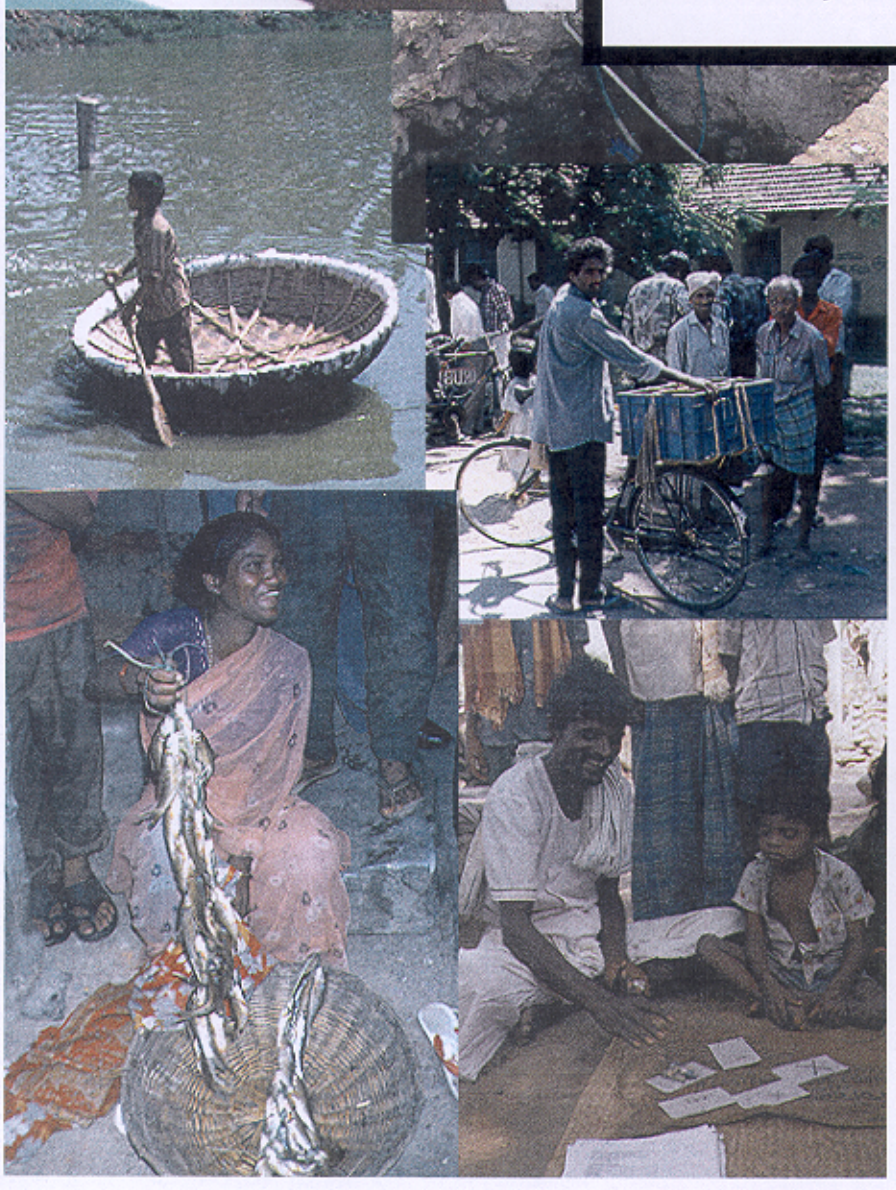

Working Paper No. 5
(July 1998)

On-farm Resources for Small-scale Farmer-managed Aquaculture in Raichur District, Karnataka, India

Aquaculture in Small-scale Farmer-managed Irrigation Systems
Funded by DFID Aquaculture Research Programme

Institute of Aquaculture
University of Stirling
Scotland, UK

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List of Working Papers

Project Summary Report

1. Raichur District: Site for a Study of Aquaculture Development in the Semi-arid Tropics
2. Methods for Participatory Information Gathering and Analysis
3. Socio-economic Analysis of Villages in Relation to Aquaculture Potential in Raichur District, Karnataka, India
4. Investigation of Gender Issues in Relation to Aquaculture Potential in Raichur District, Karnataka, India
5. On-farm Resources for Small-scale Farmer-managed Aquaculture in Raichur District, Karnataka, India
6. Inland Fisheries Resources and the Current Status of Aquaculture in Raichur District and Karnataka State, India
7. An Investigation of Aquaculture Potential in Small-scale Farmer-managed Irrigation Systems of Raichur District, Karnataka, India
8. Indigenous Freshwater Fish Resources of Karnataka State and their Potential for Aquaculture
9. Institutional Linkages of Relevance to Small-scale Aquaculture Development in Karnataka State, India
10. Fisheries Marketing, Demand and Credit in Raichur District, Karnataka, India

