Department for International Development

Field Evaluation Of A Systems Based Approach To The Reduction Of Blowfly Infestation Of Traditionally Processed Fish In Tropical Developing Countries.

Project R7971 / ZD0054

Final Technical Report

John R. Esser, Alan T. Marriott, Venkatesh Salagrama

October 2003

Mike Dillon associates Ltd

PHFRP POST HARVEST FISHERIES RESEARCH PROGRAMME

ICM Integrated Coastal Management

DFID Post Harvest Fisheries Research Programme

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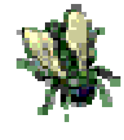

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Acronyms and Abbreviations

ai	Active ingredient
DFID	Department for International Development of the United Kingdom
dwb	Dry weight basis
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
MRL	Maximum Residue Level
MOU	Memorandum of Understanding
m/s	Metres per second
RH	Relative Humidity
Rs	Indian Rupees (approximately Rs65 to £1 Sterling)
spp.	Species
UNIDO	United Nations Industrial Development Organisation
WHO	World Health Organisation of the United Nations

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1.0 EXECUTIVE SUMMARY

1.1 Project Purpose

The project purpose was to complete the development of a prototype blowfly control strategy that is appropriate for use by resource - poor fish processors in tropical countries, and produce related training / extension materials. Field evaluation, involving collection of technical, socio-economic and cost-benefit analysis data, allowed the strategy to be validated and modified to meet the needs of small-scale traditional fish processors in coastal states of India. The strategy was developed to provide a viable alternative to the current practice of using insecticides to control blowfly infestation of traditionally cured fish.

1.2 Project Outputs

(i) **A refined blowfly control strategy that is flexible, allows for seasonal variations and offers processors a choice of control measures to suit their individual circumstances.** The systems based strategy was field tested in India at 18 small-scale processing sites in 3 locations - 2 in Andhra Pradesh and 1 in Orissa. 24 processing cycles were monitored under both monsoon and dry season conditions. Field trials data collected during the monsoon showed real benefits resulting from application of the systems based approach. Infestation and loss levels experienced by processors using the systems based interventions were consistently lower than those experienced by control processors. Since completion of the field trials, it has been reported that the processors are continuing to use the interventions introduced by the project.

(ii) **Cost benefit and social impact analysis of control measures contained in the strategy.** The processors, who came from the more disadvantaged in Indian society, proved keenly aware of the economic benefits associated with the systems based approach. When capital costs are included in the cost/benefit analysis, using best assumptions for asset life and local interest rates, the operations of processors using the interventions remain profitable. Financial appraisal suggests that the investment is desirable in business terms, but poor processors have limited access to financial capital. If investment funds were available, as a grant or at concessionary rates of interest, the interventions would be very attractive to processors.

(iii) **Training pack disseminated and adopted by trainers.** A trainer's guide to controlling blowfly infestation of traditionally processed fish and accompanying video have been produced and are being disseminated. An extension strategy has been developed for implementation by the State Fisheries Department of Andhra Pradesh and other stakeholders.

(iv) **In-country capability to address problem of blowfly infestation strengthened.** A counterpart project team has been established and trained in the systems based strategy, collection of socio-economic and technical field data and management of field trials.

The project goal was to bring benefits to poor people through the development and dissemination of a sustainable management system to reduce blowfly infestation and losses of traditionally processed fish. The systems based approach has been refined to meet the needs of poor, small-scale processors and validated in terms of its technical and cost-effectiveness. Potential constraints to the adoption of blowfly interventions by processors have been identified and are addressed in an extension strategy developed by the project team. Poor fish processors and consumers of traditionally processed fish should benefit from the research outputs in terms of livelihood security, income, nutrition and reduced exposure to harmful insecticides.

2.0 BACKGROUND

Traditionally processed fish is a nutritionally and economically important commodity in many tropical, developing countries. Fish are processed by curing, which involves salting, drying, smoking or a combination of these treatments. Extended product shelf-life is obtained by reducing the water activity of the product and consequently inhibiting the growth of spoilage microorganisms.

Throughout processing and early storage, fish are exposed to infestation by blowflies (Diptera: Calliphoridae). Infestation is a significant cause of post-harvest losses in the traditional fish processing industry, exacerbated by the basic, unhygienic conditions under which much of the fish is processed, particularly at the small-scale level. Gravid female blowflies are strongly attracted to the fish, where they oviposit in the mouth, gills, body cavity and between muscle bands. Larvae hatching from the egg masses feed on the fish flesh, so causing physical losses and deterioration of quality. Recently, infestation has been shown to also occur through secondary routes, whereby larvae move onto the fish from alternative food sources, such as fish waste and other organic debris, which are common sites for oviposition (Johnson and Esser, 1996).

Whilst few detailed, quantitative studies of insect related losses of cured fish have been carried out, losses of 25% are thought to be common and in some instances, where no preventative measures have been employed, losses in excess of 90% (Young and Esser, 1992) have been recorded. Such frequent and extensive losses cannot be sustained and so some processors have responded to the problem by applying unsuitable, toxic household and agricultural insecticides directly to their fish, jeopardising not only their own health, but also the health of fish consumers. Products such as DDT and lindane, which are organochlorines and thus accumulate in the body, and the acutely toxic dichlorvos and phosalone, are in widespread use (Walker, 1987). Of additional concern, is the use of kerosene as a carrying agent in some insecticide formulations routinely used by fish processors (Walker, 1986).

A range of methods of infestation control have been developed and promoted for use at fish processing sites over the past 15 - 20 years. These include, amongst others, the use of solar driers, mesh screens, erected over drying racks to prevent gravid females from gaining access to the fish, improved salting methods to render the fish unacceptable to ovipositing blowflies and feeding larvae, and the application of approved food-grade insecticides.

Numerous attempts have been made to introduce solar driers to fish processors in the tropics, but in most cases they have been unsuccessful (Walker and Wood, 1985). Curran *et. al*., (1985) evaluated a solar drier in the Gambia, but found that attempts to control the internal temperature by adjusting the amount of ventilation, allowed blowflies to enter, thereby offering no advantages over sun-drying. Doe *et. al*., (1977) evaluated a simple polythene tent drier in Bangladesh and found it to be effective in controlling blowfly infestation, but there have been no reports of commercial processors subsequently adopting the method.

Field trials, conducted at a fish processing site in West Java, demonstrated that fitting a fly-tight lid to the fish salting tank was completely effective in preventing blowfly infestation during salting (Esser, 1991). A simple mesh screen was evaluated in Thailand and found to be effective in controlling blowfly infestation during drying without significantly reducing fish drying rates (Esser, 1994). However, socio-economic constraints indicated that voluntary adoption of screens by fish processors would be unlikely.

During the early 1980s' it was generally believed that treating fish with salt provided protection against blowfly infestation (FAO, 1981). Subsequent field observations and laboratory studies refute this belief. Esser (1990) reported that the oriental latrine fly (*Chrysomya megacephala*) readily oviposited upon and infested fish in south east Asia, both during and after the salting stage of processing. Laboratory investigations demonstrated that, in the absence of choice, *C. megacephala* will readily oviposit on fish with salt contents of 30 - 40% (dwb) and that salt contents in excess of 39.5% (dwb) are necessary to effect a significant increase in larval mortality rates (Esser, 1991). This tolerance to high salt concentrations was also observed in the Calliphorid *Lucilia cuprina-cuprina* during trials conducted in Thailand (Esser, 1994), and, more recently, some blowfly and fleshfly species associated with fish losses in African countries, have been demonstrated to exhibit an equivalent tolerance to salt (Johnson and Esser, 1996). Although it would be possible to modify traditional processing techniques to obtain salt concentrations that are sufficient to control infestation, it is most unlikely that the resulting high salt product would be acceptable to processors and consumers of salted dried fish.

Of the commercially available insecticides that have been evaluated as protectants against blowfly infestation of fish, only the organophosphorous compound pirimiphos - methyl is approved for use on fish by FAO / WHO. Trials conducted in Indonesia (Esser and Hanson, 1990), Malawi (Walker and Donegan, 1984) and the Gambia (Walker and Evans, 1984), showed pirimiphos-methyl to be generally effective at low concentrations, safe when used correctly and economic to apply. However, the rate of uptake of the active ingredient (a.i.) by the fish is dependent upon fish size and chemical composition. Thus, what is an effective application for one fish may be inadequate or excessive in another. During trials conducted in Thailand, Esser (1994) reported that goatfish (*Parupeneus pleurospilus*) of mixed size, which had been batch dipped in 0.03% a.i. pirimiphos-methyl, contained residues ranging from 1.63 to 16.80 mg/kg. The maximum residue level (M.R.L.) for pirimiphos methyl in fish is currently set at 10 mg / kg. Given that most fish processors simultaneously process a range of fish species of different sizes, it is unfeasible to recommend a single treatment regime that would result in all fish receiving sufficient insecticide to control infestation while at the same time meeting M.R.L. requirements. Until these technical limitations, along with associated political and socio-economic factors have been addressed, pirimiphos methyl cannot be regarded as a long -term remedy to the problem of insect infestation of fish in tropical countries.

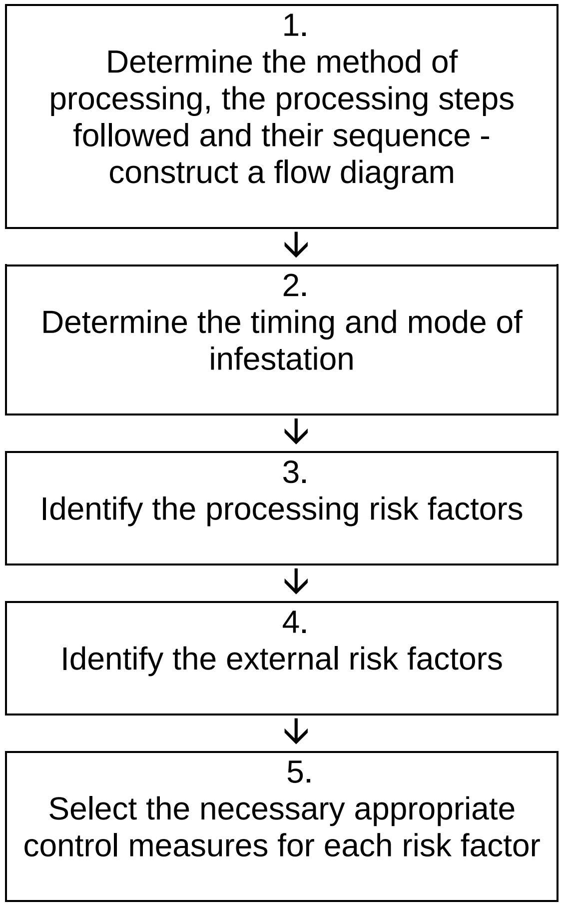
Despite extensive research and promotion of remedial techniques, uptake of recommended control measures by fish processors has been poor and so insect infestation of traditionally processed fish remains a major cause of losses. The apparent failure to successfully promote recommended control measures is generally attributed to two factors. The first is socio-economic, whereby implementation of the suggested measures may be too costly or culturally unacceptable. The second is poor extension of research findings to the fish processors. Whilst the first is difficult to overcome, the second can be improved with good training of extension workers and better incentives.

The success of the control measures must, however, also depend upon a detailed understanding of the various modes of infestation, and the influence of external factors, such as climatic variations, fish species processed, processing practices followed and insect species present, on infestation patterns and levels. Information relating to these variables has been accrued, and their importance in influencing infestation patterns has become apparent. It appears that a reduction in insect infestation of traditionally processed fish may only be achieved by developing a systematic and holistic control strategy that is adaptable to the many different fish processing systems and takes into account limiting socio-economic factors.

The systems based control strategy was a principal output of DFID project R6824 "Adaptation of a Systems Based Approach to Insect Control." The design of the strategy was fully informed by the findings of the comprehensive review of insect infestation (Johnson & Esser, 2000), which was also an output of the project. The review revealed that a crucial limitation of the control measures currently in use, was that none of them tackled the underlying cause of infestation. It also became apparent that despite the considerable body of work on insect control measures, no systematic studies on the modes and influences of infestation had been conducted. The review indicated that effective and sustainable control of infestation is only likely to be achieved if a more systematic approach, that fully takes into account infestation modes, external factors and variations in processing parameters, is used. The resulting strategy is flexible, fully transferable, sensitive to changes in infestation pressure and fish processor friendly.

The idea of a systematic approach is to study when, how and why the fish has become infested, and then to select an appropriate method of controlling the infestation based upon these findings. The strategy is applied by conducting an on-site infestation audit, which follows the five simple steps shown in Figure 1.

Figure 1. Summary of infestation audit



1. *Determine the method of processing, the processing steps followed, and their sequence*

A systematic approach involves studying exactly when the fish are becoming infested, and what processing risk factors may be influencing the infestation. It is therefore necessary to determine exactly how the fish are processed, including what order the processing steps are carried out in.
The simplest way to identify and describe how the fish are processed is to draw a flow diagram of the process.

2. Determine when in the process the fish are being infested, and by what mode

It is important to find out when the fish is becoming infested. It is possible that the infestation is occurring at more than one point in the process, or even before the fish arrives at the processing site.
Using the process flow diagram as a guide, samples of the processor's fish should be examined at each processing stage for signs of blowfly eggs and larvae. The earliest stage in the process where blowfly eggs or larvae are found on the fish is the point at which

the infestation has first occurred. If there are fresh egg batches or egg cases present on the fish at a later stage, or if larvae of different ages, or sizes, are infesting the fish, it is possible that the fish is being infested at more than one point in the process. It is also important to find out what mode of infestation is occurring. It is possible that both direct and indirect infestations are occurring at the same processing point, or at different points.

3. Consider which processing risk factors may be influencing the infestation

As many processing practices can influence infestation, it is important to consider whether any of the practices being followed may be risk factors.
Each of the processing practices up to and including the point in the process where the infestation last occurred should be considered to see if the practices may be influencing the infestation.

