

POVERTY, LIVELIHOOD RISKS AND COPIES STRATEGIES IN SPATE IRRIGATION SYSTEMS

1 INTRODUCTION

Spate irrigation is mainly practiced in arid and semi-arid areas of the world, such as the Middle East, Northern and Western Africa, the Horn of Africa, South and Central Asia as well as parts of Latin America, where rainfall is too low for rainfed agriculture. Spate irrigation is a type of irrigation where flash floods with short duration coming from mountainous catchment areas are diverted from the riverbeds to irrigate arable land.

In Pakistan, spate irrigation is practiced for a very long period and it was one of the most important agricultural systems until the end of the 18th century when the development of perennial irrigation started under the British colonial administration. In the Province of Balochistan, there is evidence that spate irrigation was practiced as early as 3,000 BC, whereas in the North-West Frontier Province (NWFP) and the Punjab the first spate irrigation systems were developed 330 BC. (Ahmad 2000) In Yemen, spate water is used for irrigation purposes for at least three millenniums and it may even date back to the third millennium BC in the Marib area. (Al-Garoo 1987, Wilkinson 200?) Spate water from about 260 wadis in the north-west coastal region of Egypt is used for irrigation since the Roman times, while spate irrigation has been practised in Morocco since ancient times as well. (Moustafa 1987, Zaqluel 1987) In Eritrea, spate irrigation only started at the beginning of the 20th century by Yemeni migrants from across the Red Sea. In central Tunisia, farmers irrigate their fields with diverted spate water since the second half of the 19th century. (Van Mazijk 1988)

It is difficult to give exact figures about the area under spate irrigation, because it changes from year to year and spate irrigation has never had the same amount of attention from governments and donors as perennial irrigation. According to FAO, Pakistan and Kazakhstan have large areas under spate irrigation with 1.4 million ha and 1.1 million ha respectively, although an estimated area of 2.0 million ha in Pakistan is also mentioned. In Eritrea, about 50% to 55% of the total irrigated area was under spate irrigation, while about one-third of the total irrigated area in Kazakhstan and Mongolia comprised spate irrigation. In Yemen, the reported spate-irrigated area ranged between 20% and 40% of the total irrigated area. Reportedly, about 90,000 ha, which accounts for 25% of the total irrigated area in Yemen, is covered by modernized spate irrigation system, while around 30,000 ha is commanded by traditional spate schemes. (FAO Aquastat, Hadera 2001, Kohler 1999) An overview of information about spate-irrigated areas in different countries is presented in Table 1 in Annex A.

Spate irrigation has unpredictable water supplies and low levels of agricultural production. Spate hydrology is characterised by a great variation in the size and frequency of floods from year to year and season to season, which directly influence the availability of water for agriculture in any one season. Consequently, cropped areas and crop production vary considerably over the years. (Camacho 1987) Downstream sections often do not receive any spate flows at all for one or more consecutive years. Flash floods and heavy siltation are constant threats to the sustainability of the irrigation infrastructure. The financial returns to spate-irrigated agriculture are relatively low and maintenance costs are high compared with perennial irrigation.

Spate irrigation is very risk-prone due to the following reasons:

- floods are unpredictable due to the irregularity of rainfall;
- diversion structures are often destroyed by large floods;
- changes to the riverbeds, including degradation of the level of the riverbed and changes in the course of the riverbed, due to large floods;
- serious erosion and loss of land in command area due to large uncontrolled floods entering the distribution system;
- conveyance of spate water is restricted due to the deposit of large amounts of sediment in the canals; and
- fields get out of command as their levels raise due to the deposit of silt.

Despite its unreliability, risks and relatively low financial returns, spate irrigation is important for the livelihoods of a significant number of rural households, who often belong to the poorest, in various countries with arid and semi-arid climates. Spate irrigation must reward the farmers for their investments as they are prepared to invest their labour and money in the operation and maintenance of the diversion structures and canal systems. In Eritrea, about 350,000 persons or 10% of the total population rely for their livelihood on spate-irrigated agriculture. (Hadera 2001) Spate irrigation provides a livelihood for about 0.5 million people in the relatively poorer coastal areas of Yemen. (World Bank 2000b)

2 LIVELIHOOD AND POVERTY

2.1 Concept of Livelihood

A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks as well as maintain or enhance its capabilities and assets both now and in the future without undermining the natural resource base. Livelihoods are built upon the following five assets: human capital, social capital, natural capital, physical capital and financial capital. Secure access to these assets, which can take the form of ownership or the right to use, is essential to achieve a secure and sustainable livelihood.

Livelihood strategies refers to the range and combination of activities and choices that people undertake and make in order to achieve their livelihood goals, including productive activities, investment strategies and reproductive choices. There is an enormous diversity of livelihood strategies within geographic areas, across sectors, within households and over time. Livelihood strategies are dynamic processes, in which people combine activities to meet their various needs at different times and under varying circumstances. For the execution of agricultural activities, for example, people may need the following assets:

- labour force and particular skills (human capital);
- cash, inputs and equipment (financial capital);
- good infrastructure (physical capital);
- land and water (natural capital); and
- access to certain groups of people for acquiring certain services, such as credit or advice (social capital).

People's access to different levels and combinations of assets is probably the major influence on their choice of livelihood strategies. (DFID 1999)

2.2 Poverty in Spate-Irrigated Areas

The standard of living of the majority of farm households in the Sheeb area (Eritrea) is low. During bad years, the crop production of most farming households is only sufficient to satisfy their food consumption for not more than 3 months. In a normal year, less than 40% of the households produce enough food for the entire year. The estimated net farm income for a typical farming household in a good year is about US\$ 520, of which US\$ 355 from crop production and US\$ 165 from livestock products, while their estimated expenditures are US\$ 700 per year. Based on an average household size of six persons, the per capita income is about US\$ 86 per year. In a year with insufficient floods, the estimated net farm income drops to only US\$ 105 or US\$ 17.5 per capita. In such years, the households reduce their expenditures as much as possible. According to a socio-economic study conducted in 1997, the estimated average income of a typical farmer ranged between ETB 4,300 and 7,000, of which ETB 2,100 to 4,000 from agricultural sales, ETB 700 to 1,800 from livestock sales and ETB 1,200 to 3,500 from wage labour. The total average expenditures varied from ETB 5,700 to 8,000, so that most households spent more than their incomes. (Hadera 2000, Halcrow 1997)

Households in the spate-irrigated areas belong to the poorest sections of Balochistan's society in Pakistan. An average household would receive a net benefit of around Rs 1,000 or about US\$ 35 per annum per household member. In the Toiwar scheme in Killa Saifullah District, an average household with about 1.7 ha accrues two-third of its agricultural income from crop production and one-third from livestock. Based on a cropping pattern of 1.2 ha of wheat, 0.4 ha of barley and 0.1 ha of maize and mash, the gross revenue is Rs 16,709 (US\$ 360), of which Rs 13,780 as grain and Rs 2,929 as straw, whereas the production costs are estimated at Rs 2,884 (US\$ 62). The net revenue from spate-irrigated agriculture for an average household is Rs 13,825 or about US\$ 300 per year. (Halcrow 1993a, 1998)

In the spate-irrigated areas of the Shabwah Governorate in Yemen, the sale of live animals and livestock products is the main source of income for most households, while the sale of fodder, wage labour and remittances from family members working abroad are important sources of income as well. Crop surpluses are only sold in good years. It is estimated that the total net annual revenue of a nuclear household with only access to spate water is about YR 70,000 (US\$ 412), whereas the net annual revenues for households with access to pump irrigation range between YR 130,000 (US\$ 765) and YR 170,000 (US\$ 1,000). As the per capita rural incomes vary from YR 9,000 (US\$ 53) to YR 21,000 (US\$ 124) per year, the majority of the population in the Shabwah Governorate has less than US\$ 1 per day, which is considered as a minimum living standard by the UN. (KIT 2002)

In 2000, 28% of the households in Wadi Tuban and 35% in Wadi Zabid in Yemen lived below the poverty line of US\$ 203 per year. According to a socio-economic baseline survey, 58% of the sample households in Wadi Zabid considered agriculture as their main source of income, whereas farming was only the main source of income for 29% of the sample households in Wadi Tuban. (World Bank 2000b, IIP 2002)

In general, many farming households in spate-irrigated areas are poor as their annual incomes from spate-irrigated agriculture and other sources of income (i.e. livestock, wage labour) are low and often insufficient to satisfy the food requirements of the household throughout the entire year. A significant proportion of households in spate-irrigated areas live below the

poverty line. The inherent risk of crop failure due to the unpredictability of spate irrigation makes the livelihoods of many farming households in spate-irrigated areas very vulnerable.

3 SPATE-IRRIGATED AGRICULTURE

In general, spate-irrigated areas support low value agriculture due to the recurrent uncertainty in the frequency and size of floods. Sometimes the spates may be beyond control and they wash away the diversion structure or the flood channels before land is irrigated. It also happens that the season may not bring any flood or only very small floods that peter out before all fields are irrigated. Another problem is that downstream water users are deprived of spate water, because upstream farmers divert all spate flows irrespective of prevailing rules regarding the allocation and distribution of flood water for irrigation purposes. A further source of insecurity is the additional moisture from rains at later stages of crop growth, particularly for crops sown at the end or after the flood season. These rains may not come and the crop may be suitable for fodder only. The risks of crop failure in spate-irrigated agriculture are high, but the probability of being irrigated or not is not equally distributed throughout the command area of spate irrigation systems. Within the area served by one flood river and within the command area of one off-take, there may be land with high, medium and low probability of irrigation. This probability depends on the location and the level of the fields. (Van Steenberg 1997)

River in Spate in Eritrea

Implications of variability in flood supplies are that:

- the area cultivated and therefore the number of farmers receiving spate water differ from year to year;
- only low value crops are grown and that risk of crop failure is significant; and
- the importance of spate irrigation as source of income will vary within a community and between communities due to the varying probability of spate irrigation along the flood river and within command areas. (Ahmad 2000).

The main aspects of spate-irrigated agriculture, such as land tenure, farm size, cropping patterns, crop yields and net revenues as well as specific risk coping strategies adopted by (poor) households are described and analysed in the following sections of this chapter. The names of spate irrigation systems from Pakistan, Yemen, Eritrea, Ethiopia and Tunisia, which are used to illustrate the main aspects of spate-irrigated agriculture, are listed in Table 2 in Annex A.

3.1 Land Tenure

In addition to the cultivation of land by the landowners themselves, it is common in most spate irrigation systems that land is also cultivated by tenants and sharecroppers. In Yemen, about 18% of the total command area of 15,218 ha in Wadi Zabid is cultivated by the (small) landowners themselves, whereas 82% of the command area is cultivated by sharecroppers and tenants. In Wadi Tuban, small owner-operators cultivate about 49% of the total command area of 12,320 ha, while sharecroppers and tenants operate the remaining 41% and 10%. (World Bank 2000a) About 50% of the spate-irrigated landholdings was cultivated by sharecroppers in Wadi Rima during the 1970s. (MOD 1977a) In the spate irrigation systems in Balochistan (Pakistan), landholders often engage tenants and sharecroppers for the cultivation of their

lands. Along the Korakan River in the Kharan District, all the land commanded by the Jama Bund and Madagan Bund is cultivated by sharecroppers. Sharecroppers cultivated 73% of the land in Nal Dat, while tenancy is also common in Mouza Yo Bund in Las Bela District. However, tenancy is not practiced in Toiwar in Killa Saifullah District, where about 375 landowners cultivate their lands themselves. (Halcrow 1994, 1993e, 1998)

3.1.1 Landownership

In Pakistan, most land in spate irrigation systems is permanently distributed and the individual land rights are formally registered in government-administered cadastral records with the name of the owners, size and source of water for each plot of land as well as the occupancy rights of tenants, if necessary. In the Province of Balochistan, land is often owned for many generations by the same tribe or clan, who have settled in the area first. Land rights could also be obtained as a gift from local tribal leaders or the British colonial administration as a reward for certain services provided. Another option to obtain land rights is to purchase it. A good example of this last option is the development of the Marufzai spate irrigation system in Loralai District. About 120 years ago, one person called Hasan Khan purchased land from another Pashtun tribe along the Chamalang River in order to bring land under spate irrigation. On the death of Hasan Khan, the purchased land was sub-divided into 14 holdings, whereas each holding comprised fertile and less fertile land based on the water-holding capacity of the soil. Each of the 12 sons of Hasan Khan received a holding, whereas one holding was reserved for the village headman and one holding is communally owned and used for hosting guests. Sub-divisions through inheritance and transactions have changed the original distribution of land in the existing Marufzai scheme, but all the land is still owned by direct decedents of Hasan Khan. (Halcrow 1993d)

In Balochistan (Pakistan), a specific form of landownership has developed, whereby tenants have acquired permanent occupancy rights and partial ownership rights in the land as a compensation for developing the land for the original landowners, including the construction of the field bunds. A more detailed description of hereditary tenancy can be found in section 2.1.2.

