DFID Post Harvest Fisheries Research Programme

Trainer's Guide to Controlling Blowfly Infestation of Traditionally Processed Fish

Part 2. Application of the Systems - based Approach in the Field – Guidance Notes, Checklists and Templates

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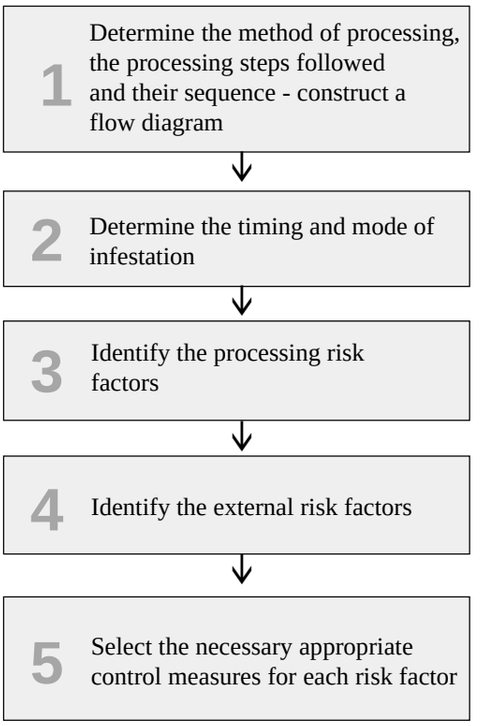
ABOUT THIS GUIDE

This guide provides practical advice on implementation of the systems – based approach in the field. Checklists and templates are provided to assist field data collection. It also contains case study based exercises designed to familiarise development workers with the logic of the approach before they venture in the field.

The systems – based approach is participative in nature and Section 1 provides a brief overview on factors that need to be considered when introducing the approach to village communities. For further information on participation in post – harvest fisheries development the reader is referred to Ward, A.R., Salagrama, V. and Joseph, M.M. (2001) *Participation and Post – harvest Fisheries: An Approach to Identifying Appropriate Interventions.* Chatham, UK: Natural Resources Institute.

Sections 2 to 6 provide guidelines on each of the 5 steps of the systems – based approach represented below:



The guide raises awareness of the diversity of traditional fish processing operations and the need to be flexible in implementing approach. Particular emphasis is placed on fully including the stakeholders in the process and the importance of taking into account their views when selecting control measures. Section 7 contains case studies and desk – based exercises, which should be worked through before attempting to apply the approach in the field.

1. GUIDELINES ON WORKING WITH FISH PROCESSING COMMUNITIES

If the systems - based approach is to be successfully introduced to a fish processing community it is essential that members of the target community are fully involved as equal partners in the process, and that interventions are decided upon as a result of consultation and agreement. This requires the development worker to adopt the role as facilitator, as opposed to that of the expert dispensing knowledge. To this end, it is strongly recommended that participatory methods are used when applying the approach in fishing villages. Guidance on the participatory approach to working with village communities is given below.

Need-based and participatory approaches: The systems - based approach can only be effective when it is applied to practical field situations, and involves the participation of intended beneficiaries at every level of its implementation. Involvement of the people will depend upon the extent to which the work addresses their perceived needs. Consequently, the systems - based approach works most effectively when stakeholders are actively involved throughout the process, commencing at the initial stage of identifying and prioritising their needs.

Positive and enabling attitude to involvement of the processors: It is important that the processors fully understand the purpose of the systems - based approach and are encouraged to select those remedial measures which best suit their individual circumstances. The attitude adopted by the development worker when initiating the fieldwork will influence the response of the processors.

Holistic and integrated strategies: The systems - based approach requires a good understanding, not only of the processing methods and the technical aspects of infestation control, but also of the wider context (socioeconomic, political, cultural, institutional and environmental) in which fish processing takes place. Development workers should be aware of issues related to use and access rights, equity and sustainability, and vulnerability and marginalisation. If the context in which the intended beneficiaries live and pursue their livelihoods is not clearly understood, it is unlikely that they will adopt the approach.

Recognising and accommodating heterogeneity: Traditional fish processing systems are rarely homogeneous. Even within the same village, different processors may be using different processing regimes. Therefore, arriving at a simple solution that uniformly addresses the needs of different processors is rarely possible. It is possible that the concept behind a particular remedy is widely applicable, but the practical form it takes can only be determined by the processors themselves. In other words, 'fixed packages' containing a set of practical tools for controlling infestation are less likely to succeed than working with a set of concepts with the processors to develop them into tools that suit their particular circumstances.

