The potential for aquaculture development in Afghanistan
The Potential for Aquaculture Development in Afghanistan

Based on the work of

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About this document

This review was requested as part of an ongoing activity of the two FAO projects “Alternative Agricultural livelihoods Programme” (AALP - GCP/AFG/036/UK) and “Development of sustainable agricultural livelihoods in Eastern Hazarajat” (SALEH - GCP/AFG/029/UK). The projects have identified the interest in the potential for fish culture activities in the provinces of Balkh and Bamyen and required a technical feasibility mission to establish the likely potential and the feasibility of establishing aquaculture activities in the two provinces. The projects further requested the development of some technical material relating possible methods for establishment of pilot culture activities and training with farming households or community groups in the target areas.
1. INTRODUCTION

A number of sector reviews, project documents and proposed development initiatives have suggested the feasibility of aquaculture in Afghanistan. There are however, relatively few concrete examples of sustainable aquaculture to be found in the country and therefore the technical and economic feasibility of aquaculture remains uncertain. There is limited documented information available although there have been a number of FAO reviews and some documents relating to previous aquaculture initiatives.

The purpose of this discussion paper is to identify some of the key constraints and actions needed to initiate aquaculture development in Afghanistan. The paper will also propose some immediate initiatives which could lay the groundwork for such a development. It is not intended to answer all the questions, but rather to raise issues and initiate a debate that could encourage potential stakeholders to agree and act on the next steps to expand aquaculture in the country.

1.1 PREVIOUS AQUACULTURE INTERVENTIONS

A number of sector reviews, project documents and proposed development initiatives have documented the demonstrated feasibility of aquaculture in Afghanistan, and one even went so far as to suggest good potential. There is limited historic documented information on aquaculture and fisheries in Afghanistan, however there have been a number of FAO reviews and there are some documents relating to previous aquaculture initiatives and relevant parts of these are copied or paraphrased below.

1.2 QARGHA DAM TROUT HATCHERY

In 1967 a trout fish hatchery was established at Qargha Dam, about 15 km from Kabul. The dam, constructed across the River Paghman, created a water reservoir of about 50 km². The hatchery was supplied with water from this reservoir. In the 1970s it was producing about 30,000 trout fingerlings, which were stocked into the Qargha Reservoir and the rivers Panjsher, Bamian, Salang and Sarde (ElZarka, 1973). The stocking of the reservoir was done largely for licensed sport fishing. In the 1970s a second trout hatchery was located near the town of Paghman, west of Kabul. In 1987, assistance was provided by the UNDP/FAO to rehabilitate the Qargha Fish Farm near Kabul. During 1988-89 supplies of spring water were restored, egg incubators repaired and fitted with new egg trays, and the hatchery brought back into production. The intention was to produce fish to market size in floating cages moored in the adjacent Qargha Reservoir.

Concrete raceways next to the farm were also brought back into usable condition. Rainbow trout were grown from eyed eggs imported from Denmark in 1988, and by 1989 six tons of fingerlings were produced. The deteriorating security situation in 1989 interfered with a successful completion of the project, with much of the trout production being stolen or sold underweight. Only 3 tons were sold, against a target of 10 tons. Nevertheless, the project demonstrated the technical feasibility of culturing rainbow trout at Qargha fish farm (FAO, 1990).

The Qargha fish farm has recently been rehabilitated.
1.3 DARUNTA FISH HATCHERY (JALALABAD)

At the same time a warmwater fish farm was located alongside Darunta, Jalalabad 150 km east of Kabul. This hatchery was completed in 1966 with the assistance of China, and China also provided technical assistance until 1972. Darunta fish farm was producing fingerlings of four carp species (grass, silver, common, and bighead). The fingerlings were stocked into Darunta Reservoir, and resulted in the production of 144.2 t of fish over the period of 1967-1973, with 30 t captured in 1973 (El Zarka). At that time there were 41 fishermen harvesting the reservoir fish. Management of fish stocks in the reservoir faced several problems, such as escape of fish during floods over the flood controlling gates, and the presence of dense aquatic vegetation. By 1973 a decline in catches was also observed.

Nevertheless, it was believed that reservoirs would be important for the future development of inland fisheries. At that time, apart from Darunta, four other reservoirs were situated in not too great a distance from Kabul: Neghlo, Soroby, Arghandab and Kajaki. Kajaki Reservoir was considered to have more favourable conditions for fish production than Arghandab Reservoir, which was considered too oligotrophic, and also subject to drastic drawdown. In 1992 Darunta Dam was seriously damaged in the war.

Darunta fish farm is currently leased by the government to a private sector operator.

1.4 CONCLUSIONS

These early projects demonstrated the feasibility of culture of Rainbow trout and warmwater carp in the Kabul area and in the surrounding low lying provinces. It is not clear from these reports how successful the stocking activities into natural waters were as this coincided with the conflict era and thus monitoring of the results was not possible.

These early initiatives demonstrate the physical feasibility in one part of the country and only the conceptual potential of aquaculture and restocking of rivers and reservoirs. The actual feasibility to implement and the attendant management and social issues have not been adequately explored and thus the potential of aquaculture and fisheries restocking have yet to be characterize in terms of its real potential and for whom.

This report will attempt to put aquaculture potential and fisheries restocking more into the context of the current situation and provide at least some guidance to enable readers to draw their own conclusions regarding the likely potential in different parts of the country. More recent news indicates a continuing belief in the potential of aquaculture as a means to enhance income generation.

2. TYPES OF AQUACULTURE

Aquaculture is a very diverse activity which allows it to be quite flexible adapted to the needs of the farmer. Typically, more rural types of aquaculture will be highly integrated into a more diverse farming strategy and be only one component of a farming livelihood. Specialization follows amongst some households which have strong comparative advantage or which are more entrepreneurially inclined.
In the case of Afghanistan aquaculture can be divided into two types of potential system: peri-urban aquaculture and rural aquaculture. The terms merely relate to the degree of connectivity to towns/cities and their markets. Aquaculture often arises initially around urban areas due to the presence of a number of enabling features and reliable demand. The demand and cash economy aspects mean that investment in production (i.e. purchase of feeds and fingerlings) is covered by the income from the sale of fish. This is not always guaranteed in rural aquaculture where home consumption of fish and lower prices may mean that investment in the activity is constrained.

### 2.1 Balkh Province

Most of the farmers visited had obtained fingerlings from trapping wild species and had placed them in ponds for ongrowing. This is a trial activity for most the people contacted. The commonest species encountered was the Zhagara (another species which seems to be varyingly identified – a riverine barbel or carp). It is clear from visiting these operations that feeding is undertaken on a very ad hoc basis and is based mostly around scattering some bread or cracked wheat or other on-farm available feed. In the most organized operation there was feeding of Alfalfa and other inputs from around the farm. All of the farmers talked to were not particularly aware of the need to feed their fish and responded that they did not know what to feed nor how much to give.

The Zhagara species also seems to be able to breed in ponds and, although farmers mentioned that they did not get many large fish, there were indications that fingerlings had been produced though natural breeding in the ponds. This species is probably a good candidate for aquaculture – it is able to breed in ponds and is obviously tolerant to cold weather (It was the species on the Chahar Kint mountain pond and had survived and bred there over the past two years). It is appreciated by the people of Balkh although it is not particularly high priced.

Some farmers had stocked the snakehead fish (*Channa* spp. local name Mar Mahi). This is highly carnivorous and must be kept separate from other species. It will also require a high protein type feed (e.g. animal slaughter wastes). Growth rates in ponds without feeding will be slow and specialized feeding for this species needs to be taught. However, the species is also highly
tolerant of ponds and low dissolved oxygen. It can be fed on a tray with a mashed feed; a mixture of bran wheat, blood, offal, intestines, cotton seed cake, flour, bread etc. The mixture is put through a mincer twice and extruded into a crude pellet. This can be fed as a paste or semi-dried, or fully sun dried and fed dry. The same sort of feed can also be given to common carp, Zhagara and even the Lakha Mahi (Wels catfish).

2.2 BAMYAN PROVINCE

Bamyan province is one of the poorest in Afghanistan with its harsh climate and mountainous topography. The rural livelihood is characterised by single cropping (of wheat or potatoes) and herding of livestock on upland and lowland pasture. Cash incomes are low and are in the range of $200-400 per family per year. This means that additional income generating activities are welcomed especially if they can be fitted into the existing agricultural livelihood without undue additional costs or exposure to risk.

There as two key fish species found in the province – the Brown trout (Khol mahi, Salmo trutta or sub species Mahi e kholdhar Salmo trutta oxenesus) and a yellow - coloured indigenous fish (which appears to be a loach species possibly Nemacheilus spp.) which is found in some of the lakes and is prized. The large lake (Band i Amir) in the province also contains fish but their capture has been prohibited by the government. However, it has been mentioned that fish from the lake are still caught and sold on occasion. There was an anecdotal comment that a predatory fish had been introduced, name unknown, that was believed to be preying on the other fish in the lake).

The above descriptions are rather general but several potential sites were observed which had all the right characteristics for aquaculture (i.e. water supply, willingness to convert, uncontested land ownership). This means that there are enough suitable sites to initiate pilot level activities with a number of individuals which is enough to demonstrate the feasibility of fish culture and act as some initial training sites for other interested communities.

Manufacturing of on-farm feeds is considered to be viable for farmers willing to invest the time and effort. This would need to be undertaken on pilot level basis initially to work out the management requirements for the collection, manufacture and feeding of on farm feeds.

