capacity and preferences of the target groups of consumers determine the price of the product. Consumers of dried fish processed on the east coast of India are usually poor. This means that their ability to pay a higher price for a better quality product is limited. It may be that in some local markets the price premium is not sufficient to justify the extra investment in time and money.

Processing methods are usually fine-tuned to the requirements of markets frequented by the processors. The variety and quality of the same products (for instance, ranging from unsalted fish in one market to very highly salted fish in another; from wet-salted fish to salted and dried fish; from fish that are gutted, de-scaled, de-gilled, beheaded, split, and scored to relatively untouched) could vary from place to place, based on the market demand. Thus, it is essential to understand the influence of market demand for particular products in an area before suggesting any improvements to existing systems.

Interventions to improve fish drying are not cost free and the processor will balance the extra revenue against the costs in determining whether to undertake the investment. Small-scale traditional fish processing is often an activity undertaken by poor people who are short of financial capital and whose ability to invest in improving their systems is very limited. In order to maximise their returns, they are frequently forced to cut corners and make compromises on quality. Whilst many of the processors have at least a good idea of the possibilities for reducing losses, they are unable to invest the required capital to access the systems. The sources of investment capital are usually dominated by local money lenders. Poor processors are not able to offer security against the loans which are, therefore, very high risk and at a very high interest rate.

Although the improved handling methods discussed here are likely to result in improved to quality throughout the year, by far the most significant effects will be when blowfly infestation is at its highest at the time of the monsoon. In India, this period extends over a few weeks only and so for much of the year there will be little return from the investment. It is understandable, then, that processors will have to be sure that investment will generate a sufficiently high return to justify the investment. Even if the investment is supported by financial capital that is available at less than commercial rates, from a public sector concessionary source for example, the interventions will be sustainable only if the processor saves enough to undertake replacement investment.

It is probable that social pressures will exercise some influence on the working practice of the processors. For new techniques to be adopted, the processors have to be open to new ideas and willing to experiment. The systems-based approach introduced here encourages innovation by involving the poor fish processors in informed decision making. In any case, the evidence suggests that processors in Andhra Pradesh and Orissa are less bound by traditional and customary practice than fish catchers are. But this must be established for the relevant area.

Property ownership issues may influence the readiness for innovation. Processors may, for example, have limited legal title to the land where they operate. Generally, fish processing is carried out on common property lands or open access lands, and very few processors own the processing areas where they work. This may have implications for the type of intervention as there may be disputes about the erection of semi-permanent structures on common land. Lack of control over the processing area makes it difficult for a few individual processors to improve their methods of working if other processors do not follow suit. Conditions that permit proliferation of blowfly infestation are the result of a whole range of factors that are often beyond the control of individual processors. This suggests a need for more concerted actions, involving both the immediate stakeholders and relevant support agencies, to ensure that their problems are addressed.

Case Study 10: Social studies: individual and community

The fishing villages of Andhra Pradesh are typically inhabited by a traditional fishing caste, like the Vadabalija and Agnikula Kshatriya respectively north and south of Kakinada. Fishing related activities dominate the economies of villages, entirely so in most small villages (although there are small enterprises like pickle making). The small-scale fish processors, both entrepreneurs and paid workers, are exclusively women. Most have male relations engaged in fish catching, either as boat owners or as crew. However, in Uppada, the largest fishing village in the area close to Kakinada, weaving is a significant second element in the economy (perhaps 30%) and there is a small sector (10%) involved in other activities. All the residents belong to the Vadabalija caste. Despite earlier interventions, which did not bring lasting benefit to the community in Uppada, there is evidence of a willingness to try new ideas.

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

The traditional gender allocation of activities among the Bengali and Oriya speakers is not necessarily the same as among the Telegu speakers, men undertake processing in some cases.

The processors who participated in recent field trials are all members of the Vadabalija caste and are 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 (one other, in contrast, had her first child in her late 20s). Most of the participant processors live in thatched houses. On the other hand it should be noted that all the participants appear to be running substantial businesses (compared to the small-scale operations typical in Uppada) and many of their children are in full time education.

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 AP at two years of age). As migrants, the community members have a demonstrable willingness to change and withstand shocks such as the 1999 cyclone.

Common ownership issues are also relevant in relation to the availability of the raw material. Increased competition for fish and reduced catches also influence the ability of processors to maintain their traditional practices. With traditional fish processing increasingly coming under threat as fish catches are threatened, the financial risks faced by the processors run are also increasing. All of these factors – costs and revenues, financial capital, social and natural capital – will influence the motivation of the processors to reduce blowfly infestation and need to be taken into account when designing control strategies if sustainable livelihoods are to be improved.

Case Study 11: Collection of financial data at fish processing sites

The first task is to identify the main costs and revenues.

Cost data: will include the cost of fresh fish; and other costs (consumables like salt; ancillary expenses like transport; capital costs like vats and knives).

Revenue data: revenue from sale of dried fish (in different batches if different products are sold to different markets, e.g. in village, in distant urban market, as animal feed).

Other business expenses and incomes: earnings from employment, payments to employees, borrowings and lendings should be recorded, together with an indication of their frequency.

If any transactions are based on custom and not driven by price they should be noted.