4. Consider which non-processing risk factors may be influencing the infestation

As some external factors can influence infestation, it is important to consider whether any of these factors are occurring at the site.

5. Select the necessary, appropriate control measures

Having determined when, how and why the infestation is occurring, it is possible to select control measures, which are appropriate to combat the type of infestation occurring.
In general, the number of control measures needed to control the infestation will depend upon:

- the number of processing points where the infestation occurs
- whether the infestation occurs through both modes
- how many processing risk factors are involved
- how many external risk factors are involved

Sometimes, a single control measure will prevent infestation caused by a number of risk factors. For example, fish processed with their heads on are more at risk of direct infestation. However, screening the fish during sun-drying will prevent all direct infestation, and so it may not be necessary to behead the fish as well.
When selecting control measures, it is important to decide whether all the control measures recommended are necessary to combat the infestation.

Sometimes, there may be more than one control measure, which is suitable for controlling the infestation occurring at a site. In other cases there may be constraints to applying a particular control measure.
The choice of control measure should therefore take into account:

- the type of process being carried out
- the availability of the control method
- the economic cost to the processor
- any social or cultural constraints.

If it is not possible to apply all of the necessary control measures, a high level of control should still be achieved if the processor selectively applies recommended control measures to combat the infestation caused by other factors.

The systems-based control strategy offers fish processors a flexible and sustainable way of controlling blowfly infestation of their products. By providing processors with the means to select control measures appropriate to their particular circumstances, a high level of control may be achieved. The combination of important benefits afforded by the strategy should aid its extension and widespread adoption by cured fish processors in different countries.

3.0 RESEARCH ACTIVITIES AND OUTPUTS

3.1 Introduction

Project activities commenced in April 2001, when the project leader and socio-economist made their initial visits to India.

The terms of reference of the initial visits were to:

- Formally agree a memorandum of understanding (MOU) with the project partners
- Survey traditional fish processing sites in Andhra Pradesh and Orissa to collect relevant socio-economic and technical data
- Train counterparts in the systems based control strategy and data collection techniques
- Design protocols for future field trials
- Agree a programme of work for the field researchers.

The responsibilities of the project partners in implementing the project were discussed and formally agreed in a MOU and a local project team was established. A programme of field trials was agreed and draft field trial protocols (Appendix I) were developed.

The local team received training in the biology of blowfly infestation, application of the systems based blowfly control strategy and socio-economic and technical field data collection and analysis. Two members of the counterpart team were identified as the project field researchers with primary responsibility for collecting the field trials data.

3.2 Initial Survey of Processing Sites

The team conducted a survey of 22 fish processing villages located in Andhra Pradesh and Orissa. Semi-structured interviews were held with fish processors and background information collected on processing techniques, losses caused by blowfly infestation, remedial measures in use, fish processing costs and the socio-economic milieu within which processors operate.

A range of fish species were being processed at the time of the survey. These included anchovy, sardine, mullet, queenfish, ribbon fish, shark, sea perch, Indian mackerel, scad and ponyfish. Fish is processed according to availability, which varies with season.

Small fish e.g. sardines and anchovies were processed whole, whereas large fish e.g. sea perch were split and gutted before salting. Fish were either brined or pickle cured, depending on species or individual processor. Brine was made up of solar evaporated salt and water drawn from the village well. Concrete vats, urns, hollowed out bases of tree trunks or plastic lined holes in the ground were used for salting. Palmyrus leaves, plastic sheeting or, occasionally, concrete lids provided by an earlier fisheries development project were being used to cover the entrances of the salting containers. Fish were usually salted overnight, although the salting period was extended during wet weather. After salting, the fish were usually placed on coir mats, old fishing net and/or palmyrus leaves spread on the ground and left to dry. Sometimes, concrete drying platforms or raised drying tables were used. Drying period was reported to be two to three days. Fishing nets were occasionally suspended above the fish to protect them from scavenging birds.

Being the dry season, there was little evidence of blowfly activity at the time of the survey, although houseflies (*Musca domestica*) were abundant. Occasional blowflies (*Chrysomya megacephala)* were observed on drying fish and there was some evidence of blowfly infestation. In one case, a batch of drying anchovy was observed to be heavily infested with Diptera larvae as a consequence of a few days of unseasonal rain. The processor reported that the fish was no longer fit for human consumption and would be sold for animal feed at a reduced price.

Processors invariably reported blowfly infestation to be a serious problem during the monsoon, particularly during extended periods of wet weather. Infestation often results in the fish being thrown away. Remedial measures employed by processors included using more salt during the monsoon, re-salting infested fish, washing fish or manually removing blowfly larvae. In one village, processors routinely de-gilled fish as an infestation control measure. Some processors reported sprinkling the insecticide Gamexin (a.i. DDT) around the fish during periods of high blowfly activity. At one location, processors were observed applying an aqueous solution of the insecticide Nuvan (active ingredient dichlorvos) to the fish. Subsequent visits revealed insecticide misuse to be widespread, with Nuvan and Lindane being the most commonly used types. Neither insecticide is approved for use on fish products.

The fishing villages visited in Andhra Pradesh were generally inhabited by a single caste, i.e. a traditional fishing caste. Fishing related activities dominated the economies of villages, entirely in most of the small villages, although there were small enterprises such as pickle making. In Uppada, the largest fishing village in the area close to Kakinada, weaving was found to be a significant second element in the local economy (perhaps 30%) with a smaller sector engaged in other activities. All the residents belonged to the same caste.

In Andhra Pradesh, the small-scale fish processors, both entrepreneurs and paid workers, were exclusively women. Most had male relations engaged in fish catching, either as boat owners or crew.

Most of the fish processing activity in the villages visited was part of a chain of activities situated entirely within the small-scale / artisanal sector: Fresh fish was bought on the local beach and sold at a retail market in the locality. However, there was some purchase of raw material from the industrial fishing sector e.g. from Vizhakapatnam (Vizag) for processing at Timmapuram, and from Kakinada for processing at a number of villages nearby. There was some grossing up of dried fish into larger lots for longer distance transport and sale but ‘wholesaling’ activity of this sort was exceptional, most processors took responsibility for retailing their own product.

Market forces were seen to control fish processing activities. In general, prices were determined by supply and demand through competitive markets. This was especially true in areas closer to urban markets in Kakinada, Vizakhapatnam and other towns. The villages on the Godavari delta e.g. Mulletimoga and Kothapalem, were much less accessible and perhaps less exposed to the full rigour of the market, but the construction of a road to those villages may be expected to open them up more.

The dominance of the market applied to both the purchase of fresh fish and the sale of dried fish. This was the case, even for purchases of fresh fish by the processor from fishermen in the same family. Social pressures were said to exclude any discriminatory treatment. Fish catchers hold village meetings and at least some aspects of the organisation of fishing appeared to be determined collaboratively (e.g. day off each week). There was no evidence of cartels among fish processors.

The links that fish processors have with money lenders appeared to be strictly commercial, i.e. money lenders do not have a dual financier/trader role. This is not to say that money lenders are not prepared to make concessions on the terms of loan repayment at times of difficulty. They are, but concessions such as this are not part of an implied contract, which affects commercial fish trading. In contrast, in fish catching, traditional ties between fishermen and trader/financiers are important.

Fish processing appeared to be a capitalistic enterprise: business expenditure and income entirely cash/money driven. Therefore, in principle, the sector lends itself to quantitative analysis.

There was no traditional fishing caste in Orissa, where fishing activity was carried out by recent entrants. They comprised (i) migrants from Andhra Pradesh (approximately 50% the fisherfolk of the state), (ii) migrants from West Bengal (30%), and (iii) local agriculturalists who have transferred into the new sector (20%). The communities lived separately, although as at Puri/Konark, in close proximity to one another.

The traditional gender allocation of activities among the Bengali and Oriya speakers was not necessarily the same as among the Telegu speakers – men undertook processing in some cases.

The coastal area of Orissa was seriously affected by the extremely severe hurricane of 1999. The fisheries sector suffered significant loss of life, particularly of fishermen, and capital equipment, both fishing boats and processing equipment. The effective delivery of external support for the regeneration of the industry has proved to be problematic with some external donors slow to honour their pledges, distribution within the state being difficult, and discriminatory treatment of Oriya and non-Oriya fisherfolk alleged.

The fishing villages visited in Orissa were larger and more accessible, both to supplies from small-scale and industrial fleets and to the market. Local small-scale catches were used at all the villages visited. Supplies from the trawler fleet were bought for small-scale processing at Paradeep for example.

There was evidence of larger scale marketing outlets for the dried fish with some long distance transport and sale. This included sales to the north - eastern states where a Cuttack based organisation has developed a market.

3.2.1 Initial Conclusions

- Most traditional fish processing in the region is conducted by resource poor, mostly female, small scale / artisanal fish processors

- Blowfly infestation and associated losses are frequently reported by fish processors to be major problems during the monsoon season

- Most processors appear resigned to seasonal losses and take little action to prevent them

- Processors in both Andhra Pradesh and Orissa rely on the use of inappropriate insecticides to protect their fish from infestation when blowfly activity is high

- Fish processing appears is a capitalistic enterprise, entirely driven by market forces

3.3 Selection of Processing Sites for Field Trials

The selection of sites was determined by a number of factors, such as village size, representative nature of fish processing operations in each area, number of people dependent on fish processing, the importance of fish processing to the community during monsoon periods (when blowfly infestation is at its highest), supply of fish throughout the year (particularly during monsoons), access of the processors to consistent alternate sources of fish (such as trawlers) in order that lack of fish landings in the village did not disrupt field research work, knowledge that exists on the villages as a result of previous work done by other development projects, the rapport between the researchers and the processor groups in the village and potential for market growth (based on improved quality of products). Three villages were selected for the field trials – Uppada, which is located nearby Kakinada in Andhra Pradesh; Timmapuram, which is located approximately 25 km north of Vishakhapatnam in Andhra Pradesh, and Shandakud, which is located on the outskirts of Paradeep in Orissa. Six processing sites, 3 control (those not using blowfly control interventions) and 3 experimental (those using blowfly control interventions) were selected in each village. Processors were profiled according to age, gender, educational background, size of operation, number of employees, processing technique, understanding of infestation issues etc. Wherever possible, control and experimental processors were paired according to similarity.

3.4 Field Trial Protocols

During the course of the fieldwork, 5 series of trials (2 in Uppada, 2 in Timmapuram and 1 in Shandakud) were carried out. In Uppada and Timmapuram, trials were conducted during both monsoon and dry seasons. Due to operational difficulties, the trials in Shandakud were restricted to the monsoon season.

Before selection of processors and commencement of field trials, sensitisation meetings were held with the fish processors and wider community to explain the purpose of the research and obtain initial feedback on processing activities and problems caused by blowfly infestation. Following profiling and selection of processors to participate in the trials, infestation audits were conducted at each processing site. The infestation audits (Appendix II) were informed by a combination of direct observations and on-site interviews with the fish processors. Further meetings were held to discuss the nature of the problem and possible interventions. The experimental processors were then invited to select from a menu of interventions which included speeding up initial processing, washing fish twice, plastic sheeting, sharper knives, improved hygiene practices, more frequent brine changing, salting tank lids and frames, drying racks and drying trays (Appendix III). Although the project provided the physical interventions, the processors themselves were fully involved in their design. The field researchers remained on-site throughout the field trials, monitoring activities, obtaining feedback and collecting technical and socio-economic data. Technical data included fish species, weights, temperature, relative humidity, wind speed, fish drying rates, brine strength, blowfly activity, infestation levels and downgrades. Socio-economic data included: caste, household size and structure, education of members, daily work schedule, personal time line, costs and revenues associated with fish processing and other business expenses and revenues.

The templates used for field data collection are given in Appendix IV.

On completion of each series of trials, meetings were held to discuss stakeholder perceptions of the interventions and potential constraints to their uptake. The interventions were ranked in order of preference by the processors.

4.0 DATA COLLECTION METHODS

4.1 Technical Data

4.1.1 Environmental Data

At each processing site, regular temperature, relative humidity and average wind speed readings were taken using a hand held Kestrel 3000 environmental anemometer (Camlab Ltd, Cambs.).

4.1.2 Drying Rates

Drying rates were determined by weighing 6 labelled fish (2large, 2 medium, 2 small) in each batch at commencement of drying and thereafter at 2 hourly intervals using an Ohaus Scout CS-5000 portable top plan balance (range 5 kg, accuracy +/- 2 g).

4.1.3 Blowfly Activity

At each processing site, 3 sticky traps (15 X 20 cm) lined with sticky fly paper (AgriSense BCS Ltd., Pontypridd) were set up close to the drying area and left in position for the duration of the trial. At the end of drying, the blowflies were removed form the traps and immersed in solvent pending identification. Blowfly activity was also monitored by 2 hourly instantaneous counts on $1m^2$ samples of drying fish.

4.1.4 Infestation Levels

During each trial, 50 randomly sampled fish were examined for the presence of blowfly larvae on arrival at the processing site, after salting and at the end of each days drying.

4.1.5 Downgrades / Damaged fish

At the end of processing, each processor graded the fish as good quality, destined for human consumption, and poor quality animal feed. Both categories of fish were weighed using a spring balance scale.

4.1.6 Brine Concentrations

A simple hydrometer was placed in the brine to determine % saturation with salt.

4.2 Socio-Economic Data Collection Methods

4.7.1 Background Data

Data were collected to establish the social background, status and mode of operation of the processors. At a very general level the socio-economic structure of the villages was established by discussion with a small number of key informants. The demographic and social status of the specific processors participating in the trials was established through the data collectors interviewing the processors. Although interviewing could be an open ended process, it was found convenient to encourage the interviewers to use a checklist of topics to be covered.

4.7.2 Business Data

The processors were selected to give a range of sizes of business (large, medium, small) and roughly paired in terms of size between control and experimental processors. General information on the size of the business (amount invested, cost of the capital equipment used in processing, membership of organisations) was collected in the initial interview with the processor.