The system which seems to have the most potential is a short season arrangement where relatively shallow ponds are stocked with fingerlings (preferable at an advanced stage to capitalize on the 4.5-5 months of warm weather in the province. There is also potential for longer terms culture of rainbow trout. However the only fish farm in the province only grows for a short period to avoid the expense of maintenance feeding through the winter (during which time trout do not grow significantly).

3. SPECIES OPTIONS

3.1 CARP AND BARBEL SPECIES

In some provinces the silver carp is the species of choice. This species needs warm water conditions for growth but will grow in greenwater systems and requires no supplemental feeding. This is the species currently cultured in provinces surrounding Kabul and is also imported from Pakistan, even reaching Mazar in Balkh Province.
The candidate species for seasonal pond culture is the common carp which is available from neighbouring countries and has been introduced to Afghanistan. This species can tolerate cold seasons although this has yet to be proven in practice under the extreme condition of Bamyan province. The common carp is also known for its ability to colonize and establish and its potential ability to be an invasive species or to displace native species. In the situation of Bamyan where the common carp would be introduced to small ponds adjoining snow melt rivers, the risk of establishment is considered negligible as the riverine environment is too cold and quite unsuitable for the common carp. However, caution should be exercised near to lakes where the carp may be able to establish and might impact native fish populations.

The Zhagara already mentioned from Balkh province, may also be a potential candidate for seasonal pond culture and appears to tolerate the cold, so could be over-wintered and bred in ponds.

The price of Shir Mahi also makes this an interesting candidate for aquaculture if commercial hatchery breeding could be established.

### 3.2 TROUT SPECIES

The rainbow trout has been introduced to Afghanistan before but has not established in the wild (unlike the brown trout which has established and is know from several rivers in Afghanistan (including Bamyan). This species is suitable for culture and is already being produced in the province (using imported eggs and imported feeds), however water temperatures are rather low and growth is perhaps slower than desired. This means that the fish are marketed quite small (200g), but this is accepted by the local market (the price is also quite good ~300 Af's/kg or $6/kg). The intention is to produce fish to supply Kabul. However in order to do this, the size of the fish may need to be larger. Trout operations also lend themselves to riverside restaurants where customers pay a premium for the fish plus the cost of cooking - which can make the culture operation quite viable despite the cost of feeds and the importation of the eggs.

### 3.3 OTHER CARNIVOROUS SPECIES

There are several carnivorous species which could be viable alternatives to trout. They do not have many bones and flesh quality is good. These are the snakeheads and catfish species (Channidae and Siluridae/Clariidae). There are two native Channa species (Channa gachua, Channa punctatus) which might have potential for aquaculture. The breeding of snakeheads is relatively straightforward and is well developed in Southeast Asia where they are valued.

Coldwater Silurid catfish (Wels) and other indigenous catfish species (Bagrid, Sisorid catfish) are prized in northern Afghanistan and are sold around the country. Hatchery production of these species might be possible once sufficient demand has developed.

It is still worthwhile considering these indigenous species before assuming that importation and introduction of alien species should be undertaken.

### 3.4 OTHER COLDWATER SPECIES

The Tor and Schizothorax species are currently of increasing interest for culture in coldwater areas of Pakistan, India, Nepal and elsewhere. These species are also present in Afghanistan, but,
since no source of fingerlings is currently available, there is no opportunity for extension to farmers. However, the hatchery techniques for these species are being developed and in the longer term they may form a viable or even preferable alternative to trout (note that these species would have local acceptability but not with the expatriate community due to their boniness).

The indigenous loach species of Bamyan province is another interesting species which may be cultured if attention were paid to its breeding and biology. This group could be considered a research challenge for the moment, but one which could be communicated more widely.

4. AQUACULTURE DEVELOPMENT

What is needed to make aquaculture ‘work’?

As with any other livestock production activity, aquaculture relies on a variety of factors which are essential in some quantity to enable the activity to be pursued successfully. In the case of Afghanistan these priority features can be listed as follows:

- Interest to try aquaculture
- Access to fingerlings
- Market demand
- Right environment (esp. temperature)
- Access to land
- Available water and access to water
- Access to investment
- Availability of feeds
- Knowledge and skills

Different systems require these factors in different proportions, which is what makes generalizing about aquaculture feasibility rather difficult. However, it can be said that if any of these factors are absent or incorrect, aquaculture is unlikely to be successful or sustained. It is possible in some cases to ‘engineer around’ a constraint if there is an inadequate level of one of the factors e.g.:

- heating water in low temperature areas (or use of warmer spring water)
- recirculating water where supply is limited
- intensifying production where land or water surface is limited

However the increased costs and technological and management requirements will typically mean that the aquaculture activity is not suited to start up situations and may also be economically unattractive (or at least require high investment and have significant risk of failure).
Other factors, which can be resolved through intervention and may not require significant investment, will however require facilitation or intervention by the state or development initiatives – good examples are:

- Lack of knowledge and skills - can be overcome through training and hands-on experience
- Investment – enabling access to loans or provision of appropriate subsidies/incentives
- Access to land - can be leased or provided by state
- Access to water can be negotiated or paid for (e.g. irrigation water or abstraction consents)

5. INTEREST TO UNDERTAKE AQUACULTURE

The issue of “interest to undertake aquaculture” needs to be treated separately. This is because interest to undertake aquaculture may derive from a person or group of people who, having observed/experienced a successful aquaculture operation:

- realize that they have similar assets and abilities and could therefore also start fish culture operations (willing and able)
- wish to also have similar benefits from this, but are limited by the lack of one or more critical assets/abilities to do this (willing but constrained)
- Lacking many or most of the critical assets and abilities (willing but unable)

As with any new livelihood strategy, the poorest and most risk averse are least likely to be able to adopt and, although they may express interest, are unlikely to be able to sustain the activity and will be heavily reliant on external facilitation and/or drivers (such as fingerling supplies, assistance with feeds, credit/subsidies, pond construction, training). Even if all of these are put in place, the activity will be vulnerable and typically unsustainable after the support is withdrawn.

It is possible to adapt systems to be lower risk, lower input intensive and more suitable for poorer farmers and this report will try to indicate this where possible.

In Balkh province, there is interest to engage in fish aquaculture as a result of familiarity with fish and good prices; however there is a complete lack of experience in the province. This means that there is considerable inertia to overcome to start fish culture as a livelihood activity. There are essentially no existing aquaculture operations which would be adequate demonstrations as they are currently operated. There is no trained capacity within the provincial extensions services and within country rather limited aquaculture technical experience. Importation of fingerlings and feeds means that there is little drive to develop national capacity although there seems s to be a national drive on to develop fish culture further. There is certainly an opportunity for stimulating some entrepreneur level aquaculture and particularly developing fingerling production. Linking fingerling production to some basic training in pond production is a quick start up technique to develop interest and basic farmer capacity in simple fish culture techniques. It is also worth noting that in Mazar at least there are also some small ponds within household compounds which may be suitable for fish nursing or fish culture and which could be an activity engaged in by women. The opportunity to involve women in fingerling production or nursing within household compounds should not be overlooked and could be included in any second phase activities or training in fingerling production and nursing. Specialized tailored training for the women would be required but would also most certainly pay off.
Apparently several organizations and NGOs have come to Balkh and enquired about aquaculture feasibility, but it appears that no further action was taken and there were no subsequent projects developed. None of the governmental organizations and NGOs group have promoted the aquaculture in Balkh province.

Bamyan province has had a previous history with aquaculture in small ponds. Up to the Russian occupation era, there were several communities which practiced the stocking of small ponds with river fish. This practice died out during the Russian period and ex-migration and emphasis on arable crops meant that the skills and knowledge were largely lost. Returning inhabitants have brought back some memory of this but do not have the original skills and practice. There is however an interest to rekindle fish culture and fish eating is also practiced in some communities where they have access to fish. Equally returnees who have spent time in Pakistan and Iran have also brought with them the knowledge of the potential of aquaculture, some skills and an interest to pursue this in Bamyan.

6. DEMAND FOR FISH AND FISH MARKETING

“No fish is better than bad fish…….”

Aquaculture thrives in an environment where there is strong market demand. Lessons from elsewhere show that aquaculture develops slowly where there is a thriving wild fishery or where there is limited preference for fish. In this respect it is worth looking at the situation in Afghanistan from the perspective of existing demand and the likelihood of increase.

From a short mission it is only possible to gain ‘snapshot impressions’ and it is recommended that a fuller study of fish marketing and demand is undertaken in Afghanistan. The urban markets of Kabul and Herat represent reasonably large urban populations and are characterized by their proximity to neighbouring countries and access to fish from them. Fish demand is difficult to assess and from available information and two key informant interviews the following picture emerges.

6.1 KABUL CITY

Demand is unrecorded but there are reports of the import of fish to Kabul from Pakistan. Herat-based fish traders mentioned that they had been requested to provide (significant quantities of) fish to Kabul. This suggests that there is a reasonably healthy demand in Kabul which could be satisfied by local production. Importantly, it is worth knowing when this demand exists and for which part of the population.

Previous projects have targeted the ex-patriate community, which is hardly a sustainable strategy, although may provide a small but reasonably reliable market for the interim. It is perhaps worth looking more closely at the domestic demand in Kabul as this would give a better impression of the likely marketability of lower priced poorer quality aquaculture products (the likely product of start-up aquaculture ventures in the country - quality productions only emerge at a later stage).

