tawila sub-district

The idea for building a dam at Hobah village came from one of the staff of the MAI in Al-Mahweet, when visiting the area in 1987. The visitor observed the low discharge of wells in the area and noted the high cost of spare parts and maintenance. The pre-dam cropping pattern in both areas is wheat, barley, corn, potatoes and other vegetables. Farmers obtain water from open wells for the vegetables. He suggested five dam sites in Al-Mahweet in 1987, including Al-Makik. In 1991, studies were completed and proposals were approved for two sites, one of which was Al-Makik. Farmers then started looking for financing and finally in 1997 got approval from the MAI special USA Agricultural Imports Fund (in the Ministry of Planning).

Construction was started in 1997, with a plan to complete it within nine months. The study under-estimated the depth of soil above the rock base for the dam so they had to request more money and this caused delay. By December 1998 the project had reached about 80% completion. The plan was that the dam would be financed 100% by the government. The project only included the dam, not any pumps or conveyance networks. During the study and planning phase, the government did not identify the service area or the beneficiaries.

The first design for the dam was about 14 meters high. This was revised to 20 meters high to the spillway plus another two meters on both sides of the spillway. The dam is 16.5 meters thick at the top and three meters thick at the top. The width at the bottom is 25 meters and at the top it is 65 meters. Total storage capacity is 200,000 cubic meters. The estimated total cost of construction is YR 55 million (about US $39,000).

The prospective upstream users estimated that they had about 70 ha which could be irrigated by the dam. The prospective downstream users estimated that they had about 17 ha which could be irrigated by the dam. The upstream users argued that they should get 75% of the water because they had most of the land. But the upstream users would need a pump while the downstream users would not. The upstream users said that the downstream users could not use the water unless both groups used it together. The upstream group was hoping to get a pump from the government. It is apparent that the water is not enough for all 87 ha in upstream and downstream areas.

When asked what they would do if the water were found to not be enough for the whole area, the upstream users said they should take 75% of whatever is available. They expect to distribute water to the upstream users nine hours a day and to downstream users three hours per day. The upstream users said the downstream group should help them find funds for the pump and distribution system. The upstream users estimated that they could irrigate 640 sq meters per hour, with an irrigation interval for a parcel of once in 15 days. There are 11,000 units of 640 sq meters in 70 ha. Upstream users say that the downstream group should pay one-third of the cost of O&M (including pumping water)

and upstream users should pay the rest, because both parties are served by the one project.

The upstream farmers said that they had already formed a cooperative organization to organize O&M for the whole project, but the downstream farmers informed this team that they did not know about this. The upstream farmers said about 95% of the members of the organization were prospective farmers and 5% were from outside the area. Upstream farmers said that the dam was the government's property. They said they expect the project to be completed successfully eventually. It is the upstream farmers who have been promoting the project and pushing for the government's approval. The downstream farmers say they will pay their share later. Upstream farmers helped pay some travel money or gave transport to MAI staff to facilitate the study, design and construction process.

Downstream farmers said that they did not know why project completion was delayed, but for the last seven months there had been no work on the dam. They said that both the upstream and downstream farmers should be beneficiaries, but priority water rights should be given to the downstream farmers. It seemed to them that the dam was located where it was in order to serve downstream users, not the upstream area behind the dam. Also, the downstream farmers were using water from the wadi before the dam. They argue that the downstream irrigable area is larger than the potential irrigable area upstream.

By December 1998, there was still no agreement between upstream and downstream farmers over how much water either would get. So neither the upstream nor downstream groups are able to identify how many and who the individual beneficiaries would be. When the downstream users were asked why they had not met with the upstream farmers and worked out an agreement, they answered that the dam was not yet completed and after it is completed they intended to have a meeting. They said the government should sort out any problems related to use of the project and supervise resolution of the dispute.

By December 1998 the contractor had not received the money for the extra excavation required to reach the rock bed, so he stopped work at 80% completion and was waiting for official approval of allocation of the additional funds from the government.