For each batch of fish dried, detailed data were recorded. These included, first, data on costs: the cost of fresh fish; and other costs (consumables like salt; ancillary expenses like transport; capital costs like vats and knives). Second, revenue data: revenue from sale of dried fish (in different batches if different products sold to different markets, e.g. in village, in distant urban market, as animal feed). Third, other business/livelihood transactions (e.g. earnings from employment, borrowings, lending) recorded together with an indication of their frequency. If any transactions, which were based on custom and not driven by, price they were noted (although there were none)

5.0 RESULTS & DISCUSSION

Of the field trials performed during the project, it was only those carried out in Uppada during the monsoon season of 2002 that were significantly affected by rain. During the other trials, environmental conditions were insufficiently challenging to provide a rigorous test of the effectiveness of the systems based strategy in reducing infestation. For this reason, and to avoid unnecessary repetition, discussion will focus on the results obtained during this series of trials, with the results of other trials being referred to where appropriate to provide illustration and comparison.

5.1 Monsoon Season Trials (2002) at Uppada

5.1.1 Environmental Data

Environmental data were collected during the course of 6 of the 11 trials conducted between 9 July and 4 September 2002. The remaining 5 trials were disrupted by rain, resulting in wet salted, as opposed to salted-dried product, being processed.

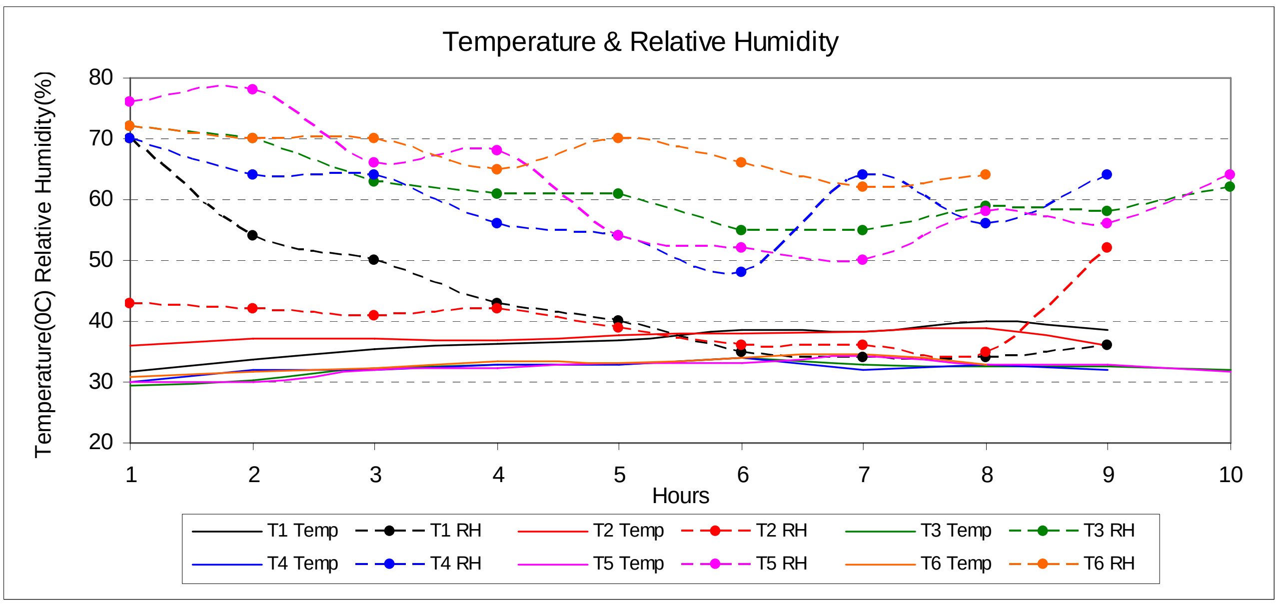


Figure 1. Air temperature and relative humidity values during trials conducted at Uppada, July - September 2002.

During the first two trials, conducted early July, air temperatures were mostly in the mid to high thirties and relative humidities were low, generally less than 50% (Fig. 1). Cloud cover was zero and wind speeds variable, ranging from about 0.5 to 3.5 m/s (Fig. 2). In effect, dry season conditions (a consequence of the delayed monsoon) prevailed. The monsoon proper, usually characterised by periods of heavy rains, interspersed with drier spells, commenced during the first week of August. Of the 9 trials conducted during this period, 5 were disrupted by rain. During periods when fish drying took place, air temperatures were in the low to mid thirties and relative humidities ranged from approximately 50 to 80%. Cloud cover was zero or light and wind speeds seldom exceeded 1.5 m/s.

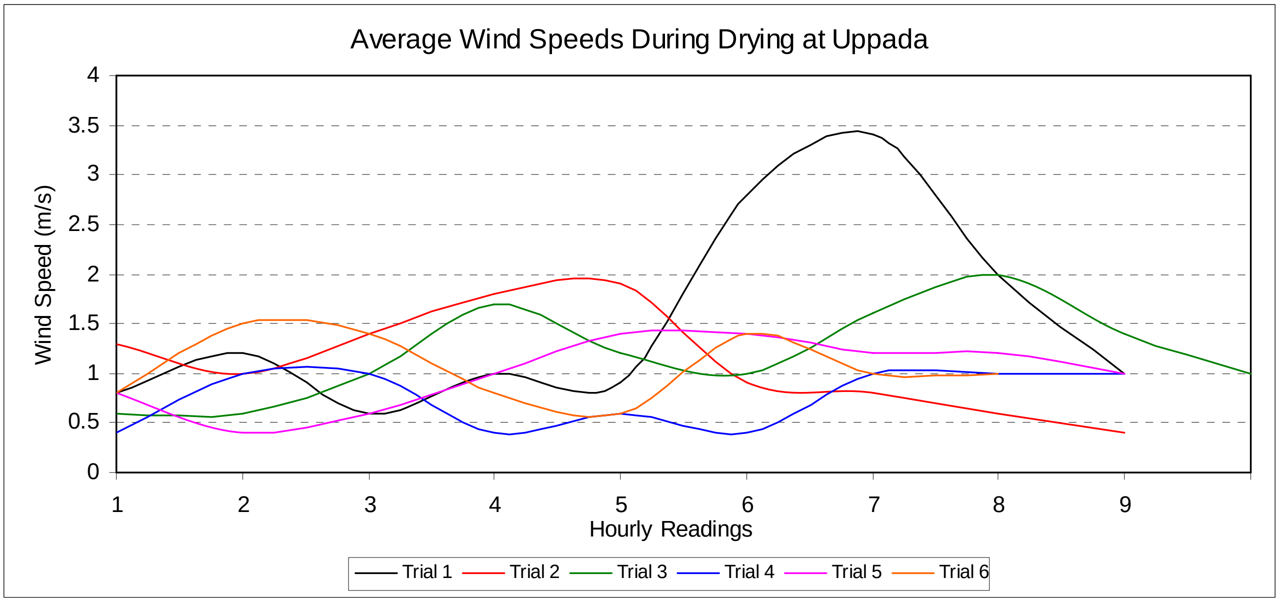


Figure 2. Wind speeds during trials conducted at Uppada, July - September 2002.

5.1.2 Fish Drying Rates

Drying rates were monitored at both control (C) sites, where fish were dried on the ground, and experimental (E) sites, where they were dried on raised drying racks. Drying curves, expressed as percentage weight loss against time, are given in Figures 3 – 8. Drying periods ranged from 6 to 16 hours. Fish drying is influenced by a combination of factors, including size, species, drying conditions, handling practices and processor preferences. It is not surprising, therefore, to find variations in drying rates of the same species of fish between both trials and processing sites. What is apparent, however, is that in 16 out of 18 cases, the drying rates of fish dried on drying racks were higher than those dried on the ground. Application of the Wilcoxon Rank Sum Test, a non-parametric significance test, based on the rankings of items from both samples combined, demonstrated differences in drying rates between experimental and control fish to be significant at the 5% level throughout the drying periods of all trials (Table 1). The processors were of the opinion that the rack-dried fish were organoleptically superior to those dried on the ground.

