FIELD SURVEY

The field survey has been carried out with the objective of getting a first hand knowledge about the methods of fish drying and storage practiced in each center, the extent of dependence of fishermen on the trade, the threats faced by this industry, the various pests attacking dried fish and the various indigenous methods of control practiced by the local fishermen.

The information thus gathered will help in devising better control methods and more hygiene ways of fish processing.

Thiruvananthapuram

Large scale as well as small-scale fish drying was observed all along the coastal belt. Dry fish industry is a 5 crore/year turnover business in these regions. Large-scale fish drying begin soon after the monsoon and continue until the onset of monsoon next year. At the first signs of monsoon, fishermen stop large-scale fish drying. Small-scale fish drying continues until monsoon attains its full strength. In addition to the local fishermen, those coming to these coasts from Mangalapuram with sophisticated gears indulge in hectic fish processing activities throughout the season. Large stretches of sandy beaches in the Thiruvananthapuram region help in making the drying process easier. Punthura and adjacent coasts lack sandy beach and here the fish drying was done upon the rocks. Fish drying peaked when there was surplus yield from the sea. Drastic fall in the fish yield has made it difficult for the fishermen community to carry on with their traditional occupation. Sardine was the major commodity available, especially during ‘Chakara’, for drying. Tamilnadu is a major market for the dried fish where it is used as poultry feed and also for human consumption. Hence, the fishermen in the Thiruvananthapuram coasts get good price for their produce. Madhya
Pradesh, Uttar Pradesh, Gujarat, Maharashtra also form major markets. Excessive use of pesticides like ammonium chloride, BHC, DDT during fish processing as well as during storage to prevent pest attack is observed in the fish drying centres of Thiruvanthapuram. Diarrhea, nausea, and other related ailments are of common occurrence among the fishermen community over here, which may be related to the contamination of the water bodies with these insecticides. Fish for both human consumption and poultry feed were processed here. Fish is dried either directly on the sand or upon the coir mat. Fish for human consumption was gutted and kept on coconut fronds (Plate III, Photo 17) /coir mat for drying. Small scale drying and its marketing were mostly done by women (Plate- III, Photo 18). Nets were placed around and on top of the drying area to protect it from being eaten by the birds, cats etc. The storing and drying areas although not hygienically maintained were devoid of any insect pests, which again indicate the possible use of insecticides. Laboratory reared larvae reared on the sand brought from the region died within a day, which further strengthens the information that insecticides are used in these areas for pest control.

**Major fish drying centers were:** Erayamanthura, Chembakaramanthur, Puthiyathura, Adimala, Pallam, Karimkulam, Kochuthura, Aadimalathura, Cherithura, Pallithura, Thumba, Saint Antruce, Punthura, Bhimapalli, Valiathura, Thoppu, Shankumukhom, Kannumthura, Cheruvettukad, Cheruvettukad, Valiyavettukad, Cheriaveli, Valiaveli, Puthanthoppu, Vettuthura, Naluthengu, Shantipuram, Marianad, Puthukuruchi, Perumathura, Thalampalli, Puyrhra, Anjuthengu, Poziyuru, Parthur, Pulluvila, Kochuvila, Vizinjam, Kollangode, Eravanthura, Fathimamatha, Ovilorpumatha, Karichankayal to Somatheram (Gramam), Parthur/ Paruthiyur (TN border), Puvar, Kochupalli, and Charathadi. There were about 150 stocking sheds (chappa) all along the sandy beach from Poovar to karichal kayal.
Major fishes dried were: - Natholi _Stolephores indicus_; kalaba _Epinephelus tauvina_; prawn; chaala _Sardinella longiceps_; kanava _Sepia pharonis_; powdered prawns, aila _Rastrelliger kanagurta_; kattila _Pristpomoides_ spp.; chuvanna kattila _Nemipteres_ spp.; chura _Euthynnus affinis_; koziyala _Selar crumnothalmus_; mural _Epinephelus diacanthus_; and kara _Penaeus monodon_.

Major pests observed were: _Necrobia rufipes, Dermestes maculatus_ and _Calliphora_ sp. Other insects associated with dried fish were Species H (Elateridae) (Plate IX, Photograph 64), Species F (Carabidae) (Plate VIII, Photograph 62), Species E (Scaraboidea) (Plate VIII, Photograph 61).

Kollam

Neendakara and Shakthikulangara are the main fish catchments areas at Kollam. Large-scale fish drying is not possible here because of the lack of stretches of sandy beaches. Small-scale fish drying of high quality fishes in courtyards attached to the habitations of the fishermen are marketed for human consumption (Plate III, Photo 19). The opened and cleaned fish are laid on coir or jute mat with a net on top to protect them from birds. Sardines marketed as chicken feed, are dried directly on the available sandy stretches. Only in Kollam the sardines were found mixed with sand (Plate III, Photo 21,24), which may delay the drying process. This may be done to prevent insect infestation as the sand was possibly mixed with insecticides as indicated by our laboratory studies. Fish drying centers were quite untidy and unhygienic. About 99% of the fish processed here were for human consumption, which is indeed of great concern in the wake of the observation made on rampant use of insecticides in the field. As there were no chappas here the fish were heaped on the sand itself (Plate III, Photo 20) and sometimes covered with plastic sheets (Plate III, Photo 22). Shakthikulangara was marked by the presence of many major shark-processing centers.
Thousands of fishermen directly or indirectly earn their livelihood from the fish drying business. Pathanamthitta and Kottayam are among the major marketing centers. There were about 15 chappas.

**Other major fish drying centers**: Mariyalayam, Puthanthura, Thankasseri, Vadi, Mathukara, Pallithottam, Port kollam, Chavara.