Indications for market prices show that fish is approximately the same price as chicken indicating ambivalent preference for fish over other forms of meat (~$2/kg). Goat and beef command higher prices. This is therefore an indicator that high prices for fish are probably exceptional and relate
to rather specific niche markets and are not representative. This therefore also suggests that the expansion of this market may not be that likely.

It should be noted that there is a recreational activity in Kabul, which sees families spending Friday holidays on picnics and fish from the river is consumed. This is a good example of specific domestic demand.

There are no clear figures for total annual importations to Kabul, which have been put as high as 4,000 mT but are probably considerably less.

6.2 KUNDUZ PROVINCE

According to the Rebuilding Agricultural Markets Programme (RAMP), demand in three Northern provinces is currently approximately 75 mT per province per year.

6.3 BALKH PROVINCE

The general preference of the people of Balkh province is to eat fish in winter. However, although there is demand all year round, the cold season demand is about twice that of the hot season. Fish is also a traditional food in parts of Balkh province and is taken by the groom to the bride’s house as part of wedding ceremonies. Fish is an important food served during the New Year period (around March 22). In this 30 day period demand for fish is extremely high with some individual orders being as much as 50 kg. This is typical for many of the northern Afghanistan provinces. People like ‘Lakha mahi’ (Wels, Siluris glanis) and ‘Shir Mahi’ (Aral Barbel), which are typically wild caught river fish, and ‘Tayara mahi’ (Grass carp) which is cultured. The preference for these species is because they have few bones or are eaten at a size large enough to avoid the bones. The price is higher than other types of fish. However there is also some prejudice against very large fish because they are fattier. There are apparently some differences on prohibition of fish between Shia and Sunni sects (Shia apparently are restrained from eating Lakha Mahi).

The main markets for fish are the city of Mazar and some specific trading points such as Haraitan. Some other smaller towns also sell fish. In the villages fish trading is uncommon. Although there is some demand, this is rather a luxury due to the available sizes and problems of preservation. Fish are caught and marketed along rather specific channels linking the Amu Darya river to the towns. Fish are also caught in other smaller rivers and are eaten or sold.

According to traders in Mazar, there are around 10-14 fish shops active in the city. In winter, up to 20 shops may be operating. The shopkeepers buy fish which come from Hairatan, Tashkent and Pakistan. The fish is sold cooked on the premises or fresh for people to take home. There are also one or two fish wholesalers trading fish imported from Pakistan and Uzbekistan. Importation is necessary as fish production inside Afghanistan is insufficient to meet local demand. This indicates that there is potential for aquaculture development in Afghanistan especially in the north.

Shopkeepers need generators in case of none availability of power, and for large scale traders there would be need for cold storage. During hot weather, shopkeepers keep the fish in refrigerators; using generators if power is not available. All fish traders visited had one or two chest freezers to store their fish. However none were really frozen, but were partially frozen, presumably due to power outages.
The fish wholesalers/traders keep fish in freezers and even the by-products of fish are sold. These traders really need larger scale cold storage facilities as sometimes, the fish catchers bring 2,100-3,500 kg fish and the traders do not have enough refrigeration capacity.

Based on these crude figures an indicative market volume for Mazar i Sharif would be approximately **190 tonnes per year** with a total market value of approximately **$762,000**. However this figure is probably conservative As it does not account for the fact that the market is probably somewhat under supplied during peak periods. The opportunity for aquaculture to compensate for importation means that the total aquaculture demand is lower than this value.

- Mazar (hot season) 14 shops: 6months@10 kg/day = 25 tonnes
- Mazar (cold season) 14 shops: 5months@75 kg/day = 157.5 tonnes
- Mazar (New year) 14 shops: 6months@200 kg/day = 8 tonnes
- Total 190.5 tonnes.( value ~$762,000)

Aquaculture production has one effect which is to depress prices as the volume of production increases in response to demand. This price reduction has, in turn, the effect of increasing demand. The relationship is therefore self reinforcing and the general experience is that aquaculture becomes its own driver after a short while. It is not expected that fish will replace the staple meats in Afghanistan. However there is certainly scope for increasing its contribution to the diet of Balkh province and possibly other provinces as well. It is already known that activities are starting up in Kunduz and the Kabul market is being appraised.

**6.4 HERAT CITY**

Key informant interviews suggest that the market for fish in Herat is slowly increasing with increased interest to consume fish for health purposes (particularly for those with heart conditions). This is rather a specific market and relates to a more educated urban dweller rather than any general preference amongst the urban and rural populations.

The market for fish in Herat is currently very seasonal due to the general perception of fish being unsafe to eat in the warm season. It is quite likely this perception persists everywhere that fish is traded or transported rather than caught locally.

During the cold months of October to February, fish sells quite well; estimates vary but are around 2-5 tonnes per day. October is the best month due to Ramadan. In the other months of the year fish is almost impossible to sell. This translates into a total annual demand for Herat City of approximately 420mt per year

Trader 1: 20mT/month (up to 30mT in October) during 4 month ‘cool’ period
Trader 2: 2 to 5mT/day during 4 month ‘cool’ period

Consumers claim they prefer the local species (‘Shir mahee’) a river barb, but do not apparently differentiate between the wild fish and the imported culture species. The fish sold in Herat is currently imported from Mashad city in Iran (~200 km from Herat), but the fish is actually cultured in “Gorgan” province. Gorgan is near the Caspian sea (~600-700km away). The fish, silver carp and common carp, are brought to the border in refrigerated trucks as chilled fish and are transported in cool boxes to Herat.
The fish sold range in size from 600g to 2 kg with the smaller size preferred due to the low purchasing power of the consumers. A fish of this size would still require a growout period of more than 8 months.

Wild fish (Shir mahee) caught in local rivers and irrigation canals are marketed at a small size and seem quite acceptable. A market vendor selling fried fish described that the fish comes from 5 dedicated fishers who sell their catch directly. Trout are also sometimes caught. The market vendor would sell the fish at 100 Afs/kg rising to 120 Afs/kg if cooked.

There are occasional quality issues, since ice making stops in the winter and can cause problems with fish preservation and market perception. In fact freshness is a major issue which was referred to as a particular advantage for locally produced fish if aquaculture were to start in the Herat area.

Marketing of fish from the traders to consumers is through pushcart vendors or small stalls (~22-30 vendors, possibly more). The price chain is unclear but one informant suggested that the Iran purchase price is ~35 Afs/kg, and he sells to vendors at ~80 Afs/kg. The pushcart vendors sell at ~100 Afs/kg. This low price of product from Iran is a serious economic challenge to locally produced fish, but may be offset with the advantage of greater freshness. An important point here is that small holders often have difficulties producing high quality fish of a large enough size.

6.5 BAMYAN PROVINCE

The marketing of any fish produced is unlikely to be a significant constrain, with only a handful of farmers producing fish. However it should be recognized that the fish will all tend to reach harvest size at the same time (rather than spread through the year), so will enter the market around the same time at the beginning of the winter season. Some farmers may be able to hold fish over winter and exploit other potential marketing “highs” such as new years or weddings.

It is recommended that, alongside any start up activities in fish culture, the marketing of fish and potential channels for this (e.g. to Kabul) are explored at a relatively early stage. This approach will also add to the economic incentive for farmers to adopt fish culture if the system proves to be viable.

Marketing at restaurant outlets in the province (e.g. at Band i Amir) or having a restaurant next to the ponds would be an excellent way to market cultured fish. The small market with only a handful of producers would cut out the need to transport fish to market and would also allow the fish to be kept alive up to the moment that they are caught for cooking, ensuring freshness. The value added by cooking also adds considerably to the overall value of the product which is another marketing advantage. This type of restaurant typically does well when it is located next to a road outside small towns where urban dwellers (who have greater disposable cash incomes) can travel conveniently to eat.

6.6 DEMAND FROM TOURISMS/EX-PATRIATES

Similar considerations have been given for the eventual emergence of tourism and its attendant demands for hotels and fresh fish (particularly trout in mountainous /cold areas). It is worth mentioning that hotels rarely source products locally at the outset since there are difficulties with quality and reliability of supply. In this respect aquaculture would normally develop post-arrival
of tourism in response to a demonstrated demand, rather than developed in anticipation of a demand that might never be realized.

“Qargha fish farm was established in the mid-sixties when hatchery-reared juveniles were released into the lake for later capture by rod and line or nets. At that time there was a strong tourist industry in Kabul, and rainbow trout from Qargha could be sold to local hotels for about ten times the average price paid for meat products.”


The FAO Project evaluation noted that the poor prices obtained for their fish, when on sale in Kabul, did not adequately reflect the market situation and that a restoration of tourism would see far higher prices prevailing. Expectations at this stage should not be based upon any assumption of a rapid return of the tourism industry.

The variability of demand for fish has been indicated with the provinces lying along the Amu Darya river (e.g. Balkh province), that have a tradition of catching and eating fish, having a much greater preference for fish. It is anticipated that these areas present a far better opportunity for exploratory aquaculture development than many other areas of the country, as, for example, fingerlings could be accessed from Turkmenistan or Uzbekistan.

A minor note here is that if a large scale aquaculture development initiative is put into an area without adequate knowledge of the market, there is a very high risk of glutting and price crashes. This is disastrous for a perishable product like fish. Proper marketing strategies are needed and a clear idea of the amounts of fish which will be produced in each part of the year. One disadvantage of seasonal fish production is that harvesting tends to take place in a narrow period at the onset of the cold seasons. It is worth noting that this was seen as a distinct advantage by a Herat based trader, who believed that demand would be at its height exactly at this point in October.