Project background

The arid and semi-arid tropics are areas in urgent need of development. As a home to a large proportion of the world's poor these regions face a future of scarcity of food and insufficient water for consumption and irrigation of crops. It has been predicted that India and Sri Lanka will face a fresh-water crisis in the near future, and as much water is currently wasted due to inadequate management and conservation practices there is a need for more integrated approaches to water management. The majority of India's surface water bodies are used primarily for irrigation. Although large-scale irrigation systems cover more surface area and supply a greater area of farmland, more farmers are dependent on small-scale systems for their daily livelihood. Irrigation systems are often very inefficient water distribution systems, and studies suggest that the efficiency of water use could be improved. The integration of aquaculture (which can be non-consumptive in terms of water use) has the potential to increase food production and improve the efficiency of the use of small-scale irrigation water resource.

These Working Papers are the first stage of the research project 'Small-scale farmer-managed aquaculture in engineered water systems' (DFID project R7064). The project aims to investigate the potential for integration of aquaculture into small-scale farmer-managed irrigation systems in arid and semi-arid regions of India and Sri Lanka. Intended beneficiaries include the rural poor, which in India belong to the Scheduled Castes (SCs)[1] and Scheduled Tribes (STs)[2]. This part of the project focuses on Karnataka State on the south west of the Indian peninsular.

During the research, the economic and technical feasibility and the social acceptability of the production of fish in such systems of arid and semi-arid regions of Karnataka were investigated. Field research took place from 6 April to 21 May 1998 and included a 'Rapid Rural Appraisal' of four villages in Raichur District, Karnataka, and semi-structured interviews with representatives from the Government Department of Fisheries, marketing organisations, academics and other relevant institutional sectors within the state.

All fieldwork was undertaken in collaboration with the NGO Samuha, an organisation undertaking wide-ranging activities in the arid and semi-arid areas of Karnataka State. Samuha has extensive experience within participatory development and its initiatives range across health, disabilities, women's development, HIV/AIDS, education, animal husbandry, drinking water and sanitation, irrigation and watershed development (Pradeep, 1994). The majority of the work of Samuha is carried out in the districts of Koppal and Raichur with a smaller project in Bangalore. The activities of Samuha are supported by a number of bodies: ActionAid; OXFAM; the Swiss Development Cooperation; the Government of Karnataka and the Government of India as well as individual donors.

The results and analysis are presented in the ten Working Papers listed above. For an overview of the content of each of the Working Papers, see the Summary Report. This series of working papers have been produced principally as a resource for a stakeholder workshop to be held in Coimbatore, 19th - 20th November 1998. Conclusions and the research agenda are therefore preliminary.

[1] SCs: lower castes identified by the Indian government as a means of classifying castes for the allocation of benefits.
[2] STs: all tribals. SCs and STs together constitute the 'socially and educationally backward classes of citizens'. The terms form the basis for policies of protection and positive discrimination.

Glossary

CIFA	Central Institute for Freshwater Aquaculture
DFID	Department for International Development (formerly ODA)
DoF	Department of Fisheries
Kharif	The first growing season (June-October)
NGO	Non-governmental Organisation
ODA	Overseas Development Agency (now DFID)
PRA	Participatory Rural Appraisal
Rabi	The second growing season (November-March)
RRA	Rapid Rural Appraisal
Rs	Indian unit of currency
SC	Scheduled Caste
ST	Scheduled Tribe
1ha	2.4 acres

Summary

1. The current Indian Department of Fisheries (DoF) recommendations include the use of large amounts of off-farm inputs (c. 84% of production costs) for aquaculture. In addition, manure is considered a 'free' and abundant resource by the DoF and the Central Institute for Freshwater Aquculture (CIFA) (the main research centre for inland aquaculture in India). Since high off-farm input costs are unlikely to be afforded by resource-poor farmers, this case study looks at on-farm resources and their availability and use within the farming system. The research required to support recommendation regarding aquaculture systems which make use of on-farm resources are considered here.