In Yemen, cultivable land under spate irrigation can be either owned by private persons, government or trusts. In Wadi Zabid, 54% of the total command area is privately owned, while the remaining 46% belongs to trusts, of which 31% by private trusts, 4% by public trusts and 11% by religious trusts. In Wadi Tuban, 20% of the total command area is government-owned land, whereas 10% is waqf land belonging to religious trusts. Following the independence of South Yemen in 1967, large landholdings were redistributed among new farmers and tenants, whereas the landholdings of the Sultan and Emirs were transformed into State farms. After the unification of North and South Yemen in 1991, a decree was issued that specified that the original landowners regained ownership over land that was expropriated during the land reforms, while the farmers working these lands for the last 20 to 30 years lost their entitlements to use the land. However, the government has not resolved this issue as it would make many household landless. (Al-Eryani 1998, World Bank 2000a)

The land reforms initiated by the Eritrean People's Liberation Front (EPLF) in the latter half of the 1970s and early 1980s have changed the landownership in Eritrea significantly by allocating small plots of land (0.5 to 1 hectare) to poor families. Before the land reforms, individuals from the upper strata held large tracts of land, which left the majority of farmers landless or working as exploited sharecroppers. At present, all land is government-owned, but

the farmers have the right to use spate-irrigated land continuously. If the actual user of the land passes away, the usufruct right is transferred to the youngest son, whereas any other son will be allocated his own plot of land by the local administration as soon as he gets married. (Halcrow 1997)

Risk Coping Strategy

One particular strategy to cope with the inherent risks of spate irrigation was practiced by the Ouled Bouaziz clan in central Tunisia until the 1940s. To ensure the equal distribution of spate water, all spate-irrigated fields were distributed every year among all households with land rights, so that each year other households had land in the upstream section of the command area. (Van Mazijk 1988) A similar method of spreading risk occurs at family level in Chandia in Balochistan (Pakistan), whereby only irrigated land is distributed annually for cultivation among the various members of an extended family after the floods. (Halcrow 1993b)

Average Landholding

In general, the average landholding in spate irrigation systems is small. In Yemen, the average farm size is 1.4 ha and 2.1 ha in Wadi Tuban and Wadi Zabid respectively, although the land distribution is very skewed in Wadi Zabid where about 25 families own about 60% to 70% of the total command area of 15,215 ha with an average farm size of about 410 ha. The landownership in Wadi Rima with 15,650 ha of cultivable land (8,000 ha spate irrigated), which is situated adjacent to Wadi Zabid, is dominated by small landholdings of 2.5ha to 3.5 ha, while only two holdings exceed 250 ha, including 1,800 ha belonging to various branches of one family. (MOD 1977a) In the spate-irrigated areas of the Shabwah Governorate in Yemen, a typical extended household comprising 8 to 10 adults and 15 to 20 children owns 2.5 ha to 5.0 ha of arable land. During the land reforms in the Sheeb area (Eritrea) in the early 1980s, each household consisting of a couple and children received about one hectare of land, whereas divorced men and women, single adults of 18 years and more and orphans younger than 18 years were given 0.5 ha. In Ethiopia, 31% of the households in the Yandafero scheme in the Konso Special Wadera have one plot of land with an average size of 0.47 ha, while another 49% of the households own two plots with an average size 0.72 ha. In the Nouael II Project in central Tunisia, the average landholding was about 1.1 ha as around 800 households owned 900 ha in the 1980s. In Balochistan (Pakistan), the average landholding in spate irrigation systems varies from 2.1 ha in Sham to 5.4 ha in Chandia and 7.8 ha in Nal Dat.

As a result of further sub-division through inheritance, the existing landholdings will become smaller. Ultimately, the individual landholdings become so small that it will be impossible to operate them efficiently. Kahsaye reports that the reduction in farm sizes through time has resulted in decreased crop output in the Sheeb area in Eritrea. One explanation is that very small landowners cannot keep their draught animals, because they are unable to produce sufficient fodder. (Kahsaye 2002)

Land Distribution

In Wadi Zabid (Yemen), 25 families own about 4,400 ha or 53% of all privately owned land that is usually located in the upstream areas of the scheme where water is available throughout the year from spate and base flows. Another 31% of the total command area belongs to family trusts, which are often managed by the same large landholding families. A total of 2,738 ha is owned by small landholders, who have often less than one hectare of land. The land distribution in Wadi Tuban is less skewed as only 7% of the total command area belongs to landlords with more than 5 ha of land, whereas 49% of the total command area is owned by

small farmers with less than one hectare. About 55% and 25% of the households living in the command areas of Wadi Zabid and Wadi Tuban are landless as they do not own or lease any arable land. These landless households usually earn an income as agricultural labourers. (World Bank 2000b) In the Shabwah Governorate, the ownership of land varies from less than 1 ha to more than 10 ha. About 10% of the resident households are landless and they cultivate land as tenants. (KIT 2002) The land distribution in the spate-irrigated areas situated in the Tihama (i.e. Red Coast region) is skewed, whereby a small number of families possesses most of the arable land in the command areas of the spate irrigation systems. In southern Yemen, land is distributed more equally due to the land reforms in the 1970s during the socialist regime. However, the situation in the South of Yemen may change dramatically if the original landowners regain possession of their expropriated land.

In spate irrigation systems in Balochistan (Pakistan), the land distribution can vary from skewed to relatively egalitarian. An example of a spate irrigation system with an unequal distribution of land is Nal Dat with 75% of all spate-irrigated land owned by the 25% largest landholders, while the 25% smallest landowners only have 2%. In Chandia and Marufzai, the land distribution is relatively egalitarian with the largest 25% landowners owning 55% and 48% of the land respectively, whereas the 25% smallest landholders possess 7% of the irrigable land. (Halcrow 1993b, 1993d and 1993e)

Due to the land reforms in the 1980s in Eritrea, the land distribution is egalitarian in quantitative terms as each household received 1 ha of land and individuals obtained 0.5 ha. However, there may be differences in qualitative terms as individual plots of land have different probabilities of receiving spate water and the quality of the soil may also vary.

Land Fragmentation

As a result of inheritance and transactions, landholdings may be fragmented in two or more plots. If a farmer must be present to appropriate spate water as it arrives to his different plots of land at the same time, he has to rely on the assistance of other household members, including his wife, or hired labourers to assist in the irrigation of all his plots. In Wadi Rima (Yemen), about 75% of all farmers cultivate three or more separate plots of land. However, fragmented landholdings are sometimes amalgamated or enlarged by marriage, inheritance or the purchase of land with remittances from migrants. Land fragmentation has the advantage that different parts of the farm are irrigated and hence cultivated at different times thereby phasing labour and management demands on a single farm. (MOD 1977a and 1977b, Varisco 1983)

Risk Coping Strategy

To cope with different probabilities of receiving spate water, it is common in small spate irrigation systems in Balochistan (Pakistan) that each household has different plots of land with high and low probabilities of irrigation. For instance, most landowners in Chandia have plots in different parts of the command area in order to reduce the risk of not receiving any flood water and to prevent any segregation between up- and downstream users. A similar strategy exists in central Tunisia, where the command areas are divided into three or four sections and each landowner has a plot of land in each section. In this way, each household would have access to spate water even if a small flood does not reach further than the first section of the command area. In the 1980s, however, it was not always possible to allocate a plot of land to each household in each section as some plots had become very small (i.e. 0.1 ha) due to the rapid population growth. (Van Mazijk 1988)

Sale of Land

In most rural communities in Balochistan (Pakistan), land is not an object of speculation but a birthright. Therefore, it is not common that owners sell their land, in particular not to people from outside their own communities. However, it occurs that landowners, who faced a series of failed crop years, are forced to raise money by selling their land. (Van Steenberg 1997) A recent phenomenon is that hereditary tenants buy out the landlord's shares mainly with money earned by family members in the Gulf States. The current landholders in three small spate irrigation systems in Musa Khel District in Balochistan have purchased their lands in 1975 after they had cultivated these lands as tenants for more than 60 years. (Ahmad 1998)

Due to the inequitable distribution of spate water in Wadi Zabid (Yemen) and the desertification of many fields in the middle and the lower reaches of the river, a substantial number of small landowners have to sell their land to larger landlords with landholdings in the upper section of the spate irrigation system as well as wealthy merchants and traders. Indebtedness can also be a contributory factor in the sale of small landholdings, in particular following a succession of dry years. (MOD 1977a)

It is very likely that the number of small landholders, who are forced to sell their lands in the command areas of spate irrigation systems, will increase as the result of the following factors:

- the landholdings have become too small to sustain their households due to further subdivision through inheritance;
- the landholdings cannot be irrigated sufficiently due to inequitable distribution of spate water; and/or
- the landowners need cash to repay outstanding loans, to purchase food items and/or to pay for unforeseen expenditures (i.e. medicines) or social events (i.e. wedding).

3.1.2 Tenancy and Sharecropping

Landowners may decide to engage tenants or sharecroppers to cultivate their lands for various reasons. For instance, they are unable to operate their lands themselves as they are too old, ill or they are not resident in the village. Larger landlords have to hire the services of tenants or sharecroppers, because they do not have sufficient labour force to cultivate all the fields themselves and/or they may be engaged in other off-farm activities, such as trade, business or transport. For female landowners, such as divorcees and widows, it is often very difficult if not impossible to cultivate their fields themselves due to lack of resources (i.e. labour and/or draft animals) as well as cultural and/or religious constraints. Landholders may also be "too poor to farm" as they lack the necessary resources (i.e. draft animals or tractor) to prepare and repair the bunds as well as the inputs (i.e. seeds) to grow crops themselves. As a result, they are forced to rent out their land to tenants or sharecroppers, who have access to these means of production.

Sharecropping

In spate irrigation systems, sharecropping is the most common arrangement, but the "contracts" between the landowners and the sharecroppers vary considerably, mainly due to factors as the availability of sharecroppers and the prevailing cropping pattern.