Strong and positive relationships with end users: The systems - based approach presumes the existence of trust and rapport between the development worker and the processors. This is possible only where there is already a well established direct relationship between the two, or between the processors and an intermediate development organisation (government department or an NGO).

Village selection: Because it is seldom possible to work in every processing community, care must be taken when deciding which villages to target in disseminating the systems - based approach. Factors which may influence selection include

- Nature of fish processing operations and their relevance to the wider area
- Number of people depending on fish processing
- Importance of the problem being investigated, i.e. blowfly infestation, to the processors
- Importance of fish processing when blowfly infestation is at its highest
- The rapport that exists between the development organisation and the processor groups in the village

- Potential for market growth (based on improved quality of products and transport links)
- Potential for secondary dissemination

Meeting with all processors in the village: When beginning to work in a village, an effective way of introducing the project and its staff to the people is by holding a meeting with all the processors in the village. Ideally, a meeting should not have more than about 10-15 processors. If there are a large number of processors in a village, it might be useful to hold a number of small group meetings, rather than one large meeting which may be difficult to organise and could be unproductive.

Involvement of other influential people in the meeting: The initial meeting should also involve key figures in the village, like elders, schoolteachers, health workers and other government and NGO staff. The involvement of such people encourages village ownership of the project, alerts the wider community of the potential benefits, raises awareness of problems being faced by the processors, allows access to local resources and facilitates uptake of the project outputs. Some of the control strategies for reducing infestation, such as improving general hygiene and cleanliness, are often beyond the capacity of the small-scale processors to implement alone, requiring wider awareness and involvement by other sections of the village. After the general awareness raising meeting is over, more in-depth discussions with the processors alone can take place.

Place and Time of the meeting: The meeting should be arranged at a time when the processors are not otherwise busy with processing or household chores. The meeting should take no longer than a couple of hours, although arranging the meeting itself may take more than an hour. The place of the meeting should be ideally somewhere that can be easily reached by all processors, preferably a processing site, to make it possible for both processors and researchers to relate what they discuss to what they see.

Contents of the meeting: The meeting involves the researchers introducing themselves to the villagers and establishing their credentials. They proceed to give a brief overview of the work they are doing and how it seeks to address the infestation problem. Although there is much evidence of the widespread and serious nature of infestation, it is still very necessary to clearly establish with each group of processors whether the problem exists and gain an impression of its severity, both in terms of physical and economic losses. This often involves undertaking a problem-ranking exercise to establish the seriousness of the problem, and its place in the larger context of life in each community. Even though it is unlikely that all the processors will be directly involved in the project at the beginning, involvement in the initial meetings helps them understand the purpose of the exercise and ensures their participation as observers in the fieldwork. Involving as large a number of processors as possible at this stage will facilitate collection of information on:

- Differences in processing methods and infestation patterns
- Socioeconomic status of different categories of processors
- Power and patronage relationships within the processor groups, and between them and the larger village
- The processors ability and capacity to change and to bring about change
- The use and access rights to processing areas
- The differences in preferences for dried fish in the various markets processors cater for.

Coping strategies: It is to be expected that most processors will have developed their own ways of controlling blowfly infestation. During discussions, it is important to establish:

- What the coping strategies are
- How effective they are in terms of controlling infestation
- Their implications in terms of quality, costs and health
- Whether the processors feel that the measures are sufficient in themselves to solve the problem.

2. GUIDELINES ON USING PROCESS FLOW DIAGRAMS

The process flow diagram covers all of the steps in the processing of a fish product. It offers a simple and effective way of identifying process steps and describing how the fish is processed. The process flow diagram allows information to be presented in a clear, diagrammatic form and makes it easier for potential infestation points and controls to be discussed and identified in a logical way. When similar processing steps are used for different products the same process flow diagram can be used. The process flow diagram provides the main point of reference for the infestation audit and subsequent actions and is a valuable tool in applying the systems - based approach.