2. The most important cereals grown in the research villages are millets and sorghum (both on dry and irrigated land) and maize (irrigated land only). Pulses include red, green and horsegram (all on dry and irrigated land) and the major oilseeds are groundnut (irrigated land), and sunflower (dry and irrigated land). Vegetables are grown on irrigated land only and include aubergine, onion, garlic, chilli, tomato, cucumber and ladies finger. Millets and sorghum are mainly used for consumption, whereas crops such as sunflower and groundnut are sold in markets. Livestock fodder include sorghum and millet stover and groundnut husks, which are also used for fuel.

3. Livestock kept in the villages include cows, buffaloes, oxen, goats, sheep and chicken. Cows, buffaloes and goats provide milk, and goats, sheep and chicken are eaten. Oxen are used for draft work and organic fertiliser is obtained from cows, buffaloes, oxen and also goats to a minor exent. Furthermore all livestock can be sold and thus provide an additional income for the farmer

4. Rainfed (kharif) crops are grown on un-irrigated land, whilst crops are grown in irrigated areas both during kharif and rabi seasons. Sowing takes place June to July (kharif) and December to January (rabi), and crops are harvested in September to November (kharif) and in February (rabi). Overall the farmer is busiest in the rainy season and least busy in the winter, and most credit is available in the summer.

5. Of the resources present in the area, several are suitable as inputs for aquaculture. Possibilities include supplementary feeding using the crops or by-products on-farm such as silk worm pupae and wastes, and duckweed. Although generally thought to be of more use on land than in aquaculture, organic fertilisers can be used for ponds. Inorganic fertilisers are currently widely used in the area for field crops, and their strategic use in aquaculture is also a possibility.

6. Most resources have a number of uses and the flow of resources is likely to become more intricate should aquaculture be introduced. Aquaculture would compete for resources with other uses, and further studies are needed before the impact of introducing aquaculture into the farming system can be reliably assessed.

7. Recommendations for further research include the effect of the introduction of aquaculture on the flow of farm resources as well as detailed cost-benefit analysis of aquaculture options in the area. Furthermore it is recommended that crop residues suitable for use as supplementary feeds in semi-intensive systems are investigated.

On-farm Resources for Small-scale Farmer-managed Aquaculture in Raichur District, Karnataka, India

Table of Contents:

1 Introduction 1
2 Methodology 1
3 Crops and livestock 1
4 Potential resources for aquaculture 3
4.1 Labour 3
4.2 Crops and residues 3
4.3 Fertilisers 3
5 Resource flow 3
6 Potential impacts of the introduction of aquaculture 3
7 Recommendations for further research 4
References 8
Appendix 1: Statistical analysis of livestock uses 9

List of Tables:

Table 1: Main crops grown in the research villages and their uses 2
Table 2: Livestock kept in the research villages and their uses 2
Table 3: Summary table of resources, major competing uses and research questions 7

List of Figures:

Figure 1: Seasonal chart of farm resources and activities 5
Figure 2: Resource flow diagram 6

1 Introduction

This Working Paper describes the on-farm resources present in the project area. The target group of this project are subsistence farmers of the semi-arid tropics. As these have limited access to credit and resources, any aquaculture development is most likely to develop as a low-input activity integrated within the farming system. Such development could shift the use of available resources and affect other sub-systems. This paper therefore focuses on the on-farm resources available in the project area and their current major uses in the farming system. Common field crops and livestock are described first along with their major current uses, before the seasonality of the farming system is outlined. Potential resources for use in aquaculture are then considered in more detail, and a generalised flow of resources within the farming system described, and the potential effect of introducing aquaculture on the resource flow discussed.

2 Methodology

Rapid Rural Appraisal (RRA) was carried out in four villages in Raichur District, Karnataka. These are listed in Box 1 and can be seen on the map in Working Paper 1. Village group meetings were held in each of the villages and the major crops and livestock in the area and their uses were identified. Individual farm walks and semi-structured interviews with farmers were conducted, and the uses of crops and livestock were ranked or scored in order of importance for farmers. Working Paper 2 contains details on the statistical analysis of the ranked and scored data.

Box 1: Research villages in Raichur District.

Village name	**Taluk**[3]
Jumlapur & Ainapur	Kushtagi
Chikkawankalakunta	Yelbarga
Pai Doddi	Lingsugur
Mallapur	Deodurg

3 Crops and livestock

The main crops grown in the different villages and their uses can be seen in Table 1.