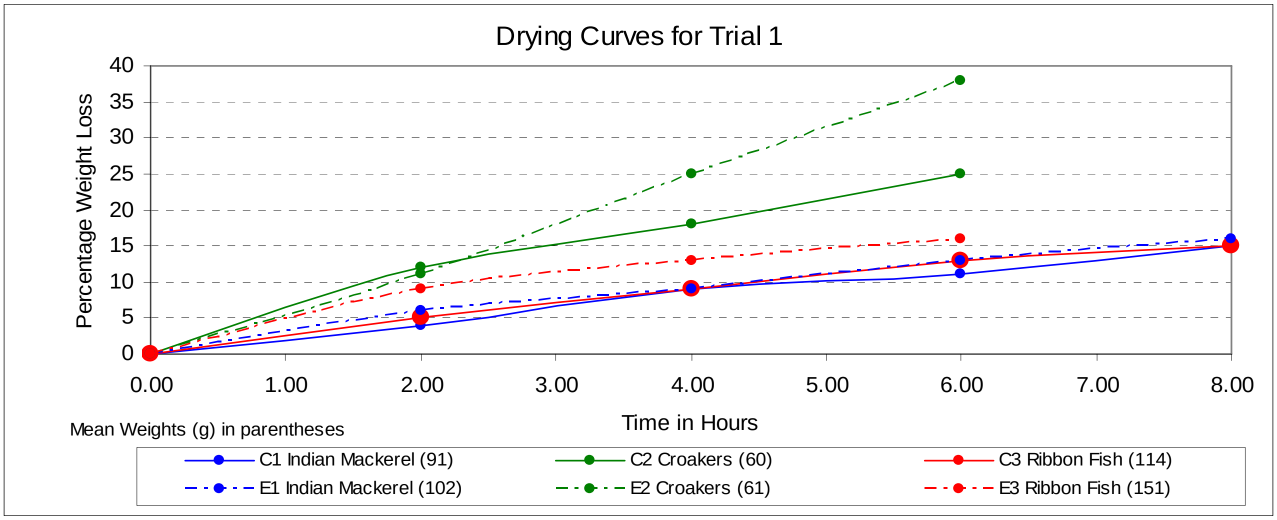


Figure 3

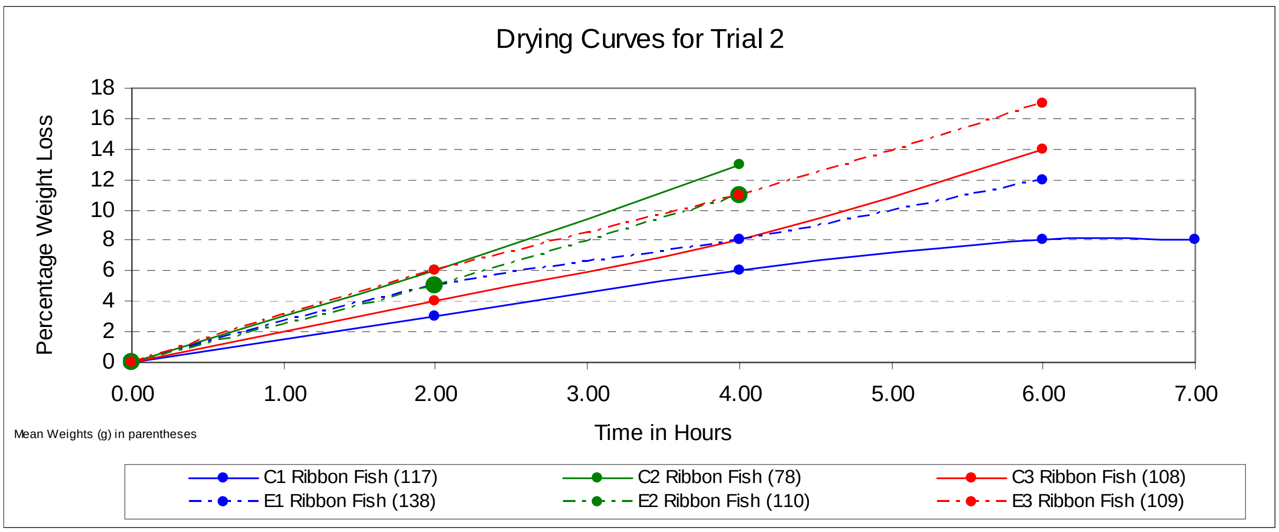


Figure 4

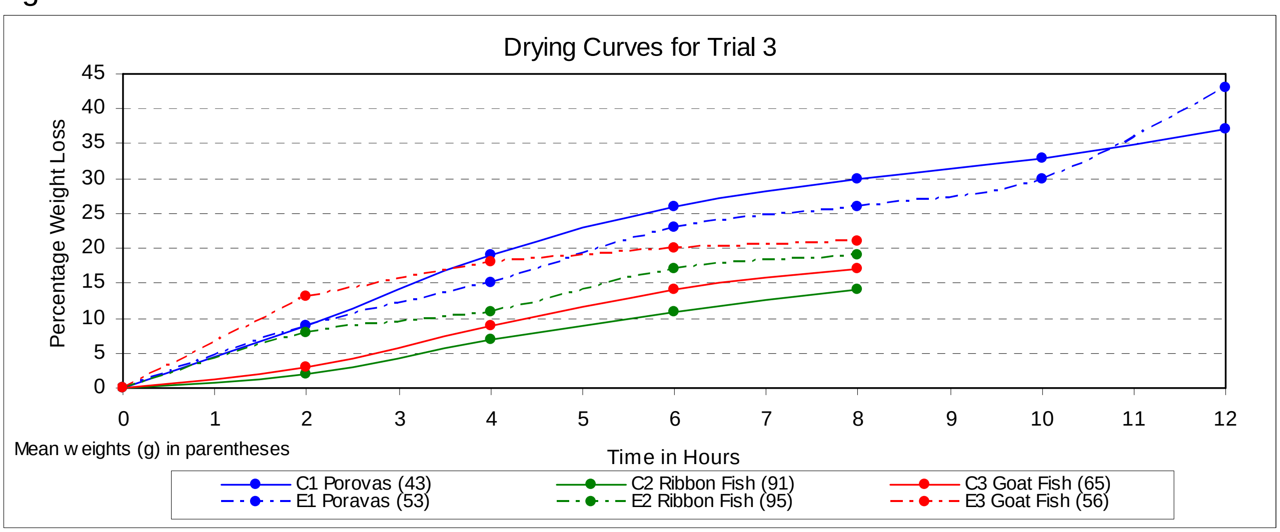


Figure 5

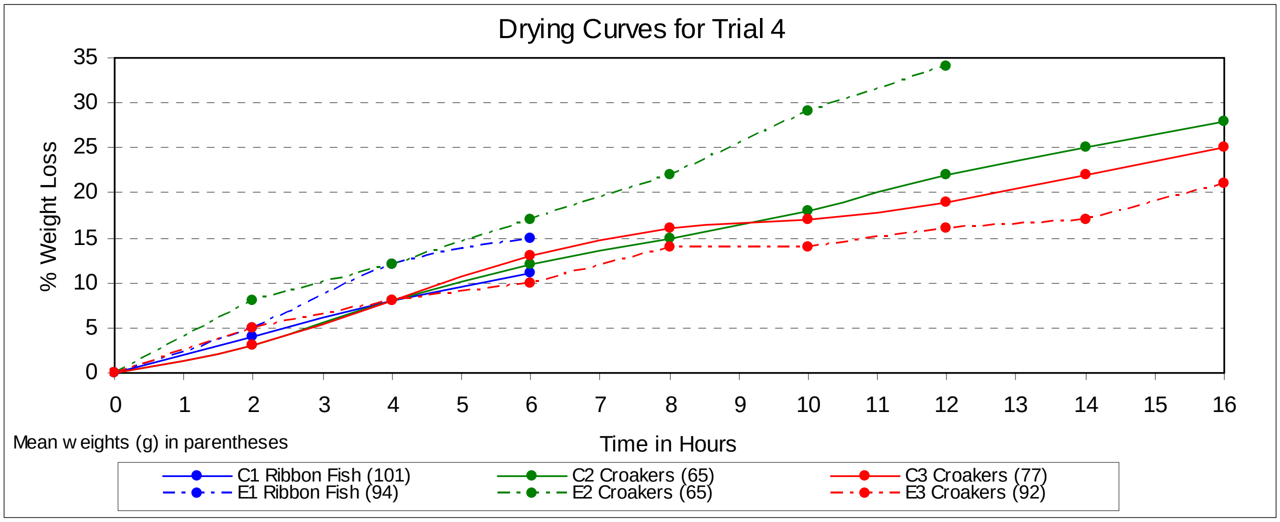


Figure 6

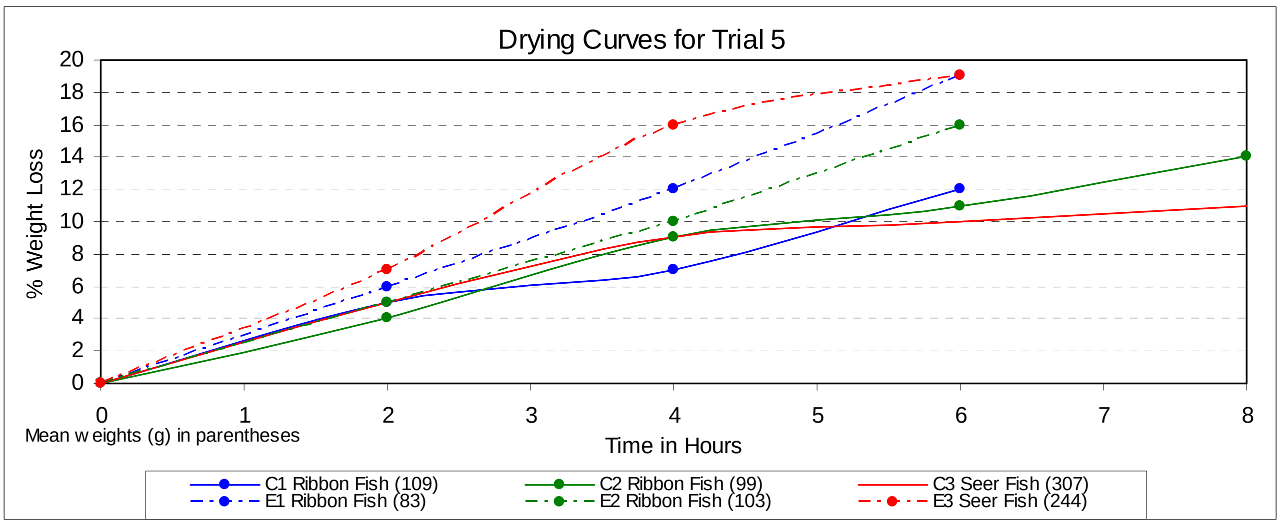


Figure 7

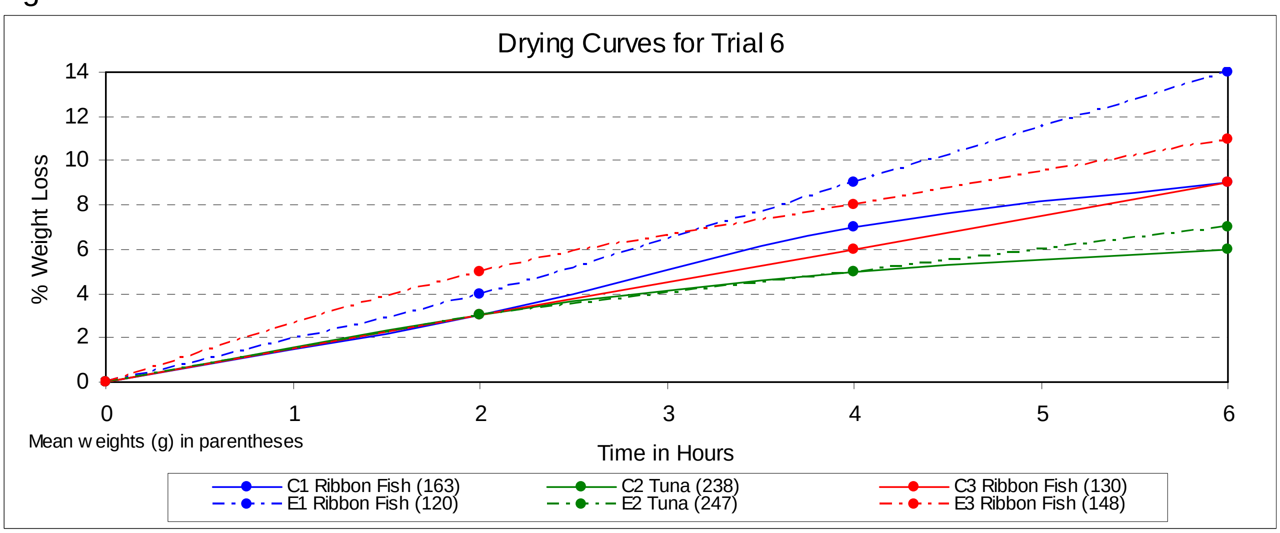


Figure 8

Table 1. Points during drying at which differences in drying rates of control and experimental fish were statistically different

Trial	Times at Which Weight Losses Were Recorded During Drying (hrs)			
	2	4	6	8
1	*	*	*	
2	*	*		
3	*	*	*	*
4	*	*	*	
5	*	*	*	
6	*	*	*	

* Significant at 5% level

5.1.3 Blowfly Activity

The blowfly population at Uppada was dominated by the Oriental Latrine Fly, *Chrysomya megacephala* (Fabricius). Adult females were significantly more numerous than males. *Chrysomya albiceps* ((Weidmann), *Lucilia cuprina* (Weidmann) and *Sarcophaga* spp. were also present.

Counts of blowflies trapped on sticky traps located at the different processing sites are given in Figures 9 and 10.

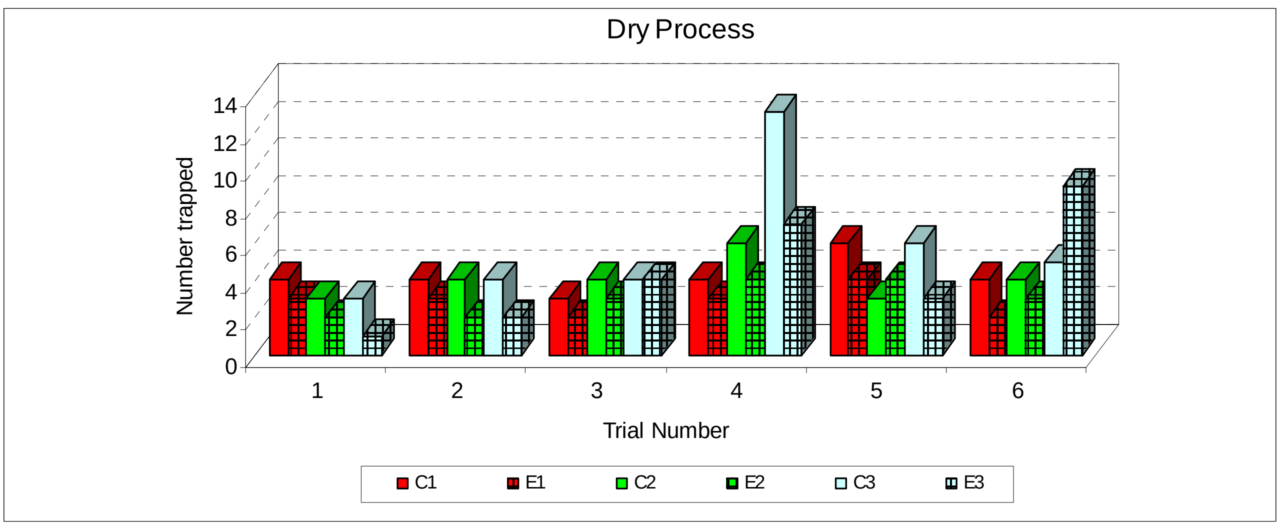


Figure 9. Blowfly counts during salted-dried fish processing trials

During the salted-dried fish processing trials, no statistical differences were demonstrated between blowfly counts at the experimental and control sites. However, Figure 9 shows that counts at the experimental sites were generally lower than those at the control sites. Although improved hygiene would be expected to make the experimental sites less attractive to visiting blowflies, any difference would be mitigated by the close proximity of the sites to each other.

Blowfly counts recorded during the wet salted fish trials (Fig. 10), when processing was disrupted by rain, indicate higher levels of blowfly activity than was the case during the salted-dried fish trials. Counts recorded at the experimental sites were significantly lower than at the control sites ($t=3.96$, $p<0.001$). It is during the salting stage that fermentation processes in the fish produce the volatiles that attract gravid female blowflies. The entrances to the salting tanks at the experimental sites were sealed with closely fitted lids, which would have been more effective in controlling the release of attractant volatiles than the loose palmyrus leaves used to cover the tanks at the control sites. This may have contributed to the lower levels of blowfly activity observed at the experimental sites.

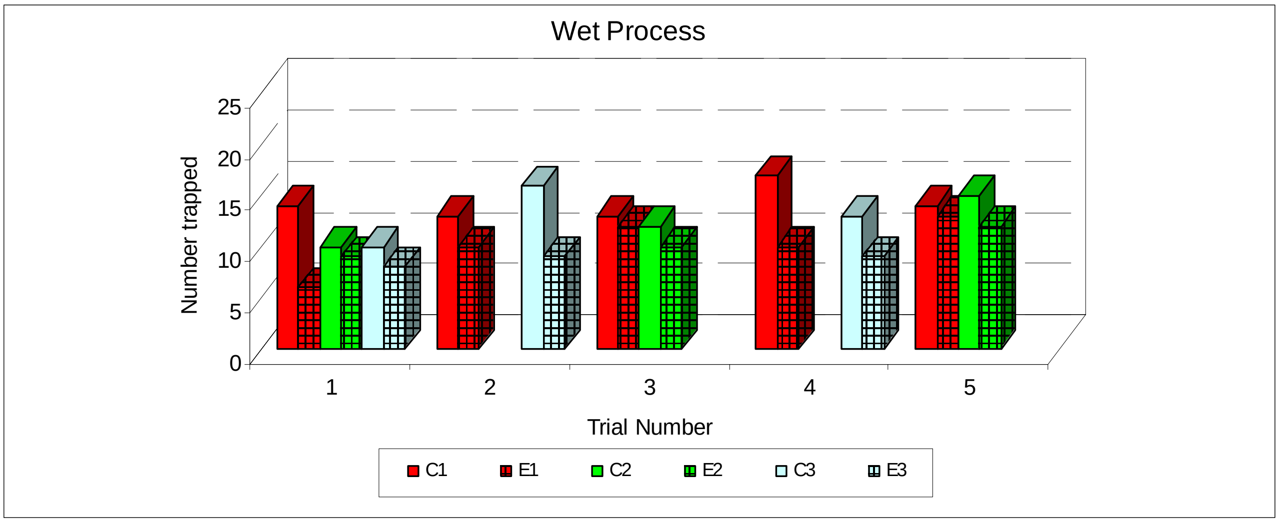


Figure 10. Blowfly counts during wet-salted fish processing trials

5.1.4 Blowfly Infestation

Fish are susceptible to blowfly infestation during both the salting and drying stages of the process. In the wet salting trials, the fish salted in the control vats became heavily infested with blowfly larvae on every occasion (Table 2).

Table 2. Infestation during the salting stage of the wet process

Trial	Control Processors			Experimental Processors		
	C1	C2	C3	E1	E2	E3
	Larvae	Larvae	Larvae	Larvae	Larvae	Larvae
1	+ve	+ve	+ve	-ve	-ve	-ve
2	+ve	nd	+ve	-ve	nd	-ve
3	+ve	+ve	Nd	+ve*	+ve*	nd
4	+ve	nd	+ve	-ve	nd	-ve
5	+ve	+ve	Nd	-ve	+ve*	nd

+ve Surface layer of fish heavily infested with blowfly larvae during salting
-ve No infestation present
nd No data (processor unavailable for trial)
* Salting tank lid incorrectly fitted by processor

In all cases, when the experimental processors correctly fitted the salting tank lid, infestation was prevented.