6.7 CONCLUSION

National demand for fish in Afghanistan could be conservatively estimated at about 2,000 mT/year. There almost certainly some scope to increase demand; however, it should be cautioned that flooding these emerging markets could be done rather easily if production was increased rapidly across several provinces. The marketing of fish and the development of markets will be an important aspect of any sustainable increase in production.
7. ENVIRONMENTAL FACTORS

The two principal environmental factors necessary for successful aquaculture in Afghanistan are undoubtedly water and climate. In an ideal situation the growing season is all year round. This stabilizes production and allows longer growout periods which result in larger fish and typically higher prices. If suitable conditions are available, this makes hatchery production more straightforward, since broodstock can be held in ponds throughout the year, which is vital for the operation of a fish hatchery.

If conditions are not suitable for the holding and maintaining of broodstock all year round, then typically fingerlings need to be imported to the grow-out location. Many livestock systems are based around this – such as broiler chickens, where chicks are available from specialized producers and transported quite long distances to growers. However this is a highly developed and standardized system and aquaculture does not have equivalent infrastructure arrangements. Thus, where all year culture is not possible, seasonal fish culture can still be an option. Seasonal production relies on the availability of water and suitable growing temperatures for part of the year; typically around 6 months or more.

This can still be quite successful and profitable provided that the critical supporting features are present. The main requirement for seasonal production is the availability of fingerlings of the right size/age ready for stocking at the beginning of the warm season. This requires hatcheries/fingerling production facilities to be accessible at the right time (a good road link and means of transportation are essential). In situations where this is well developed, fingerling traders can be encouraged or will start up operations to satisfy demand (see Section 8 – Access to Fingerlings, below)

7.1 WATER

When considering aquaculture in Afghanistan it is worth starting with the issue of water. Aquaculture is a user of water but at least part of this can be considered to be ‘borrowed’ in as much as the water can subsequently be returned to the river or source it is abstracted from, or can be used for other activities such as irrigation after it has passed through a farm.
In a hot, low humidity climate such as Afghanistan, there will be irretrievable losses from seepage and evaporation. These losses from large pond water surface areas may be considered unacceptable wastage in comparison with alternative water use for crops – in which case some economic valuation might be considered. In Pakistan aquaculture represents a more cost efficient use of water than cash crops such as wheat or cotton.

**Water resources of Balkh province**

Balkh province has considerable water resources and several districts clearly have the potential for aquaculture through the abstraction of water from rivers or from irrigation canals. Borewells may also be an option in some cases. Irrigation infrastructure development also creates structures which could be used for aquaculture purposes – particularly where structures are put in place for drainage. Some follow-up with irrigation projects could identify basic information on locations where drainage channels and straddling ponds may be constructed as well as known areas with permanent waterlogging. These areas could be excavated to make permanent ponds. The river bank areas of the main rivers also offer some potential for aquaculture ponds. This has been used in some cases (e.g. at Haraitan). Leases of river bank areas, which are government owned, have now been extended to 90 years which makes their use for aquaculture a potentially attractive option.

What is perhaps more important is the use of water by a single (aquaculture) operator versus the use of water by a broader group of (usually less wealthy) individuals who wish to irrigate crops.

**Case example - government leasing of facility to private sector**

A government fish farm in Herat was leased to a private group of investors, but the local water users group banned the investors from using the irrigation canal water next to the farm (which was allowed when it was a state activity). Now the farm needs to pump water from a shallow well on the farm.

This is an example of how aquacultural development in water constrained areas can be a source of conflict. Therefore careful consideration of how water will be abstracted (how much, when/how often) and the likely impact this will have on other users of the resource is essential. It is worth noting that, in flow through systems such as trout ponds/raceways, this is less of a problem as the water is visibly returned from the farm, usually a short distance from the abstraction point and flow in the water course is maintained.

Problems may arise where water is abstracted (by pumping or diversion) from rivers or lakes and there is no obvious immediate return of the water (i.e. in ponds with little flow through). The worst situation is where water is abstracted and the water course is run dry (e.g. from irrigation channels) and crops suffer. The impacts of this are catastrophic and will usually result in serious conflict between users. In this case it is important that a project does not support activities which risk such situations arising.

It is apparent that abstraction of water from rivers (by pumping into ponds or diversion is not always allowed or is strictly regulated (either formally through government ‘law’ or by local customary systems – this needs to be clarified as a matter of priority). It is unclear where abstraction in a flow through situation is permissible (i.e. the only losses are evaporation and seepage)
THE POTENTIAL FOR AQUACULTURE DEVELOPMENT IN AFGHANISTAN

Water resources of Bamyan province

The water resources of Bamyan are quite impressive with rivers flowing through all the main valleys, with the lowest flow rate still quite adequate to support fish ponds or raceways as part of small diversions schemes or could even be pumped into ponds. Due to the gradients in the valleys most also have small irrigation systems running along the edges of the rivers and thereby distributing water to the fields along the length of the valley. This means that the source of the water supplied by these irrigation channels is higher than the farmland that it supplies, making gravity fed water supplies a good possibility in all the valleys observed. The amount of water available is a different matter, but if fish ponds were operated on a flow through basis or in such a way that all overflow was passed on to crops, it is quite likely that the use of water for aquaculture would be tolerated by other water users.

Case example – water requirement of a trout pond

Flow through systems for trout use very high volumes of water – although these are returned to the river they came from. As a crude estimate, the approximate water requirement of a pond producing rainbow trout (a unit holding 1 tonne of portion-sized fish) is about 0.01 m\(^3\)/sec of water (i.e. 600 litres a minute). This gives an idea of the sort of river flows and diversion requirement that even a small trout unit would require.

On ground adjacent to river courses, there is probably a good quantity of water that seeps from the river bed. This means that water can be obtained on the site from shallow wells. However this would limit the scale of the operation and require small pumps. Nonetheless, for small pond operations this could still be feasible.

Water quality is a secondary issue and relates to the chemical characteristics of water for fish culture. This is probably not a primary concern for Afghanistan. Typical water quality parameters concern appropriate pH, hardness, alkalinity and turbidity/silt loading. Snow melt and urban or agricultural pollution can impact aquaculture water supplies, but this seems to be a minor concern at the moment.

7.2 WATER & IRRIGATION

Aquaculture can be integrated with irrigation under certain circumstances and is already practiced in Afghanistan. The stocking of irrigation channels with fish or the presence of wild fish in irrigation channels is a resources already exploited by Afghans. The stocking or use of water bodies created for irrigation purposes also offers the potential for aquaculture (e.g. irrigation reservoirs, or large channels and buffer ponds).

It is important to appreciate that aquaculture is the secondary user of water in these systems. Therefore management decisions will prioritize water flow for crops and thus draining down of channels and reservoirs may occur. This can be unpredictable and result in the loss of fish – a catastrophe if significant investment has been made (e.g. cage culture operations in reservoirs or villager stocking of channels). This may lead to dissatisfaction by farmers if too much effort is invested in the fish and this is compromised due to poor water management.

Irrigation water from snow melt or mountain run off may contain a high silt loadings (good for weed control) which limits light penetration and can reduce the productivity of fish.
7.3 TEMPERATURE

The Afghan climate can be extreme and finding aquaculture fish species which are able to tolerate these conditions is problematic.

- Too cold - growth stops and feeding may stop, problems with icing;
- Too hot – feeding stops, problems with dissolved oxygen.

Fish can tolerate a reasonably wide range of temperatures, providing changes are not too rapid. However they have one range which is suitable for normal growth and a wider range which they are able to tolerate. Outside the suitable range, fish will tend to stop growing, stop feeding and will pursue a simple maintenance strategy. They may even lose weight. Over short periods this is acceptable but an aquaculture operation cannot survive this situation for long periods and remain profitable. In extreme cases of long term exposure to unsuitable temperatures or temperature shock (e.g. if hail showers land in water), fish mortality will occur.

Case example – trout can be cultured in Qargha

“The project has demonstrated the suitability of Qargha fish farm for trout culture. Water supplies to raceways were always of adequate quantity and quality. Water temperature was recorded daily, and ranged from a minimum of 4°C in January-February to a maximum of 20°C for a few days during September. This is a very suitable range for trout growth.”


Air temperature is not the same as water temperature and in many cases water may be slightly warmer due to high specific heat capacity. Ponds can heat up in the day and this prevents low temperatures at night which allows aquaculture to be pursued into cold weather. Deep ponds can exploit the high specific heat capacity of water to maintain fish in cold seasons (need to be careful with flow through); however construction costs are high.

It is important not note that there is no apparent water temperature data available for Afghanistan. Having this would significantly increase the ability to predict the areas where specific species could be cultivated with low risk. Ideally, there needs to be available information on water temperatures in ponds/raceways etc. for each major province in each month of the year.

Cold weather considerations (e.g. Bamyan Province)

Bamyan has a very cold winter season, starting in October temperatures begin to fall until the coldest month in February. The valleys are more protected and the presence of spring water can keep some water temperatures several degrees above zero. The river waters are exposed to ambient temperature and will be close to zero in the coldest months.

The cold seasons which lasts nearly six months in all , will generally result in slow growth of fish. Water temperature data is not available (one of the activities of support to pilot fish culture will be to collect some of this primary data) and so it is not possible to indicate pond water temperatures or river water temperature. Trout will continue to grow down to a temperature of
about 5 degrees, but common carp will not, although they will tolerate water of 4 degrees and can survive in ponds which are frozen over (if they are deep enough) by exploiting the warmer water (3-4 degrees) which can be found at the bottom of the pond. In this situation, it is essential that water is not exchanged in this situation (unless it is spring water that is warmer than 3 degrees) as this will further cool the bottom water and could result in the death of the fish.