The vegetables grown include aubergine, chilli, cucumber, garlic, okra and tomato. Most of the major market crops are grown exclusively on irrigated land, which means that they can only be grown by relatively wealthier farmers (see Working Paper 3). However as outlined in Working Paper 9 there are various government and NGO schemes aimed at helping poorer farmers (SCs[4] and STs[5] mainly) to build farm ponds and open wells. Common property water resources (e.g. tanks) where they are used for irrigation (see Working Paper 6), provide some farmers without ponds or wells an opportunity to irrigate their land.

[3] Taluk: sub-administrative region

[4] SCs: lower castes identified by the Indian government as a means of classifying castes for the allocation of benefits.

[5] STs: all tribals. SCs and STs together constitute the 'socially and educationally backward classes of citizens'. The terms form the basis for policies of protection and positive discrimination.

Table 1: Main crops grown in the research villages and their uses. Importance: * = least; * = most). For livestock consumption and fuel only hay or husks are used. Irrigated land (IL) yields two harvests (kharif and rabi) and dryland (DL) only one (kharif).**

	Consumption	Market	Fodder	Fuel	Land type	Notes
Cereals:						
Sorghum	***	*	**		IL & DL	Major crop in all villages
Millet	***	*	**	*	IL & DL	Major crop in all villages
Maize		***		*	IL	Jumlapur, Ainapur and Chikkawankalakunta
Wheat	**	**			IL	All villages
Pulses:						
Red gram	*	*	*	*	IL & DL	All villages
Green and horsegram	*		*		IL & DL	All villages
Oilseeds:						
Groundnut		***	**	*	IL	All villages
Thill	*	*		*	DL	All villages
Sunflower		***		*	IL & DL	Not in Mallapur
Cotton		***			IL	Rare
Vegetables	**	***			IL	All villages

Table 2 shows the main livestock kept and their major uses.

Table 2: Major uses of the main livestock kept in the four project villages. Cow and buffaloes were grouped together because their uses were the same.

Livestock	Major use	Lesser use
Cow & buffalo	Milk	Salable asset
	Organic fertiliser	Manure for house construction
	Manure for fuel	
Ox	Draft work (ploughing, pulling carts etc.)	Salable asset
	Organic fertiliser	Manure for house construction
	Manure for fuel	
Goat	Milk	Salable asset
	Meat	
	Organic fertiliser	
Sheep	Meat	Salable asset
Chicken	Meat	Salable asset

The uses of different types of livestock were ranked and scored in Chikkawankalakunta and Pai Doddi villages, but no significant differences between the important of different uses were found (see Appendix 1 and Working Paper 2 for details of analysis). On several occasions pigs were observed in the villages as well, but no villagers interviewed owned any and there was general agreement that only very few, low caste individuals ever eat pig (it seemed to be considered to be just about as 'unclean' as eating beef). This may be because scavenging pigs may be utilising human waste as a feed.

Goldey *et al.* (1996) report significantly different views on resource use between men and women from a PRA/RRA study carried out in Nepal. In the present study no gender division could be detected in the resource use data. Men and women both agreed on the major uses of the crops and livestock and analysis of the ranked data for the uses of livestock in Chikkawankalakunta and Pai Doddi indicated no difference between men and women (see Appendix 1).

As can be seen from Table 1, most crops have multiple uses and very little is wasted. The main uses of the different types of livestock are shown in Table 2. From here it is evident that manure is used not only for fertilising the fields, but also as fuel and to a lesser extent for the construction of houses. If part of the manure was to be used for fertilising ponds or wells for fish farming, it could mean that less was available for fertilising fields and for fuel, resulting in declines in fertility and yields. Most

farmers use chemical fertilisers for parts of the year (see Figure 1), but it is unlikely that there is a surplus of manure to be used for fertilising fishponds. However because aquaculture could provide valuable protein and possibly extra income, it may be beneficial for the individual farmer to allocate some of the farm resources for this purpose.

4 Potential resources for aquaculture

The introduction of aquaculture would impact on the farming calendar. Fish seed and sufficient water for aquaculture are only available at certain times of the year, and these do not always coincide. Similarly time and availability of credit to buy seed or fertiliser vary with season.

4.1 Labour

The seasonality of the farming system is depicted in Figure 1, both men and women are most busy during the months of the kharif harvest, and least busy during the summer season. However many farmers migrate to other taluks for work in June, September and October. Overall it seems most labour is available for aquaculture during the summer season (February – May).

4.2 Crops and residues

Composting of vegetable and plant residues could be encouraged, or these could be fed directly to fish where applicable. Supplementary feeding carried out by fish farmers visited in a nearby irrigated belt usually consisted of rice husk and oil seed cake.