In the salted-dried processing trials, infestation levels were significantly lower ($t=7.12$, $p<0.001$) in the fish produced by the experimental processors. In all trials, infestation was either absent or reduced in the experimental group (Fig. 11).

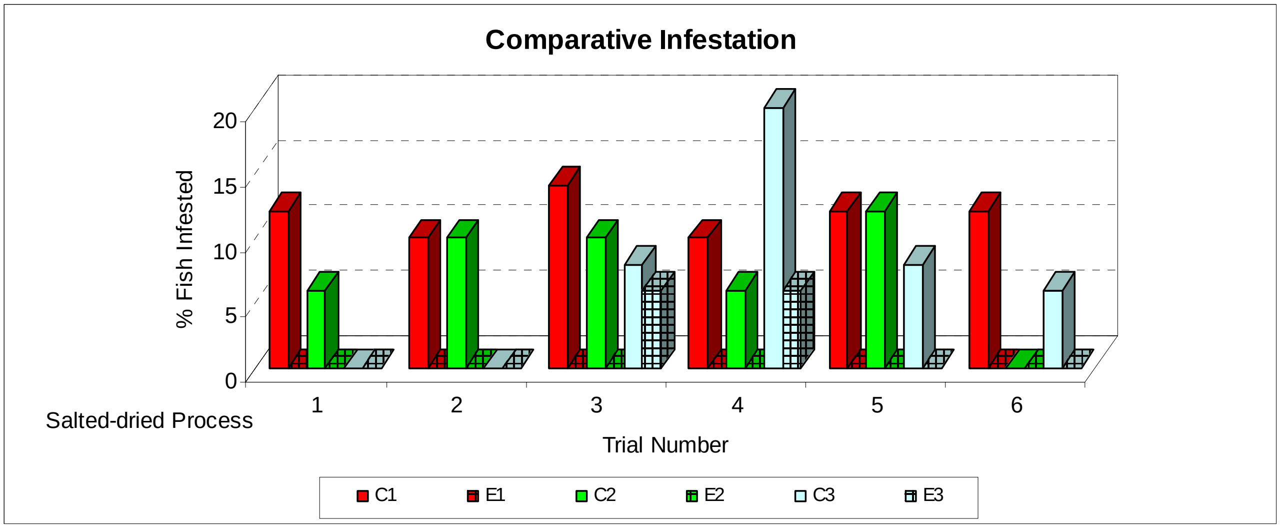


Figure 11. Infestation levels in fish processed by salting and drying

The field trials provided a convincing demonstration of the effectiveness of the systems-based strategy in controlling blowfly infestation during processing.

5.1.5 Damage and Spoilage

Various factors, including infestation damage, low quality raw material, poor handling, microbiological spoilage and biochemical reactions, can combine to affect the final quality of the processed fish. At the end of processing, processors generally grade their fish according to quality and sell low quality product at a reduced price' either as animal feed or fertiliser.

In the wet salting trials, all of the fish produced by the control processors, and those experimental processors who failed to correctly fit the salting tank lids, were downgraded and sold for Rs 4-5/kg. None of the fish produced by the remaining experimental processors were downgraded. These fish sold for Rs7.5/kg.

Results obtained from the salted-dried fish processing trials (Fig.12) consistently demonstrated the effectiveness of the systems-based strategy in reducing losses due to spoilage and damage.

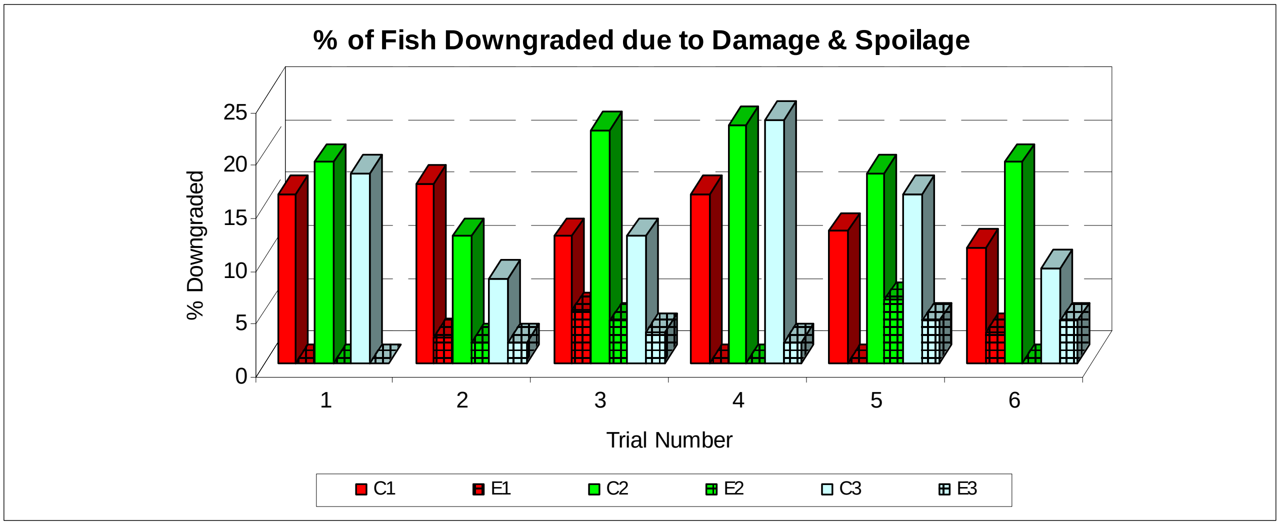


Figure 12. % Of Fish Downgraded during Salted-dried Fish Processing Trial

The principal factors that are believed to have contributed to the poor quality of the downgraded fish are infestation and inadequate salting. Brine concentrations in the control tanks were significantly lower than in the experimental tanks ($t=2.7$, $p<0.01$). Saturation values of brine in the experimental tanks were generally between 85 and 95%, whereas brine in the control tanks tended to be in the region of 70 to 85%. Rainwater ingress will undoubtedly have led to dilution of the brine in the control tanks. This in turn will have facilitated both microbiological and chemical spoilage in the control fish as well as rendering them more susceptible to blowfly infestation.

5.2 Summary Of Findings Of Other Trials In Uppada, Shandakud And Timmapuram

5.2.1 Monsoon Season (2001) Trials in Uppada

Data collected during these trials, which were conducted between June and August 2001 are located in Appendix V. Interventions selected by the experimental group of processors comprised regular salting, vat cleaning, washing fish twice, using plastic groundsheets, better quality knives, improved waste disposal, more regular brine changes, salting tank trays, tank lids and drying racks.

Weather conditions were generally favourable for drying and on no occasion was processing disrupted due to rain. The design of the drying racks used in these trials did not confer any advantages in terms of improved drying rates.

Blowfly counts were higher than those recorded during the monsoon 2002 trials, and again, counts at the experimental sites tended to be lower than at the control sites. Infestation and downgrade levels were similar to those in the Series 2 trials; again significantly lower at the experimental sites than at the control sites.

5.2.2 Monsoon Trials Conducted at Shandakud, Orissa

The data for these trials, which were conducted on 3 separate occasions between September and November 2001, are given in Appendix VI. Interventions selected by the experimental group of processors were the same as those selected during the Uppada trials.

During Trial 1, air temperatures fluctuated between the high 20s and mid 30s, and relative humidities hovered around 70%, peaking at 85%. Wind speeds were low at around 1.5 m/s. The weather was generally overcast with periods of light rain, which disrupted processing on one occasion. Drying conditions were better during Trial 2, with temperatures generally in excess of 30^{0}C and relative humidities seldom exceeding 60%. Wind speeds were generally in excess of 1 m/s, peaking at 2.3 m/s and cloud cover was absent or low. Environmental conditions were also favourable to drying during Trials 3 and 4. Temperatures were in the mid thirties, and relative humidities between about 50 and 60%. Skies remained clear and wind speeds were less than 1.5 m/s. On 9 out of 11 occasions, drying rates of fish dried on the racks were higher than those dried on the ground.

Blowfly counts were generally less than those recorded in Uppada during the same season and infestation levels and percentages of fish downgraded were also lower. Again, blowfly activity, infestation level and downgrades were consistently lower at the experimental sites.

5.2.3 Dry Season Trials Conducted at Timmapuram, Andhra Pradesh

Data collected during the dry season trials are presented in Appendix VII. The interventions selected by the processors were the same as in Uppada and Shandakud.

Drying conditions were good throughout the trials; cloudless skies, temperatures in the low to mid 30s, relative humidities generally less than 70% and light, variable winds, peaking at almost 3 m/s. Drying periods ranged from 10 to 16 hours, and in 7 out of 9 cases, drying rates of fish dried on the racks were higher than those dried on the ground.

Blowfly counts were the lowest observed during the field trials and infestation levels and downgrades were correspondingly very low.

5.2.4 Monsoon Season Trials Conducted at Timmapuram, Andhra Pradesh

Data from these trials are given in Appendix VIII.

The experimental processors again selected the interventions used in the dry season trials.

Drying conditions during Trial 1 were good; cloud cover was absent or light, air temperatures in the low 30s, relative humidities between about 40 and 70% and wind speeds variable between about 1.5 and 3.5 m/s. Conditions were less favourable during Trial 2, with generally overcast skies and occasional rain, which disrupted processing for a short period on one occasion. Drying periods ranged from 8 to 16 hours, and in every case, drying rates of fish dried on the racks were higher than those dried on the ground.

Blowfly counts were higher than those observed at the same location in the dry season and at Uppada in the monsoon. Comparative infestation levels increased during Trial 2 and were similar to those recorded at Uppada during the same period. Percentages of downgraded fish were higher than in the dry season and again similar to those recorded in Uppada. Once more, blowfly activity, infestation level and downgrades were consistently lower at the experimental sites.

5.2.5 Ranking of Interventions According to Processors Preferences

At the end of the trials, the processors were asked to rank the interventions used in order of preference (Table 3).

Table 3. Interventions ranking table

Intervention	Overall ranking		
	Uppada	**Shandakud**	**Timmapuram**
Plastic groundsheet for initial processing	6	1	4
Better quality knives	4	4	8
Regular cleaning of vats	8	6	6
Additional fish washing	7	7	7
Disposal bins for Processing waste	5	5	5
Regular brine changes	9	8	4
Salting vat lids	2	2	1
Drying racks and trays	1	3	2
Submerging frame	3	-	3

Of the interventions selected by the processors, the drying racks, salting tank lids and submerging frames were consistently ranked in the top three. The processors at Shandakud also gave the plastic groundsheet top ranking. These interventions were perceived to confer immediate benefits and required little extra effort by the processors. However, the initial capital required to purchase the drying racks and lids were identified as possible constraints to their adoption. Interventions that involved collecting water e.g. vat cleaning, extra fish washing and brine changes were less well received by the processors, mainly because of the extra labour involved in fetching water and the cost of salt.

The field researchers recently revisited Uppada to monitor uptake of the interventions and obtain current data on processor perceptions. Their observations are summarisesd in Tables 4 and 5

Table 4. Ranking of different interventions by processors

Intervention	Ranking
Wooden lids	1
Drying racks	2
Submerging Frame	3
Plastic sheet	4
Tubs	5
Dustbin	6
Knives	7

It is encouraging to see that the processors have continued to use the interventions and in some cases have adapted them to suit their individual circumstances. In the case of the drying racks, the processors have clearly identified benefits in respect of improved quality and reduced losses. Initial capital cost, however, is a barrier to their adoption that will have to be taken into account during any subsequent extension. The ranking of interventions in order of preference was similar to that recorded earlier i.e. wooden lids, drying racks and submerging frames found most favour with the processors.

In conclusion, the technical data provides clear evidence that the systems based approach is effective in reducing blowfly infestation and losses of traditionally processed fish, particularly at the salting and drying stages of processing. The processors remarked on the improved quality of the processed when the interventions were used. The research findings indicate that the systems based approach has the potential to offer real benefits in terms income and health to poor people. For these benefits to be realised, however, it is important that the approach is introduced as part of an extension campaign that takes into the socio-economic constraints that are discussed in the next section of the report.

Table 5. Usage of interventions in the post-project period in Uppada:

Intervention	Particulars of usage	Response of other processors
Drying racks	• 3 Experimental and 2 Control processors continue to use them. • The remaining Control processor is unable to use the rack because the cement poles were damaged when children played on them during summer. • Commercially important varieties of fish, which are known to fetch better income, are being dried on the racks, while the rest continued to be dried on ground. • The processors prefer to dry as much fish as possible on the racks, and keep only the excess quantity on ground. • During the current monsoon season, dry fish production was confined to fish dried on the racks, while the rest was entirely wet salted. In other words, if they had no drying racks, everything would have gone into wet salting, but they managed to salvage at least a part of the fish to make dried fish.	• Other processors reported that they were impressed with the quality of the product made using the racks. • There have been no new racks in the village because the cost of setting up a rack appears to be prohibitive for most processors, who also feel it to be a risk because of uncertain returns.
Wooden lids	• All six processors continue to use the lids provided during trials. • For covering the other vats, two processors – Kare Annavaram and Dhoni Mambulli – have begun using wooden planks lying idle or being used for other purposes.	• Some processors have reported using wooden planks on their vats, covering it up with a plastic sheet and weighing it down with stones. These makeshift lids work adequately since the edges of the vats are smoothened to close all openings for blowflies to enter.
Submerging Frame	• All six processors are using them. • When the trays provided by the project were damaged, the processors are making their own trays using any bamboo material available in the village.	• At least three non-project processors have begun using trays made with bamboo wood because they found the trays to reduce losses.
Plastic sheet, tubs, dust bins and knives	• All women continue to use them, as they had done previously.	