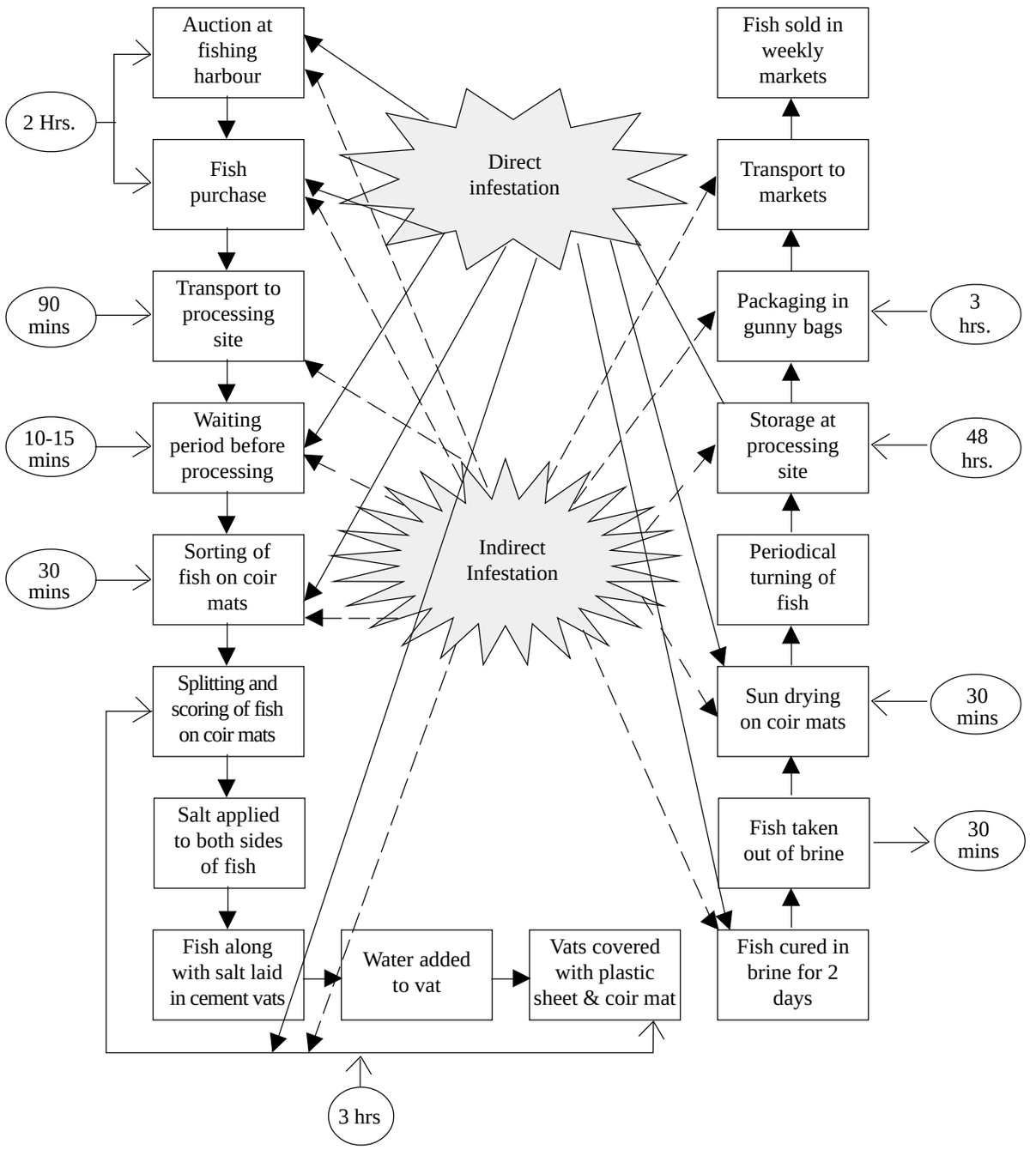


Figure 1. Example of Process Flow Diagram Completed at a Small-Scale Fish Processing Site in Orissa, India

The process flow diagram should be drawn up in collaboration with the processors. The initial diagram can be attempted with groups of 10-15 processors, so that the differences in approaches, systems and processes can be incorporated into the diagram. Using a set of cards (about 15 cm^2) on which each stage is written down, and placing them in a chronological sequence on the ground can be a useful communications aid. Additional information e.g. infestation points, seasonal variations etc. can be added using cards of different shapes and colours. Flow chart cards used to indicate infestation are generally made of two colours, one to indicate indirect infestation and the other, direct infestation. Cards of different sizes can be used to indicate the relative levels of infestation e.g. high, medium, low, insignificant etc.

By taking the processors through the flow diagram, and where possible eliciting information on causes and consequences, it is possible to arrive at the specific points in the processing chain where infestation levels are particularly important and where control measures can play a significant role in reducing losses.

The initial diagram can then be refined and validated by directly monitoring the process at selected processing sites. The entire process, from purchase of the raw material through to despatch of the final product, should be monitored. An example of a completed flow diagram is given in Figure 1.