In many small spate irrigation systems in Balochistan (Pakistan), sharecroppers are entitled to 50% of the harvested crop and straw if he provides the bullocks for the preparation of the land as well as all labour required for planting, weeding and harvesting. Seeds are either provided

by the landlords (i.e. Nal Dat) or by the sharecroppers (i.e. Barag). In some spate irrigation systems, the sharecroppers are also (co-)responsible for the maintenance of the field bunds (i.e. Marufzai) or even the reconstruction of the diversion structure in the river (i.e. Madagan Bund and Shah Bund along the Korakan River). The tenant's share of the harvests is reduced to 25% if the landowner provides the bullocks or mechanical traction, although the sharecroppers in Marufzai still receive 33% if the landlords prepare the land. In addition to their share of the harvest, sharecroppers in Mouza Yo Bund also receive a food ration throughout the year from the landholders. In areas where it is difficult to find sharecroppers due to competition from other economic sectors, landlords provide substantial loans of Rs 30,000 to Rs 70,000 (US\$ 1,000 to 2,325) to sharecroppers in order to secure their services. In some regions of Balochistan, such as the Anambar area in Loralai District, the practice of providing loans has evolved in debt-bonding, whereby the sharecroppers have to work for the same landlord until the loan with interest is repaid. (Halcrow 1993b-f; Halcrow 1994)

In Wadi Rima and Wadi Zabid in Yemen, the sharecroppers only receive one-third of the total output after they have paid 10% of the total output as Zakat (i.e. Islamic duty to give alms to poor and needy persons) and 5% to the canal master. The sharecropper contributes proportionally to agricultural inputs and the maintenance of the canals, but he has to provide all labour, including the employment of wage labour. If major canal repair works are required, both the landowner and sharecropper pay 50% of the costs. (MOD 1977a) In Wadi Tuban, the sharecropping conditions are more favourable for sharecroppers as their share is 70% to 75% of the harvest, but they have to take care of all inputs, irrigation fees and maintenance costs. (World Bank 2000a)

Hereditary Tenancy

Hereditary tenancy is a form of sharecropping that is very common in spate-irrigated and rainfed areas of the Province of Balochistan in Pakistan. In the past, owners of large tracts of land gave plots of land to other persons, who would develop the land by levelling it and preparing the field bunds. As a compensation for their investments, the person became a hereditary tenant (lathband) as he received a permanent and alienable occupancy right as well as a partial ownership in the land that he had developed. However, the hereditary tenant loses his rights if he fails to cultivate the land and to maintain the field bunds. If the landlord wants to cancel the hereditary tenancy arrangement or sell the land, he must give the hereditary tenant a previously agreed portion of the land (i.e. one-fourth to one-third) or the actual value in money. The landowners receive one-eighth to one-fourth of the harvested crops from the hereditary tenants as rent for the use of the land. The hereditary tenant is responsible for providing all inputs and labour, including the maintenance and repair of field bunds, canals and diversion structure. The hereditary tenant has the right to sublet his lease to an ordinary sharecropper or tenant. (Halcrow 1993a-e, 1994)

Tenancy

Tenancy, whereby the tenant rents a plot of land for a fixed amount of money, is not common in spate irrigation systems, which is understandable under a farming system with uncertainty as a dominating factor. (MOD 1977a) In Yemen, however, tenancy is more common in spate-irrigated areas as substantial amounts of land are owned by the State and trusts. In Wadi Zabid, some 5,000 tenants cultivate about 46% of the total command area with an average area of 1.4 ha, whereas 10% of the command area in Wadi Tuban is operated by 1,266 tenants having an average area of 0.9 ha. In Wadi Tuban, tenants normally pay an annual rent of YR 2,000 to YR 2,500 (about US\$ 10 to 15) per hectare for waqf land, whereas the rent for State-owned land is usually lower. Tenants in Wadi Zabid usually pay 5% to 10% of the crop as

rent, provided that they have a direct contract with the owners of the waqf land. It is common in Wadi Tuban and Wadi Zabid, however, that the Government and religious trusts lease their waqf lands to leading community leaders, who sub-lease these lands to tenants and sharecroppers against significantly higher rents. (World Bank 2000a-b; Al-Eryani 1998)

3.2 Cropping Patterns

In spate-irrigated areas, the cultivation of subsistence and low-value cash crops prevails, whereby drought-resistant crops, such as sorghum, millet, wheat, pulses, oilseeds, cotton and melon, dominate the cropping patterns. Archaeological research has revealed that wheat, barley, sorghum, millet, sesame, teff, grape and dates were cultivated in the spate-irrigated areas of Yemen between the third and first millennium BC. (Wilkinson 200?) The production of fodder is a priority in most spate-irrigated areas in order to support the livestock sector, which is not only an important source of income for many farming households but livestock is also a form of saving that can be sold in bad years and certain animals are used for traction and transport.

Risk Coping Strategies

To cope with the risk of crop failure, farmers in spate irrigation systems have developed various strategies:

- One strategy is that farmers prefer to grow crops, which would produce at least sufficient fodder even if the floods were not even sufficient to grow grains;
- Another strategy is intercropping, whereby two or even three different crops with different water requirements and harvesting times are planted in the same field, so that at least one of the planted crops could be harvested even in bad years; and
- A third strategy is that the crop choice is determined by the timing of the first irrigation and the result is often a "banding" of the command area, whereby sorghum is grown in fields with early irrigations, oilseeds and pulses dominate fields that were irrigated later and the last summer floods are reserved for the cultivation of wheat during the winter months. (Van Steenberg 1997)

In the Sheeb area in Eritrea, the main spate-irrigated crop is sorghum, which is planted in September at the end of the flood season and harvested for grain in January. The farmers prefer a local, high yielding, dwarf, fast maturing variety of white sorghum, which was introduced from Sudan in 1967 and it is well adapted to the local agro-climatic circumstances. Depending on moisture availability in the soil, a second harvest of sorghum can be obtained in April from the same plant by ratooning, whereby a new shoot grows from the roots of a cropped plant. In a good flood season, maize is planted right next to the first harvest of sorghum from mid-November to mid-December and harvested in February. Minor crops include millet, sesame, groundnut and some vegetables. (Hadera 2001; Kaysay 2002)

Spate-Irrigated Crop in Sheeb Area

In the Konso area in Ethiopia, farmers in the midlands mainly grow sorghum, maize, teff and beans under spate irrigation. In the Yandafero scheme in the lowlands, intercropping is the norm, whereby sorghum-cotton and maize-cotton are the predominant combinations with sunflower grown on the field bunds. (Farm Africa 2003)

In the Dera Ghazi Khan area in Pakistan, wheat was the most dominant crop with 30% to 70% of the spate-irrigated areas during the 1980s, whereas gram was the second most important crop followed by guar, pulses, sorghum, rapeseed, millet and maize. (Nawaz 2002a). Along the Korakan River in Kharan District, predominantly wheat is grown during the rabi season (October-May), while sorghum and watermelon are the main crops during the kharif season (June-September) if the fields could be sufficiently irrigated with spate water. (Halcrow 1994) In Chandia, the cropping pattern is dominated by the cultivation of sorghum as fodder, which is intercropped with pulses, during the kharif season, while wheat and oilseeds (i.e. mustard and rapeseed) are grown on residual moisture in the soil and early spring floods during the rabi season. Minor crops include coriander, radish and melons, while the leaves of the mustard plant are used as a vegetable. The main cropping season in Marufzai is the kharif season when farmers plant sorghum, pulses and melons between June and mid-July and both crops are harvested between late September and early October. Wheat, cumin and coriander are grown during the rabi season, whereby wheat is sown in October and harvested in April and May. Sorghum, guar and pulses are grown during the kharif season in Nal Dat, whereby guar is an important cash crop as it is sold as fodder. Wheat and some oilseeds are mainly grown during the winter months. In Toiwar, wheat and barley are cultivated during the rabi season, whereas mash and maize are the main crops grown during the kharif season. (Halcrow 1993b-f)

The main cropping season for spate irrigation systems of the Shabwah Governorate in Yemen is from August to December, when farmers cultivate sorghum, millet, sesame and wheat. (KIT 2002) The cropping patterns in Wadi Tuban and Wadi Zabid have changed dramatically, mainly due to the remarkable increase of (shallow) wells since the 1980s. As a result, the area under banana has increased from 20 ha in 1980 to more than 3,500 ha in 2000 in Wadi Zabid, while about 2,300 ha are under vegetables in Wadi Tuban. Cotton, sorghum, sesame and millet are the main crops for the majority of farmers, who only have access to spate water to irrigate their fields. Sorghum is mainly grown as fodder for their own livestock and to be sold against good prices in the local markets. It is estimated that 40% of the command area in Wadi Tuban is under cotton, 25% under fruits and vegetables, 20% under sorghum as fodder, 10% under sesame and 5% under sorghum and millet as cereal crop. Reportedly, the area under sorghum is declining in Wadi Tuban and Wadi Zabid due to the inequitable distribution of spate water and competition with pump-irrigated cash crops. Furthermore, the existing sharecropping arrangements in Wadi Zabid encourage sharecroppers to cultivate cash crops at the expense of cereal crops. One of the consequences of the reduction in the area under sorghum is that the cattle production in the Tihama has decreased, which may threaten the region's food self-sufficiency. (Arcadis Euroconsult 2002a, 2002b) In 1990, about 75% of the spate-irrigated area of 15,000 ha in Wadi Mawr was under white and red sorghum, while about 10% under millet and another 10% under sesame. (Shahin 1990) The cultivation of groundnut and melons as well as maize, peas and lentils is also reported in other spate irrigation systems in the lowlands and highlands of Yemen respectively. (Al-Shaybani 2003)

Typical planting and harvesting dates for a number of spate-irrigated crops cultivated in the coastal regions of Southern Yemen are presented in the following table:

Crop	Planting Month(s)	Harvesting Month(s)	Number of Crop Days
Sorghum (grain)	August	October	90
	September	November	90

Sorghum (fodder)	April	May	50-60
Cotton (long staple)	August	Jan-Mar	240
	September 15	Jan-Apr	225
Cotton (medium staple)	August	Dec-Feb	212
	September 15	Dec-Feb	195
Melons	August	October	90
	November	January	90
Sesame	August	October	90
	October	December	90

Source: Mu'Allem 1987

An overview of the cropping patterns for different spate irrigation systems can be found in Table 3 in Annex A. There is a tendency that the cultivation of traditional spate-irrigated crops is declining due to different factors. In Pakistan and Yemen, traditional cereal crops, such as sorghum and millet, cannot compete with (imported) wheat, which is sold against low, subsidised prices in the local markets. With increasing prosperity and urbanisation, changing taste may lead to a deterioration in the position of the local producer compared with that of the importer. Rising standards of living and changing habits could reduce the market for traditional grains, such as sorghum, whereby imported wheat and other cereals take over their place. (MOD 1977a) In addition, consumers prefer wheat as the consumption of traditional food crops has a low socio-economic status. Furthermore, governments have directly and indirectly promoted the cultivation of modern cash crops at the expense of traditional spate-irrigated crops by directing their research, extension and credit services exclusively on these high value crops.

Crop Husbandry

Farmers in spate irrigation systems mainly use local varieties, which are adapted to the local agro-climatic conditions. Seed is normally retained from one year to the next. The practice of using self-produced seed can lead to various problems, such as diseases. However, there are very few substitutes for the used varieties as agricultural research is concentrated on perennially irrigated crops. The spacing of the plants is usually wide to provide each plant with a large volume of soil moisture. In the coastal region of Southern Yemen, the best interval for land preparation after flooding is considered to be about 10 days. (Mu'Allem 1987)

In general, farmers do not use chemical and organic fertilisers neither do they incorporate crop residues in the soil. In addition to the fact that many small farmers cannot afford the use of chemical fertilisers, many farmers believe that the nutrient requirements of their spate-irrigated crops are sufficiently satisfied by the fertile sediments deposited during each irrigation.

Although the use of tractors is increasing rapidly, many farmers still use bullocks to prepare their fields, including the repair of the field bunds. In general, farmers try to keep the input of labour as minimal as possible. Normally, only family labour is used, but additional labour may be hired at time of harvesting and threshing. Areas with more reliable spate irrigation and

regular cropping have often attracted a high proportion of landless families, who form the basis of a permanently resident labour force. Most of itinerant labourers live in nearby towns and villages or in neighbouring spate-irrigated areas. (MOD 1977a)

Generally, households use traditional storage facilities to store their harvested crops. The risk of losses can be high as the stored crops could be attacked by fungi, insects and rodents. In the Sheeb area (Eritrea), crops are usually stored in woven containers and sacks and the post-harvest losses are estimated to be as high as 25%. (Kahsaye 2002) The methods of storing grain in Wadi Rima (Yemen) have changed little over the years. Usually food is stored in mud huts, although rooms are used in stone houses near the mountains. Some farmers only store their grains in bags that are usually left outdoors, which are sometimes raised on a small platform of poles and roughly covered with straw or they are plied high on a low mound of sand and bundles of sorghum stalks are placed over the bags. Jute bags, large earthen jars of approximately 1.5 bags (135 kg), baskets varying in capacity from 1 to 3 bags (90-270 kg) and metal drums are used as storage containers. Many stores showed evidence of endemic insect infestation. Rodent infestations are widespread and control is attempted by mechanical trapping and hunting, but neither of which is effective. The basic method used for insect control is “sunning” by spreading the crop out in the sun until it becomes heated and the adult insects emerge. Another control method sometimes used for the storage of seed and cowpeas is the practice of mixing ash with the grains, while sorghum chaff may be spread over the floor to deter termites. Overall, it is considered that grain losses amount to an average of 5 to 10% of the weight stored, but in exceptional circumstances this figure can rise to over 25%. (MOD 1977a)

Most farmers, who grow traditional spate-irrigated crops, do not have access to agricultural research and extension services that are provided by government agencies and/or private sector. As a consequence, it is difficult for these farmers to increase their yields and revenues by improving the husbandry of their spate-irrigated crops. Consumers often prefer spate-irrigated crops as they have not lost their original taste due to excessive irrigation and the use of chemical fertilisers and pesticides.