Example: On 4 September 2002 Marupali Parvathimma, a processor at Timmapuram who was implementing improved processing methods, spent Rs 900 on croakers, Rs 90 on salt, Rs 40 to transport the fish from the fishing harbour to Timmapuram, Rs 120 to transport the processed fish from Timmapuram to Nakkapali/Manapuram markets, Rs 10 on food during the day at market, Rs 60 as payment to employees, Rs 10 as personal travel expenses and Rs 60 as a market fee. Income from the sale of dried fish was Rs 1375. Profit was Rs 85.

On the same day Chipili Sathiyama, a processor who was using traditional methods, spent Rs 800 on fish, incurred Rs 355 in other expenses, and sold her production for Rs 1050 at a loss of Rs 105.

Case Study 12: Costing the interventions

Typical requirements were: (i) drying racks, (ii) wooden lids, (iii) plastic sheet, (iv) bamboo trays. These requirements, it must be emphasised, will be determined by the processors themselves, but during the initial stages of implementation, would normally be provided by the development agency.

In recent field trials, costs were about Rs 1,800 for each processor. Facilitators should, of course, find the cheapest sources of materials, but we may expect that local people will be able to find cheaper sources, through their local knowledge, once they are investing on their own behalf.

Case Study13: Analysing the costs and benefits

Field trials suggest that processors who have adopted the interventions operate much more profitably than those who follow traditional methods. For example, over the four cycles monitored, the experimental processors generated an aggregate surplus of 11% of their total costs while the control processors made a loss of 2%. There is a clear difference in profit in each of the four cycles:

Table of Profits

Cycle(2001)	Control Processors	Experimental Processors
10 September	+15%	+33%
29 September	-18%	-2%
17 October	+4%	+10%
18 October	-2%	+9%

The low returns for the second cycle are the result of changes in overall market conditions, namely the introduction of extra supplies from other sources.

The analysis should be completed by the incorporation of an estimate of the costs of the interventions which in these trials, the cost of the interventions was about Rs 1500. If we assume that (i) the capital items have a life of about four years, (ii) processors will buy and process fish twice a week if possible, (iii) practically all of the benefit of the capital investment is experienced during the monsoon, which will interfere with processing on approximately 10 occasions during a year, it follows that approximately one tenth of the annual cost of the investment should be allocated to the costs of the processing each batch.

To allocate an amount of capital expenditure for physical capital assets to the costs of a business over the length of the asset's life it is necessary to take account of the interest rate. If the interest rate is 10% and the asset has a life of four years, 32% of the cost of the asset should be allocated to each year's costs. (See separate box for an explanation of this process.) Thus, if the capital costs are Rs 1,800 each year, Rs 576 (i.e. 0.32 X Rs 1,800) should be regarded as additional to the current costs. If the beneficial effects of the costs are mainly concentrated on 10 occasions during the monsoon, Rs 58 (i.e. one tenth of the annual cost) should be allocated to the processing cycle.In the case of Marupali Parvathimma (Case Study 11) adding Rs 58 to her costs reduces her profit from Rs 85 to Rs 27. But she remains in profit.

Interest rates charged to small-scale processors by informal money lenders are likely to be very high and the data should be calculated using local rates of interest. In this case at a 20% interest rate, 0.39 of the capital costs should be allocated to each year; at 30%, 0.46; and at 40%, 0.54. Only at the latter figure will the processor make a loss. (The dividing point comes at 31% interest where a factor of 0.47 leads to a break even situation.) But note that (1) these calculations have taken no account of the smaller benefits gained during the dry season and (2) the actual capital expenditure will probably be much lower than costed here.

CHAPTER 2: TECHNIQUES FOR CONTROLLING BLOWFLY INFESTATION AT TRADITIONAL FISH PROCESSING SITES

Several blowfly control measures have been evaluated at traditional fish processing sites and are recommended for use by fish processors. Many processors, however, continually rely upon one particular control measure, as they may not be familiar with the other methods available to them. In some cases, the control measure in use may not be appropriate for the type of infestation occurring.

This chapter contains descriptions of currently available blowfly control measures, along with details of how to use them. Possible control measures warranting further investigation are also presented.

2.1 Physical control measures

2.1.1 Fly-proof lids for salting / fermenting tanks

Fish that are being pre-fermented or even salted can be very attractive to adult blowflies. The salting or fermenting tanks are often situated away from where people work, and so the blowflies can settle on the fish to lay their eggs without being disturbed. The top layers of fish in the tank can easily be reached by the female blowflies, which will lay their eggs on the fish.

Fitting a lid (Plate 8a) to the tank is a very simple and cheap method of stopping the blowflies from reaching the fish during fermentation and salting. To be effective, the lid must fit firmly across the tank without leaving any gaps. If there are any gaps, the blowflies or migrating larvae will enter and reach the fish. It may be necessary to repair the walls of the tank to give a smooth, flat surface on which to rest the lid.

The simplest way to construct the lid is to lay a solid piece of wood over the top of the tank and hold it in place with a heavy weight, such as a rock. A more permanent lid can be constructed by taking a sturdy piece of wood, and fixing wooden insteps to it that will fit snugly to the inside walls of the tank (Figure 1).