<table>
<thead>
<tr>
<th>Fish Name</th>
<th>Ideal range (°C)</th>
<th>Max. temp (°C)</th>
<th>Tolerance range (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown trout</td>
<td>5-18</td>
<td>&gt;23</td>
<td>0 Stops growing</td>
</tr>
<tr>
<td>Rainbow trout</td>
<td>14-18 note egg survival best below 12°C</td>
<td>&gt;23</td>
<td>5 stops growing</td>
</tr>
<tr>
<td>Common carp</td>
<td>12-24</td>
<td>&gt;30</td>
<td>2-3</td>
</tr>
<tr>
<td>Silver carp</td>
<td>23-30</td>
<td>&gt;30</td>
<td>0 – 40</td>
</tr>
<tr>
<td>Grass carp</td>
<td>~40</td>
<td></td>
<td>0 – 30</td>
</tr>
<tr>
<td>Rohu</td>
<td>23-30</td>
<td>&gt;30</td>
<td>15</td>
</tr>
</tbody>
</table>

Some locations have spring water available which increases the potential for keeping fish over winter as the temperature of the water remains somewhat warmer than the ambient temperature. It is however probably colder than ambient in the summer. Thus in summer on water flow is used only to top up for seepage and evaporation and in the winter flow may be more continuous to keep temperatures in the pond above freezing.

The ability to overwinter broodstock will be an important factor in deciding the viability of the production of fish fingerlings in Bamyan province and hence the long term ability of the province to sustain fish culture activities without significant reliance on the importation of fingerlings. Even if fingerling production cannot be initiated for some time, the establishment of a chain of supply of small sized fingerlings to the province for early nursing and onward sale to producers would still be a viable strategy and one which would be quite possible to sustain provided there are sufficient interested farmers to create the demand to make the trading and nursing of fingerlings a financially attractive activity.

8. ACCESS TO FINGERLINGS

Fingerlings are a key requirement for aquaculture and are often cited as the single most important constraint to farmers starting production; because, on the production side, they can use their own labour, use savings to build ponds and find feeds from on farm resources. Making fingerlings available is a key input to stimulate aquacultural activities and encourage farmers to try out aquaculture.

The accessibility of fingerlings is also a key issue for farmers in more remote areas. Often a government hatchery will produce fingerlings but these are only accessible to peri-urban farmers.
THE POTENTIAL FOR AQUACULTURE DEVELOPMENT IN AFGHANISTAN

Lack of transport, high temperatures and lack of cash limits poor farmers’ access to these resources. Project interventions may step in to purchase and deliver fingerlings to farmers to ‘kick start’ aquaculture operations. However the sustainability of such activities must be critically evaluated. This situation cannot be sustained and distorts the actual viability of the activity in remoter areas.

Exit strategies include developing farmer capacity to produce their own fingerlings or encouraging fingerling traders who will provide the fingerlings on a commercial basis to the farmers. If these remote farmers are also accessing an urban market with their product, the two way trade can develop together. A critical factor in this case is the quality of the road connection by between towns and the producing areas.

In seasonal pond production, the critical aspect of fingerling availability is that they are ready for the beginning of the growing season. If the fingerlings arrive too late then precious growing months are lost and farmer cannot get the size of fish they would like. This reduces the final value of the crop and can deter subsequent activity.

In Herat, fingerlings can be obtained from Iranian aquaculture producers (prices seem to be high ~$0.25 each not including transport). This cross border trade can be used in the interim to obtain good quality fingerlings at the right time of year. This also means that any intervention encouraging aquaculture development in Herat would not need immediately to be concerned about the construction of hatcheries and the maintenance of broodstock (a considerable reduction in complexity).

A proposed project for the Kabul area (and also the Kapisa project proposal – see Annex I) seeks to revive fingerling production and dissemination to farmers in the Kabul area. This strategy may be sustainable if the fish can be grown profitably in ponds. Transportation of fish is an important consideration here and it seems that the farm undertaking its own transportation is envisaged. This could be a critical bottleneck if distribution is required to large numbers of farmers at around the same time for seasonal production.

9. AVAILABILITY OF FEEDS

Aquaculture operations can be tailored to suit a variety of feeding strategies. These include:

- Feeding of fish in a pelleted formulated feed made in a factory;
- Feeding fish on a home made pellet/paste/ground feed made on site using off farm ingredients;
- Feeding fish in on a mixture of agricultural wastes derived form on farm resources;
- Fertilizing ponds with manures/fertilizers to stimulate phytoplankton productivity with little or no supplemental feeding.

Feeding costs can represent up to 50% of operational costs in more intensive aquaculture systems, but, if the feeds are derived from on farm sources, this percentage comes down and the principal cost will be the cost of fingerlings for stocking.
9.1 WARMWATER OMNIVOROUS/HERBIVOROUS SPECIES

In many low intensity ponds complete feeding is not provided but manures and some additional agricultural products are added. For warmwater species that can feed on green water (e.g. the silver carp and tilapia), operational costs can be quite low and the system, although not highly productive (~500-800 kg/ha), still generates significant income due to the low investment cost. Mixing with common carp (a bottom feeder) can give good results. This system is easy to manage and, provided there is adequate water for 6 months, can give quite a reasonable yield.

More intensive feeding methods using supplemental feeds can give significantly more production, but there are attendant management issues such as water quality management and regular feeding and guarding what is becoming rather a valuable crop.

The table below gives an idea of the sorts of agricultural by-products that can be fed to fish in warmwater ponds. These feeds would be suitable for most of the general aquaculture species such as Indian carps, common carp, and tilapia.

Importantly, some adaptive work with fish farmers will determine the sort of intensity levels they are able to manage and the sorts of feeds and investments which are appropriate in terms of acceptable risk and feasibility.

Balkh Province

The farms of Balkh province produce a wide range of products and bi-products which can be used for aquaculture. Below is a list of some of the ingredients which were specifically noted as having some potential as they are either abundant or under-utilized.

<table>
<thead>
<tr>
<th>Feed ingredient</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>Balkh is a wheat producing province and the whole wheat can be sprouted and fed, or milled and used as a feed ingredient. Wheat bran would be an excellent feed ingredient containing both protein and oil.</td>
</tr>
<tr>
<td>Blood</td>
<td>This is discarded and not used for any purpose currently. It can be used as a high quality feed ingredient in a moist or dried feed preparation.</td>
</tr>
<tr>
<td>Animal offal/intestines</td>
<td>Significant amounts of animal wastes are generated as a result of meat slaughtering and butchering – there can be minced and used as fresh feeds for carnivorous species such as Lakha mahi and Mar Mahi or mixed with other vegetable ingredients to make a good feed for other more omnivorous species</td>
</tr>
<tr>
<td>Cotton seed</td>
<td>This is pressed for oil and the cake can be mixed as a feed ingredient.</td>
</tr>
<tr>
<td>Vegetable trimmings, spoiled fruits and vegetables</td>
<td>Grass carp can be fed on many on-farm vegetable wastes such as carrot tops or other trimmings.</td>
</tr>
<tr>
<td>Pulses/legumes</td>
<td>These are prepared as snacks but could be mealed for feeds</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>Can be used as a feed ingredient or fed directly.</td>
</tr>
</tbody>
</table>

Moist or dried preparations could be made depending upon the intensity of production. For many farmers simple feeds such as oil cake and vegetable wastes may be the first low cost option while they become familiar with the idea of fish culture.
9.2 CARNIVOROUS SPECIES

The feeding of carnivorous fish such as trout can be a major expense which (in the case of poor feed management, high mortality or slow growth) can even exceed the income from the fish sold. This makes trout culture rather risky for a small operator with limited cash flow. Trout are a carnivorous species and although they grow best on formulated feed, they can still be produced using other farm-made feeds (e.g. blood, lungs, liver, eggs, slaughterhouse waste). If such farm-made feeds are used, nutritional problems may emerge (these need to be dealt with on a case by case basis) and there is reduced survival.

**Case example - FAO trout project imported feeds for the production of trout at Qargha trout farm.**

"Currently there is no industry in Afghanistan producing compounded feeds for animals or fish. Consequently few of the major raw materials needed to make dry pelleted trout diets are available in Kabul. In particular, no fishmeal is produced in Afghanistan, and presently none is imported. It was always understood that such ingredients would need to be imported to manufacture good-quality diets for rainbow trout.......The important issue is that the market price of the trout be high enough to cover the cost of such imports."

The critical point here is that commercial trout culture is most likely to be dependent upon imported feeds for the foreseeable future, unless a reliable source of alternative local feed ingredients can be found (e.g. silk worm pupae, slaughterhouse wastes) Despite the apparent need for formulated pellet feeds, trout can be fed on locally made feeds. Due to the non-arrival of feed (a significant risk using imported feeds), the FAO project used an interim diet

"Pending delivery of imported feeds, fish were fed on an improvised wet pelleted diet composed of offal (livers, stomachs, lungs, etc. of sheep, cows and camels) mixed with cereal flour and extruded through a hand mincing machine"


The conclusion here is that, in the absence of a reliable feed for trout, the investment required and likely productivity of trout makes this a relatively high risk venture.