To avoid the loss of soil fertility, farmers have adopted various types of crop rotation, whereby fields are left fallow during one season. For instance, farmers in Chandia (Pakistan) apply the following rotation schedule: sorghum-fallow-oilseed. (Halcrow 1993b) As the cropping pattern in many spate irrigation systems is dominated by monocultures and large areas are planted at the same time, the impact of pests and diseases can be dramatic. The use of pesticides and insecticides is very rare as most farmers lack the financial resources to apply these products. Following a number of insect attacks, which affected the quality and quantity of the crops, several types of crops were no longer cultivated by the farmers in the Sheeb area (Eritrea) during the 2000-2001 cropping season. (Kahsaye 2002) Changing of sowing dates is one of the control measures used to cope with outbreaks of pests and attacks by birds. (Hadera 2001)

Ground Water Irrigation The use of ground water as source for irrigation is an important strategy to cope with the risks of crop failure due to the unpredictability of spate irrigation. Since the early 1980s, an increasing number of dug- and tube-wells have been installed in the command areas of spate irrigation systems by the farmers themselves for one of the following reasons:

- to change their cropping patterns towards high value cash crops, such as vegetables and fruit, whereby they irrigate their fields solely with ground water or conjunctively with spate water;
- farmers in the middle and tail reaches of spate irrigation systems have less chance to irrigate their lands with spate water as their fields have a low probability of irrigation and they only receive water during large floods; or
- farmers in the middle and tail reaches of spate irrigation system have less access to spate water as traditional rules regarding the allocation and distribution of spate water are not respected by upstream water users, whereby the latter divert more spate water to their fields as they are entitled to.

In the command area of the Nouael II Project in central Tunisia, about half and two-third of the households in the middle and tail sections of the main canal had developed their own dug-wells for the cultivation of vegetables. As a result, the well-owners had stopped their contributions to the maintenance of the spate irrigation system. (Van Mazijk 1988)

As spate water only reached the tail of Wadi Al' Ain/Harib (Yemen) during large floods following the construction of two weirs in 1980, many farmers have developed wells in the downstream reaches in order to become less dependent upon spate water. (Kohler 1999) In the central region of Shabwah Governorate in Yemen, about 20% of the households have installed wells in order to reduce the risk of crop failure. Households with access to pump irrigation obtained net annual revenues that are at least twice as much as for households depending exclusively on spate irrigation. (KIT 2002)

The coastal areas of Yemen have witnessed the installation of a large number of shallow wells and tube-wells since the 1970s and 1980s due to the availability of remittances from family members working in the Gulf States and subsidised credits from the Cooperative and Agriculture Credit Bank, the government policy to ban the import of fresh fruit and vegetables as well as less-effective government control. In Wadi Rima, the abstraction of ground water for irrigation already started during the second half of the 1960s, whereby the number of pumped wells increased from less than 10 in 1965 to more than 325 in 1975. (MOD 1977a) There are about 1,900 operational wells in the command area of Wadi Tuban, of which about 300 well are situated in the upper reach of the Wadi. A total of 2,000 to 2,400 wells with motor pumps have been developed in Wadi Zabid, which are mainly located in the middle and lower reaches of the Wadi. (World Bank 2000a) If pump irrigated land is leased to a sharecropper and all the costs are shared, the owner of the pump receives 50% of the crop, whereas the landowner and sharecropper are entitled to 25% of the produce. Tenants pay a total annual rent of YR 15,000 to 20,000 (about US\$ 100 to 135) in cash for using 1 feddan (0.44 ha) of pump irrigated land. Landowners can purchase water from well-owners for YR 10,000 to 15,000 (about US\$ 65 to 100) per feddan. In Wadi Mawr, the number of shallow wells increases further downstream the main canal system.

Harvesting of Pump-Irrigated Sorghum as Green Fodder in Wadi Zabid

In addition to the cultivation of bananas, farmers in Wadi Zabid also use ground water for the irrigation of sorghum, which is sold as green fodder against favourable market prices. This practice illustrates that sorghum can be an important cash crop for farmers in spate-irrigated areas and that it is not only a poor man's crop.

It seems that the number of wells installed in the command areas of spate irrigation systems in Pakistan is less than in Yemen. There are reports that tube-wells have been installed in the spate-irrigated areas of Dera Ghazi Khan as well as in a number of spate irrigation systems in Balochistan, such as Nal Dat and along the Korakan River.

As already illustrated in the Nouael II Project in central Tunisia, one of the impacts of the installation of wells may be that the importance of spate irrigation diminishes for the well-owners and that they are less willing to contribute to the maintenance and repair of spate irrigation systems. The result may be that the spate irrigation systems cease to function, because the remaining farmers, who are often the small, poorer owner-operators and sharecroppers, are unable to mobilise sufficient labour and draught animals that are required for the reconstruction of the diversion structure and the cleaning of the canal system.

3.3 Crop Yields and Revenues

On average, the yields of spate-irrigated crops are low. In bad years when large parts of the command area cannot be irrigated at all, most fields will not produce any crop, whereas the crops on other fields can only be used as fodder. In good years when fields can be irrigated at least twice, the yields could be high.

In the spate-irrigated areas of the Shabwah Governorate in Yemen, the average yields are 1,500 to 2,000 kg/ha for sorghum and 1,000 to 1,500 kg/ha for millet. However, the yields of sorghum and millet could be more than 2,500 kg/ha and 2,000 kg/ha respectively in years with good rains and floods, while it may be less than 800 kg/ha and 600 kg/ha respectively in dry years. (KIT 2002) The average yields of main crops under spate irrigation in the coastal area of the Tihama (Red Sea coast) and the Aden Gulf are presented in the following table:

Crop	Yields in Coastal Area of Red Sea	Yields in Coastal Area of Aden Gulf	Yields in Coastal Area of Southern Yemen (tons/ha) (b)	Yields in Wadi Rima (Red Sea Coast)	Yields in Wadi Mawr (Red Sea Coast)
	(tons/ha) (a)	(tons/ha) (a)		(tons/ha) (c)	(tons/ha) (d)
Sorghum	2.0 - 3.5	0.7 - 1.2	0.9	1.1	1.0
- white				0.6	0.6
- white ratoon					
- red					
Millet	-	0.7 - 1.2	0.9	0.8	0.6
Cotton	0.65 - 1.35	0.85 - 0.95	0.9	1.1	1.0
- extra long staple		1.0 - 1.6	1.5		
- medium staple					
Sesame	0.7	0.35 - 0.65	0.5	0.7	0.7
Maize	1.1 - 1.5	-	-	1.4	1.0
Melon	-	7.9 - 14.1	10.0		5.0 - 5.5
Groundnut	-	1.2	1.2		-

Source: (a) Al-Shaybani 2003; (b) Mu'Allem (1987); (c) DHV 1979 and (d) Shahin 1990

The average yields for perennially, regularly and irregularly spate-irrigated areas in Wadi Rima is presented in Table 4 in Annex A. In the coastal region of Southern Yemen, respectable yields are obtained for field crops grown under spate irrigation despite the lack of fertilisers and pest control and without following certain crop rotation or improved cultural practices. The yields of sorghum, millet, sesame and melons may fluctuate from year to year due to the planting date as well as sensitivity to attacks by insects and diseases. A probable explanation might be that soils in spate-irrigated areas are highly retentive of moisture and the good quality of spate water. However, yields could be increased by 30 to 50% if improved cultural practices, pest control and fertilisers are applied. (Mu'Allem 1987)

During the 1997-98 cropping season, the average grain yield for sorghum in the Sheeb area (Eritrea) was in the range of 1,200 to 1,500 kg/ha for the main crop, while the (first) ratoon crop had a yield between 700 and 1,000 kg/ha. Farmers also collect the straw of sorghum, maize and millet from their fields to be used as fodder and for roofing of their dwellings. (Hadera 2001)

Compared with the yields of spate-irrigated crops in Yemen and Eritrea, the yields in Balochistan (Pakistan) are significantly lower as they are in the range of 450 to 900 kg/ha for wheat, 360 to 550 kg/ha for sorghum, 200 to 500 kg/ha for pulses, 360 to 620 kg/ha for cotton and 150 to 350 kg/ha for oilseeds. (Van Steenberg 1998) In Toiwar, the average yields for maize and barley are about 740 kg/ha and 1,300 kg/ha respectively. (Halcrow 1998)

Net Revenues

In the coastal area of the Red Sea in Yemen, the net revenues during the 2000-2001 cropping season were YR 72,100/ha (US\$ 480) for cotton, YR 46,200/ha (US\$ 310) for millet, YR 36,830/ha (US\$ 245) for maize and YR 15,190 to 25,400/ha (US\$ 100 to 170) for sesame. (Arcadis Euroconsult 2002a) According to a World Bank report (1986), the income of a farm with 3 ha in the upstream reach of the wadi in the Tihama plain was about US\$ 1,766/ha, whereas a farm of 6 ha in the downstream section of the wadi would have an income of only US\$ 300/ha. (Tihama Development Authority 1987)

In the Sheeb area (Eritrea), the net return for sorghum (main and ratoon crop) was about US\$ 355/ha in a good year with sufficient floods (1997-1998), while it was only US\$ 54/ha in a bad year (1996-1997) as the yield of the main crop was lower and no ratoon crop was harvested. The net return for ratoon crop is normally higher than for the main crop as the production costs are lower. (Hadera 2001)

In the Toiwar scheme in Balochistan (Pakistan), the net revenue was about Rs 8,340/ha (US\$ 180/ha). The gross revenue for wheat (1,000 kg/ha) was Rs 9,530/ha (US\$ 205/ha), of which Rs 8,025/ha are grain and Rs 1,505/ha as straw. After deducting the input costs (Rs 1,855/ha) and labour costs (Rs 1,480), the net revenue for wheat was Rs 6,195/ha (US\$ 134/ha). The gross and net revenue for barley (1,300 kg/ha) were Rs 11,350/ha (US\$ 245/ha) and Rs 8,500/ha (US\$ 184/ha) respectively, whereas maize (760 kg/ha) had a gross and net revenue of Rs 16,180/ha (US\$ 350/ha) and Rs 13,455/ha (US\$ 290/ha) respectively. (Halcrow 1998)

Marketing

In spate irrigation systems, farmers usually sell any surplus grain and/or cash crops within their own village, in local markets or to nomadic herders, who are migrating between the

winter grazing areas in the plains and the summer rangelands in the highlands. It also happens that traders come to village to purchase any surplus produce. There are also farmers, who take their produce to large urban centres in order to get a better price. The sale of (green) fodder is an important source of cash income for farmers in the spate irrigation systems in Balochistan as well as the coastal areas of Yemen.

In the area of Wadi Rima and Wadi Zabid, markets range in size from small to large, whereby the small markets have a retail function, whereas the larger markets serve two functions: distribution centres for food items and small hardware and as outlets for farm produce, mostly grain and livestock. There is a weekly market on every day of the week and they play a key role in the local economy. While a proportion of local produce is sold by the farmer directly, most farmers sell their produce to itinerant merchants, who market the purchased produce locally and regionally. Within each market, specific networks exist for trading each of the principal local products, in particular grains and livestock. Even goods for export are collected in small lots at most markets, whereby main exporters employ agents, who travel to the markets to purchase the exportable goods. For all commodities, the frequency of markets, the large number of small traders present in most markets and the multiplicity of areas in which they trade make price-fixing rather difficult. The marketing system is dependent on an element of mutual trust between all participants, which is based on Islamic principles that speculative trading and the payment of interest are both forbidden. It is still general practice for a majority of goods to be traded on delayed payment. Until a product reaches its final market, the price is not irrevocably fixed. Even if an entrepreneur purchases goods on credit at a fixed price, he can often negotiate a reduction if he fails to realise the price he anticipated. (MOD 1977a)

4 LIVELIHOOD STRATEGIES IN SPATE-IRRIGATED AREAS

With crop returns being low even in good years and the likelihood of the absence or failure of a crop always there, spate-irrigated agriculture makes a precarious living. Farming households in spate irrigation systems have, therefore, adopted a number of livelihood strategies to cope with the uncertainties of spate-irrigated agriculture:

- One strategy is to save the surplus of grains from a bumper year to a next year. A more common method to compensate bad years with good years is to monetise the surplus crop by investing in disposable property, such as livestock in general and draft animals in particular.
- The most common strategy is the diversification of the household economy, whereby households in spate-irrigated areas generally depend on multiple sources of incomes. The co-existence of livestock keeping and spate irrigation has been noted in various arid regions. Small ruminants in particular are an integral component of the household production system and often serve as a buffer to overcome dry years.
- Locally available natural resources often play an important role in satisfying various needs of many households.
- Wage labour and off-farm activities are often other important sources of household income in spate-irrigated areas.
- A failed flood season often triggers off substantial migration, in particular of able-bodied male family members, in search of labour.
- Another strategy to survive an adverse year is borrowing money to purchase additional food items or to obtain seeds at the start of the cropping season.