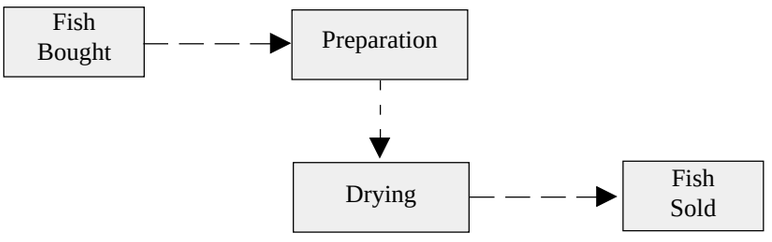
The following template flow diagrams show the processing stages followed in each of the principal types of curing process. The steps which may be followed during the preparation stage are described in a separate flow diagram.

The templates can be copied and used as guides when identifying the particular processing stages being followed at a processing site. They may also help in determining the order in which each stage is carried out.

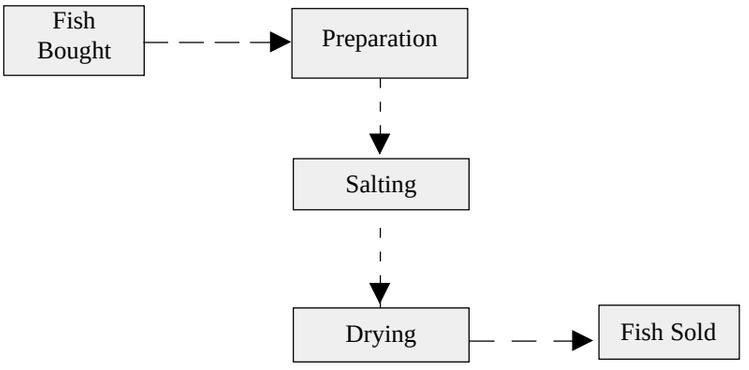
When drawing the flow diagram for a process, each of the preparation stages being carried out should be included in the same diagram.

Using the flow diagram as a reference point, discussions on where infestation occurs in the processing chain can proceed with the processors.