Foam rubber should be attached under the edges of the lid. The lid is fitted over the tank and weights placed on top. The weights cause the foam rubber to compress so that the lid fits tightly onto the tank, leaving no gaps through which flies and larvae can enter. The insteps ensure that the lid is always placed correctly over the tank opening.

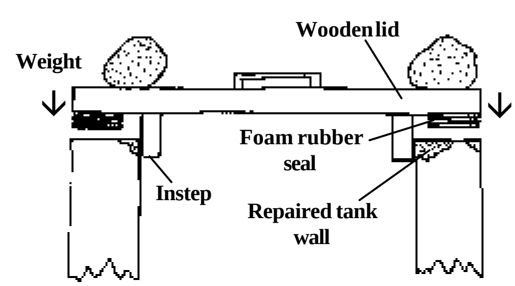


Figure 1. Construction of simple fly proof lid for tank

To provide ease of handling, it is sometimes useful to construct the lid using two inter-locking pieces. The two halves may alternatively be joined together along the centre with hinges, so that each half can be lifted without moving the other (Plate 8b). This will reduce the scope for entry of blowflies whenever the lid is opened. The junction where the two pieces come together can be sealed by sticking a strip of rubber tube (such as used in bicycles, scooters, cars or trucks) along the join. The wooden lid can be painted or laminated with a coat of fibre-reinforced plastic, to make it durable and waterproof.

2.1.2 Fly-proof holding boxes or plastic barrels

Befor fish are processed, it is very important that they are protected from blowflies. The adults may lay their eggs on the fish whilst they are waiting to be processed, and any larvae on the ground where the fish is being held may crawl onto it and infest it. As fish are very attractive to blowflies during the early stages of spoilage, it is very important that any boxes or barrels used to hold the fish can be easily cleaned and are insulated if the fish are to be held for very long. Insulated boxes will stop the fish from becoming too warm in the heat of the day, and can be used to ice the fish, if ice is available.

If an insulated box is unnecessary, plastic tubs or barrels, preferably with fitted lids, are very suitable alternatives. If there is no lid, it will be necessary to construct one to fit over the container. A piece of wood covered in heavy-duty plastic sheeting could be cut to fit the container. It may be necessary to have drainage holes at the bottom of the container, to stop the fish at the bottom from becoming spoiled in the fluids draining from the fish. Blowfly larvae may crawl through drainage holes and so the containers should therefore be raised above the ground on supports.

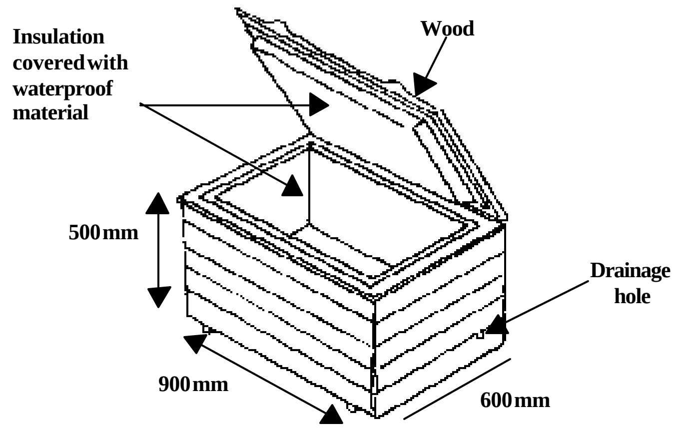


Figure 2. Construction of an insulated box

Wooden boxes can be adapted to allow easy cleaning by lining them with heavy-duty plastic sheeting. Drainage holes will need to be made in the bottom of the plastic if the fish being held is wet, or packed in ice. The boxes should be raised from the ground.

An insulated box is very expensive to buy, but it is easy to construct one at much less cost (Figure 2). A wooden box should be lined with expanded polystyrene to provide an insulating layer. The polystyrene must then be covered with heavy-duty plastic sheeting, to provide a waterproof layer. The polystyrene and plastic layers can be fixed to the wooden box with nails. A drainage hole will need to be made in the bottom of the box.

Plastic crates are increasingly being used to hold fish at landing centres and for transportation over long distances. These are fairly cheap, robust, and accessible in most coastal areas, and can be easily carried manually or on bicycles. It is relatively easy to adapt these crates by fitting polystyrene lids and drilling drainage holes, for short-term storage of fish prior to processing.

2. 1. 3 Screens and nets

It is often necessary to protect the fish from adult blowflies during sun-drying. An effective way of doing this is to use screens or nets. Carefully erected and well-maintained screens or nets have been shown to be completely effective in preventing direct infestation by blowflies. The main drawback with screens and nets is that the fish may take longer to dry, as the screens will cut down the movement of air over the surface of the fish. This effect can be minimised by increasing the distance between the fish and the mesh, so that there is more circulating air available to take up the moisture from the fish. The reduction in drying rates, caused by the screens and nets, can, however, be an advantage to processors when drying conditions are very good, as they can help to prevent case-hardening, so producing a much better product, as well as reducing the risk of indirect infestation by blowfly larvae. The benefits of reducing blowfly infestation and producing a better product should therefore outweigh any disadvantage caused by a slightly increased drying time.