- Traditional mechanisms of solidarity and mutual assistance still play an important role in the local communities. (Van Steenberghe 1997)

The different livelihood strategies will be described and analysed in the following sections by using information about spate irrigation systems from Pakistan, Yemen, Eritrea, Ethiopia and Tunisia. The names of spate irrigation systems, which are used to illustrate certain aspects of livelihood strategies, are listed in Table 2 in Annex A.

4.1 Livestock

Livestock is an integral component of the livelihoods of most households involved in the cultivation of spate-irrigated crops as it is an important strategy to cope with the risks related to spate irrigation. The importance of livestock may be less if the probability of spate irrigation is relatively high or if there are good opportunities to generate an income outside the agricultural sector.

In general, livestock may have the following important functions in the livelihood strategies of households cultivating spate-irrigated crops:

- Oxen and to a lesser extent camels are traditionally used for the preparation of the fields and the maintenance of the field bunds as well as the (re)construction of the diversion structures in the riverbeds and the cleaning of the flood canals.
- Camels and donkeys are used for the transport of crop produce, water and people;
- Cows, goats, sheep and poultry are raised as a source of food and income, whereby milk, dairy products (i.e. yoghurt, whey and butter), meat, wool and skins are the main livestock products, which are mainly used for home consumption but also sold to raise cash;
- Small ruminants, such as goats and sheep, are important savings to cope with crisis situations because of their high reproductive rates and high degree of resilience to drought conditions, although oxen are also sold to bridge adverse years; and
- Cattle, donkeys and camels provide dung, which is used as fuel by making dung cakes and as building material by mixing it with earth and straw.

Camels for Transport of Crop Produce in Balochistan

Role of Oxen

The ownership of at least one pair of oxen is often an indicator of wealth. For many households in spate irrigation systems, it is difficult to support a pair of oxen, because the average farm size is often too small to produce sufficient fodder to feed them in years with normal floods. At times of drought, oxen and other large ruminants are a risk and many households do not have another choice to sell them or to move to other areas where fodder is available. Due to increasing farm mechanisation, the number of draught animals in spate-irrigated areas in Balochistan has reduced significantly, which has had consequences for the livelihoods of many households and the social organisation of the spate-irrigated communities. The sale of bullocks has lost its importance as a mechanism to cope with a crop failure or any other crisis. The replacement of bullocks by tractors has undermined the traditional organisation of system maintenance, whereby every household was contributing all its labour and animals for the (re)construction of the diversion structure and cleaning of the canal system in accordance with its capabilities. (Halcrow 1993a)

Oxen and draught equipment were commonly exchanged or hired in Wadi Rima (Yemen) as only 40% of the farmers possessed their own oxen. Hire charges for oxen may be twice as high in the peak season than during the off-season. Farmers may work for owners of oxen in return for the use of the animals, usually at a rate of 3-day labour for one-day oxen hire. (MOD 1977a)

Use of Oxen during Repair of Diversion Structure in Eritrea

Composition and Number

The composition and number of livestock owned by households in spate-irrigated areas reflects their needs (i.e. traction, transport, food) as well as the local environmental conditions, including the availability of forage. In Wadi Rima, the stocking density of oxen is closely associated with cropping intensity. (MOD 1977a) A common strategy among livestock owners is to build up livestock numbers in anticipation of recurrent droughts, so that a minimum herd size is left after a crisis period. In the Shabwah Governorate in Yemen, an average household in the central-northern region owns 10 to 20 small ruminants, 5 to 10 camels and some poultry, whereas a typical household in the central parts possesses 20 to 30 small ruminants and some poultry. In Wadi Zabid, an average household has 2 cows, 2 calves, 5 goats and 4 sheep, while a minority of households owns two oxen. In the spate-irrigated areas of Wadi Rima, most households had on average 1.5 cows, 7.2 sheep, 1.5 donkeys and 6.4 hens, while about a quarter of the households had 2.1 oxen and about 40% had 3.4 goats. (KIT 2002; IIP 2002, MOD 1977a))

In the Sheeb area, about 30% of the farmers do not own bullocks and they have to rent or share a pair of oxen for the preparation of their fields. A typical household has 1.5 to 2.7 dairy cattle and 1 to 2 draught animals. (Hadera 2001) Only 31% of the landowners in the Yandafero scheme in Ethiopia have one or two oxen, whereas the other farmers hire or borrow draught animals or gain access through the exchange of labour. (Farm Africa 2003)

The number of livestock owned by an average household in spate-irrigated areas in Balochistan (Pakistan) varies considerably. In Chandia, Barag, Nal Dat and Marufzai, an average household owns 3 to 6 sheep, 5 to 9 goats, 1.5 to 3.5 cattle and 1 to 4 chickens, whereas one-third of the farmers in Chandia possess bullocks and a number of households in Barag and Nal Dat has a camel. (Halcrow 1993b-e) In other small spate irrigation systems, the number of livestock is considerably higher as 90% of the households in Toiwar have an average number of 62 small ruminants and two cows, whereas an average household in three schemes (i.e. Dudar, Sohar Khor and Sham) in Musa Khel District and one scheme (i.e. Jhalwani) in Barkhan District possesses 29 to 75 small ruminants and 2 to 10 large ruminants. (Halcrow 1998; Ahmad 1998)

The principle of sharecropping is also practiced in the livestock sector, whereby livestock owners place animals in the care of others in return of a proportion of the produce. In the D.G. Khan region and Balochistan in Pakistan, the herder receives 25% to 50% of all new born, surviving lambs and kids. (VBB Viak – NESPAK 1995, Ahmad 1998) Similar sharecropping arrangements for livestock also exist in Wadi Rima in Yemen, whereby the daily management and the costs of maintenance are the sharecroppers' responsibility, for which he usually acquires half of the offspring and all of the milk in return. (MOD 1977a)

Small ruminants are usually grazed on the rangelands, whereas large ruminants are fed with green fodder and crop residue (i.e. straw and stalks) that are collected from the fields. In Wadi

Rima, (store-damaged) sorghum grains are occasionally used for feed as well as surplus cotton seed and cakes, sesame cake and date waste. To cope with shortage of fodder in the vicinity of their villages, livestock-owners have to migrate with their animals to other areas, such as the highlands, where they can find sufficient fodder. In the Sheeb area (Eritrea), all livestock is kept in the village and fed with cut grass during the cropping season in order to prevent livestock from trampling and grazing young growing plant. (MOD 1977a, Hadera 2001, Nawaz 2003)

Revenues

Most households use their livestock products, such as milk, butter, yoghurt, whey, eggs, meat and skins, for home consumption, although some items may be sold locally to raise cash income. In the Sheeb area, an average household with two cows, two goats, one sheep and one chicken has an annual production of 625 litres of milk, 18 kg of butter and 130 eggs in a good year, whereas the production levels are 50% lower in a bad year. The incomes from livestock range from US\$ 165 in a good year to only US\$ 12 in a bad year. (Hadera 2001) Live animals are usually sold to repay outstanding loans and/or to purchase additional food items. In the spate-irrigated areas of the Shabwah Governorate, an average household generates a revenue between US\$ 235 and 470 per year from livestock activities, including the sale of 5 to 15 sheep. (KIT 2002)

In addition to spate-irrigated agriculture and livestock, bee-keeping may be another important source of income for households in spate irrigation systems. Many households in the Shabwah Governorate, in particular in the spate-irrigated areas, are engaged in bee-keeping, of which 5% can be categorised as professionals with an average of 150 beehives, 10% as semi-professionals with about 50 colonies and the remaining 85% have a few beehives. It is estimated that small beekeepers could earn between US\$ 60 and 295 each year, whereas professional bee-keepers have an annual income of US\$ 3,000 and more. (KIT 2002) Bee-keeping is also an important secondary source of income among households in the Konso Special Wadera in Ethiopia, who are involved in spate-irrigated agriculture. (Farm Africa 2003)

4.2 Access to Locally Available Natural Resources

Spate water and land are two natural resources that are essential for the livelihoods based on spate-irrigated agriculture. However, there are also other locally available natural resources that play a very important role in the livelihood strategies of farming households in spate-irrigated areas.

Drinking Water

The access to reliable sources of (ground) water for potable and domestic purposes throughout the entire year is a condition for the permanent settlement of people in an area. In a number of spate-irrigated areas, however, (ground) water is not available permanently and the local population does not have another choice than to leave their villages in search of water for themselves and their animals. For instance, the majority of the local population in the Sheeb area (Eritrea) migrates each year for a number of months to the mountains, because there is not sufficient water for themselves and their animals in the lowlands during the summer months. (Hadera 2001; Halcrow 1997)

A similar situation also exists in the Kachhi Plain in Balochistan (Pakistan), where existing water sources could not supply sufficient water to satisfy the water requirements of the local

population for the entire year. As a result, people have to migrate to other areas for a number of months each year. The most important sources for potable water are earthen tanks and low-level sites in the riverbeds. Most of these earthen tanks are located miles away from the villages and they often have insufficient storage capacity, which is further reduced to improper maintenance. To improve the access to potable water for the local population and to reduce the need to migrate temporarily to other areas, a number of newly designed water storage tanks have been constructed under the Pak-German Self-Help Project. The main improvement in the design of the water tanks is its increased depth in order to reduce water losses due to evaporation and seepage. As a result, the newly constructed tanks provide water for eight months, while the traditional tanks could not store water for more than three months. (BRSP 19??)

Due to the installation of an increasing number of tubewells for irrigation purposes, the aquifers in many spate-irrigated areas are seriously over-exploited. Due to this development, households in these areas have less secure access to potable water as the level of the water table is decreasing rapidly and an increasing number of shallow wells in the villages do not supply sufficient throughout the entire year. In addition, the quality of drinking water may be adversely affected as well as it becomes more saline.

Natural Vegetation

In a number of spate irrigation systems, trees play an important role in the livelihoods of the rural households as well. In the central-northern region of Shabwah Governorate in Yemen, each household has an average number of 25 to 50 *Ziziphus* trees in and around their spate-irrigated fields for bee-keeping, fodder, fruits, timber, fuel wood and medicinal uses. (KIT 2002) A large number of trees, such as acacia, can also be found in the command areas of spate irrigation systems in the Konso (Ethiopia), in which many beehives have been installed. In Pakistan, multi-purpose trees as the *Tamarix* are common in the spate-irrigated areas of Balochistan and Dera Ghazi Khan. In the Sheeb area in Eritrea as well as in the spate-irrigated areas along the Korakan River in Balochistan (Pakistan), households earn an income with the cutting and sale of (fuel) wood. The production and sale of charcoal is also undertaken by a number of households in Balochistan and the Tihama region in Yemen. (MOD 1977a, Hadera 2001; Halcrow 1993d, 1994)

Charcoal Production in Balochistan

In many spate-irrigated areas of Balochistan and Punjab (Pakistan), the dwarf palm is used by women for making different items, such as mats, ropes and sandals. (Ahmad 1998, VBB Viak – NESPAK 1995, Nawaz 2003) Trees with large spines, such as the acacia, are also used for the construction of fences around fields to protect standing crops from being damaged by roaming animals as well as to form corals where livestock is collected and protected for the night.