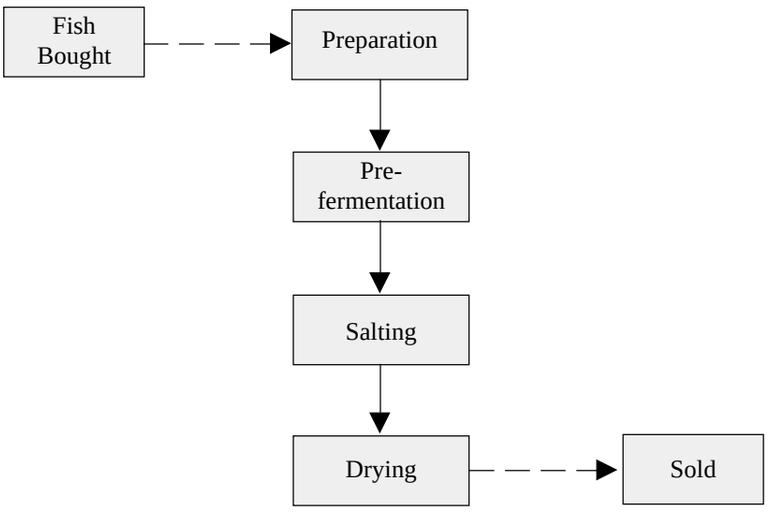
TEMPLATE FLOW DIAGRAM OF FISH PROCESSING BY SUN-DRYING ALONE



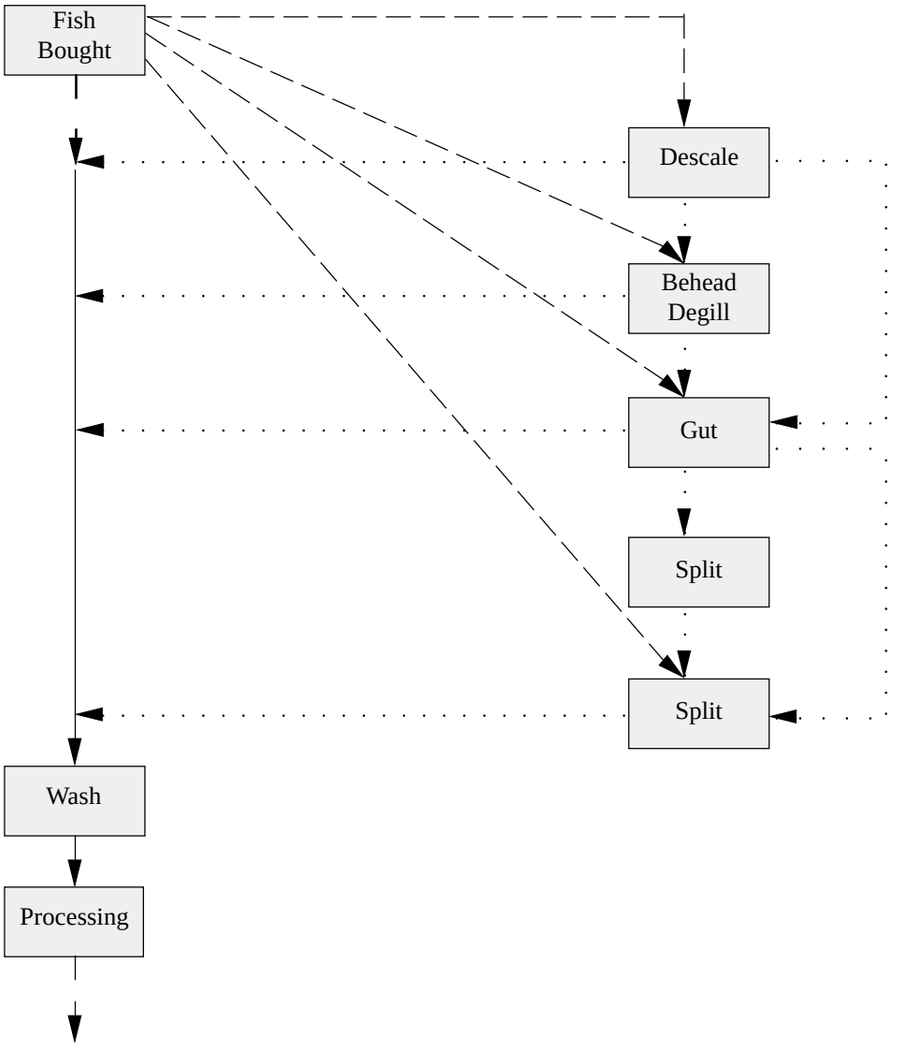
TEMPLATE FLOW DIAGRAM OF FISH PROCESSING BY SALTING AND SUN-DRYING



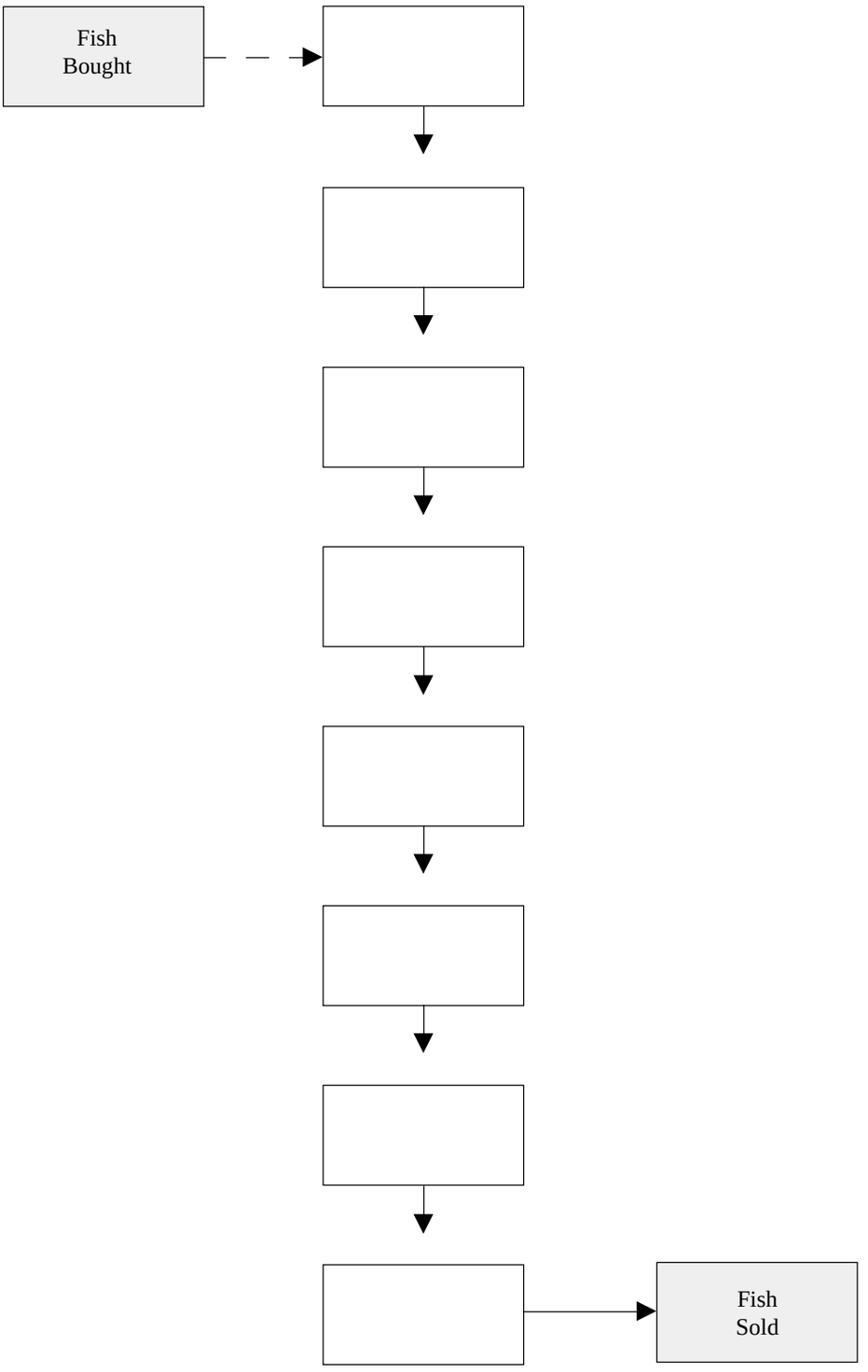
TEMPLATE FLOW DIAGRAM OF FISH PROCESSING BY PRE-FERMENTATION, SALTING AND SUN-DRYING