The fish need only be screened whilst the moisture content is high enough to make the fish attractive to blowflies. Under most drying conditions, this is around two days for medium sized fish. After this period, the fish is usually no longer at risk of direct infestation from blowflies, and so the screens or nets can be removed. The drying rate will then increase, and so, overall, the fish will not take very much longer to dry than would fish dried solely without screens or nets.

If the processing area is large enough, it is possible for the processor to have fish at different stages of drying being processed at the same time. In this way, fewer screens or nets are needed. In addition, it may be practical to set aside a permanent screened area in one part of the processing site. At smaller processing sites, the screened area could be used co-operatively between a number of processors. Some larger-scale processors have erected permanent walk-in screened areas for drying their fish. These make access to the fish much easier, but the cost of construction and maintenance is quite high.

There are several ways to construct a screen or net over the fish. The method of choice will depend upon the cost and availability of materials and on the requirements of the processor. Probably the simplest method is to construct a 'tent' over the drying area, using fly-proof netting attached to a tent frame made from bamboo canes or other solid material (Figures 3, 4 and 5). The tops of the canes should be covered with rubber, or other soft material, to stop them from piercing the netting. It is important that the base of the netting is firmly fixed to the ground, or the edge of the drying rack, so that blowflies cannot crawl under the netting to reach the fish. The processor can gain access to the fish by lifting a side of the tent. More sophisticated openings can be devised by making a vertical split in the netting up one side, and attaching a broad piece of netting over the slit to make a door covering. The door covering will need to be weighted to prevent it from flapping open in the wind, and allowing blowflies to enter the tent. As access to the fish is easy, the drying fish can be protected from the rain by covering with a plastic sheet as usual.

Processors sometimes make use of cast-off nets from fishing operations for protecting the fish. These nets are either spread directly on the fish, or erected around the processing area in the form of tents to protect the fish against scavengers such as birds and dogs, but are not effective in excluding blowflies because of their large mesh sizes. To be able to control direct infestation, nets with much smaller mesh sizes are necessary. Overlaying two pieces of smaller-meshed nets, such as those used for catching small pelagic species (anchovy nets), or using the plastic netting in common use at fish farms, may deter entry of blowflies into the drying area. These nets are widely available, cost little to buy and if installed properly, can reduce infestation.

More robust screens can be constructed using rigid wooden frames with wire mesh or plastic coated netting stretched across and fixed in place with nails. These frames can be sized to cover a single drying tray, or a whole table, according to the requirements of the processor. The larger the screens of course, the more cumbersome they are to move. The main disadvantage with these screens is that they can be awkward to move in bulk, if the processor needs to reach his fish quickly, for example to bring the fish under cover during rainfall. If fish are to

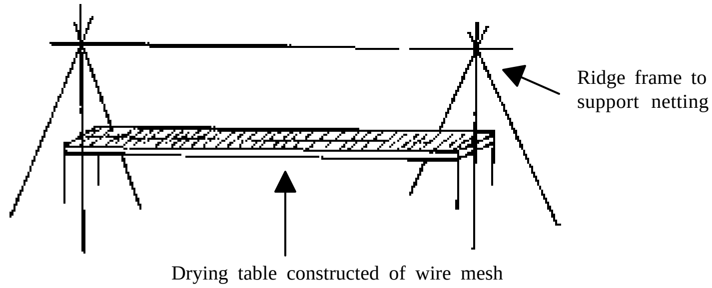


Figure 3. Ridge tent frame construction of poles or canes.

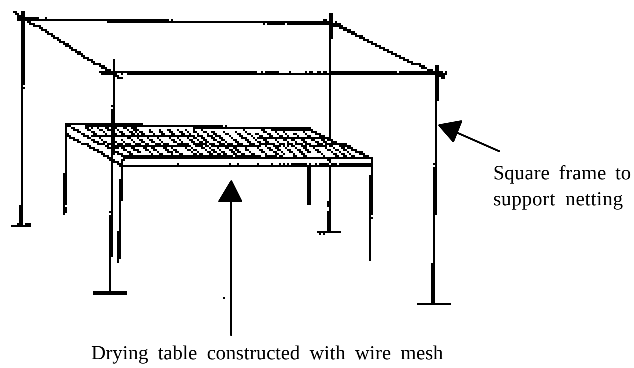


Figure 4. Square tent frame construction of poles or canes

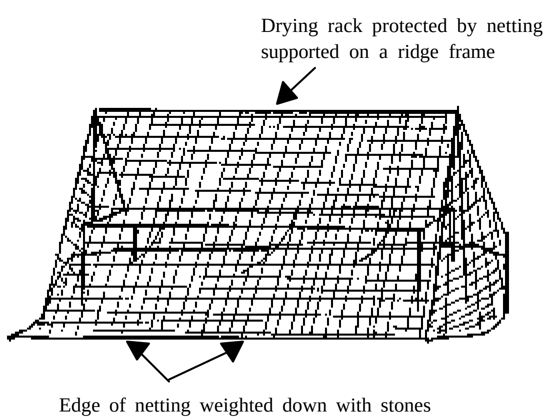


Figure 5. Fly-proof netting over a drying rack using a ridge frame

be dried under this type of screen, it may be preferable to cover the screens instead of removing the fish.

Permanent screened areas can be constructed using metal uprights sunk into concrete, with metal or plastic coated mesh attached around the uprights. This is probably the ideal type of screening, as the fish is protected from blowflies, but can be handled by the processor as easily as fish dried without screening. At large processing sites, fixed screening can be inexpensive in relation to other processing costs.