Downstream farmers said they should allocate water in shares of 50% of supply to the upstream area and 50% to the downstream area, in order to resolve the dispute. They reported that they had no money to contribute to purchase of a pump or conveyance pipes. They said they intend to specify a fixed time period to wait and not use any water while the upstream farmers obtain a pump and pipes. After this period if the upstream group was not able to get a pump they intend to go ahead and start using the water downstream.

This case points out the hazards of the government starting an infrastructure project before the membership of the group of beneficiaries is identified. Without an initial investment by either the downstream or upstream group, it was difficult for either group to assert a dominant set of rights.

Case 6. Zeham Dam, Zeham village

A few years ago, residents of Zeham village made a request to the district MAI office in Al-Mahweet to have a feasibility study done for a dam project at their village. Farmers from the village visited the MAI to seek technical advice and get the MAI to give them some cement. They wanted to make a small dam which would not be too expensive because they only had a limited amount of funds. The district MAI office did a study and submitted a request to the central MAI for cement. A team came to the site from MAI-Sana'a and proposed to change the site to another location where the storage capacity would be larger. They recommended that the farmers submit an application for assistance through the AFPPF. Due to the high expected cost (about YR 30 million), it was rejected by AFPPF. Generally, the maximum level of assistance allowable per dam was YR 15 million (about US $39,000).

After this they went to the Social Development Fund (SDF) and an SDF engineer also saw that the plan was too expensive. So he went to the site with staff from the MAI and did another study and estimated what the service area would be. This team found that the wells had very low yields and could only be operated about two or three hours at a time before they ran out of water. So they agreed with the original design but disagreed with the estimated cost. They revised the cost estimate to YR 28.7 million and proposed to go ahead with the project, with the SDF providing 85% of the financing and the villagers 15%. The cooperative contributed its 15% share in the form of renting and providing heavy equipment for construction (which heavy equipment was owned by its own members).

The farmers organized themselves into Al-Faiha Agricultural Cooperative, in order to be eligible for SDF assistance. Since it was a multi-purpose, profit-making cooperative, villagers could voluntarily invest as much capital as they liked and thereby become shareholders in the cooperative. They planned to periodically distribute dividends to shareholders from profits of the cooperative. Dividends were based on original capital investment in the dam project.

The application was submitted to the SDF in September 1997 and was approved in November 1997. Construction began soon thereafter, with an estimated time of 24 months needed for completion. By December 1998 it was already about 80% completed.

Farmers calculated that during the two rainy seasons (seif and kharif) they could provide supplemental irrigation for 30 ha, providing two irrigations per parcel at 16 days apart at the latter part of the season. Between these seasons, when there is normally no rain, farmers could provide full irrigation to about 12 ha out of the 30. During the supplemental irrigation period, farmers estimated that the irrigated area per parcel served would be about 1,000 sq meters. This would drop to about 640 sq meters per irrigated parcel during the full irrigation period. Annual rainfall in the area is 700 mm.

The dam was built 12 meters thick at the bottom and 3 meters thick at the top. The width is 62 meters at the top. Height is 18 meters. Total capacity is 120,000 m3. Total beneficiaries for the 30 ha are estimated to be about 1,875 people (or about 300 farms).

Before the project, the area was dependent upon rainfall and without supplemental irrigation they often experienced crop failure and had to cut the crop early and use it for livestock feed. Farmers intend to plant 100,000 coffee trees in the irrigated area.

At the recommendation of the SDF (which has a primary goal of poverty alleviation) the cooperative decided to charge YR 10 per m3 to "normal" farmers and YR 5 per m3 to "poor" farmers. The definition for "normal" vs. "poor", according to the SDF, should be based on the following criteria: total number in family, woman-headed household, number of old people in the household, socio-economic status, total farm area owned, number of workers in the household and number of handicapped people in the household. It was decided that the total water allocated at the rate of YR 5 should not exceed 50% of the service capacity area of the dam.