TEMPLATE FLOW DIAGRAM OF POSSIBLE PREPARATION STAGES



BLANK PROCESS FLOW DIAGRAM



3. GUIDELINES ON DETERMINING INFESTATION MODES AND POINTS

Fish can become infested with blowflies at any point after they have been landed. The infestation can be caused by blowflies laying their eggs directly onto the fish (direct infestation), or by older larvae moving onto the fish from another food source (indirect infestation). In order to control the infestation, it is first necessary to find out when the fish are becoming infested, and through what mode. Whenever possible, the points at which infestation occurs and infestation modes should be verified by direct observation of the process. Ideally, verification should take place when the processors' losses from infestation are severe, i.e. monsoon periods.

The following notes describe how infestation may occur at each processing stage.

Raw Fish

Direct Infestation	Indirect Infestation
As soon as the raw fish is landed it is at risk from direct infestation. Blowfly eggs are often present on the fish even when it arrives at the processing site. If fish is held at the processing site before processing, blowflies may attack the fish.	The fish is at risk from indirect infestation whenever it is held unprotected in areas where blowfly larvae are present. Indirect infestation of raw fish is more likely to occur at the processing site if the fish is held before processing.

Preparation

Direct Infestation	Indirect Infestation
Direct infestation is only likely to occur during the preparation stages if the fish is held for any length of time between steps. Blowflies will not be able to settle to lay their eggs whilst the fish is being handled.	Indirect infestation is the most likely mode of infestation during the preparation stages. This will occur if fish are stacked anywhere where blowfly larvae are present. Such places can be the ground, on processing tables or in containers which are regularly used to hold fish and are not cleaned in between. During the preparation stage fish are often placed in such places between each processing step.

Pre-Fermentation

Direct Infestation	Indirect Infestation
Direct infestation may occur during the pre-fermentation stage if the fermentation tank is not covered, allowing female blowflies to lay their eggs upon the fish at the top of the tank.	Indirect infestation may occur during pre-fermentation if the fish are already infested with larvae when they are placed in the fermentation tank, as the larvae may move between adjacent fish.

Salting

Direct Infestation	Indirect Infestation
Direct infestation may occur with any method of salting if the fish is not protected. When salting tanks are not covered, female blowflies can lay their eggs on the fish at the top of the tank. They will even do this when the fish are partially submerged in brine. When fish are dry salted in stacks, blowflies will crawl through the sheeting used to cover the fish unless it is well secured.	Indirect infestation may also occur with any method of salting if the fish is not protected. Fish is most at risk during dry salting if it is stacked where feeding larvae are present, for example on the ground or in dirty containers which are regularly used for holding fish. If the fish is already infested with larvae at the time of salting, the larvae may move between adjacent fish whilst it is stacked during dry salting, or even in the salting tank during wet salting.