2.2 Chemical Control Methods

2.2.1 Salting

Salting fish may help to deter larvae from infesting them. To be effective, the salt content of any part of the fish flesh must be a minimum of 8% w.w.b., i.e. 8g of salt in every 100g of salted fish, at the time it is **first** infested by the larvae. As the fish dry, the salt content on a wet weight basis will therefore increase. It is important that enough salt has penetrated through to the deeper tissues of the fish to ensure that all the flesh contains at least 8% salt w.w.b., or the larvae will be able to survive by feeding in the deeper tissues where the salt content is lower. If older larvae infest the fish, through indirect infestation, the salt content of the fish will need to be higher than this, if the larvae are to be deterred.

Depending on the size and thickness of the fish, it may take several days to salt the fish to 8% w.w.b. throughout the flesh. The rate of salt uptake into the flesh is affected by the amount of salt used, the temperature of the fish or brine, the freshness oil content of the fish. The following are important points for producing a good quality, salted product, where the salt content is sufficient to control blowfly infestation:

- Only good quality, fresh fish should be used.
- Large fish should be split before salting to increase the surface area exposed to the salt.
- Although the uptake of salt is more rapid at higher temperatures, the fish will spoil before the salt content is high enough to protect them. It is therefore preferable to salt the fish at a low temperature for longer, to ensure that the salt has time to penetrate to the centre of the fish, but that the fish do not spoil.
- For wet salting, a saturated brine should be used at all times, and the brine strength should be checked and adjusted regularly, as water drawn from the fish will dilute the brine
- Care must be taken to ensure that the fish are completely submerged in the brine and not exposed to the outside. This can be done by placing a frame (Plate 8c) on the fish and holding them down with the help of stones or a bag of salt. Using a salt bag helps maintain salt concentration of the brine at saturation levels.
- For dry salting, sufficient salt must be used to cover the fish thoroughly. In dry salting, salt penetration into the flesh is slower and more uneven than it is in wet salting. This may mean that some areas of the fish have a salt content below 8% w.w.b. It is therefore preferable for the fish to be wet salted, if salt is being used to control blowfly infestation.
- In oily fish, the oil will slow down the rate of salt penetration. This is because the salt ions are water-soluble but not oil soluble. When the salt ions reach an oil layer in the fish, they cannot pass through the layer as they are not soluble in the oil, and so the oil repels the salt away from it.
- Oily fish should normally be wet-salted, as the brine keeps the oxygen in the air from reaching the fish flesh. Oxygen reacts with the oil in the flesh and makes the fish rancid.

It is not possible to specify exactly how long the fish should be salted for in order to achieve a salt content of 8% w.w.b. This would need to be determined experimentally for each particular fish species and processing regime. One experiment showed that lean fillets of 2.5 cm thick, salted at $5^{\circ}C$, took three days to reach a salt content of 14.1%. Smaller fish are likely to take less time than this and oily fish much longer.

2.2.2 Insecticides

At present, only two preparations are approved by the Joint Pesticide Committee, of the World Health Organisation (WHO) and the Food and Agriculture Organisation (FAO), for use on fish. These are:

- pyrethrins synergised with piperonyl butoxide
- primiphos-methyl.

All other insecticide preparations have either not been assessed for use on fish, or have been found to leave unsafe residues.

The most effective way to apply insecticide to fish is by dipping the fish in a suspension of the product, diluted to the correct concentration. A residue of the insecticide is left on the fish, which will kill most or all of the larvae infesting them. Some insecticides e.g. pyrethrin also repel adult blowflies, so fewer eggs are laid on the fish. Unfortunately, pyrethrin is only effective if combined with a compound called piperonyl butoxide, and to be effective, this compound has to be used at concentrations which leave very high residues on the fish. This can be dangerous for anyone eating the treated fish, and so, although this product is licensed for use on fish, many scientists think that it should not be used. Another compound, pirimiphos-methyl, does not repel the adults, and so eggs are still laid upon the fish. The insecticide is not toxic to the eggs or adults, but only to the larvae. Using this insecticide therefore only protects the fish by killing the larvae already infesting it. The larvae will die in the fish, and so their bodies will be visible to buyers, unless they are removed. Despite these drawbacks, insecticides are effective at killing larvae and so remain a very popular method of blowfly control. An unfortunate consequence of the effectiveness of insecticides is that in some countries fish processors directly apply unsuitable, unapproved insecticides to their fish, endangering both themselves and consumers.

A major problem with using insecticides is that residues are left on the fish. Safe limits for insecticide residues have been determined by WHO/FAO. Unfortunately, the amount of residue remaining on a fish after treatment varies with the size and species of fish. Small fish have a larger surface area for their volume compared with large fish. This means that more insecticide is absorbed for each gram of fish than occurs in large fish. The insecticides are also soluble in lipids. This means that more insecticide is absorbed by fish than a non-oily species. If a processor is processing fish of mixed size and species, treating the fish in a single concentration of insecticide will leave different residues on the fish, some of which may be above the safe limit. It is therefore very important that if fish are to be treated with insecticides, samples are first taken for residue analysis to determine the most suitable dip concentration for each type of fish.