**Feeds in Bamyan Province**

Feed resources in the province are generally adequate with the availability of wheat and barley and also the brans from their milling. The province also produces potatoes however these are not particularly suitable as a feed unless cooked and in an energy constrained situations such as this province (where fuel for heating is a priority), advocating the cooking of fish feeds is unlikely to be adopted readily. Manures are also widely available as the province produces livestock and this is a significant source of cash income to many families. Here again constraint in expectations must be exercised as the manure is widely used as a fuel for cooking and heating and using it in ponds may be unacceptable.

Blood and offals from slaughtering are available at households level and within the markets – this is an untapped resource (especially blood which is discarded and not acceptable for human or ruminant livestock production. However, it might be used as a supplement for egg laying chickens. The use of blood in fish feeds can greatly increase their protein content as well as acting as a binder.
As a result of promotion of chicken production – such as the supply of vaccinated chicks and development of or network of feed agents, chickenfeed mill development in Kabul - the availability of chicken feed can be expected in Bamyan from 2007 onwards. This has several implications:

- chicken feed can be used directly as a basic fish feed. Its limitation is that it is not pelleted and disperses and sinks quickly, so modified feeding methods need to be devised.
- the potential for integrating chicken cages with fish ponds – benefiting from fish feed and chicken manure in the pond;
- the availability (potential supply) of chicken starter feed. This starter feed is high protein and often contains some fish meal. It is an excellent feed for fingerlings during nursing – giving fast early growth.

The availability of these chicken feeds will certainly benefit the maintenance of common carp broodstock and the nursing of common carp fry and fingerlings, bit will not have any significance for trout culture.

10. ACCESS TO LAND

Farm siting is a critical aspect of successful aquaculture and land based operations (as opposed to floating cages in lakes and reservoirs) require that a farm site is within easy access of a water supply. In the case of Afghanistan this might be divided into the following basic types:

- Land next to a river where a diversion weir can pass water through a farm site for its eventual return to the river. This is typical on land where there is some gradient. The flow-through aspect is critical for fish such as trout which require rapid flowing oxygenation of water. But water diversion can also be done occasionally as needs arise for static water ponds.
- Land adjacent to rivers where water can be pumped into small ponds. This type of pond might be within the gardens and lands that fringe rivers. The pumping is occasional and requires fuel and a small water pump (for a very small operation a 3” petrol water pump is adequate – cost ~$150). This sort of site would be most suited to seasonal warm water culture during the summer months.
- Land with a water source on the land. This could be a well source (drawing from ground water) or close to rivers but not directly adjacent, and would be suitable for small ponds using pumping as described above. There is limited capacity for water exchange, and productivity of the pond would be low.
- Ponds constructed within small irrigation systems – again suitable for seasonal warmwater fish culture as an additional income generating activity within a farming system.
- Ponds constructed and fed by spring water. This water can maintain higher temperatures in the cold winter. Flow rates are a key consideration. A single spring may be adequate for only a limited number of ponds.

Aquaculture is best pursued on private land. In some cases aquaculture extension would only target pond owners rather than lessees due to problems with continuation of leases. This is a significant issue when trying to develop aquaculture with poorer farmers who may not actually have tenure of their site. It should be noted that customary tenure in communities where there are strong social bonds is sufficient; the main point to ensure is that the target beneficiary is able to control the asset once its value is enhanced through some form of project intervention.
Land resources in Balkh
Small land parcels caused by sub-division of family lands means that some plots are small but still have significant irrigation water rights attached to them. The implication of this is that any intensification of use of the land parcel can exploit this situation of small land area but relatively abundant water. Aquaculture is perfectly placed to make use of this potential opportunity and may also provide some benefit to households with small discontinuous/dispersed land holdings.

If a project invests too heavily in the development of aquaculture activities (e.g. digging ponds), there is a risk that the land owner or powerful local figures may end up capturing that site and using it for their own benefit. This is one reason why effective aquaculture development with poorer farmers focuses on the software aspects as well as assisting with the operational cost of production, rather than getting involved in the hardware element; purchasing pumps and equipment, and constructing ponds or facilities.

Land resources in Bamyan
Soils in the area have a reasonably clay content (witnessed by the fact that they are universally used in house construction), although soils in higher pasture areas seem to be slightly more sandy. Soil permeability and compactability are unlikely to be a significant problem in most locations in this province.

Land availability is a different matter. Most of the valleys have fields fringing the rivers and the level land that is irrigated for wheat and barley seems to be quite limited. Conversion of this land to aquaculture ponds is unlikely to be considered (initially) by the farmers, although small parcels may be acceptable if the land owner has enough land to spare.

There are significant amounts of pastureland in some valleys – pasture land is land that either cannot be irrigated or which is too wet to cultivate. Much of the pasture is unsuitable for aquaculture as it would have excessive seepage rates as well as lack of water supply (unless irrigation was extended to it – or water were actively pumped). Waterlogged pastures can be found in many places and these offer some potential for construction of ponds. The water table is at ground level and in many cases there are small streams or springs passing close by. Ponds constructed on this land (the soils observed were largely clay type) would not be drainable and
would require pumping to drain them as well as some pumping during their excavation. This land is however of relatively low value and farmers do not have a particular problem with its conversion.

Land tenure is another matter which needs to be considered in site selection. Cultivated land typically has ownership and the more marginal (typically grazing/pasture land will be more open access communal lands. This situation presents a problem for its conversion to ponds to be operated by an individual as it would effectively be the granting of common land for private use.

11. KNOWLEDGE & SKILLS

This is perhaps an area which responds best to intervention and significant impact can be made through provision of appropriate opportunities to farmers to improve skills and knowledge. Typically this would be:

− Hands-on training courses;
− Direct experience through production of fish for a crop, with appropriate risk reduction strategies i.e. project support to fingerling supply, backstopping and assistance with adaptive learning through group experience/sharing.

Pilot style activities (e.g. model farmers) are less convincing to farmers, since the pilot farmers are frequently the most entrepreneurial, risk-taking and asset secure in an area. They are therefore rather unconvincing demonstrations since they do not represent the ‘typical situation’ of the majority. Having said this, such farmers often play a catalytic role in demonstrating feasibility in an area and subsequently may often diversify into fingerling production or other activities, which can open opportunities for poorer farmers.

Although printed media is of limited value and videos are attractive, it is the concrete example of the feasibility of production in a locality which has the most direct impact on the awareness of farmers of the possibility of fish culture. Transferring the practical aspects is more complex as wealthier farmers may not be able to transfer techniques effectively or may not be willing to do so. This is very dependent upon the type of relationships with other farmers/families and cannot be generalized. Using a group approach allows an averaging out of the different capacities and resource bases of farmers so that the group as a whole learns lessons from each others’ experiences. This typically requires a degree of capacity building with local livestock/fisheries staff or development agents (NGO facilitators etc.)

Case example – Herat

A wealthy entrepreneur who had leased a government fish farm site stated that his staff badly needed training and knowledge about fish culture. Investment in an operation was not the constraint to this person. In fact, due to the likely re-possession of the farm by the local agriculture office (due to the arrival of a development project funding for its upgrading), the entrepreneur was considering obtaining land next to the river to develop a farm. What he badly needed was advice as to how to design, construct and manage such a farm. The complete lack of information on fish culture and lack of advisory personnel prevents further movement on this sort of development. Access to information from outside the country (i.e. Iran) could be considered – either privately accessed or through some form of project support to basic awareness and training in simple fish farming.
12. INVESTMENT

Investment is a key aspect of aquaculture development, but does not always have to be a monetary issue. Successful aquaculture requires a variety of inputs, financial and otherwise, to ensure its success and these can be loosely grouped into the following:

12.1 TIME

Fish farms require some time to manage, even when they are well integrated into the surrounding farm. Farmers may have to make special visits to change water, or to feed fish. This is most effective when the fish pond is close to the family home or when the pond is close to fields or gardens.

Guarding fish can be a significant problem for farmers. In areas that have problems with theft, a member of the family may have to guard the pond at night. This can be an unworkable situation if there are security issues (e.g. banditry, conflict). Theft is less of an issue in communities with relatively strong social cohesion or where there is strong disapproval of theft.

Short term intensive time inputs may be made in the form of labour required to construct a fishpond on farm facilities. This can be paid for, but may be too expensive for poorer farmers to consider.

12.2 FINANCIAL INVESTMENT

The most significant cost of farm development is the cost of pond construction (typically excavated structures which may occasionally be lined) or the construction of tanks/raceways (typically concrete or brick structures raised above ground).

The cost of pond construction can be recouped over several crops if the cost has to be paid in cash. Loans are difficult to access for pond construction. Hand excavation is the cheapest option, but suffers from lack of compaction. It is quite acceptable for small fish ponds.

Mechanical excavation is expensive but is quick and efficient and results in good compaction of the ponds. Unfortunately the cost of moving machinery to a site means that single ponds do not justify the expense of moving the equipment and so, unless many ponds are to be built, this is rarely an option. Although some projects can subsidize the provision of machinery, farmer still need to pay the direct excavation costs of their pond.

Equipment may also need to be purchased for the farm. This can be relatively simple and often locally made. Exceptions to this are pumps - although irrigation pumps are perfectly acceptable for aquaculture purposes if available. Other minor items include nets for harvesting, small hand mincers or electric grinders for preparing on-farm feeds.