Crops are harvested February and September to November (Figure 1), and thus the majority of crop resources will be available at these times, which is also when the farmer has most credit available for investment in aquaculture (see Working Paper 3).

4.3 Fertilisers

Animal manures may be of most benefit to land crops, having less effect on the growth of phytoplankton (Cresswell, 1992). The biological loading of manure can be considerable and its effect on the oxygen budget must be considered. Social taboos also constrain the use of manure. In a Bengali refugee camp in the southern part of Raichur, human excreta was added to fishponds. However, local non-Bengali, villagers were reluctant to eat cultured fish because the fish were considered to be polluted.

Inorganic fertilisers (high inputs of di-ammonium phosphate and ammonium phosphate) are widely used on kharif crops in the project villages. Some of these inputs will inevitably leach into the pond and this may explain the high phosphate levels encountered (see Working Paper 7 for a discussion of water quality in the region). The use of inorganic fertilisers is a highly effective way of stimulating primary (green and blue-green algae) production in ponds. Studies have shown that the net profit of feeding with fertiliser alone was over double that of a fertilised pond also receiving supplementary feed (Bafru/ODA, 1989).

In irrigation ponds much of the fertiliser input would find its way directly back onto the fields in the enriched water. In addition, pesticides are also widely used in the area, and the leaching of these must be considered as a potential constraint.

5 Resource flow

Figure 2 was constructed from interview data, and is an example of a typical resource flow diagram for farmers in the area. As can be seen almost all resources have multiple uses, and as many of them might also be used for aquaculture this could alter the flow of the different resources greatly. Data will be required so that farmers can make informed choices about resource use.

6 Potential impacts of the introduction of aquaculture

In Table 3 the major resources which could potentially be used for fish farming, their main competing uses and key research questions arising from this are shown.

The use of irrigation wells or ponds for aquaculture may prevent farmers from using the water for drinking[6], bathing and washing clothes, with implications for drinking water collection, impacting mainly on women. For further discussion about the uses of water bodies, see Working Paper 7.

To establish the effect of introducing fish production to farm resource-flow, it would be useful to construct resource flow diagrams for existing small-scale aquaculture systems. A comparison of the uses of different resources in systems with and without aquaculture could give an indication of the changes that the introduction of fish production may bring about.

7 Recommendations for further research

1. The effect of the introduction of aquaculture on the flow of farm resources needs further investigation. One way of doing this would be to create resource flow diagrams for farms where aquaculture is already established and compare these to the situation before aquaculture was established or to a farm with no aquaculture.
2. An inventory of the suitability of the different crops in the villages as semi-intensive feeds should be constructed, and the costs of alternative solutions such as the use of silk-worm wastes, or the inclusion of duckweed into the water bodies should be established.
3. Detailed cost-benefit analysis of the various aquaculture options in the area should be carried out and further research carried out on systems that are thought to be viable.
4. Stocking ponds with grass carp should be considered since these can increase the organic input into ponds considerably (Shepherd 1992). Grass carp is also an early spawner, which would help the stocking of seasonal water bodies (Working Paper 7).

[6] In water scarce areas pond water is used for drinking.