5.3 Socio-Economic Findings

5.3.1 Description of processing sites

Uppada is a relatively large fishing village, with a population of about 6,000. However, the village is, in effect, divided into six separate "hamlets" or neighbourhoods which although adjacent to one another function fairly separately in economic and social terms. Two of these "hamlets" were utilised in the fieldwork. As in all the Andhra Pradesh villages visited there is very little spatial separation of activity except that the beach landings are a few metres away from the settlement. Processing and the whole gamut of domestic, economic and social life are conducted in close proximity. The arrangement has the disadvantage of bringing fish drying in close proximity to undesirable unhygienic activities, but it does, of course, facilitate the multiple focus which is traditional in the households concerned. For example, domestic cooking and cleaning can be carried on while the processor is also managing a livelihood activity like turning the drying fish. There is evidence of planned interventions intended to assist the processors that have been abandoned because of their poor location. This suggests that the interventions the processors choose to adopt should be at a location of their choosing, in close proximity to their homes if they prefer that.

Trimmapuram, in northern Andhra Pradesh, is an atypical processing site. The fish processing community based here was formerly located adjacent to the fishing harbour in Vizakhapatnam. Their site was taken for commercial development 1985 and the community was relocated to Trimmapuram, several kilometers north of the town. Here, distant from their ready supply of fish, they have suffered a significant reduction in their prosperity.

Shandakud is situated on the outskirts of the major industrial coastal town of Paradeep at a distance of approximately 15 km from the commercial fishing port at which the processors purchase their fish. The village has a population of 15,000 comprising Telugu, Oriya and Bengali speaking people. A total of 98 fish processors, the majority being Telugu, operate in the village. Most of the processing takes place on common land at the edge of the village.

5.3.2 Demographic and Social Structure of the Households of Processors used in the Trials

Monsoon Season Trials (June 2002) at Uppada

The processors who participated in this series of trials were from relatively socially and economically disadvantaged groups. They were located in the hamlet of Mayapatnam in Uppada village and were all drawn from the Vadabalija caste, which is the fisherman caste of the northern part of the Andhra Pradesh coast. The households vary in size from four to nine persons with a mean size of six. All the households are three generation. In five of the six cases the three generations comprise one or more of the processor's children; the wives of one or (in the case of the nine person household) two of the processor's sons; and one, two or three grandchildren. In the sixth case the processor's co-residents included an elderly father. Four of the processors (all six of whom are women) are widowed. In one case, the four-person household, the processor lost her husband when her only son was two years old. The average age of the processors is 53, although the recorded ages may be approximate - all were stated in multiples of five as were the vast majority of the ages of all the adult household members in all the trials.

All of the processors and their husbands are illiterate. So too are most of their adult children, although the oldest person who received education is 35 years old. There is, however, pleasing evidence of increasing attendance at school. In one household the eldest son, born in 1974, is illiterate. But his wife and younger brother, respectively four and two years younger, have been educated. In other households the adoption of schooling is more recent: In one the 14-year-old granddaughter is illiterate, the 11 year old at school. In another the 15-year-old daughter is illiterate, the 8-year-old grandson is at school.

Some of the processors exemplify a bane of Indian demographic conditions, early marriage, although not the much more serious demographic and health problem of early childbirth. Three processors were married at 15 years of age and others at 18 and 21; they had their first children at 18, 19 and 20 (the processors married at 15), 22 and 23. (The data for the sixth household appear unreliable.) Interestingly the ages at which the next generation married are generally higher - although the data are slight. One son married at the very early age of 16, others at 17,19, 20 and 23, and daughters married at 17, 20 and 21. Perhaps this is further evidence of some social progress in Uppada.

Monsoon Season (June 2001) Trials in Uppada

The processors participating in this, the first series of trials were located in Suradapeta hamlet. Households varied in size from one to eight persons with an average of four. The only household which is not three-generation comprises the processor (aged 55) her husband (aged 60) and her granddaughter (aged 10). All five members of one household are illiterate, including the son-in-law and daughter both in their mid-twenties. There are illiterates recorded in their mid-teens but generally younger people are receiving education. The oldest household member who had been educated was a 35-year-old man. The average age of the processors was 54.

Monsoon Season Trials (September 2001) in Shandakud

The processors in the second trials (Shandakud, Orissa, September/October 2001) were also all members of the Vadabalija caste and, in line with DFID’s focus, relatively socially deprived. Some of the processors were married as young as 9, 11 and 12 years of age, and at least one appears to have cohabited with her husband from the start of her marriage having had her first child as young as 13. (Another processor, in contrast, had her first child in her late 20s.) Most of the participant processors live in thatched houses and many of their children are in full time education. The average age of the processors is 42, which is the lowest mean of all the groups of processors used in the project.

But it should be noted that all the participants appear to be running substantial businesses with a weekly investment of Rs 20,000-25,000/- (compared to the much smaller-scale operations typical in Uppada).

The participants are members of a migrant community. As is typical of the Telugu speaking fisherfolk in Orissa they were all born in Andhra Pradesh (except one who was born in Burma but who migrated to Andhra Pradesh at two years of age).

Dry and Monsoon Season (March and June 2002) Trials in Timmapuram

The participants in the Timmapuram trials had similar characteristics, although there were households of as much as 11 and 12 persons in size. There was one household member, the son of the processor, who holds a BCom degree. He was running a prawn business. Additional data were collected at this site about the households of processing assistants. Most of these households were two generation apparently consisting of small nuclear families. Normally both adults work in processing, although many of the men earned extra income in labouring in quarrying, building, etc. This no doubt reflects the fact that Timmapuram is not a traditional fishing village and other economic activities are readily available. One 5 member processing assistant's household co-resides with the two-person processor's household. The average age of the processors is 48.

5.3.3 Livelihood base, Livelihoods Vulnerability

Monsoon Season Trials (June 2002) at Uppada

The six fish processing households located Mayapatnam hamlet have a common experience of loss at times of major environmental shocks. Three of the interviewees reported serious losses in the 1996 cyclone, and one in the 1986 cyclone. Loss of fish, typically valued at Rs 5,000/-, through blowfly infestation was reported by four processors. The fact that the processors reported this only in the most recent or preceding monsoon season suggests that the event reported was not unique but was in the processor's mind because it was recent. In one household there were losses resulting from damage to fishing equipment. Other livelihood shocks were associated with injury, illness and death. For example, one processor reported spending Rs 8,000/- on medical expenses before her husband's death in 2001. Finally, one processor was cheated of Rs 11,500/- by her chit fund company. Since this represents the failure of an institution which should be encouraging development, this event is possibly more antagonistic to development than the natural catastrophes.

Monsoon Season (June 2001) Trials in Uppada

These households were exposed to the same shocks and seasonal threats. There were losses of fishing equipment and of fish being dried in the 1996 cyclone by four households. The 1986 cyclone destroyed the houses of three of the processors. Blowfly losses were also reported. Injuries to crew on the boats owned by the processors' households were reported - and in one case the processor's households made a payment of Rs 4,000/- to an injured crewmember. There were also shocks associated with illness. One expression of vulnerability apparent in Suradapeta hamlet, but not in Mayapatnam, was the loss of houses to marine erosion. Three of the processors had been affected in this way, in 1981, 1986 and 1994. Suradapeta is situated closer to the sea than Mayapatnam.

Monsoon Trials (September 2001) in Shandakud

The processors here have suffered from two cyclones: in 1986 and 1999. In 1986 two lost their husbands and most report the loss of equipment. The 1999 cyclone appears to have caused more destruction of property - four interviewees lost their houses, fish and processing equipment, reportedly worth Rs 300,000/- in one case - although none of the processors was widowed. One personal loss may have been significant, was the loss that one processor suffered of her gold ornaments whilst travelling on a train. Their value is not recorded. Finally, although not specifically a livelihood issue, the problems caused by living in a migrant community should be noted. One processor has sent her eldest three children to her parents in Andhra Pradesh.

Dry and Monsoon Season Trials (March and June 2002) in Timmapuram

Five of the six processors mention the 1985 move to Timmapuram from Vizakhapatnam in their personal time lines, although without additional comment. (It was clear during the fieldwork that this move had had a very negative effect on livelihoods.) One processor's eldest son had been murdered during political clashes in 1996, although this is only indirectly a livelihood issue.

5.3.4 Economic status of the processors

Monsoon Season Trials (June 2002) in Uppada

The financial status of the households varied. As one indicator of wealth, it should be noted that three of the processors live in thatched and three in tiled houses. The size of the fish processing businesses also varied. Four invested (i.e. had a working capital of) Rs 10,000/- weekly, the others Rs 5,000/- and Rs 3,000/-. Two households are also boat owners. Sales of processed fish are not, of course, the only source of income for the households. All six of the households received income from fishing activities as well as fish processing. In three of the households fish processing was the main source of income. In three households fish catching was dominant. The data, obtained by interviewing the female processors, suggest that on average fish processing and marketing and fish catching each generate exactly half the household income. At one extreme is one household where the widowed processor and her daughter in law generate 80% of the household income and her son and grandson 20% from fishing. The other extreme is one of the boat owning households, which receives 70% of its income from fishing (exceptionally, this business was centred on prawns rather than finfish) and 30% from processing. In two households there were people who worked in agriculture as a secondary source of income, a daughter and a daughter in law.

Monsoon Season (June 2001) Trials in Uppada

The data from this series of trials showed that, on average, the selected households received nearly 60% of their income from fish processing activities and slightly more than 40% from fish catching. This is a reflection of the higher level of ownership of fishing assets in this sample. Four of the six households owned FRP boats and some also owned nets. The most economically atypical household is also demographically atypical. The household comprises the processor by herself who was 60 years old at the time of interview. Her husband died when she was 34 years old with three children between 9 and 13. She was already processing fish at the time. A few years ago she purchased a boat and now the boat and nets have a value of Rs 250,000/-. 60% of her income comes from the boat and only 40% from dried fish. There was no report of additional sources of income like agriculture in this sample.

Monsoon Trials (September 2001) in Shandakud

The six processors ran relatively large businesses; five have a weekly investment of Rs 20000/- and one Rs 25000/-. Fish processing dominates the household income in most cases, representing 100% of income in three cases, 80% in another and 50% and 40% in the remaining two cases. Other sources of income were fishing, fresh fish vending, labouring in the fishing sector and (just 10% of one household's income) agricultural labouring.

Dry and Monsoon Season Trials (March and June 2002) in Timmapuram

Most of the businesses for which data were collected during the 2 series of trials performed at Timmapuram were relatively large, with an investment of Rs 10,000-15,000/- or more. A number of the households had prawn businesses. Typically the dried fish businesses generated 60-70% of household income. Prawn businesses and fishing were the most important additional sources in come, but other kinds of labouring also generated income.

5.3.5 Current costs

There is a range of expenses incurred by processors. Their frequency varies from twice weekly or more e.g. the purchase of fish on the beach, to once every five or more years e.g. vats for salting. Some of the services and consumables are used by all processors; some are used by single processors. The costs identified in the interviews at Uppada (September 2002 and June 2001) were:

- Fish - bought by competitive bargaining or private treaty on the beach; sold by the piece, not by weight.
- Porterage of fish from beach to processing area; Rs 10-25/-.
- Use of processing area - most use community designated areas, some have own areas, and some rent areas at a notional rent: one cent.
- Labour during processing - employed by larger processors fairly regularly, by smaller processors when own and family labour insufficient, to carry water for salting, turn the fish during drying etc; rate about Rs 30-50/- per day.
- Salt - purchased weekly or fortnightly, usage -six bags per week; cost Rs 50-100/- per bag, less if bought at Gurajanapalli.
- Insecticide - to control pests like ants and blowfly larvae during fish drying and storage in the rainy season; cost Rs 20-25/- per kg.
- Transport to market - e.g. to Kakinada or Peddapuram by bullock cart or Nakkapalli by truck; charge by the basket at Rs 30-60/- for a large basket (contents approximately 50-60 kg) and Rs 20-30/- for a small basket (contents 20-30 kg).
- Transport to market, initial stage - some processors also use rickshaw to the road; Rs 10/- per basket.
- Market fees - Rs 25/- for each basket.
- Bed (when selling at Nakkapalli) Rs 10/-.
- Food expenses at market - Rs 40/-.
- Travelling expenses to market (bus) - Rs 36/-.

5.3.6 Capital costs

There are items of capital equipment which have productive lives varying from a few weeks to a few years. The costs of capital items, as reported at Uppada, were:

- Vats for salting - last five to ten years, a processor might have four vats, purchased locally; cost Rs 150-250/- each.
- Cement tank or cistern for salting larger quantities of fish - a few processors own these; Rs 20,000/-.
- Net pieces for placing fish on and protecting from birds when drying - processor may have a number of net pieces; free or negligible cost.
- Palmyrus leaves - for fish to rest on during drying, expected life of about a year, processor may have 50-100 palm leaves; cost 50 cents to Rs 1/- each, but some processors have their own palmyrus trees.
- Knives for fish gutting, scoring, de-scaling, splitting etc (especially horse mackerels, seer fish, Indian mackerels), a processor may have four-six with an expected life of about a year; cost typically Rs 20/- but may be between Rs 10 and 40/- per knife.
- Aluminium utensils - purchased from cycle traders or Pithapuram, two-four in number with life of two years; cost Rs 75-125/- each.
- Plastic buckets (and plastic tubs) for carrying fish, water etc - expected life of one year (but quality varies), two owned; cost Rs 50-60/- each.
- Plastic sheet used by some processors for covering stored fish - three kgs in weight, renewed annually (depending on quality); cost Rs 200/-.
- Brooms - have a life of about a year, purchased on local market; cost Rs 5-10/-.

- Bamboo baskets for transporting dried fish - replaced approximately monthly, may own five; costs Rs 40-50/- each.