Accessing funds for fish farm development is often difficult, but may be possible through loans against the value of land (using the land or a house as collateral). Typically, banks are reluctant to lend for aquaculture as it is an ‘unknown’ for them and they have difficulty assessing the risk of
THE POTENTIAL FOR AQUACULTURE DEVELOPMENT IN AFGHANISTAN

lending. Banks also most certainly will not lend for operational costs, which is a major constraint for small farmers who have constructed ponds themselves but require cash for fingerlings, fuel for pumping and basic equipment. It is here that project intervention can enable farmers to ‘experiment’ with aquaculture by supporting these input costs. Feeds have to be found by the farmer.

Typically, where farmers have no prior experience of aquaculture, they are unwilling to risk investment without having seen some sort of successful demonstration in their locality. This is even more convincing if the demonstration is that of a person/family with similar assets and resources as themselves.

13. MANAGING FISHERIES – AN ALTERNATIVE TO AQUACULTURE?

Aquaculture development may not always be the most effective way to impact livelihoods. As has been pointed out in the above sections, aquaculture is typically a land-based productive activity that requires inputs. In this respect it has many similarities to livestock production and, depending on the scale of the activity, can have quite high entry costs. This means that resource poor farmers and even poorer landless people may not be able to start aquaculture activities, even though there is a strong desire to do so.

Afghanistan has many rivers and a number of lakes and reservoirs. These are fished by local people and have traditionally provided fish for local consumption. The list of indigenous fish species in Afghanistan is quite long and these are dominated by species that are particularly cool-tolerant and which do well in fast flowing river environments (e.g. Schizothorax spp.). See Annex II.

There is interest to culture some of these species in neighbouring countries, but this is still in its infancy and could not easily be transferred to the current Afghan situation.

13.1 REDUCING DESTRUCTIVE FISHING

The lack of control over fishing and fishing techniques is a cause for concern. Explosive and electric fishing are reportedly widespread and these two forms of destructive fishing cause the rapid deterioration of wild fish stocks. This is because the non selective and destructive nature of the fishing method results in the loss of fish of all ages (especially juveniles, which are needed to replenish the adult stock).

13.2 MANAGEMENT BY COMMUNITIES

Simple management measures can be introduced to improve the status of fish stocks, enabling the recovery of fish in a river course and potentially providing an activity for those specialized in fishing. The local management of a river or lake fishery requires that the relevant parties agree to act according to a set of measures designed to improve their fishery. This typically involves:

- Establishing a local committee (this may or may not be an existing social structure);
- Control of access and limitation of access to a ‘membership’;
- Agreeing on boundaries indicating where the authority of the community fishery starts and stops;
Agreeing on some simple management measures which all will abide by - such as banned destructive fishing methods, appropriate gears, closed seasons, spawning refuges/closed areas;

− Having a local system of enforcement (through a customary system – such as village elders or through a governmental system such as local government office;

− Recognition of the group and its rights to control a fishery are important and the assistance of local government in respecting these rights is essential. Although in many cases there are already local systems in place to address issues such as this.

An important feature, which will determine whether it is really worth going to all this trouble to develop a community level fishery arrangement, is whether there is actually a fishery worth protecting. In this respect, the community itself is usually the initiator of the request (e.g. though participatory assessments). If a community mentions that they have a problem with fishery decline and would like to act to resolve this, then this is a typical opportunity /entry point for starting the organizational process to develop community management.

Since fisheries are a traditional open resource (i.e. fish are ‘hunted freely’) it may be that adequate cultural norms regarding the ‘ownership’ of a river fishery or lake do not exist. This needs to be investigated. A simple first step is just to open the discussion of river and lake fishery resources during dialogue with communities to see if there is something worth working with.

13.3 STOCK ENHANCEMENT AND RESTOCKING

This has been suggested as an accompanying measure to aquaculture development in Afghanistan. Stock enhancement has the attraction that the ‘technical effort’ is focussed on the production of fingerlings. By stocking into the wild there is little responsibility for the onward management of the fish. The fish feed themselves in the water body and harvesting/capture of the fish is undertaken by individuals.

There are several weaknesses in this approach which need to be explored. The most significant of these is the sustainability of the stocking activity. If fish are stocked on a one-off basis and they form self recruiting populations, then the activity may be justified in terms of initiating a fishery.

The problem comes with the management of that fishery. There is little point stocking a water body (lake, reservoir, river) if there is going to be uncontrolled fishing and use of destructive fishing techniques. The stock will decline or disappear; requiring further restocking to restore the fishery. This seems to have been the case with some of the stocked lakes and reservoirs in Afghanistan.

Having a degree of management through an organized system of communities which abides by commonly agreed rules allows the control over fishing methods and the effort in the fishery. The fishery may not be sustained, but at least the access to the fish is more equitable.

In some fisheries the fish that are stocked do not reproduce in the fishery and therefore numbers gradually decline as they are fished. This means that the fish must be replaced regularly (every year or two years) through restocking. This is an ongoing commitment which carries a cost (the cost of restocking).

Ideally the communities which will benefit eventually from the stocking activity are in a position to pay for their restocking themselves or even produce fingerlings to restock. This is seen only in
highly organized ‘culture-based’ fisheries, where fishing cooperatives manage and license fishers and extract revenue, not revolved into the restocking activity, for the benefit of their members.

13.4 STOCKING OF LARGER WATER BODIES – RESERVOIRS, IRRIGATION PONDS AND CHANNELS

This is an opportunity which can provide fisheries benefits to a group of people (e.g. irrigation user groups or communities situated near a water body) by improving the fishery resources as described above. The process for community organization is the same, although it is better if a pre-existing community arrangement can be built upon.

Before starting this sort of activity, it must be clearly understood how the water in the water body is managed. If the water body is drained down then the stock must be harvested at that time. However, this may not be at a suitable time for fish harvesting and may result in small fish or the spoilage of fish due to the harvest occurring at one time. This is mostly only an issue for stocking of irrigation channels and small irrigation water bodies.

This sort of arrangement requires fingerlings for stocking and the system for obtaining these is a critical organizational aspect. If they are provided by the state then dependence on the state for restocking will arise. In some countries there are institutionalized restocking schemes as part of general rural poverty alleviation initiatives; however there are complex problems with this. Ideally, the restocking activity is undertaken during a trial period and then the beneficiary community needs to develop its own mechanisms for recouping some costs (from fish sale) to be used for purchasing of fingerlings.

With all of these restocking and enhancement activities, there is an assumption that there are fingerling production facilities which are accessible to the communities. The reality is that most communities find it difficult to access fingerlings in a timely manner and inefficient government hatcheries cannot provide the quantity, quality and timeliness required. This means that the system is critically flawed and will tend not to be sustained.

It is worth pointing out that sometimes investment in this sort of focal activity can actually contribute to community coherence. In many cases, when community fishery activities are evaluated, the community fishery members claim the activity has improved their community cohesion, even when the actual fishery benefits may have been quite marginal.

14. INTERVENTIONS AND OPPORTUNITIES

This review of aquaculture and fisheries is intended to outline the operational issues which confront the establishment of a relatively new agricultural activity in Afghanistan. It is common sense that aquaculture and fishery management activities are most likely to succeed in those areas which have a pre-disposition towards fisheries activities and fish consumption. Strong community organization or coherence is a major factor in determining whether group based initiatives will succeed and important for the piloting of new farming methods.

Although aquaculture provides an excellent opportunity to increase livelihoods options and farm income, it is clearly only viable in areas where water is readily available. This limits its general applicability in opium poppy growing areas. However, in provinces such as Balkh – discussed above – and Helmand, in the south, where a substantial proportion of the opium poppy crop is irrigated, aquaculture could provide a viable alternative income source for opium poppy farmers.
Piloting aquaculture activities is such irrigated opium poppy growing areas should be a priority for the projects alternative livelihoods activities aimed at increasing farmers’ income generating opportunities and reducing opium poppy production. It must also be recognized that there is little likelihood of immediate impact from the introduction of a new activity such as aquaculture. There will be a lead-in time as the techniques and knowledge of how to make aquaculture work under Afghan conditions.

The tables below give a summary indication of where interventions could be made at the policy level, capacity building levels and direct interventions to impact livelihoods. The areas indicated are, by necessity, generalizations and would require considerable ground-truthing, particularly in the areas of direct intervention with communities. The most important pre-requisite is the interest and commitment of groups/communities to try out aquaculture or new ways of looking at their aquatic resources.
### ANNEX I - POTENTIAL AREAS FOR INTERVENTION IN FISHERIES AND AQUACULTURE IN AFGHANISTAN