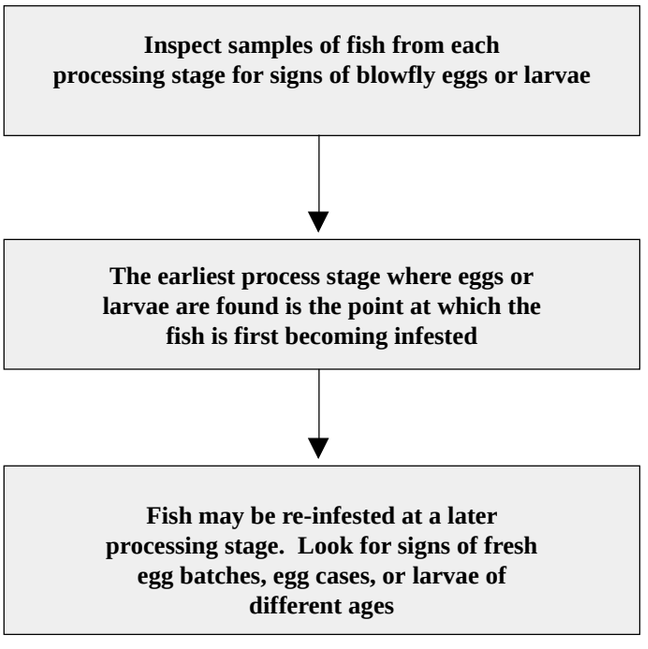
Sun-Drying

Direct Infestation	Indirect Infestation
The fish is most susceptible to direct infestation during the sun-drying stage. The female blowflies can settle on the fish whilst it is spread out, or hung up to dry. If they are left undisturbed, they will lay their eggs on some or all of the fish.	Indirect infestation can be a problem during sun-drying too. If there are blowfly larvae present on the ground or racks on which the fish are laid out to dry, the larvae will move onto the fish and infest it. Indirect infestation can also occur if fish which are already infested with blowfly larvae overlap one another during sun-drying. The larvae may move from the infested fish to another and begin to infest it.

Early Storage

Direct Infestation	Indirect Infestation
Fish which has been improperly dried will continue to attract blowflies during early storage. If they can gain access and are left undisturbed, adult females will lay their eggs on some or all of the fish. The larvae will hatch and infest the fish.	Indirect infestation can be a problem during early storage, particularly when uninfested fish comes into contact with infested fish. If blowfly larvae are present in the storage area and the fish is unprotected, the larvae will move onto the fish and infest it. The larvae may move from the infested fish to another and begin to infest it.

Step 1: How To Determine The Timing Of The Infestation



Step 2: How To Determine The Mode Of Infestation

INFESTED FISH

Direct Infestation

Look for these signs of direct infestation:

- **Egg batches present on fish**
- **Empty egg cases present on fish**
- **Female blowflies settling in mouth, gills or crevices in the flesh**
- **Female blowflies seen with ovipositor extended**

Indirect Infestation

Look for these signs of indirect infestation:

- **No egg batches or egg cases present on fish**
- **All larvae are of second instar or older (no very small larvae present)**
- **Larvae present on ground or in areas where fish are being held or processed**

The same fish may be infested by both modes

4. GUIDELINES ON IDENTIFYING THE RISK FACTORS ASSOCIATED WITH EACH PROCESSING STAGE

Factors associated with each processing stage can cause the fish to become infested. Once the timing and mode/s of infestation have been determined, it is necessary to find out which of these processing factors may be influencing infestation at the processing site. The following notes describe the risk factors associated with each processing point that are important in causing the infestation.

RAW FISH QUALITY

Using poor quality fish for traditional curing will increase the risk of blowfly infestation:

- During early spoilage, microorganisms produce compounds, which are very attractive to adult blowflies. Blowflies are therefore more likely to lay their eggs upon partially spoiled fish.
- Unhygienic handling of the fish increases the risk of infestation because spoilage microorganisms can be spread to the flesh of the fish from dirty hands, knives, tables, fish boxes and other surfaces. If the fish are handled roughly, their gut contents may spill onto the clean flesh of other fish and contaminate the flesh with spoilage or disease causing microorganisms. The fish will therefore spoil more quickly and be more attractive to blowflies.
- Holding the fish without protection from blowflies, can lead to eggs being laid on the fish. Fish may therefore become infested before it is even processed.
- Holding the fish without protecting it from any larvae, which may be present where it is being held, can lead to indirect infestation. Fish may therefore become infested before it is even processed.