Furthermore, trees are also intensively used in the maintenance and repair of irrigation structures in traditional spate irrigation systems. Branches and even entire trees are used to strengthen diversion spurs as well as flood protection works. (Scheitz 1987) In Somalia, low dams of wooden poles are used to divert spate flows into the fields or to open ponds and pools for temporary storage. (Hag Nur 1987)

Use of Bushes for Strengthening of Diversion Spur in Eritrea

In addition to the cultivation of fodder crops, in particular sorghum, it is common that bushes and grass growing along flood canals and around the spate-irrigated fields are used to feed animals as well. Normally, small ruminants, such as goats and sheep, graze along the flood canals and the fallow fields in search of edible vegetation, whereby the herdsmen may sometimes cut branches of larger bushes, so that the animals can eat the (new) leaves. During the cropping season, it is not uncommon that women and children cut grass and take it home in order to feed their animals, which are kept within the compound as a measure to prevent damage to standing crops in the spate-irrigated fields.

Pasture

As livestock plays a crucial role in the livelihood strategies of households in spate-irrigated areas, access to sufficient fodder in terms of quantity and quality is conditional. In addition to the cultivation and/or procurement of (irrigated) fodder crops, such as (green) sorghum, and the use of leaves and grass found in the command area of the spate irrigation system, natural pastures are another important source of fodder for livestock. In Wadi Rima in Yemen, sheep and goats graze and browse for much of their feed along canal banks and on fallow fields and bushlands. In sparsely populated areas, such as Balochistan and the mountainous areas of Yemen, livestock owners may find pastures in the vicinity of their villages. In the Sheeb area in Eritrea and the Kachhi Plain in Balochistan, livestock owners have to migrate with their animals to the pastures in the highlands for several months each year due to shortage of fodder in the vicinity of their villages. (MOD 1977a, Hadera 2001, BRSP 19??)

In some (remote) areas of Balochistan (Pakistan), rangeland is communally owned by a tribe and their members have the right to use the resources from these communal lands, such as fuel wood, building materials, wild fruits, honey and edible roots. Outsiders can only graze their animals on the communally owned lands, if they have received permission and paid a grazing tax. In the Barkhan District, outside herders paid Rs 80,000 (US\$ 2,330) to graze their 12,000 to 14,000 animals from October to March. In Marufzai, a total amount of Rs 45,000 (US\$ 1,800) was raised in 1992 as grazing tax for the use of their communal rangelands by nomadic herdsmen. (VBB Viak-NESPAK 1995; Halcrow 1993d)

In particular in densely populated areas, over-grazing has seriously affected the quality of pastures, while more and more pastures are transformed in arable land for the cultivation of (rainfed) crops due to the increasing population pressure. As a result, livestock owners have to look for alternative sources of fodder for their animals, including the (seasonal) migration to the highlands and/or the use of cultivated fodder crops. However, these two options may not be affordable for poorer households and their only option may be the sale of most of their animals.

4.3 Wage Labour and Off-Farm Incomes

In addition to an income from spate-irrigated agriculture and livestock, households in spate-irrigated areas may have adopted the risk coping strategy to earn an additional income as labourers and/or from off-farm activities. Especially at harvesting time, most households have to hire additional labour as the available family labour is insufficient to carry out all the field activities. The available pool of wage labourers may comprise members of landless households, households with landholdings that are too small to sustain the household throughout the entire year as well as landholding households whose fields could not be irrigated during the last flood season. Wage labour is the second source of income for 25% of the households in the Toiwar scheme in Balochistan. Nomadic tribes and temporary migrants

may also come to the spate-irrigated areas during harvesting time in search of wage labour. Wage labourers are often paid in kind, whereby they receive a fixed portion of the harvested crop. In Nal Dat, for example, wage labourers receive one-twentieth of the crop for harvesting, while they get one-tenth of the grain with chaff or one-eighth without chaff for threshing. (Halcrow 1993e, 1998) In the Sheeb area in Eritrea, a typical household accrues 25 to 50% of its average annual income from wage labour. (Halcrow 1997) The large majority of households in Chandia have one or more household members in the civil service with low-ranking jobs, such as messengers and workmen. (Halcrow 1993b)

Wealthier households may also be engaged in business, trade and transport, whereas poorer households in Eritrea, Pakistan and Yemen may also earn an income with the production and sale of handicraft products, such as pottery, mats, baskets and sandals (MOD 1977a, Hadera 2001, Nawaz 2003)

4.4 Migration

Different forms of migration can be found in spate-irrigated areas, which are often an integral and crucial component of the livelihood strategies of many households in order to reduce the inherent risks of spate-irrigated agriculture. One reason for migration is to move livestock to other areas where fodder and water can be found, which may take place annually or only in dry years. In the Sheeb area in Eritrea, a large majority of the population migrate every year to the highlands during the summer months (May to October) in search of fodder and water and to escape the harsh climate in the lowlands during this time of the year. Only the male members of each household remain behind temporarily to divert the floods in July and August and to plant their fields in September. Although this livelihood strategy exploits different agro-ecological zones for acquiring water, food and animal feed, certain activities, such as the emergency repairs of the irrigation structures, are not undertaken at the right time due to shortage of labour. In addition, the annual costs of the seasonal migration, both in cash and labour, are substantial and could be as high as one-fourth of the annual income of a typical households. (Hadera 2001; Halcrow 1997; Kahsaye 2002)

Another reason for migration is the search of wage labour by male household members as the incomes generated by spate-irrigated agriculture and livestock keeping are not sufficient to sustain the entire household throughout the year. Most commonly, one or more male members of the household migrate for a number of months to other areas, where they may find work as labourers in the agricultural sector, mines or industry. Normally, these seasonal migrants return to their communities before the start of the flood season or cropping season to assist in the irrigation, preparation and/or planting of the fields. Especially small landowners having land with a low probability of irrigation may have to migrate each year for a number of months to other areas in search of labour, because their small landholdings cannot support their households throughout the entire year. Other landowners only have to migrate in search of labour in dry years as their landholdings produce sufficiently in normal years to sustain their households. In the spate-irrigated areas of Dera Ghazi Khan and Balochistan (Pakistan), seasonal migration is common. In Marufzai, for instance, the most common response to cope with bad years is to seek temporary employment in the coal mines around Duki or become tenants where the water source is more reliable. Poor households in Nal Dat migrate to spate-irrigated areas in Las Bela District, in particular during the harvesting season in December. (Halcrow 1993d-e)

Households having spate-irrigated land may also decide to migrate permanently when they have found permanent employment elsewhere. In Chandia, more than 25% of the landholding households live permanently in a nearby town, where most of them work as civil servants. As the existing spate irrigation system cannot support the entire community, more than half of landholding households in Marufzai have migrated permanently to other spate irrigation systems in the Anambar valley, where they work as casual labourers and in some cases as bonded tenants. (Halcrow 1993b+e)

Migration abroad is reported in spate-irrigated areas in Yemen. In Wadi Rima, much of the labour force is underemployed, if not unemployed, for most of the year as employment is limited to short seasons, principally the main harvest from October to December. As a result, a high proportion of the local population (17% of the adult males) left the country in the 1970s, mostly for Saudi Arabia, where employment opportunities are both expanding and lucrative. In the Shabwah Governorate, 10% to 25% of all extended households have a family member in the Gulf States in 2002. (KIT 2002) In the 1970s, migration from the spate-irrigated area in central Tunisia to Libya was important and many farmers in the Nouael II Project area could install shallow wells with the remittances. (Van Mazijk 1988)

Due to permanent migration, depopulation is a constant and self-reinforcing threat to the farming communities in spate irrigation systems as at a certain moment the number of landowners might be too small to reconstruct the diversion structure and to clean the flood canals in time. As a result, the diversion of sufficient spate water becomes more difficult, causing further depopulation as more landowners decide to migrate. Ultimately, the remaining farmers have to abandon the entire spate irrigation system as the critical mass for maintenance is lost, which occurred in a number of areas in the Las Bela plains in the South of Balochistan. (Van Steenberg 1997; Ahmad 2000)

4.5 Credit Facilities

Indebtedness is common in spate-irrigated areas as many farmers usually encounter serious cash deficits at certain times of the year and/or they have to make debts to survive an adverse year. Friends and relatives are usually the first source of credit for many small farmers. Shopkeepers and traders are another important source of credit as many small farmers obtain seeds on credit at the start of the cropping season. The interest charged is often very high, which reflects the risks associated with spate irrigation. In Chandia, for instance, farmers took loans for seeds from shopkeepers against a monthly interest rate of 5 to 10%, whereas farmers in Barag purchased seed on credit and paid an 80% mark-up. Farmers may also be obliged to sell their produce at low(er) prices to traders, from whom they borrowed money or products. In Chandia, farming households also buy a pair of bullocks on credit by paying the due sum after the harvest at 25% higher prices. (Halcrow 1993b-c; Hadera 2001)

In the Tihama region in Yemen, the most common form of credit is the traditional system of delayed payment, acceptable to most merchants, traders and shopkeepers. Interest is not officially charged but different price levels may be negotiated depending on the time delay in payment. Traders in expensive capital equipment, such as tractors and pumps, usually offer credit up to 2 years. Shopkeepers and merchants give credit for shorter periods. However, deposits, security and/or a reserve of capital are required for most forms of public and private credit, but this practice precludes poorer farmers from taking advantage of credit for purchase of equipment. (MOD 1977a)

Remittances from abroad could be another source of capital for households in spate-irrigated area. Due to the inherent risks of spate-irrigated agriculture and the cultivation of mainly low value crops, farmers in spate irrigation systems do not have access to formal credit facilities of banks and financial institutions. In Wadi Zabid (Yemen), only large landlords have access to credits with subsidised interest rates from the Agriculture Credit Bank, which they mainly use for the installation of tube-wells for selling ground water to smaller farmers. The latter do not have access to these cheap credit facilities as the bank requires that at least 50% of the investment shall be self-financed by the farmer. (IIP 2002)

4.6 Solidarity and Mutual Assistance Mechanisms

Traditional mechanisms of solidarity and mutual assistance still exist in the spate-irrigated areas to help people in need, struck by a calamity or during important social events (i.e. wedding). However, households facing a crop failure cannot reckon on any form of solidarity or mutual assistance from fellow villagers as it occurs frequently and affect some landowners more than others due to the location of their fields.

Among the Tigre population living in the Sheeb area of Eritrea, groups of five to ten farmers work together on a rotation basis, whereby the farmer for whom the labour is performed provides food. Labour and oxen are also mobilised to cultivate the land belonging to widows and very poor households. Furthermore, mutual self-help groups are spontaneously formed to help each other during field activities or the construction of houses. (Halcrow 1997)

In Balochistan, it is common that labour and means of production are shared to a certain extent. Although tractors gradually take over the role of draught animals, bullocks are still lent to poor villagers for a number of days without charging a rent. Farmers without seeds at the start of the cropping season may ask their fortunate neighbours to help them out. If a farmer cannot access his field or his field bunds have broken during the flood season, others will come to his aid by either irrigating the field on his behalf or assisting in the repair of the field bund. These forms of mutual assistance are more or less an insurance system, because in other years, given the unpredictability of spate irrigation, the current “haves” may be on the receiving end as they have to ask the assistance from those who they have helped this year. (Halcrow 1993a-e, Van Steenberg 1997)

The most prevalent solidarity mechanism in the rural areas of Balochistan is the Islamic duty (i.e. Zakat) to give part of the agricultural produce and livestock as alms to the needy, whereby preference is given to members of the same family or clan. The payment of Zakat may also be used to finance local religious institutions, such as the mosque or religious school. Zakat is either given in cash or kind and the prescribed amount is one-tenth of the harvest of rainfed and spate-irrigated crops, one-twentieth of the harvest of pump irrigated crops and one-fortieth to one-fifth of the livestock. However, it seems that the actual donations are usually less than the prescribed amounts and that not all landowners pay their Zakat on a regular basis. (Halcrow 1993b-e, 1998)

Another type of assistance is to allow poor persons to pick small amounts of vegetables (i.e. mustard leaves) and melons for home consumption or to collect wheat kernels left on the threshing floor. A less common practice is to give some land in usufruct to a poor relative. Furthermore, it is common that relatives and neighbours offer gifts in cash and kind during special occasions, such as birth, wedding and funeral. For instance, fellow villagers in Chandia arrange food for the first three days of the condolence period for the family facing a

death case. These forms of assistance are reciprocal and often within the own social inner circle. (Halcrow 1993b-e, 1998)

5 ROLE OF WOMEN IN LIVELIHOOD STRATEGIES

The role of women in the livelihood strategies of households in spate-irrigated areas shall not be under-estimated and under-valued as they are important actors in spate-irrigated agriculture and rearing livestock. Furthermore, women of poorer households are often engaged as wage labourers and/or they are involved in handicraft and petty sale. All domestic tasks are the exclusive responsibility of the female members of each household, including the fetching of potable water and the collection of fuel wood. Women are often members of (informal) saving groups or other self-help groups at village level.