Other drawbacks with the use of insecticides are:

- ☹ **They are poisonous.**
- ☹ **Processors need to wear well-maintained protective clothing when handling insecticides, and insecticide treated fish. It is highly unlikely small-scale processors will have access to, or the ability to pay for and maintain suitable protective clothing.**
- ☹ **Insecticides need to be safely stored. Most small-scale processors barely have adequate room to live in, or store their foodstuffs and other items. Storing insecticides in the same house will almost certainly bring them into close contact with the people, including children, and their food.**
- ☹ **Processors need to be trained in the safe use of insecticides. The knowledge, ability and skills of the small-scale processors to safely use insecticides is very limited, with the result that misuse of insecticides, even the approved varieties, could easily take place, both to the detriment of the processor and consumers.**

- ☹ **Approved insecticides need to be continuously available locally. This is highly unlikely, particularly in remote locations. Adulteration of insecticides is a serious problem in most rural areas, forcing processors to increase dosages used in processing, which has both cost and health implications.**
- ☹ **The use of insecticides at fish processing sites needs to be closely monitored by the appropriate authorities. The expense and logistical difficulties of monitoring activities at widely dispersed traditional processing sites will in most situations prevent reliable monitoring.**
- ☹ **After use, the insecticide needs to be safely disposed of to avoid environmental and health problems. Bearing in mind the basic conditions and lack of safety awareness present in most villages where traditional fish processing takes place, it is unlikely that safe disposal of insecticides will be a priority amongst processors.**

Taking into account the above, the use of insecticides, whether approved or not, cannot be recommended at small-scale fish processing sites. Wherever possible, safe alternative control measures should be used.

2.3 Potential control measures that warrant further development

To control blowfly infestation completely, it is important that other control methods are considered. This section gives an overview of two potential control methods that warrant further evaluation.

2.3.1 Plant-based Repellents

A potentially important method of preventing blowfly infestation in cured fish is to repel the blowflies away from the fish. Very few investigations into the effectiveness of repellents have been carried out at fish processing sites. Surveys conducted at fish processing sites and markets show that some plant-based repellents are occasionally used in dried fish during storage in some countries. Repellents which have so far been reported to be effective include gingelly, mustard and sunflower oils, neem leaves, citronella oil, chillies, onion, garlic, white pepper, acetic acid and star fruit. There may be other repellents, which have not yet been reported. Applying the repellents to fish during processing is, however, likely to result in undesirable tainting. It is likely that the repellents would need to be scattered amongst the processed fish, or applied to 'sacrificial' fish, which could be dispersed on the drying racks amongst the other fish. The potential for repellents in controlling blowfly infestation in cured fish, and the most appropriate way to utilise them at fish processing sites, needs to be further investigated.

2.3.2 Blowfly attractant baits

It may be possible to use some kind of attractant bait, to control infestation in the fish, and blowfly numbers at the processing sites. To be effective, the baits would have to be more attractive than the large expanses of drying fish. A sophisticated bait has recently been developed, which uses a specific cocktail of chemicals to attract the adult blowflies to a coloured sticky board. The flies then stick to the board and die.

Whilst the chemical baits may be effective in controlling infestation, they could be too expensive or unavailable to small-scale fish processors. There is therefore a need to develop alternative low-cost, low technology attractant baits. Possible approaches include the use of fish waste treated with an insecticide and coated with a natural feeding attractant such as sugar, glycerol or fruit extracts. These baits may be effective in controlling adult numbers at sites. Adult blowflies often shelter in trees during the heat of the day. Sticky baits could perhaps be hung in the trees to trap the flies. These too could be treated with a feeding attractant to encourage more blowflies onto them. Certain fruits, in particular jackfruit and mango, are reported to be very attractive to blowflies. These could perhaps be used as a type of bait, lacing the fruit with insecticide or sticky gums. There are probably many other local products which are also known to be attractive to blowflies, and which could be exploited in a similar way.

CHAPTER 3. A SYSTEMS-BASED BLOWFLY CONTROL STRATEGY

Blowfly infestation is a complex process. Levels of infestation can be influenced by a number of factors including processing techniques, fish species processed, season, location and standards of hygiene. The situation is further complicated by fish processing sites being highly variable both in terms of types of fish and methods of processing. No two processing sites are the same, which means that a blowfly control measure that is effective at one site may be inappropriate at another. Successful blowfly control therefore depends upon the use of control measures which are appropriate to the particular circumstances at each processing site.

Recent research suggests that if control measures are to succeed they must be based on a detailed understanding of infestation modes, external factors, variations in processing techniques and the socio-economic context within which the processing takes place. The most effective and sustainable way to control blowfly infestation in traditionally cured fish is through a systematic approach. This is because the timing, mode, and causes of the infestation vary considerably between processing sites, and can even alter at a particular site, if the processing practices, or the external conditions, change. The best way to control the infestation will also vary, according to the particular circumstances of the infestation. Approaching the problem of blowfly control systematically, allows a control measure to be chosen that is appropriate to the infestation problem at any given site.

The systems-based approach to blowfly control has recently been evaluated during community-based field trials conducted at small-scale processing sites located in Andhra Pradesh and Orissa, India. This research has demonstrated that the systems-based strategy offers a safe, efficient and cost-effective remedy to the problem of blowfly infestation at small-scale traditional fish processing sites.