The farmers of the cooperative expressed their view that they own the dam 100%. They will distribute water on a demand basis giving priority to farms nearest the dam and only after the nearest farms are finished with water will it go to fields further away. This would be done irrespective of the "poverty" status of farm families. The criteria for water charging, to help the poor, was imposed by the SDF and was separate from the rules for how they were to distribute water equitably.

The agreement signed between SDF and the Cooperative did not include anything about development of the irrigation network. But there is a fixed pipe outlet built into the dam. The cooperative had not yet planned how to develop the conveyance network.

Analysis of small dam development in Al-Mahweet

Table 1 below provides information on the levels of investment farmers have provided in the Bait Abdullah and Bait Fakhor Ad Den small dam projects (cases 1 and 2). In the first phase of development in both cases, where farmers only expected modest assistance from the government, they provided between 71 and 75% of the cost of materials and all of the labor.

In the second phase of development in both cases, after farmers became aware of government assistance programs, their share of investment was dramatically less. Development costs per m^3 of water storage created (not including labor) varied from YR 21 to YR 763 per m^3. This wide range in cost per unit output reflects the relatively ad hoc and unsystematic nature of project selection. It can also be noted that in both sites, cost per m^3 water storage created was substantially higher for the second phases of development which received substantial government assistance.

Table 1. Investment data on two early cases of small dam development (in 1998 YR)

Item	Bait Abdulla Phase 1	Bait Abdulla Phase 2	Bait Fakhor Ad Den - Phase 1	Bait Fakhor Ad Den - Phase 2
Government cost for materials	YR 345,000 (25%)	YR 6,296,925 (96%)	YR 276,000 (29%)	YR16,016,000*
Beneficiary cost for materials	YR 1,035,000 (75%)	YR 269,868 (4%)	YR 690,000 (71%)	(Small but unspecified)
Labor provided by	Beneficiaries (72)	Government contract	Beneficiaries (12)	Govt. contract & beneficiaries
Year completed	c. 1990	Pending	1987	Pending
Area irrigated (ha)	4.5 ha	--	21 ha	--

Storage capacity created	24,000 m^3	48,000 m^3	75,000 m^3	21,000 m^3
Cost per ha irrigated (YR)**	YR 306,666	--	YR 46,000	--
Cost storage created/m^3 (YR)**	YR 57.5	YR 137	YR 21	YR 763

* 1 US dollar = 140 YR. How material costs will be shared between government and farmers is still under negotiation. ** Does not include costs of labor

Table 2 below provides data on the four other cases of dam development. Data includes total cost of development, including labor. We again see a differential response to degree of availability of external assistance. Where the share of farmer investment is substantial (in Al-Ma'mar and Saheb) the total cost per ha, or per m^3 storage created, tends to be lower than where the external assistance constitutes the large or entire share of total investment. In other words, external assistance produces high-cost projects but discourages local investment. The two sites with high external assistance also had poorly developed rules and institutions for managing water. One of them (Al-Makik) had a serious dispute over water rights. The other (Zeham), adopted a two-tiered water charge due to pressure from the project donor. It appeared difficult for the villages to define who was "poor" versus "normal" and the water charge rule appeared to be somewhat incompatible with the water distribution rule.

Table 2. Investment data on four recent cases of small dam development (in 1998YR)

Item	Al-Mamar	Saheb	Al-Makik	Zeham
Total cost borne by government	YR 120,750 (2%)	YR 7,000,000 (50%)	YR 55,000,000 (100%)	YR 24,368,313 (85%)
Total cost borne by beneficiaries	YR 6,242,250 (98%)	YR 7,000,000 (50%)	0	YR 4,300,290 (15%)
Total cost	YR 6,363,000	YR 14,000,000	YR 55,000,000	YR 28,668,603
Area irrigated (ha)	63 ha	16 ha	78 ha	30 ha
Storage capacity created	40,000 m^3	80,000 m^3	200,000 m^3	120,000 m^3
Cost per hectare	YR 101,000	YR 875,000	YR 705,128*	YR 955,620*
Cost per m^3 storage created	YR 159	YR 175	YR 275*	YR 239*
Year of completion	1992	1997	Pending	Pending

* 1 US dollar = 140 YR. Since construction is not yet complete, these figures are planned amounts.