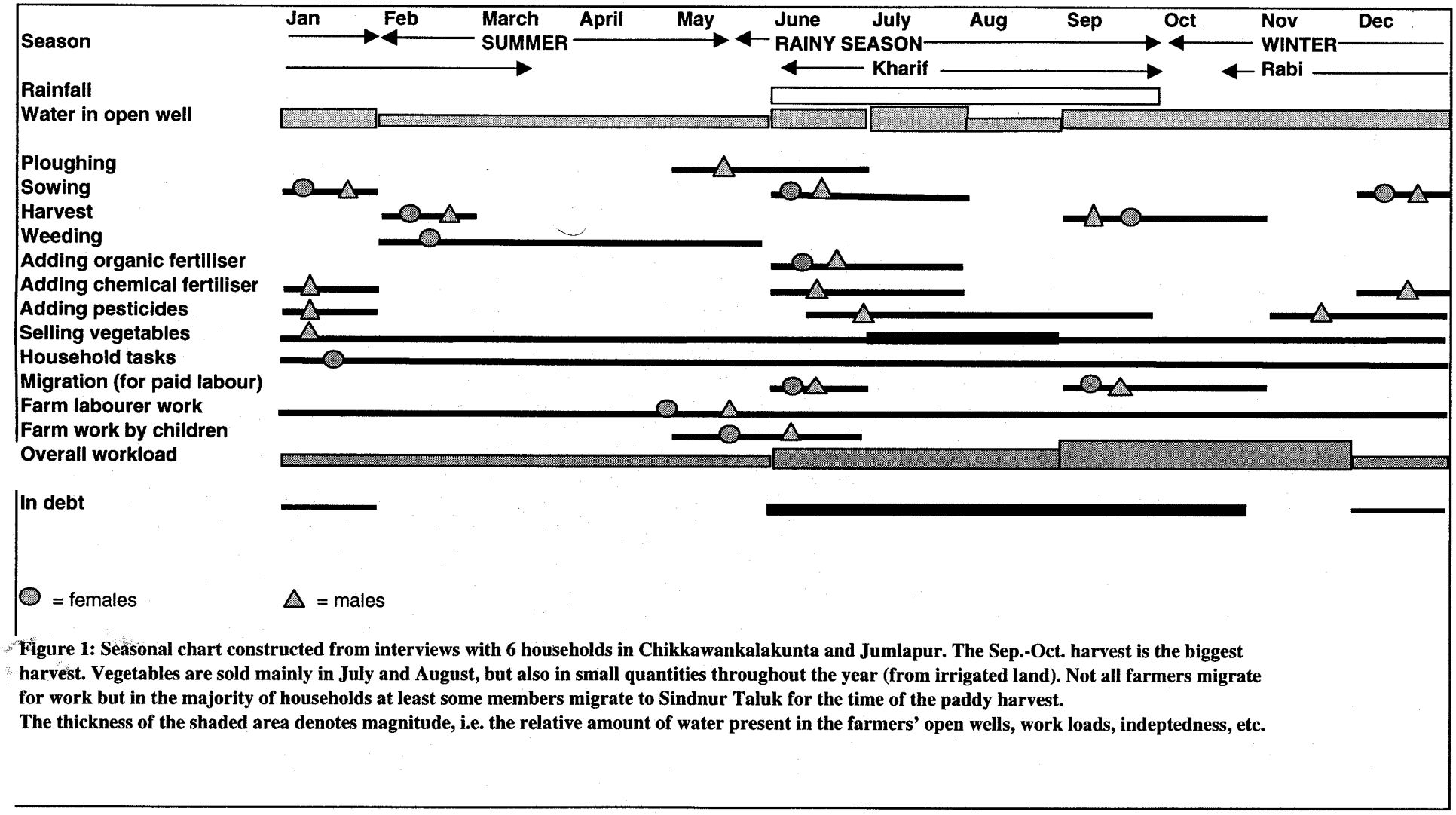

Figure 1: Seasonal chart constructed from interviews with 6 households in Chikkawankalakunta and Jumlapur. The Sep.-Oct. harvest is the biggest harvest. Vegetables are sold mainly in July and August, but also in small quantities throughout the year (from irrigated land). Not all farmers migrate for work but in the majority of households at least some members migrate to Sindnur Taluk for the time of the paddy harvest.
The thickness of the shaded area denotes magnitude, i.e. the relative amount of water present in the farmers' open wells, work loads, indeptedness, etc.