In Shabwah Governorate (Yemen), women take care of most crop husbandry activities of food and cash crops, including the application of farmyard manure, sowing, weeding, harvesting, threshing and removing of the crop residues from the fields. Men are responsible for the maintenance of the canals and terraces, ploughing of the land with tractors, bee-keeping and the marketing of crop produces and livestock. (KIT 2002) In Wadi Zabid and Wadi Tuban, men and women undertake most tasks together, including the cleaning of small canals. The general rule is that women take on the more traditional production practices, including spate irrigation, while men specialise more in the technical aspects of modern agricultural practices. Raising livestock is considered to be the responsibility of rural women and their children. A number of women take care of cows belonging to wealthy households and they share in the cow's production, whereby the first calf will be for the woman. Although women are actively involved and often responsible for most agricultural and livestock activities, the marketing of any produce is exclusively reserved for men. (World Bank 1999, 2000a)

In the Sheeb area in Eritrea, women undertake agricultural activities, such as harvesting, threshing and transport of grains and straw. A small proportion of women is involved in petty trade, which is mainly the sale of handicraft products, such as mats and baskets, whereas a few women operate a shop. These women are usually widows, divorcees or former freedom fighters. Due to the policy of the Eritrean government, women are also active in community affairs, although the majority of men reject such activities of women outside their houses for cultural reasons. With regard to the sale or slaughter of livestock, women have little or no authority. However, the distribution of milk and meat from slaughtered animals among all household members as well as the selling of eggs are the right of the women. (Hadera 2001; Halcrow 1997; Kahsaye 2002)

In the Konso Special Wadera in Ethiopia, the role of women in agriculture is substantial. Particularly during periods of droughts when men migrate in search of employment, women undertake all agricultural activities, including the maintenance of the stone terraces and irrigation of the prepared fields. In addition, women are also involved in petty trade and sale of fuel wood. (Farm Africa 2003)

Among the Qaisrani tribe in the Dera Ghazi Khan area (Pakistan), the role of women in spate irrigation is very important as they have developed local knowledge about the intensity and magnitude of spates in their areas and skills for assessing the probability of rain occurrence. Furthermore, women are involved in supervising the irrigation process, guarding infrastructure and applying spate water at field level. (Nawaz 2002b) In the spate-irrigated

areas of Balochistan (Pakistan), almost all agricultural activities are carried out by women, except the tillage of the land. In Nal Dat, women assist the male members of their households with the supervision of the infield irrigation and the repair of minor damage to the earthen channels close to their fields during daytime. (Halcrow 1993e) Animal husbandry is predominantly the domain of women, who are responsible for cutting and transport of fodder, milking goats and cows, preparation of a variety of dairy products, taking care of sick and pregnant animals as well as the drying of dung for fuel. The grazing of animals is the responsible of men, who also purchase veterinary medicines. (Halcrow 1993b+e, 1998)

6 CONCLUSIONS

Livelihoods are built upon five assets: human capital, social capital, natural capital, physical capital and financial capital. Secure access to these five assets is essential to achieve a secure and sustainable livelihood. To cope with the unpredictability and inherent risks of spate-irrigated agriculture, whereby seasons of meagre crop production, absolute failure and relatively high production occur alternatively with no predictable pattern, households have developed different livelihood strategies to ensure a minimum standard of living, which are based on their different levels of access to the five assets.

The most common livelihood strategy of many households in spate-irrigated areas is the diversification of the household economy. In addition to a highly variable income from spate-irrigated agriculture, many households also have one or more other sources of income, in particular from livestock keeping and wage labour and to a lesser extent from the sale of handicraft products. As a result of their adopted livelihood strategies, most spate-irrigated farmers are incorporated in the regional and national economies, in particular through the sale of crop surpluses and livestock as well as the labour migration. (Van Steenberg 1997) Despite the diversification of their sources of income, most households in spate-irrigated areas are poor as their per capita income is less than US\$ 1 per day. In the Shabwah Governorate in Yemen, the annual net income ranges between US\$ 53 and US\$ 124 per capita, whereas 28% and 35% of the households in Wadi Tuban and Wadi Zabid lived below the poverty line of US\$ 203. The estimated net farm income in the Sheeb area in Eritrea is US\$ 86 per capita, while the net benefit from spate irrigation is about US\$ 35 per household member in Balochistan. The living conditions in most communities situated in spate-irrigated areas are poor as they lack basic amenities, such as potable water and sanitation facilities, electricity and health care. High infant mortality due to malnutrition among children and pregnant women is evident in most villages as well as anaemia, malaria and other health problems.

The main features of these three main sources of income for households in spate-irrigated areas are presented below.

Spate-Irrigated Agriculture

- The cropping pattern in spate-irrigated areas is dominated by the cultivation of traditional, drought-resistant crops, such as sorghum, wheat, pulses, oilseeds, cotton and melons.
- Most farmers only plant local, self-selected seed varieties, which are often well adapted to the local agro-climatic circumstances, although this practice may cause various problems, such as increased vulnerability for diseases.

- Many farmers do not apply (chemical) fertilisers, pesticides and insecticides as they cannot afford the use of these inputs and they believe that their crops receive sufficient nutrients from the sediments deposited during each irrigation.
- Research and extension services are not directed towards spate-irrigated agriculture, so that it is very difficult for farmers to enhance the yields of their spate-irrigated crops by applying improved crop husbandry techniques.
- Many small farmers growing spate-irrigated crops do not have access to (subsidised) credits from banks and financial institutions as they are unable to fulfil the conditions for acquiring loans. As a result, many small farmers have to rely on other sources of credit, such as moneylenders and traders, who charge high interest rates.
- The distribution of arable land in spate-irrigated areas may vary from relatively egalitarian to very unequal, whereby most of the land is owned by a few very large landholders.
- It is common in many spate-irrigated areas that a substantial proportion of land is cultivated by sharecroppers and to lesser extent by tenants.
- In general, women play an important role in spate-irrigated agriculture as they are involved in almost all crop husbandry activities, including sowing, weeding, harvesting, threshing and storage. Reportedly, women in some spate irrigated areas in Yemen, Pakistan and Ethiopia are also involved in the irrigation of fields as well as the maintenance of field channels.
- Most farming households try to keep the input of labour as minimal as possible, whereby mainly family labour is used.
- Most farmers in spate irrigation systems only cultivate small areas of less than 1 ha to not more than 8 ha.
- In years with normal floods, the average yields for sorghum range between 600 to 2,000 kg/ha in Yemen and Eritrea, while the average yields of millet and cotton vary from 600 to 1,500 kg/ha and 650 to 1,600 kg/ha respectively in Yemen. The average yields in Balochistan (Pakistan) are significantly lower than in Yemen and Eritrea.
- Even in years with normal floods, most farmers do not produce enough to feed their households throughout the entire year. Only in (very) good years, a majority of farmers is able to sell any crop surpluses.

Risk Coping Strategies

To reduce the risks of crop failure due to the unpredictability of spate irrigation, farmers have adopted a number of the following strategies:

- Actually spate-irrigated fields are distributed annually among all households with land rights.
- Households have different plots of land with high and low probabilities of spate irrigation.
- Cultivation of traditional crops, such as sorghum, which would produce at least sufficient fodder in years with less floods.
- Crop rotation, whereby fields are left fallow during one season, in order to reduce the loss of soil fertility.
- Changing of sowing dates to control the outbreaks of pests and attacks by birds.
- Intercropping, whereby two or three different crops with different water requirements and harvesting dates are planted in the same field, so that at least one crop could be harvested in a dry year.
- Crop choice is determined by the timing of the first irrigation.

- Use of ground water as an alternative source for irrigation.

Livestock Keeping

- Most households in spate-irrigated households keep livestock for various important functions, such as traction and transport as well as sources of food items, such as dairy products, meat, wool, dung and skins, which are mainly used for home consumption but also sold to raise cash. Furthermore, small ruminants and oxen are important savings, which are sold to cope with crisis situations.
- Oxen still play an important role in the maintenance and repair of irrigation infrastructure and field bunds, although its role is gradually taken over by tractors.
- Almost all activities related to raising livestock are considered to be the responsibility of women and their children.
- The composition and number of livestock owned by households in spate-irrigated areas reflects their needs (i.e. traction, transport, food) as well as the availability of forage (i.e. rangeland, fodder crops).
- Beekeeping could be another important source of income for households in spate-irrigated areas.

Wage Labour and Off-Farm Income

- Income from wage labour is often an important source of income for many households in spate-irrigated areas, especially for households with no or limited access to land or whose fields could not be irrigated.
- Household members can find wage labour either in their own communities or they have to migrate temporarily to other areas in search of employment.
- Most households earn an additional income as agricultural labourers, especially during the harvesting season, whereby they often paid in kind (i.e. fixed portion of harvested crop).
- The sale of (fuel) wood and handicraft products may be an additional source of income as well.

6.1 Threats to Livelihoods in Spate-Irrigated Areas

The existing livelihood strategies based on the cultivation of spate-irrigated crops in combination with additional incomes from livestock and wage labour are undermined by a number of developments:

- The importance of spate-irrigated agriculture as a source of income for many households diminishes as the average size of their landholdings decreases due to further sub-division through inheritance.
- As more landowners install their own wells to become less dependent upon spate water for the irrigation of their fields and the gradual depopulation of communities as a result of permanent migration, the remaining farmers are often unable to mobilise sufficient labour and draught animals for the (timely) reconstruction of the diversion structure and the cleaning of the flood canals. The result will be that the diversion of spate water to their fields becomes more difficult and more landowners have to give up spate-irrigated agriculture, who may also decide to migrate elsewhere in search of

other sources of income. Finally, the spate irrigation system ceases to function as the capacity to maintain the irrigation infrastructure is lost.

- The modernisation of spate irrigation systems, whereby the traditional diversion structures are replaced by a concrete weir, has often had a detrimental impact for farmers in the middle and tail sections as it has become easier for upstream water users to divert more if not all spate water to their fields despite existing rules regarding the allocation and distribution of spate water. For instance, spate water only reached the downstream sections of Wadi Al'Ain/Harib in Yemen during large floods following the construction of two weirs in the head reach, whereas the spate-irrigated area in the upstream section increased by 300%. (Kohler 1999) The same problems are also reported in the Nouael II Project in Tunisia as well as in Wadi Tuban, Wadi Zabid and Wadi Mawr in Yemen.
- Degradation and/or widening of the riverbed may progress to such an extent that farmers are unable to (re)construct diversion structures that are high and/or long enough to divert spate water into their flood canals. Uncontrolled cutting of trees and bushes as well as overgrazing in and along the riverbed may accelerate this natural process.
- Due to the installation of an increasing number of dug- and tube-wells as a risk coping strategy to become less dependent upon the unpredictable supply of spate water for irrigation purposes, the ground water table in many spate-irrigated areas is falling rapidly. The result is that older and shallower wells dry up, the quality of the ground water deteriorates and an increasing number of fields are abandoned due to desertification. Ultimately, the population of entire villages may have not other choice than to migrate permanently as they have lost a secure access to potable water and/or arable land.
- **ANNEX A**
- **Table 1: Total Irrigated Area and Spate-irrigated Area for Number of Countries**

Country	Year	Total Irrigated Area (ha)	Spate-irrigated Area (ha)	Spate Irrigation as % of Total Irrigation
Algeria	1992	555,500	110,000	19.8
	1997/1987	560,000	70,000	12.5
Eritrea	1993	28,124	15,630	55.6
	1997/1995	28,000	14,000	50.0
Kazakhstan	1993	3,556,400	1,104,600	31.1
Libya	1997/1987	470,000	53,000	11.3
Mongolia	1993	84,300	27,000	32.0
Morocco	1989	1,258,200	165,000	13.1
Pakistan	1990	15,729,448	1,402,448	8.9
	1997/1987	17,580,000	1,450,000	8.2
Somalia	1984	200,000	150,000	75.0
	1997/1987	200,000	2,000	1.1
Sudan	1995	1,946,200	46,200	2.4
	1997/1987	1,946,000	280,000	14.4
Tunisia	1991	385,000	30,000	7.8
	1997/1987	380,000	10,000	2.6
Yemen	1994	481,520	98,320	20.4