Preparation

Practices followed at each of the preparation stages can increase the risk of blowfly infestation.

- As soon as the fish dies, the micro-organisms which live in the fish guts will begin to cause the fish to spoil and therefore become attractive to adult blowflies.
- If the gills and / or head are left on the fish, the fish is more likely to be attacked by blowflies, because the female blowfly likes to lay her eggs in the head and gills.
- Fish which are not split have a smaller surface area than do fish which have been split, and so they take longer to dry. They will therefore be attractive to blowflies for longer.
- If fish are gutted through the mouth cavity but not split, the adult females will enter the body cavity and lay their eggs deep inside the body where they will be unnoticed and can develop safely.
- If the fish are split in such a way as to leave rough, uneven surfaces, any eggs, which are laid on these surfaces, will be protected from the sun by the crevices, which are left in the flesh. The hatching larvae will also be protected from the sun.
- Although scoring the sides of large fish will increase the rate of water loss and salt penetration, it may also provide crevices in which eggs can be safely laid and the larvae develop.
- If the fish is held without protection for long periods during the preparation, blowflies may lay their eggs upon the fish. Fish may therefore become infested before it is cured.
- If the fish is stacked in areas where larvae are present, it may become infested during the preparation stages.

Pre-Fermentation

Pre-fermenting the fish makes it much more attractive to adult females.

- The pre-fermentation stage encourages anaerobic microorganisms to grow and produce compounds, which are very attractive to adult blowflies. Pre-fermented fish is therefore much more likely to be attacked by blowflies.
- Not covering the fermentation tank properly allows adult blowflies to get access to the fish and lay their eggs on it.
- When fish, which are already infested with larvae, are placed together in the fermentation tank, the larvae can easily move between adjacent fish, and so more of the fish may become infested.

Salting

Although salting the fish may help to protect the fish from blowfly infestation, some practices followed may stop the salting from being effective.

- Not covering the fish properly during salting allows adult blowflies to get access to the fish and lay their eggs on it. Larvae may hatch from the eggs and begin feeding before the salt content of the fish is high enough to protect it.
- Larvae may crawl onto the fish, from the ground or another food source, during salting if it is not properly protected. Allowing older larvae to move onto the fish during salting can lead to greater infestation, as older larvae are more salt-tolerant than are the newly hatched larvae.
- When fish, which are already infested with larvae, are salted, the larvae can easily move between adjacent fish, and so more of the fish may become infested.
- Sun-drying the fish before salt penetration is complete allows blowfly larvae to feed upon parts of the flesh where the salt content is still low.
- If the fish is salted to less than about 8g of salt per 100g of fish, blowfly larvae will be able to feed and survive upon the fish.

Sun-Drying

The fish is at great risk of infestation during sun drying. Some practices however, increase the risk further.

- Fish, which are dried on the ground instead of on raised racks, are more likely to become infested for three reasons. First, they dry more slowly as only the upper surface is exposed to the sun and wind. They are therefore at risk of infestation for longer. Second, they are at greater risk of indirect infestation, as larvae feeding on waste on the ground can move onto the fish**.** Third, when the ground on which the fish are dried is earth or sand, the larvae can escape from the heat of the sun by burrowing into the ground. They can then re-infest the fish once the temperature decreases to an acceptable level.
- Fish dried on trays made of leaves or split bamboo, or other loose material, is at risk of indirect infestation. Any larvae leaving a dried fish can hide and move easily amongst these materials. This enables them to move onto and infest other fish placed upon the rack.
- If too many fish are dried at one time, a shortage of space may mean that the fish overlap one another. This slows down the rate of moisture loss from the area of the fish, which is covered by another fish. The processor may consider the fish dry when the covered part of the fish is still not dry. The fish will therefore be at risk from infestation. When fish overlap, larvae are also able to move between fish more easily.
- During the early stages of drying, the high moisture content of the fish makes it very attractive to female blowflies. If they are not excluded from the fish, they will lay their eggs upon it. The eggs will hatch within 12-24 hours, and the larvae will burrow into the fish and begin to feed in large packs.
- If the fish is not protected during drying, larvae may move onto the fish from another food source, possibly another fish, and begin to infest it.

Early Storage

Fish that has been properly salted and dried is generally unattractive to egg laying blowflies. However, infestation during early storage may occur when:

- Incompletely processed fish are placed in storage
- Stored fish absorbs moisture from the atmosphere
- Blowflies can gain access to the stored fish
- Fish comes into contact with previously infested stored fish