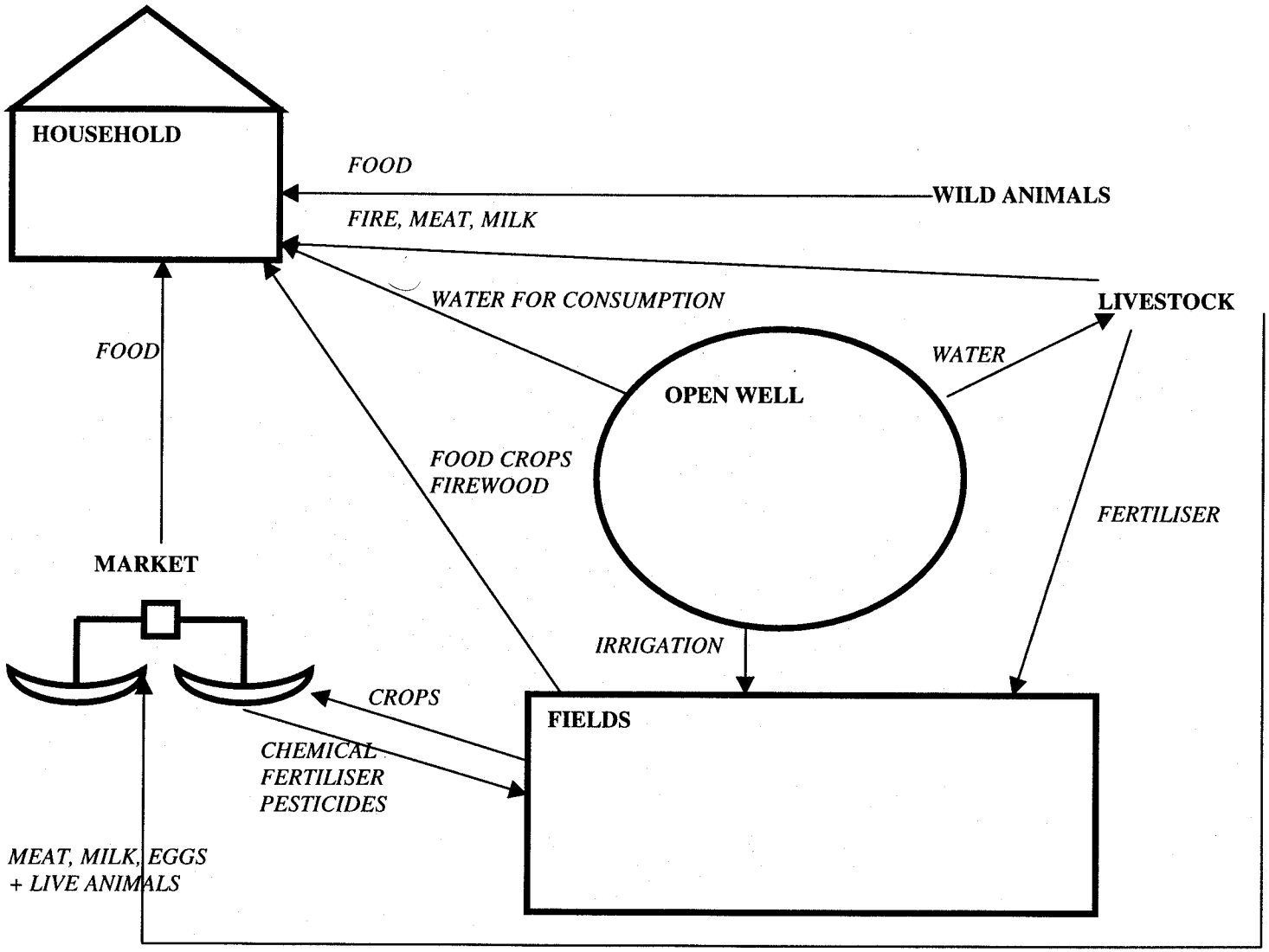

Figure 2: Resource flow diagram for Hanumappa Gouda, 25 April 1997, Chikkawankalakunta. Arrows denote direction of flow of resources listed next to arrows. For an outline of which crops and livestock are used for what purpose, see Tables 1 and 2.

Potential resources for aquaculture	Main competing uses	Key research questions arising
Manure	Fertilising of terrestrial crops	- Are there any periods of the year where manure is not used to fertilise fields and therefore would be available for aquaculture? - Detailed nutrient flow description for livestock and people.
Crop residues	Livestock fodder Fuel	- What is the relative importance of crop residues and grazing as fodder for different types of livestock? - How important are crop residues as fuel compared to other types of fuel such as wood?
Inorganic fertilisers	Terrestrial crops	- Exactly how much money do farmers currently spend on inorganic fertilisers? - What is the relative importance of inorganic compared to organic fertiliser? - How much inorganic fertiliser would be needed for the farming of fish in ponds or wells, and would the cost of this be affordable for the farmer?
Water	Drinking water, washing clothes and bathing	- How close are alternative drinking water resources (e.g. village common wells) to individual households? - To what extend would the introduction of aquaculture extend the time spent collecting water for individual households? - How many users would be affected if community water resources such as check dams are used for aquaculture, and would alternative water resources of adequate quality be available for all of these? - Could aquaculture be integrated with the other uses, e.g. by the provision of separate storage for water for drinking and washing clothes?
Credit	Investment into agriculture	- Detailed assessment of the income and expenditure of individual farms is needed in order to provide idea of when most credit is available for aquaculture investment. - If farmers have few or no resources for investment into aquaculture activities at times when ponds should be stocked (beginning of rainy season), would alternative (private or institutional) credit be available? - Would farmers consider investing resources into a new and untried activity such as aquaculture, and if so, what impact would this have on the investment into agriculture?
Labour	Farm-work or migratory work	- Assessment of the additional workload associated with the introduction of fish farming, and whether the existing workforce could manage this or farm-labourers have to be employed. - Cost/benefit analysis of the profitability of some family members carrying out aquaculture rather than migratory work or of employing farm-labourers to carry out aquaculture activities.