	1976/77	238,000	120,000	50.4
	1990	436,500	101,000	23.1
	1997/1987	485,000	193,000	39.8

- Source: FAO Aquastat; Hadera 2001; Kohler 1999
- **Table 2:** List of Spate Irrigation Systems

Country	Name of Spate Irrigation System	Location
Pakistan	Chandia	Sibi District, Balochistan
	Barag	Las Bela District, Balochistan
	Marufzai	Loralai District, Balochistan
	Nal Dat	Khuzdar District, Balochistan
	Toiwar	Killa Saifullah District, Balochistan
	Mouza Yo Bund	Las Bela District, Balochistan
	Dudar	Musa Khel District, Balochistan
	Sohar Khor	Musa Khel District, Balochistan
	Sham	Musa Khel District, Balochistan
	Jhalwani	Barkhan District, Balochistan
	11 collective bunds in Korakan River	Kharan District, , Balochistan
	Jala Khan Dam	Kachhi District, , Balochistan
	Sonwah Dam	Kachhi District, Balochistan
	Pachhaad and Damaan Plains	DG Khan District, Punjab
Yemen	Wadi Tuban	Lahej Governorate
	Wadi Zabid	Hodeidah Governorate
	Wadi Rima	Hodeidah Governorate
	Wadi Mawr	Hodeidah Governorate
	Wadi Al'Ain/Harib	Central Yemen
	Wadi Jirdan, Wadi Erma, Wadi Dhuhur	Central-Northern Area, Shabwah Governorate
	Wadi Mayfa'a, Wadi Nisab, Wadi Beihan	Central Region, Shabwah Governorate
Eritrea	Wadi Laba	Sheeb area, Eastern Lowlands
	Mai Ule	Sheeb area, Eastern Lowlands
	Wadi Labka	Sheeb area, Eastern Lowlands
Ethiopia	Arfaydelehayte	Midlands, Konso Special Wadera
	Yandafero	Lowlands, Konso Special Wadera
Tunisia	Nouael II Project/Wadi El Fekka	Sidi Bouzid, Central Tunisia

- **Table 3:** Cropping Patterns in Spate Irrigation Systems

Country	Scheme/Area	Spate-irrigated Crops
Eritrea	Sheeb	sorghum, maize, millet, sesame, groundnut, vegetables
Ethiopia	Konso: Midlands	sorghum, maize, teff, beans
	Konso: Lowlands	sorghum, maize, cotton, sunflower

Pakistan	DG Khan Division	wheat, gram, guar, pulses, sorghum, rapeseed, millet, maize
	Korakan River	wheat, cumin, sorghum, pulses, melon
	Chandia	sorghum fodder, mung, wheat, oilseeds, coriander, radish, melon, mustard
	Barag	sorghum, guar, sorghum fodder, oilseed, mung
	Marufzai	sorghum, pulses, wheat, melons, cumin, coriander
	Nal Dat	sorghum, guar fodder, pulses, wheat, oilseed
	Toiwar	wheat, barley, mash, maize
Tunisia	Nouael II Project	wheat, olive, almond
Yemen	Shabwah Governorate	sorghum, millet, wheat, sesame
	Wadi Tuban	cotton, fodder (sorghum, millet), sesame
	Wadi Zabid	sorghum, millet, fodder (sorghum, millet), cotton, sesame
	Wadi Mawr	sorghum, millet, sesame, maize, cotton, melon
	Highlands	sorghum, wheat, lentils, peas, maize
	Tihama	sorghum, millet, maize, cotton, sesame, tomato, vegetables
	Southern coast	cotton, sorghum, millet, sesame, watermelon, groundnut

- **Table 4:** Average Yields for Perennially, Regularly and Irregularly Spate-Irrigated Area in Wadi Rima

Crop	Perennially Spate-Irrigated Area	Regularly Spate-Irrigated Area	Irregularly Spate-Irrigated Area
	(t/ha)	(t/ha)	(t/ha)
Maize	1.2 - 1.3	1.2	-
Sayf Sorghum:	1.0	0.8 - 1.0	0.6
- grain	3.2	1.9 - 2.3	2.0
- fodder			
Sorghum:	1.4	0.4 - 1.1	0.85
- grain	3.5	1.0 - 2.8	2.2
- fodder			
Sorghum ratoon:	0.8	0.3 - 0.8	0.2
- grain	2.5	1.0 - 2.5	1.1
- fodder			
Cotton	0.85	0.35 - 0.85	0.35
Millet	-	0.5 - 1.0	0.5
Sesame	-	0.2 - 0.5	0.2

- Source: MOD 1977a
- **References**
- Ahmad, S. (1998):
Land Tenure and Water Rights in Isolated Spate Irrigation Systems in Balochistan, Pakistan; WRI/ICARDA

- Ahmad, S. (2000):
Indigenous Water Harvesting Systems in Pakistan; WRRI-NARC, Islamabad
- Al-Eryani, M. & Al-Amrani, M (1998)
Social and Organisational Aspects of the O&M of Spate Irrigation Systems in Yemen, Background Paper for PIM Seminar (Hudaidah, November 1998), World Bank
- Al-Garoo, A.S. (1987):
Historic Review of Spate Irrigation and its Effect on Agricultural Development. In: Spate Irrigation, Proceedings of the Sub-Regional Expert Consultation on Wadi Development for Agriculture in Yemen (Aden, December 1987), FAO/UNDP
- Al-Shaybani, S.R. (2003):
Overview of Non-Modernised Spate Irrigation Systems in Yemen
- Arcadis Euroconsult (2002a):
Water Management in Wadi Tuban and Wadi Zabid, Working Paper 1; Irrigation Improvement Project, Sana'a
- Arcadis Euroconsult (2002b):
Water Right and Irrigation Management in Wadi Tuban and Wadi Zabid, Internal Memo, Irrigation Improvement Project, Sana'a
- BRSP (19??):
Natural Resources Development Scheme under Pak-German Self-Help Project 1984-1990
- Camacho, R.F. (1987):
Traditional Spate Irrigation and Wadi Development Schemes. In: Spate Irrigation, Proceedings of the Sub-Regional Expert Consultation on Wadi Development for Agriculture in Yemen (Aden, December 1987), FAO/UNDP
- DFID (1999)
Sustainable Livelihoods Guidance Sheets
- DHV Consulting Engineers (1979):
Wadi Rima Irrigation Development; Feasibility Study, Volume 1 Main Report
- Farm Africa (2003):
Spate Irrigation in Konso Special Wadera
- Hadera, M. T. (2001):
Soil and Water Management in Spate Irrigation Systems in Eritrea; Tropical Resource Management Papers 36, Wageningen
- Hag Nur, A. & H. Abdi Mah (1987):
Spate Irrigation in Somalia. In: Spate Irrigation, Proceedings of the Sub-Regional Expert Consultation on Wadi Development for Agriculture in Yemen (Aden, December 1987), FAO/UNDP
- Halcrow (1993a):
Flood Irrigation in Balochistan, Internal Memo; BMIADP, Quetta
- Halcrow (1993b):
Chandia, Feasibility Study 1, Volume 1 – Main Report; BMIADP, Quetta
- Halcrow (1993c):
Barag, Feasibility Study 2, Volume 1 – Main Report; BMIADP, Quetta
- Halcrow (1993d):
Marufzai, Feasibility Study 3, Volume 1 – Main Report; BMIADP, Quetta
- Halcrow (1993e):
Nal Dat, Feasibility Study 4, Volume 1 – Main Report; BMIADP, Quetta
- Halcrow (1993f):
Mouza Yo Bund, Field Visit Report; BMIADP, Quetta

- Halcrow (1994):
Korakan Flood Irrigation Study, Internal Memo; BMIADP, Quetta
- Halcrow (1997):
Strategy on Farmer Participation and Formation of Farmer Organisation; ELWDP, Asmara
- Halcrow (1998):
Toiwar, Feasibility Report F-05; BCIAP, Quetta
- IIP (2002):
Socio-Economic Household Baseline Survey and Focus Group Discussions in Wadi Zabid and Wadi Tuban
- Kabsaye, W. (2002):
The Cultural Ecology of Pastoralism in Eritrea – A Geographical Inquiry
- KIT (2002):
Economic Opportunities in Shabwah, Improving People's Livelihoods by Sustainable Economic Development; SBDP, Ataq
- Kohler, S. (1999):
Institutionen in der Bewässerungs-Landwirtschaft im Jemen, Jemen-Studies Band 13, Wiesbaden
- Ministry of Overseas Development (MOD) (1997a)
Montane Plains and Wadi Rima Project; Land and Water Resources Survey, Irrigation and Agricultural Development in Wadi Rima, Volume 1
- Ministry of Overseas Development(MOD) (1997b)
Montane Plains and Wadi Rima Project; Land and Water Resources Survey, Irrigation and Agricultural Development in Wadi Rima, Volume 2
- Moustafa, A.T.A., A.A. El-Meligy and M.AA. Allam (1987)
Spate Irrigation in Egypt. In: Spate Irrigation, Proceedings of the Sub-Regional Expert Consultation on Wadi Development for Agriculture in Yemen (Aden, December 1987), FAO/UNDP
- Mu'Allem, Ab. S. (1987):
Crop Production under Spate Irrigation in Coastal Areas of PDR Yemen. In: Spate Irrigation, Proceedings of the Sub-Regional Expert Consultation on Wadi Development for Agriculture in Yemen (Aden, December 1987), FAO/UNDP
- Nawaz, K. (2002a):
Spate Irrigation Systems in Pakistan – An Alternative to Present Crises (draft)
- Nawaz, K. (2002b):
Traditional Flood Irrigation Systems in Pakistan
- Nawaz, K. (2003):
Spate Irrigation in Dera Ghazi Khan (draft)
- Scheitz, E.L. (1987):
Certain Aspects and Problems of Wadi Development. In: Spate Irrigation, Proceedings of the Sub-Regional Expert Consultation on Wadi Development for Agriculture in Yemen (Aden, December 1987), FAO/UNDP
- Shahin, F.A.R. (1990):
Wadi Mawr Project – Short Study on Water Regulation and Distribution, draft report
- Tihama Development Authority (1987)
Wadi Development for Agriculture in Yemen Arab Republic. In: Spate Irrigation, Proceedings of the Sub-Regional Expert Consultation on Wadi Development for Agriculture in Yemen (Aden, December 1987), FAO/UNDP

- Van Mazijk, R. and S. Sheer (1988)
Irrigatie in Tunesie, een overheidsinterventie in een traditioneel irrigatiesysteem beschouwd vanuit een interfaceperspectief; LUW; Wageningen
- Van Steenbergen, F. (1997):
Institutional Change in Local Water Resource Management: Cases from Balochistan; Netherlands Geographical Studies, Utrecht
- Van Steenbergen, F. (1998):
Organised Farmers; Spate Irrigation in Balochistan
- Varisco, D.M. (1983): Sayl and Ghayl:
The Ecology of Water Allocation in Yemen
- VBB Viak – NESPAK (1995):
Conservation and Development of Land and Water Resources in Upper Kaha Hill Torrent Watershed – Watershed Management Plan, Volume III – Socio-Economic Profile, Federal Flood Commission of Ministry of Water and Power
- Wilkinson, T.J (200?):
Agriculture and the Countryside.
- World Bank (1999):
Preparation Study Report - Wadi Tuban Phase I; Spate Irrigation Improvement Project
- World Bank (2000):
Project Preparation Report, Annex G – Social Assessment; Irrigation Improvement Project
- World Bank (2000)
Project Appraisal Document; Irrigation Improvement Project
- Zaqluel, L. (1987):
Spate Irrigation in Morocco. In: Spate Irrigation, Proceedings of the Sub-Regional Expert Consultation on Wadi Development for Agriculture in Yemen (Aden, December 1987), FAO/UNDP