3.1 What is a systematic approach to blowfly control?

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.

Fish may become infested:

- At any time after landing
- Through direct or indirect modes.

Fish are more likely to become infested, or may be more heavily infested, if:

- Certain processing practices are followed
- Certain external conditions exist.

These points must be considered if the infestation is to be successfully controlled. It is important to remember that the circumstances of the infestation may be different at each site.

3. 2. Using a systematic approach to blowfly control

Approaching blowfly control systematically involves following these five simple steps:

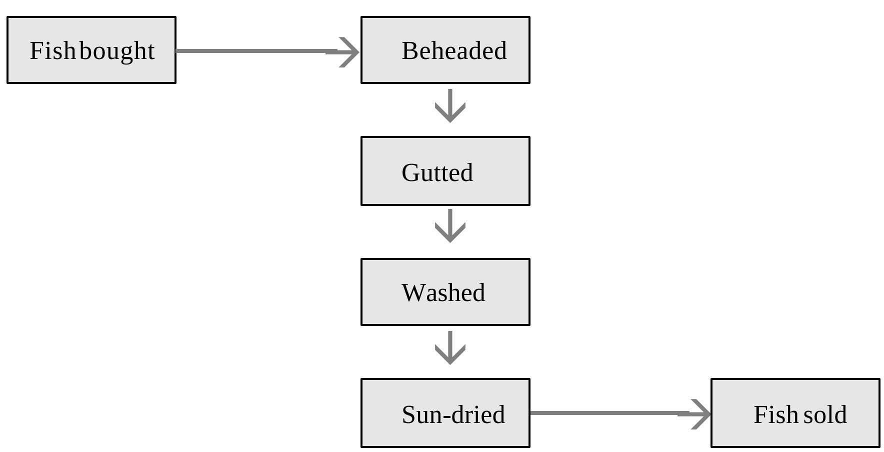
1. Determine the method of processing, the processing steps followed and their sequence - construct a flow diagram
2. Determine the timing and mode of infestation
3. Identify the processing risk factors
4. Identify the external risk factors
5. Select the necessary appropriate control measures for each risk factor

Step 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, showing each of the steps followed in order.

Example of a Process Flow Diagram



Step 2. Determine when in the process the fish are being infested

It is important to find out when the fish are becoming infested. It is possible that the infestation is occurring at more than one point in the process, or even before the fish arrive 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 are being infested at more than one point in the process.

It is 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.

Determine the mode of infestation by looking for key indicators.

Key indicators for direct infestation are:

- Presence of egg batches or empty egg cases on the fish
- Presence of small, first instar larvae
- Groups of female blowflies settling in the gills, mouth or in crevices on the fish
- The ovipositor extended in female blowflies (a tube-like appendage, located at the rear end of the fly, through which the eggs are laid).

Key indicators for indirect infestation are:

- Absence of any egg batches or empty egg cases on the fish
- Only large, second or third instar larvae present on the fish
- Presence of many larvae on the ground or close to where the fish are being held or processed.

Step 3. Identify processing risk factors

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.

Step 4. Identify external risk factors

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

- Consider the environment and climate at the processing site in terms of any risk factors for blowfly infestation.

Step 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:

- 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.

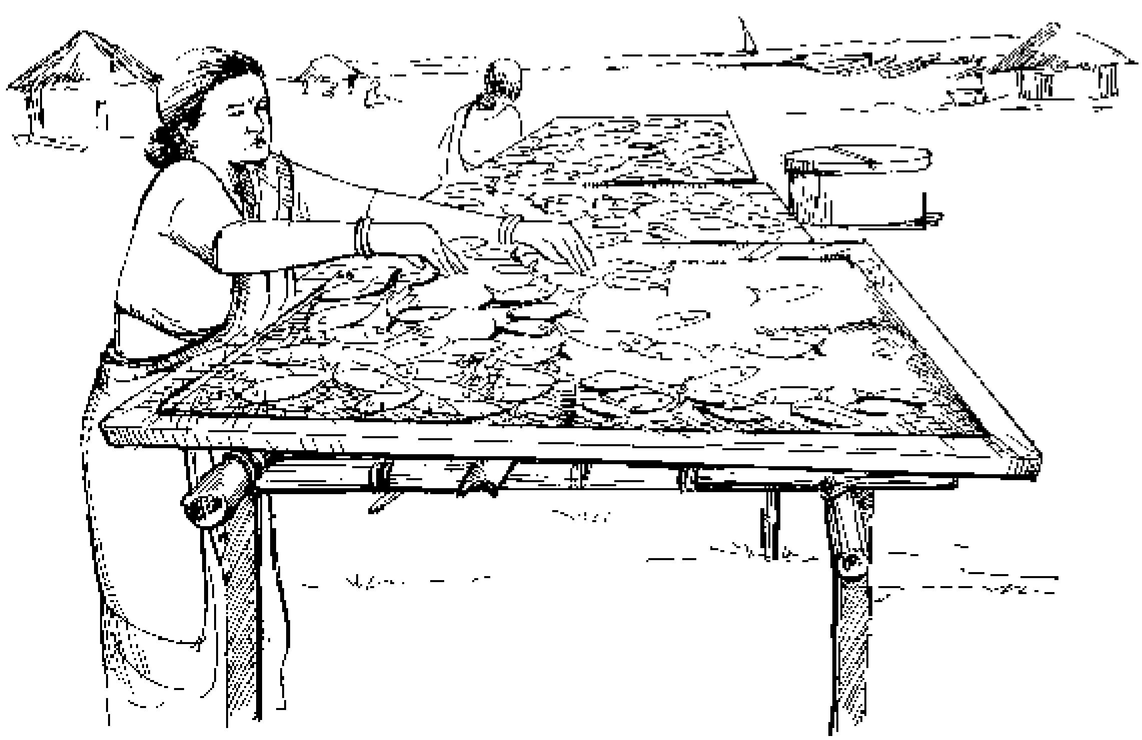
The choice of control measure should therefore take into account:

- Type of process being carried out
- Availability of the control method
- Economic cost to the processor
- 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 applies any other control measures suggested to combat the infestation caused by other factors.

- Select control measures that are both appropriate for controlling the blowfly infestation and also meet the socio-economic needs of the processor and the consumer.

Part 2 of this Guide provides practical advice on how to apply the systems-based approach at fish processing sites.



CHAPTER 4. BENEFITS OF REDUCING INFESTATION

The potential benefits to processors and processing communities of implementing the systems-based approach to reducing infestation can be summarised as follows:

Economic (Livelihood related)

- Reduced losses, hence increased income
- Reduced requirement for credit to purchase fish
- Better quality product that sells faster, and fetches a better price
- Increased number of processing cycles during monsoon periods
- Longer product shelf life and improved appearance offer scope for diversifying to other markets that pay better

Health related

- Less dependence on harmful insecticides which may have adverse effects on the health of consumers and the processing communities
- Improved practices create a safer working environment for the processors and a more hygienic product
- Numbers of disease carrying blowflies are reduced
- General improvements in community health resulting from raised standards of hygiene in and around processing areas

Social

- Opportunities for processors to collaborate and raise issues of common interest and concern with decision makers
- Opportunities for processors to access support from social and economic development programmes organised by the government and NGOs

Environmental

- More efficient use of resources through reducing losses
- Improved hygiene and cleanliness around the processing areas, ensuring better living conditions in the village as a whole
- Reduced quantities of insecticides disposed to the local environment

Case Study 11: Benefits of Controlling Infestation

Kambala Yellayyamma (55) ventured into fish processing more than 15 years ago when she and her husband found it increasingly difficult to make ends meet with his earnings from fishing alone. The boat that her husband owned, a traditional catamaran, had to be sold along with the nets to finance the marriages of their three daughters. By the time their last daughter left home, Yellayyamma was had to fend for herself and her husband in addition to paying off the large debt incurred for the wedding. With her husband effectively unemployed, Yellayyamma joined hands with Bondu Appayamma (60), another processor who had prior experience of fish trade, and began fish processing. The arrangement was simple: Appayamma procures fish for processing and sells the product in the markets, while Yellayyamma handles the processing work.

Until 1999, the Appayamma-Yellayyamma duo, like all other processors in the village, regularly suffered from losses due to monsoons and infestation, regarding infestation losses as an integral part of business.

Yellayyamma has since been involved in a few projects aimed at reducing fish losses through controlling infestation, and in due course, has begun employing some simple methods to reduce infestation, which she claims have significantly reduced her losses.

The methods that Yellayyamma uses are quite straightforward. She ensures that the fish reach her processing yard as soon as they are bought at the beach, rather than waiting until sufficient quantities are bought. She also begins to process the fish almost as soon as they reach the processing yard. Reducing processing time, she has discovered, is an important factor in reducing infestation. When processing, she spreads the fish on a polythene sheet and uses good quality, sharp, knives for gutting and other operations, to avoid jagged and irregular cuts to her fish. She cleans the fish twice, once as soon as they arrive at the processing yard, and the second time, before placing them in salt. When she has large quantities of fish to process, she settles for one wash after completing the pre-processing operations, as obtaining water can be difficult. Fish are dried on drying racks. She has erected a net canopy around the processing area using cast off nets (in two layers to restrict the movement of blowflies through them), and although not perfect, it has reduced infestation.

Whilst the cost of the interventions had not been very high, the reduction in losses was substantial. The quality of fish has improved, and this is reflected in their ability to quickly sell their fish at market, rather than waiting long periods for a buyer. It is well established that the prices of fish sold early are about 10-15% higher than those sold later in the day. In addition, Yellayyamma calculates that her income has further increased due to reduced losses. Because of the slating vat lid, she says she could sleep uninterrupted, even during monsoons. She can afford to buy fish throughout the monsoon period when other processors reduce processing for fear of infestation. She feels that being able to process fish through the monsoon, considered to be the good period for pelagic landings, enhances the size and scope of her operations, which can only mean higher returns. One important indicator of the usefulness of the loss reduction tools is the fact that she has not had to take a loan from the local moneylender during the last monsoon period. Once, during 2000, she purchased an excessive quantity of fish and could not give the fish her full attention. She paid dearly for this, losing about Rs. 3,000 in one cycle, and is still repaying the loan incurred to begin her operations again. It is a mistake she will not commit again.