MAI officers reported that in the beginning of a project farmers tend to agree to provide 50% of the total cost. Later they realize they can not invest this amount, often due to occurrence of unexpected expenses, such as need for more excavation or building of access roads. Sometimes farm land is lost to the dam or tank and no compensation is given by the government. So the farmer group pays compensation money to the farmer whose land is taken up and this detracts from the money they were planning to provide for their 50% share of the core project.

Also, sometimes a road has to be built or repaired, especially during rainy season, and that takes extra work and a large truck to transport cement and materials, for which the farmers must pay. Sometimes farmers don't have money to follow through with their agreement. If the village leader is not strong or is not supporting the project, it can be difficult for farmers to raise the agreed level of local investment.

In the case of Bait Abdullah, large trucks needed to enter the area and it was rainy season and the road which passed through five villages needed to be repaired. The main beneficiary village agreed to pay half of the cost of road repair and the other 4 villages would pay the other half of the cost. The total cost of road repair was YR 400,000 (US $2,860), done in 1998. A bulldozer and driver were hired to do the work and they shared the cost according to size of village and distance of the village from the road. The beneficiaries made these unanticipated expenditures and then did not have enough left to cover their 50% share of the project. Sometimes villagers or farmer groups get into disputes between farmers over accusations that some are working less than others. This can also stop farmers from providing their share of the investment.

Conclusion

When villagers build a dam, they consider it their own property. They define criteria for membership and identify rules for investment, water extraction, water distribution, silt removal and canal maintenance. Initial or founding investors tend to set themselves apart from late-coming investors. They assign themselves lower water fees and restrict others from becoming shareholders. This serves to protect their prior water right and the value of their shareholdings.

If the government builds a dam at its own expense, villagers see it as the government's dam. If farmers are not organized as a group and invest cooperatively in dam development, they tend to be poorly motivated to use and maintain the dam. They lack the "social capital" or organizational capacity to complete, operate and maintain the project.

The cases show that where the share of farmer investment in a dam project is dominant (such as in Al-Ma'mar and Saheb) the cost per ha and even cost per m3 of water storage created is significantly lower compared with projects dominated by government assistance. The cases suggest that external assistance produces high-cost projects and discourage local investment. The cases with high proportions of external assistance also have poorly developed rules for investment, water rights and O&M.

Small dam projects normally only include construction of the dam and not the irrigation network. The study team observed several cases in Al-Mahweet where extended time had passed after completion of the dam and farmers have not developed the water conveyance and distribution network. Farmers reported that they were waiting and hoping for additional government financing. Also, dams are sometimes designed without due consideration for how they are going to be used.

Small dams are planned and constructed without reference to what kind of water service would be provided or exactly where the service area would be located. Who the

beneficiaries will be or how local traditional water rights will be effected are not considered during project development.

It is apparent that creation of local organizational capacity should be given as much attention as the construction of small dams. Creating a local sense of ownership through requiring substantial local investment in project development is an essential part of developing local institutional, managerial and financial capacity (i.e., social capital) to use the dam effectively and sustainably after completion. Prior to project implementation, beneficiaries should be organized into a group and make agreements with the government to provide a significant share of the total cost of the project, through labor, material, equipment or other contributions.

To ensure that both parties (government and farmers) fulfill their commitments, it is recommended that projects should be divided into stages, each with agreed targets and levels of investment to be provided by both parties. At each stage, each party can demonstrate that they are fulfilling their part of the agreement. If the beneficiary group fails to fulfill its part of the agreement, the government would be able to contain unproductive use of its funds. This would provide more incentives for farmers to fulfill their agreed share of investment.

Finally, donors should not attempt to impose different and incompatible terms for providing assistance for small dam development. This creates local dependency on the government and encourages villagers to shop and speculate among donor projects. The Government should adopt a single strategy for assisting villages to develop small dams and the social capital to fully use and sustain them.