Table3: Resources which could be used for aquaculture, their main competing uses and suggestions for further research. For detailed description of the different types of small-scale farmer-managed water bodies considered, see Working Paper 7, and for further information about credit and expenditure, see Working Paper 3.

References

Bafru/ODA (1989) A guide to carp culture in Bangladesh.

Cresswell, R. (1992) Aquaculture desk reference. Van Nostrand Rheinhold N.Y.

Goldey, P; Martin, A.; Marcus, R. & Le Breton, S. (1996) Approaches to address gender specific needs in relation to access to technological change. ODA/NRSP Socio-Economic Methodologies (SEM) Workshop 29-30 April, 1996. 42pp.

Jauncey, K. (1997) MSc Aquaculture nutrition course notes: Stirling University IoA.

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Appendix 1: Statistical analysis of livestock uses

Following the recommendations outlined in Working Paper 2, Friedman's non-parametric two-way analysis of variance was carried out on ranks. Calculations used are detailed in Working Paper 2, where the tables used can also be found. In the section below, F_r refers to the Friedman test statistics, df to degrees of freedom, and p to the significance level of the result (a significance level of α=0.05 was used).

An outline of the statistical tests carried out for each village is shown in the following. For each village ranks and scores were compared when both available, and on the basis of their correlation, one of them were selected for the test. Because scores contain more information (Lawrence *et al.*, 1997) they were generally preferred, and those which did not correspond to their equivalent rank (for the same criteria by the same farmer) were discarded. In cases where only scoring had been carried out and no ranks were available for triangulation, the scores were assumed to correctly reflect the opinion of the farmer. However in some cases (mainly in Pai Doddi village) ranks and scores by the same farmer for the same criteria differed widely. In such cases it was assumed that the ranks were correct (because this technique is easier to understand) so all ranks were analysed (regardless of whether they corresponded to their equivalent scores or not) and scores discarded. The selection procedure for each ranking and scoring exercise is outlined in the following under the appropriate villages.

Chikkawankalakunta

Tests for the uses of livestock:

Ox: Data included 3 ranks and 3 scores (all from the first visit), of which 2 do not correspond. Ranks used for test

Fr	2.60
df	3
p	>0.05

No significant priorities.

COW: 3 ranks and 3 scores, 1 not corresponding. Decided to use ranks for same reason as above.

Fr	2.93
df	4
p	>0.05

Not significant, but cannot test for gender as all males and cannot test for wealth groups as all belong to the same wealth group.

Pai Doddi

Data available for cow/buffalo, ox and goat/sheep.
COW/BUFFALO: 7 ranks and 5 scores, of which 1 correspond. It was decided to use ranks for reasons as above.

Fr	1.63
df	3
p	>0.05

No significant priorities for the use of cow/buffaloes.
Only one woman was present in the group of respondents, and in the following she was excluded and analysis carried out for men only.

Fr	2.60
df	3
p	>0.05

No significance found, so analysis was carried out for different wealth groups.
Present were 2 farmers from wealth group 2 (who do not agree), 1 in group 3, and 4 in wealth group 4:

Fr	6.9
df	3
p	>0.05

Again no significance.

OX: For ox data included 3 ranks and 1 score (which corresponded), and ranks were used again.

Fr	4.67
df	2
p	>0.05

Test shows no significant priorities for the uses of oxes. The three ranks are from 1 woman and two men, and so tests could not be carried out for gender sub-groups. However from examining the data it was obvious that there was no agreement between the men. Incidentally the men belong to the same wealth group and so there is no agreement within this wealth group either.

GOAT/SHEEP: For goat/sheep data included 6 ranks and 5 scores, of which 2 of the ranks are from the same farmer (for goat and sheep) and 1 does not correspond. It was decided to use ranks as before.

Fr	4.33
df	2
p	>0.05

Test showed no significance. Only one woman was amongst the respondents and from examining the data from the men, it was obvious that there was no agreement at all. As for wealth sub-groups, 2 individuals belong to wealth group 2 (and do not agree) and another two belong to wealth group 4 and show total agreement.