5.3.7 Payments for financial capital

A proportion of the processors (as many as four out of the six studied in the last trials at Uppada) use local moneylenders. Among the Uppada processors indebtedness varied from Rs 2000/- to Rs 5000/-, and repayments are made weekly. Repayments were reported as irregular and variable, although presumably both borrower and lender were able to assess the cost of the loan. The Timmapuram processors, which were larger businesses than at Uppada, borrowed more (Rs 2000/- to Rs 15,000/- at the time of the investigations) but one was a lender (of Rs 10,000/-). Some processors have access to financial capital from semi-formal institutions at a lower rate of interest. In total three processors were members of DWACRA (Development of Women and Children in Rural Areas), which provides funding from public sources and six members of a co-operative.

Identifying the appropriate interest rate is important for the analysis of the investments undertaken as part of the project. Yet this is difficult. Four alternative rates will be discussed here: (1) the rate charged by local money lenders; (2) the rate charged by DWACRA; (3) the rate charged in the commercial financial sector; and (4) the rate implied by processors saving and consuming activities.

(1) The rate charged by local money lenders

From the limited data collected during the trials (only a minority of the processors were debtors) it is difficult to establish the effective interest rate. In one previous study conducted by Intervention (India) Pvt Ltd (undated) for the Overseas Development Administration Bay of Bengal Post Harvest Fisheries Project, interest rates of 24-60% per annum were estimated for both Andhra Pradesh (p 32-33) and Orissa (p 61). These rates are remarkably low for informal sector loans in general, where interest rates of 300% are not uncommon. It may be that the earlier study incorrectly converted monthly interest rates to annual. The calculations which follow use interest rates of 2.5% per week (361% per annum) which was reported as the normal interest rate for loans from local money lenders. This rate is consistent with the figures discussed during the fieldwork although it should be noted that lenders may postpone or waive payment of interest at times when the processor is experiencing difficulties. This, effectively, lowers the real interest rate.

(2) The rate charged by DWACRA

The three processors who were members of DWACRA almost certainly have access to funding from public sources at a lower interest rate. All six of the processors at Timmapuram were members of a fisher women's co-operative society, which may be able to lend at lower rates. All the processors at Shandakud were members of a dry fish processors group and one at Uppada was a member of a mahila mandal (women's group), but these groups may not have access to capital funding. It was reported that interest rates of 24% per annum were charged to members of a DWACRA group and this is also used in the calculations below.

(3) The rate charged in the commercial financial sector
None of the processors are of the size or institutional structure, which would allow access to commercial banks. The interest chargeable would depend on size and security but could be 10-15% per annum or more.

(4) The processors' subjective rate
This interest rate is a hypothetical construct associated with the willingness of the processors to forgo consumption in favour of saving. This rate is included to have a measure to test the investment of the processors from their own savings rather than from borrowing. This rate may well vary sharply from time to time as the processor's personal circumstances change. The willingness of the people of India in general to hold savings in the form of gold ornaments suggests that the interest rate is not central in their decision making. Hence a relatively low rate - 10% - is used here.

The investments considered will be analysed using the first, second and fourth of these rates.

5.3.8 Revenues

The main source of revenue is, of course, the sale of dried fish for human consumption. The sale of dried fish for animal consumption is a source of income when the product is of poor quality. Prices are:

- Dried fish; Rs 10/- per kg.
- Wet salt fish: Rs 5/- per kg.
- Fish for animal feed: typically Rs 2-4/- per kg, but exceptionally more.

5.3.9 Allocation of capital costs to individual batches

The processors invest in some capital items as part of their business activities (see Section 5.3.6.) These items are used throughout the year and in the following analysis the costs of traditional items of capital expenditure were allocated to batches processed throughout the year.

In contrast the items of capital expenditure undertaken as part of the project were designed specifically to improve the quality of the dried fish during the monsoon season. While these may be expected to have a significant effect in rainy conditions, they may be expected to have no impact at all (or a very limited impact) on the quality of the product in the dry seasons. These costs were therefore set only against the batches processed during the rainy weeks. We have assumed 10 weeks out of 52.

5.3.10 Profitability of fish sales

This analysis will proceed in three stages. First current costs and revenues will be examined (section 5.3.11.). Then the analysis will be extended to include the costs of the traditional capital investments (5.3.12.). Finally the costs of the capital investment undertaken as part of the project will be incorporated in the analysis (5.3.13.).

5.3.11 Current costs and revenues:

Dried Fish Sales in Uppada

For the cycles studied the processors incurred expenses for salt, porterage from the beach, transport to market, labour, travel and living expenses during market visits, and market fees as well as the cost of the fish. The costs varied: salt Rs 10-150/-, transport to market Rs 20-250/-, market fees Rs 20-60/-, and the fish itself Rs 85-1400/-. The sale of dried fish raised Rs 160-2015/-. The return per batch varied between a loss of Rs 180/- and a profit of Rs 360/-.

Analysis of the control and experimental processors separately is more revealing - and shows the business benefits of the use of the interventions. The processors selling dried fish from the final series of trials at Uppada are taken as the standard. There were six cycles of trials in this group, each consisting of three control and three experimental processors. The control and experimental groups had similar business profiles: they spent approximately the same on all the items of expenditure. (See Table 6.)

Table 6. Average values of major items of current expenditure of control and experimental processors: dried fish

	Control (Rs)	Experimental (Rs)
Fish	659	649
Salt	47	48
Porterage from beach	6	6
Transport of fish to market	57	53
Subsistence and travel to market	25	23
Employees	8	11
Market fees	29	30
Total expenses	831	820

Source: Field data summarised in Appendix IX.

But there is a sharp difference in the revenue from the sale of dried fish: Rs 775/- for the control group and Rs 933/- for the experimental group (Table 7). It should be noted, however, that the way the data are recorded understates the beneficial impact of the interventions on the revenues of the experimental processors. This because some of the fish processed was not exposed to the whole set of interventions. Experimental processors were provided with only one drying rack, hence, only a proportion was dried on the drying racks.

Despite this limitation further evidence of the improvement in quality comes from the value of sales of damaged fish. Since the experimental processors suffered less damage the revenue from the sale of damaged fish was clearly greater for the control group than for the experimental group: Rs 25/- as against Rs 13/- (see Table 7).

Table 7. Average revenues of control and experimental processors: dried fish

	Control (Rs)	Experimental (Rs)
Total revenues	775	933
Of which Damaged fish	26	13

Because the revenues are so different the profit levels of the two groups are different in turn. The control processors on average have a total loss of Rs 56/-, which is a loss of 7.0% of the expenses incurred. The experimental processors return a total profit of Rs 113/-, i.e. 16.5% of their current costs.

Table 8, below, shows how clearly the two groups profit levels differed - although the limitations of the data for significance testing must be noted, especially since the samples were purposively rather than randomly selected.

Table 8. Statistical Significance of the Difference Between Control and Experimental Processors, processing Dried Fish, Uppada (Wilcoxon Rank Sum Test)

Cycle	Significant difference in percentage profit between control and experimental processors
09/07/02	Yes
10/07/02	Yes
19/08/02	Yes
24/08/02	Yes
27/08/02	Yes
04/09/02	Yes

Dried Fish Sales in Timmapuram

There were two cycles of trials at Timmapuram from which dried fish was produced. The pattern of spending was similar for the batches studied in Timmapuram (Table 9), although the business turnover was rather higher.

Table 9. Average Costs in Timmapuram

	Control (Rs)	Experimental (Rs)
Fresh fish	825	732
Salt	76	70
Carrying from beach	33	31
Transportation to market	90	82
Subsistence	12	12
Payments to employees	42	40
Travel expenses	12	12
Market fee	50	48
Total Costs	1140	1025

The revenue from the sale of dried fish were also higher in Timmapuram than in Uppada (Table 10). Although as in Uppada, and the control processors gained more income from the sale of damaged fish than the experimental processors (Rs 67/- compared with Rs 20/-).

Table 10. Average Profits in Timmapurum

	Control (Rs)	Experimental (Rs)
Current Costs	1140.0	1025
Revenues	1030.0	1142
Profit	-110.0	118
% profit	-9.5	13

Wet Fish Sales in Uppada

The selling of dried fish is the usual business aim of the processors of Uppada but when fish is purchased and weather conditions deteriorate before processing is complete salted wet fish are sold. Data were collected for five trials in Uppada when the product was wet salted fish sold locally. For these cycles the processors incurred expenses for the fish, salt and porterage from the beach, but not labour and marketing expenses (transport to market, travel and living expenses during market visits, and market fees). Expenditure on both salt and fish was higher and more varied than in the dried fish trials: salt from Rs 40 to 200/-, and fish from Rs 300 to 1600/-. The sale of wet salt fish raised from Rs 205 to 1980/-.

Once again the separate analysis of the control and experimental processors shows the greater profitability of the experimental processors (Table 11).

Table 11. Average current expenses of control and experimental processors: wet salt fish

	Control (Rs)	Experimental (Rs)
Fish	918	931
Salt	120	110
Total expenses	1049	1055

In these cases also there is a clear difference in the revenue from the sale of the product: an average of Rs 741/- for the control group and Rs 1177/- for the experimental group (Table 12). There was no recorded revenue from the sale of damaged fish.

As in the case of dried fish production, the contrasting revenues result in contrasting profit. The control processors on average have an average loss of Rs 307/-, which is an average loss of 30.9% of the expenses incurred. The experimental processors return an average profit of Rs 122/-, i.e. 6.6% of the current costs

Table 12. Average Current Costs, Revenues and Profits: Wet fish sales Uppada.

	Control (Rs)	Experimental (Rs)
Current expenses	1049	1055
Revenue	741	1177
Profit	-307	122
Percentage profit	-30.9%	6.6%

5.3.12 . Capital costs

The capital costs vary according to the size of the enterprise, and the resulting need for capital equipment, and the cost of borrowing capital. Assuming a rate of interest of 10% per annum and that the capital equipment is used twice a week, processors may have to put Rs 12/- aside from each batch of fish dried to make capital repayments (see Table 13).

Table 13. Capital cost to be allocated to each batch of fish at various interest rates.

				2.5% per week		24% per annum		10% per annum	
	Expected life in weeks (and in years)	Number	Cost (Rs)	Capital recovery factor	Allocation to each batch (Rs)	Capital recovery factor	Allocation to each batch (Rs)	Capital recovery factor	Allocation to each batch (Rs)
Vats	286 (5.5)	4	175	0.0250	8.8	0.3460	2.4	0.2451	1.7
Palm leaves	52 (1)	75	1	0.0346	1.3	1.2400	0.9	1.1000	0.8
Knives	52 (1)	2	30	0.0346	1.0	1.2400	0.7	1.1000	0.7
Aluminium utensils	104 (2)	1	90	0.0271	1.2	0.6864	0.6	0.5762	0.5
Plastic buckets	52 (1)	2	55	0.0346	1.9	1.2400	1.4	1.1000	1.2
Plastic sheet	52 (1)	1	200	0.0346	3.5	1.2400	2.5	1.1000	2.2
Brooms	52 (1)	1	8	0.0346	0.1	1.2400	0.1	1.1000	0.1
Bamboo baskets	5.2 (0.1)	5	10	0.2075	5.2	11.2774	5.6	10.5421	5.3
Total					23		14		12

Including these amounts - at the processors' subjective interest rate - the loss of the control processors is increased to 6.6% of their current expenditure, the profit of the experimental processors is reduced to 12.3% of their current expenditure (see Table 14).

Table 14. Profit and loss with capital expenses included: Dried Fish Processing at Uppada.

	Control (Rs)	**Experimental (Rs)**
Current expenses	831	822
Capital expenses	12	12
Revenue	799	946
Profit	-44	112
Percentage profit	-5.3	13.6

5.3.13 . Cost of Interventions

The costs in Table 15 and Table 16 are the costs incurred by the project in providing the interventions selected by the processors in the fourth series of trials at Uppada and Timmapuram respectively. These costs are discounted and adjusted to reflect the fact that the full benefit will be felt only during the monsoon season. Hence, it is assumed that the processor will benefit from the use of these capital inputs during the rainy season, during which time the processor would produce about 10 batches of fish.

Table 15. Discounted cost of interventions at Uppada, Fourth Series of Trials

					2.5% per week		24% per annum		10 % per annum	
Item	Interven-tions preferred by processors	Expected life in weeks (and in years)	No.	Total Cost (Rs)	Capital recovery factor	Allocation to each batch (Rs)	Capital recovery factor	Allocation to each batch (Rs)	Capital recovery factor	Allocation to each batch (Rs)
Cement poles	*	520 (10)	4	260	0.0250	32.5	0.2716	7.1	0.1627	4.2
GI pipes	*	1040 (20)	2	217	0.0250	27.1	0.2433	5.3	0.1175	2.5
Webbing	*	104 (2)	2	65	0.0271	8.8	0.6864	4.5	0.5762	3.7
Wooden frame	*	156 (3)	2	392	0.0255	50.0	0.5047	19.8	0.4021	15.8
Labour charges	*	260 (5)	1	25	0.0250	3.1	0.3642	0.9	0.2638	0.7
Wooden lid	*	156 (3)	1	500	0.0255	63.8	0.5047	25.2	0.4021	20.1
Bamboo tray	*	156 (3)	1	60	0.0255	7.7	0.5047	3.0	0.4021	2.4
Plastic sheet		104 (2)	1	185	0.0271	25.1	0.6864	12.7	0.5762	10.7
Plastic tub		156 (3)	1	45	0.0255	5.7	0.5047	2.3	0.4021	1.8
Plastic dust bin		156 (3)	1	15	0.0255	1.9	0.5047	0.8	0.4021	0.6
Knives (big)		156 (3)	1	55	0.0255	7.0	0.5047	2.8	0.4021	2.2
Knives (medium)		156 (3)	2	48	0.0255	6.1	0.5047	2.4	0.4021	1.9
Knives (small)		156 (3)	2	44	0.0255	5.6	0.5047	2.2	0.4021	1.8
Sickle		156 (3)	1	20	0.0255	2.6	0.5047	1.0	0.4021	0.8
Totals (Rupees)						246.9		89.9		69.3
Totals of preferred interventions (Rupees)						192.9		65.8		49.5
Totals of salting interventions only						63.8		25.2		20.1