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Target beneficiaries</th>
<th>Activities/inputs</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| Restocking large water bodies such as reservoirs | Would benefit communities which were able to fish the reservoirs. | - Fingerling stocking  
- Entry point for organization/dialogue between communities over access and management | - Requires hatchery produced fingerlings  
- Difficult to recoup costs – long term viability and issue |
| Restocking small water bodies/irrigation canals etc. | Benefit water users and a focal community. May benefit resource poor fishers if allowed by the community | - Fingerling stocking  
- Organization/dialogue within water users/communities  
- Facilitation of group to organize plan and manage  
- Management plan needed  
- Local govt. recognition of the right to manage | - Requires fingerlings (from state hatchery or imported)  
- Easier to control  
- Community could sustain activity if they find it worthwhile  
- May have problems with sudden draw down/draining of system  
- Probably seasonal stocking |
| Small pond (warmwater) aquaculture [seasonally warm i.e. summer months] | Individual farmers with land close to a water source (ideally formed as a focal group) | - Allowed to abstract water (from river or irrigation) or have spring water on land  
- Small pond construction  
- Training of farmers (ideally as small groups so that there is an adaptive learning/self help element)  
- Fingerlings for stocking  
- Available on-farm feeds or purchasing power to buy simple off farm feed inputs  
- May need to pump water if not allowed to abstract from irrigation or divert from river | - Pond construction by hand or to be paid for (requires investment/loan)  
- Seasonal activity  
- Probably use warmwater species (i.e. low protein requirements)  
- Farmers need to have contact point to assist with adaptive learning element and to provide some basic information on culture techniques and problem solving  
- Some form of access to small scale finance may also be a strong facilitating factor |
<table>
<thead>
<tr>
<th>Intervention</th>
<th>Target beneficiaries</th>
<th>Activities/inputs</th>
<th>Remarks</th>
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</thead>
</table>
| Small pond coldwater aquaculture| Individual farmers with land close to a water source (ideally formed as a focal group) | − Allowed to abstract water  
− Small pond construction  
− Training of farmers (ideally as small groups so that there is an adaptive learning/self help element)  
− Fingerlings for stocking  
− Access to high protein type feed ingredients (available on farm or purchasing power to buy off farm feed inputs)  
− Must be able to divert water from river to give adequate flow through  
− Traders identified and prepared to buy stock from farm – good communications link (road and mobile telephone) a major enabling factor. | − High protein feeds require reliable local sources  
− Unlikely to be successful with imported feds or transported feeds from long distances due to logistical problems  
− Cannot store feeds for long periods  
− Higher production cost means that market must be relatively stable and guaranteed.  
− Good road access to city market probably essential.  
− Ideally traders will undertake marketing |
| Large pond (or multi-pond aquaculture) | Benefit individual entrepreneurs with access to land and water | − Allowed to abstract water  
− Rational farm design  
− Pond and canal works construction  
− Inputs feeds  
− Labour  
− Staff training  
− Demonstrated Market  
− Investment capital (typically own money but possibly bank loan) | − Typically require technical advice  
− Information or access to advisory support |
<table>
<thead>
<tr>
<th>Intervention</th>
<th>Target beneficiaries</th>
<th>Activities/inputs</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity building of local government staff</td>
<td>Province level livestock staff</td>
<td><strong>Aquaculture</strong></td>
<td>The strengthening of national and local capacity in the techniques for the extension of aquaculture and fisheries.</td>
</tr>
<tr>
<td></td>
<td>National level coordinating staff</td>
<td>− Training in basic warmwater aquaculture techniques</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Training in basic coldwater aquaculture techniques</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− (including simple pond construction, basic pond economics, on farm feeds preparation and feeding, harvesting and water management)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Training in organization of groups and initiating group pilots of aquaculture</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Identification and mobilization of communities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Simple marketing strategies</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Fisheries</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Identification and mobilization of communities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Training in organization of groups and initiating community management of aquaculture</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Community fishery organization − basic management plans, boundary demarcation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Conflict resolution</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>− Fingerling transportation and stocking techniques (for warmwater &amp; coldwater species)</td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>Target beneficiaries</td>
<td>Activities/inputs</td>
<td>Remarks</td>
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</tr>
</tbody>
</table>
| Adaptive research / additional advisory inputs   | National capacity/knowledge base Development organizations National line agencies | - Clarification of water use regulations under law and customary/local management in both rivers and irrigation systems. Rights and rules and abstraction regulations. If necessary policy level clarification could be sought.  
- Comprehensive market study for fish products in provinces (including some basic market chain descriptions and costs). Demand, seasonality.  
- Identification of potential on-farm and off-farm feed resources.  
- Specific targeting of communities which utilize fishery resources for potential entry points.  
- Technical advisory input to hatchery development/reconstruction  
- Simple hatchery design and operation for entrepreneurs  
- Simple extension materials developed (ideally based on the experiences and outcomes of farmer trial activities. | Will strengthen understanding of the potential and feasibility of fish culture in Afghanistan.  
Clarification of the types of intervention and areas/environments where aquaculture development may be allowable/possible.  
Provide a national information resource for interested entrepreneurs to initiate aquaculture activities. |
### ANNEX II - SCIENTIFIC AND LOCAL NAMES OF FISH SPECIES IN AFGHANISTAN
*(note: “Mahi” means “fish”)*

<table>
<thead>
<tr>
<th>Local name</th>
<th>Name</th>
<th>Comment</th>
<th>Purchase</th>
<th>Sell Fresh</th>
<th>Sell Cooked AFg/KG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lakha mahi</td>
<td>Amu river catfish – Silurid type catfish in appearance possibly <em>Siluris glanis.</em>&lt;br&gt;&lt;br&gt;Varyingly identified – black Lakha is well but the white variety may be <em>Wallago attu</em> or similar.</td>
<td>Highly prized and excellent price – the most expensive fish. This could be bred and could also be produced in ponds with appropriate feeds for carnivorous species. White and black varieties recognized. The white catfish can reach over 250 kilos</td>
<td>200</td>
<td>250</td>
<td>142-157 180-200 200-220 250</td>
</tr>
<tr>
<td>Zaghara mahi</td>
<td>Riverine carp/barb&lt;br&gt;Possibly the Bulatmai barbel <em>Barbus capito capito</em></td>
<td>Grows well in ponds and seems able to breed in them. Cold tolerant and also survives high altitudes. Fingerlings reasonably easy to obtain – moist likely candidate for aquaculture</td>
<td>220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zaghara mahi (2)&lt;br&gt;Karpoor (Herat)</td>
<td>Common carp</td>
<td>Found in aquaculture and referred to by the name of the indigenous species (see above).</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Tayara mahi</td>
<td>Assumed to be grass carp (might also be confused with large <em>Tor</em> spp.?)</td>
<td>Grows fast and tastes good. Large size imported from Uzbekistan. Size up to 10-12 kg</td>
<td>180</td>
<td>190</td>
<td>142-157 180-200 200</td>
</tr>
<tr>
<td>“Silver”</td>
<td>Silver carp <em>Fatoor Faq</em> (Herat name)</td>
<td>Large fish (1-2 kg) imported from Pakistan. Sometimes referred as Shir mahi, but is not the native by the same name). Fingerlings also imported. Grows in greenwater but does not do well in small ponds.</td>
<td>120</td>
<td>100-120</td>
<td>160</td>
</tr>
<tr>
<td>Mar mahi</td>
<td>Snakehead, Channa (orientalis, gachua or punctata) spp</td>
<td>Stocked into aquaculture ponds but poorly fed. Needs high protein type feed but could be easily made with on farm ingredients.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shir mahi</td>
<td>Aral Barbel?&lt;br&gt;<em>Barbus brachycephalus brachycephalus</em>&lt;br&gt;or <em>Barbus capito conocephalus</em></td>
<td>Preferred river fish and common in the market with good price. Performance in pond unknown. Barbels (in the carp family), said to be of the species, are found in streams both north and south of the Hindu Kush. The name most probably came about because of the milky white underbelly of the fish in southern Afghanistan (it is yellow in the north). This tasty but bony fish is perhaps the most commonly found and eaten all over the country.&lt;br&gt;&lt;br&gt;Shir Mahi in market reach up to 5-7 kg.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
### THE POTENTIAL FOR AQUACULTURE DEVELOPMENT IN AFGHANISTAN

<table>
<thead>
<tr>
<th>Name</th>
<th>Species/Description</th>
<th>Notes</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chapat</strong></td>
<td>A small bream.barb&lt;br&gt;Carp bream?</td>
<td>Used to feed carnivorous species and is rather low in price.</td>
<td>14</td>
</tr>
<tr>
<td><strong>Surkh Dom</strong></td>
<td>unknown</td>
<td></td>
<td>78</td>
</tr>
<tr>
<td><strong>Zaghara mahi</strong></td>
<td>unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Loqmoak mahi</strong></td>
<td>unknown</td>
<td>Used as feed for other species.</td>
<td></td>
</tr>
<tr>
<td><strong>Shim mahi</strong></td>
<td>unknown</td>
<td>Stocked into a pond in Balkh district but obtained from Amu river.</td>
<td></td>
</tr>
<tr>
<td><strong>Regh mahi</strong></td>
<td>Amu Darya sturgeon&lt;br&gt;<em>Pseudoscaphirhynchus kaufmanni</em>&lt;br&gt;Literally &quot;Sandfish&quot;</td>
<td>Amu river. Very popular and highly rated to eat.</td>
<td></td>
</tr>
<tr>
<td><strong>Khol mahi</strong></td>
<td>Brown Trout&lt;br&gt;<em>Salmo trutta</em></td>
<td>Found in the wild in rivers, prized as a delicacy.</td>
<td></td>
</tr>
<tr>
<td><strong>Mahi-e-khalda (see above)</strong></td>
<td>Brown Trout&lt;br&gt;<em>Salmo trutta</em></td>
<td>A sub-species of brown trout (<em>Salmo trutta oxenesus</em>) swims in streams north of the Hindu Kush</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rainbow trout&lt;br&gt;<em>Oxyrhynchos mykiss</em></td>
<td>Introduced to several fish farms for culture (Quarga Dam and Bamiyan Trout farm)</td>
<td></td>
</tr>
<tr>
<td><strong>Moree</strong></td>
<td>Mrigal&lt;br&gt;<em>Cirrhinus mrigala</em></td>
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<td></td>
</tr>
</tbody>
</table>
ANNEX III - BIBLIOGRAPHY

- Afghan Government website, projects search (search terms: “fish”, “aquaculture”, “fish culture”, “fish farming”)
- FISHBASE (www.fishbase.org)