It can be seen that at both Uppada and Timmapuram similar costs were incurred in effecting the selected interventions, although the details of the way the implementations were implemented differed - most notably different materials were used. The total costs amounted to Rs 247/- per processor at Uppada and Rs 244/- at Timmapuram. Table 17 shows the impact of discounting these data and estimating an amount to be allocated to each batch of fish processed in the monsoon season at three alternative interest rates: (1) 2.5% per week - the local money lender rate; (2) 24% per anum - the DWACRA rate; and (3) 10% per annum - the assumed subjective rate. The difference remains small: Rs 917/- at Uppada and Rs 981/- at Timmapuram, when the investment is financed by borrowing at the local money lender rate of 2.5% per week (see Table 15). The similarity continues if the only interventions costed were the ones preferred by the processors (see section 5.2.4). Then the relevant data are Rs 193/- at Uppada and Rs 139/- at Timmapuram. Finally the table shows the impact of the reduction of the interventions to those relating to the salting process, which appears to be the most effective single change

Table 16. Discounted cost of interventions at Timmapuram, Fourth Series of Trials

				2.5% per week		24% per annum		10% per annum	
Item	Interven-tions preferred by processors	Expected life in weeks (and in years)	Total Cost (Rs)	Capital recovery factor	Allocation to each batch (Rs)	Capital recovery factor	Allocation to each batch (Rs)	Capital recovery factor	Allocation to each batch (Rs)
Casuarina poles	*	208 (4)	177	0.0251	22.2	0.4159	7.4	0.3155	5.6
Bamboo mats and trays	*	156 (3)	617	0.0255	78.7	0.5047	31.1	0.4021	24.8
Marine plywood lids	*	208 (4)	303	0.0251	38.0	0.4159	12.6	0.3155	9.6
Carpenter charges		260 (5)	283	0.0250	35.4	0.3642	10.3	0.2638	7.5
Plastic sheet		104 (2)	60	0.0271	8.1	0.6864	4.1	0.5762	3.5
Plastic tubs		156 (3)	62	0.0255	7.9	0.5047	3.1	0.4021	2.5
Knives		156 (3)	60	0.0255	7.7	0.5047	3.0	0.4021	2.4
Wood for net frame	*	156 (3)	117	0.0255	14.9	0.5047	5.9	0.4021	4.7
Labour charges		260 (5)	113	0.0250	14.1	0.3642	4.1	0.2638	3.0
Transportation charges		260 (5)	127	0.0250	15.9	0.3642	4.6	0.2638	3.4
Old net		104 (2)	8	0.0271	1.1	0.6864	0.5	0.5762	0.5
Totals					244.0		86.9		67.3
Totals for preferred interventions					138.9		51.1		40.0
Totals for salting interventions					38.0		12.6		9.6

Table 17. Profitability with capital costs included.

	Uppada Processors				Timmapuram Processors			
	Control processors (10% per annum interest)	Experimental processors (2.5% per week interest)	Experimental processors (24% per annum interest)	Experimental processors (10% per annum interest)	Control processors (2.5% per week interest)	Experimental processors (2.5% per week interest)	Experimental processors (24% per annum interest)	Experimental processors (10% per annum interest)
(1) Revenue	775	933	933	933	1030	1142	1142	1142
(2) Current costs	831	820	820	820	1140	1025	1025	1025
(3) Profit [(1)-(2)]	-56	113	113	113	-110	117	117	117
(4) Traditional capital costs	12	23	14	12	12	23	14	12
(5) Profit [(3)-(4)]	-68	90	99	101	-122	94	103	105
(6) Total intervention costs		247	90	69		244	87	67
(7) Profit [(5)-(6)]		-157	9	32		-150	16	38
(8) Preferred intervention costs		193	66	50		139	51	40
(9) Profit [(5)-(8)]		-103	33	51		-45	52	65
(10) Salting intervention costs		64	25	20		38	13	10
(11) Profit [(5)-(10)]		26	74	81		56	90	95

Table 17 shows that the impact of the traditional capital costs are negligible (Row (4)) and their inclusion serves to modestly reduce the profit level of the experimental processors (or increase the losses of the control processors).

At the most realistic interest rate - the subjective rate of 10% per week - the difference between the two sites in the extra costs to be allocated to each batch is small: Rs 69/- per processor at Uppada and Rs 67/- at Timmapuram.

The similarity continues if the only interventions costed were the ones preferred by the processors (see section 5.2.5). Tables 15 and 16 show the preferred items as established in interviews with the processors. Row (8) in Table 15 gives the capital cost of these items and row (9) the profits resulting from allowing for this expenditure only. The experimental processors at both locations would make a profit if they had had to meet these expenses themselves, of Rs 51/- at Uppada and Rs 65/- at Timmapuram.

Finally, since the technical results suggest that the largest gain in the quality of the fish is achieved at the salting stage, the data are recalculated to exclude the costs of all the interventions except the lids of the salting vats (row (10)). These additional costs would leave the experimental processors with a slightly higher profit (row (11)) (Rs 81/- and Rs 95/-). It should be noted, however, that this unreasonably reduces the costs that should be allocated to the batches of fish. This is because the greater revenue of the experimental processors is not wholly the result of the improvements in salting techniques. A proportion, even if a small proportion, of the improvement comes from other interventions the costs of which are excluded.

The analysis so far has used the assumed processor subjective interest rate. That is the rate applicable to investments financed from their savings. (The vast majority of investment decisions made by the processors are almost certainly backed by savings rather than borrowings.) Some investment decisions are financed in other ways and these are relevant when processors do not have capital to undertake investment. At the DWACRA rate, which we may use as a proxy for public sector and co-operative rates in general - the processors would still remain in profit. At the highest rate - the local money lender - the processors will make a loss. But the local money lender will almost certainly be used only as a source of working capital on a short term basis and not for long term investment decisions.

5.3.14 . Discussion

The cost-benefit analysis suggests that the proposed interventions are worth while in a business sense. This conclusion is strengthened by a consideration of some of the assumptions made. In particular many of the uncertainties in this analysis tend to lead to a lower level of profit than might be expected in processing businesses. (1) Because of better handling, there will almost certainly be some gains in the quality of the dried fish outside the rainy season. This will have a beneficial effect on incomes throughout the year. (2) We may expect the processors themselves to identify cheaper ways of effecting the improvements, from the use of alternative materials, cheaper sources of materials and local craftsmen. (There is some initial evidence of this in Table 4.) If the capital costs of the improvements were reduced to one half - probably achievable - they would not adversely impact on processors' investment decisions. Some of the items in the processors' wish list of capital items (Tables 14 and 15) are items they would have already, most obviously knives. (3) The revenue data of the experimental processors underestimate the gains associated with the interventions in that not the whole of a batch benefited from the intervention - for example, much of their fish continued to be dried on the ground.

If the proposed investments are so profitable it may be a matter of surprise that they are not being adopted more quickly by the processors. The major difficulties in the way of investment are almost certainly, first, lack of savings; second, high perceived risk; and, third, absence of demonstration. We will briefly comment ion each in turn.

(1) The inventions introduced by the project are, in comparison with the traditional technology, expensive. Their purchase would require much more forgone consumption than the present methods. Although some of the processors appear willing to invest in expensive items of capital equipment, like the large concrete tanks for salting, not all of them are able to make that commitment.

(2) There is a high risk associated with the proposed investments. This is largely derived from their use in a only few weeks of the year – and that the extent of their use is (like the monsoon itself) ultimately unpredictable .. If their use is less than the 10 weeks used in these calculations the cost per batch will be higher. The converse is also true, of course - lengthier use will reduce the cost per batch. But even if the probabilities either way are equally balanced the effect will be to retard innovation. Producers with a small margin to experiment with will find the penalties of failure outweigh the benefits of success. It is not just the average return but also the variation in the return which will weigh on the poor decision maker.

(3) Innovation is facilitated if there are adopters of a new technology. These have been lacking up to the present. The reports in Table 4 suugest that this may be beginning to happen in the experimental villages.

The overall conclusion from the socio-economic analysis is that the development of the sector would have a progressive effect in terms of the distribution of income in India and that the interventions are themselves commercially worthwhile. Loans at concessionary rates (or grants) like the ones offered to DWACRA members would facilitate the implementation of these improvements to the benefit of the fishing communities.

6.0 OUTPUTS

Planned outputs were (i) a refined blowfly control strategy that is flexible, allows for seasonal variations and offers processors a choice of control measures to suit their individual circumstances. (ii) Cost benefit and social impact analysis of control measures contained in the strategy. (iii) Training pack disseminated and adopted by trainers. (iv) In-country capability to address problem of blowfly infestation strengthened.

The systems based strategy has been field tested at 18 small-scale processing sites in 3 locations; 2 in Andhra Pradesh and 1 in Orissa. During the course of the trials, 24 processing cycles were monitored under both monsoon and dry season conditions. Field trials data showed real benefits associated with the adoption of the interventions selected by the processors e.g. salting tank lids, raised drying racks, more hygienic fish handling practices etc. Infestation and loss levels experienced by processors using the interventions have been significantly and consistently lower than those experienced by the control processors. Since completion of the field trials, the processors have continued to use the blowfly control interventions and feedback has been highly positive, particularly in respect of salting tank lids, drying racks and submerging frames. Reductions in infestation and losses have been translated into economic benefits.

The processors were seen to come from among the more disadvantaged in Indian society, but have proved keenly aware of the economic benefits of the interventions. On the days when wet weather conditions prevailed, the processors using the improved methods earned significantly higher levels of profit in terms of current costs and revenues. There are problems associated with estimating capital costs, first in that the interventions were designed and commissioned by the project and the local processors may well be able to exploit cheaper materials and second in determining the best interest rate to use in the analysis. But when capital costs are included in the cost/benefit analysis, using best assumptions for asset life and appropriate interest rates, the operations of processors using the interventions are still profitable. The financial appraisal suggests that the investment is desirable in business terms, but poor processors have limited access to financial capital. If investment funds were available as a grant or at concessionary rates of interest the interventions would be very attractive to processors.

A trainer's guide to controlling blowfly infestation of traditionally processed fish and accompanying video have been produced and disseminated at a workshop in Vizag attended by 43 representatives of government organisations and NGOs based in India and Bangladesh. Feedback from the delegates on the quality and usefulness of the training outputs was very favourable. An extension strategy (Appendix X) to further disseminate the systems based approach has been developed and adopted by the State Fisheries Department of Andhra Pradesh. The Fisheries Department has also offered mobilise funds to translate the training guide into Telugu. The video CD has already been dubbed into Bengali, Oriya, Telugu and Tamil.

The DFID funded SUFER project in Bangladesh has expressed interest in extending the systems based approach to Bangladesh where abuse of insecticides by fish processors is reported to be widespread.

Potential constraints to the successful adoption of blowfly interventions by processors, which were identified during the course of the field trials, are addressed in the extension strategy developed by the project team and the policy guidance document (Appendix XI) prepared by the project policy group led by Mr D.S. Murty, former Commissioner of Fisheries for Andhra Pradesh.

A counterpart project team has been successfully established and 7 team members trained in the systems based strategy and collection of socio-economic and technical field data. The team fully managed the field trials and trained the fish processors in use of the blowfly control interventions. Two members of the Andhra Pradesh Fisheries Department staff have also been trained in the systems approach by the project team and directly involvement in the field trials. At the request of the Commissioner for Fisheries (AP), a 2-day DFID/PHFRP funded workshop on the FLAC tools and systems based approach was delivered by the project team in Kakinada during March 2002. The increased capability of the project team is also reflected by its positive response to requests for training in the systems approach by the NGOs AFPRO (Action for Food Protection), FIRM (Forum for Integrated Rural Management) and grassroots fishermen's organisations. The project team will lead the extension programme being developed for Andhra Pradesh and Orissa under the auspices of the World Bank Velugu livelihoods project.

Since completion of the project, the ICM team, at the request of the Department Fisheries, has disseminated the project outputs in training programmes for fisherwomen in Vizag, Uppada, Revu Polavaram and Srikakulam. Requests for similar training programmes have been received from CMFRI, UAA and CPDA.

7.0 CONTRIBUTION OF OUTPUTS

It is believed that the project has contributed to DFID's developmental goal of "Benefits to poor people generated by the application of new knowledge to the utilisation for human consumption of fish from coastal fisheries in South Asia".

The project goal was to bring benefits to poor people through the development and dissemination of a sustainable management system to reduce blowfly infestation and losses of traditionally processed fish.

The systems based approach to reducing blowfly infestation has been field tested during trials conducted at small-scale fish processing sites and validated in terms of its technical and cost-effectiveness. Through gaining an understanding of the socio-economic context within which small-scale fish processing take place, the systems based approach has been refined to better meet the needs of poor fish processors.

The training materials developed by the project have been specifically designed to assist trainers in imparting the knowledge and skills required by field workers for them to effectively disseminate the systems based approach. A small core of expertise that is capable of delivering this training now exists in Andhra Pradesh. It is anticipated that this team, with the support of the Department of Fisheries, will implement an extension programme to encourage adoption of the systems based approach by processors in Andhra Pradesh and further raise awareness of the approach elsewhere.

The project has generated a great deal of interest in South Asia, where the training materials have been widely distributed (Appendix XII). NRINT has distributed copies to organisations in Ghana, Uganda, Kenya, Tanzania and elsewhere. Multiple copies have been provided on request to organisations such as OXFAM, AFPRO and UAA. Efforts are currently being made to post the training materials on the FAO OneFish website.

It is intended that the findings of the research will be published in conference proceedings and refereed papers.

Funds will be sought from DFID, UNIDO and the EU to undertake demonstration projects in other countries e.g. Bangladesh, Cambodia, to raise awareness of the systems based approach amongst relevant stakeholders and test its transferability.

To summarise, the systems based approach to reducing blowfly infestation and losses of traditionally processed fish has been validated in the field and an extension strategy developed to promote its uptake in eastern coastal states of India. Poor fish processors and consumers of traditionally processed fish should benefit from the research outputs in terms of livelihood security, income, nutrition and reduced exposure to harmful insecticides.

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