**Major pests observed were**: *N. rufipes, D. maculatus* and *Calliphora* sp. in very low numbers.

**Fishes commonly used for drying were**: - Mullan *Leognathus* spp. (Plate- III, Photo 23); bral _Chana muraleus_; manthal *Cyanaoglossus semifasciatus_; Natholi *Stolephores indicus* (Plate IV, Photo 25), Kora *Sciaenids* spp; shark _Carcharionus* spp; prawn, sardine *S. longiceps*; mackerel *R. kanagurta* (plate IV, photo 26,27).

**Alappuzha**

Vast stretches of coastal areas were used as fish drying yards. Coir mats are spread on the sandy coast and fishes are dried over it. The sacks were mostly filled in the open (Plate V, Photo 37). There were about thirty Koodam (Chappa) (Plate V, Photo 35, 38) along the coasts from Thottappalli to Valizazeekkal, Thaikkal, Mararikkulam, and Omanappuza coasts, which are used as the temporary storing place for dried fish. High demand for the commodity left no room for stocking the commodity for long, hence the few number of chappas. Thousands of labourers depend on the dry fish industry for their livelihood. Low fish catch was the major problem that threatens the dry fish industry in Alappuzha. DDT and other insecticides were found to be used extensively to prevent insect pest infestation. In addition to mixing with the sand upon which fishes were spread for drying, insecticides were also dusted on sacks in which dried fishes are packed (Plate V, Photo 36). All along the coastal belt from Thottappalli to valizazeekal (about 25 km), fish
drying practices are in full swing throughout the season beginning from August to May. In Alappuza coastal belt, the Chakara is not a constant phenomenon pertaining to a particular region and it can shift, which compels fishermen to move from one area to another in search of a bulk yield. For these reasons, permanent fish drying centers were absent in these regions. Fish drying for human consumption depends on availability of commercially valuable fish for a moderate price. Steady hike in the price has left fishermen with no option other than drying cheaply available fish for poultry feed. The difference noticed here when compared to other fish processing centres in Kerala is the cleanliness in processing practices. Fishes were spread over the coir mat and coconut fronds (Plate IV, Photo 30,33 and 34), which prevent mixing of the dried fish with the mud, sand etc. The dried fish were sometimes stored in the beach itself and coir mats were used to cover them. (Plate IV, Photo 28). Clean dried fish fetch more money for the fishermen. ‘Kudumbasri’ (NGO) provide labourers for the chappa owner. Three wards, namely; Therayilkadavu, Perumpalli, and valizazeekkal known for intensive fish drying activities were devastated by the tsunami which hit Alappuza and Kollam districts in 2001. Sandy beaches disappeared; fish yield declined which adversely affected the dry fish industry. Years after the tragedy, the situation has improved and slowly and steadily the fish drying activities were gaining momentum.

**Major fish drying centers were:** North: - Purakkad, Punnapra, Kurishumpallikkal, Esa, Nadakkal, Vattayal, Kanchiramchira, Omanappuza, Kattur, Mararikkulam, Chethi, Cheriavali, Arathingal, Thaikkal, Manakodum, Puthithodi, South:-Varakkad, Valanjavazi, Ambalappuza, Thottappalli, Pallana, Thrikkunnappuza, Arattuvazi,, Kallikkad, Kayamkulam, Vadakkal, Kakkazam, Vattachal, Perumpalli, Therayilkadavu, Mangalam, Arattupza (Pathisseri), Cherthala, Anthakaranazi.
Major pests collected: *N. rufipes, Calliphora* sp., and *D. maculatus* were collected from the storing sheds along with Species I (Tenebrionidae) (Plate IX, Photograph 65).

Major fish available for drying process were: sardine *S. longiceps*; chuda *Escolosa thoracata*; mackerel *R. kanagurta*; thala *Trichurus lepturus*; natholi *Stolephores indicus* and manthal *C. semifasciatus*. Prawns were also dried in the cost in large quantities (Photo IV, Photo 29).

Ernakulam

Vypin

About fifteen fish drying yards and stocking sheds were located adjacent to each other. Hundreds of such yards were there until a few years back. A steady decline in the fish yield and consequent hike in the price left this business unaffordable and many quit the field. The fishermen in this area were specialized in mackerel processing. They were processed in two different ways. In one method, fishes with their operculum, gills and intestinal parts removed and cleaned were spread in layers with salt alternating in concrete tanks (Plate V, Photo 39,40). An average of 2 kg salt / 1 kg of fish were used. After 2-3 days the fishes were removed from the tank and cleaned well, spread on coir mats over the floor of the yard (Plate VI, Photo 41). Processed fishes were packed in coconut leaf mat and are transported to various parts. About twenty workers were engaged in a single fish processing shed and attached yard. Many more are indirectly engaged in the fish processing and allied work. Another processing technique practiced here is to keep the fish in tanks filled with saturated salt water, for about 1 week and then taken out and the salt-water drained off (Plate VI, Photo 42). After proper drying fishes were cleaned and packed in bamboo containers (Kotta), which enclose about 44 kg of fish, to which 8 kg salt were added. The major
markets for the processed fish are Parinthalmanna, Trichur, Palghat, Aluva, kottayam, Athirampuzha, Changanassery, Ernakulam, Kodungallur etc. in Kerala and Trichi (especially Velipuram), Chennai etc in Tamil Nadu. Chemban (keziyali), vaala, ribbonfish etc are considered as quality dried fishes. The processing sheds were concrete structures with well-plastered walls and floors without any crevices. The processing method practiced here resulted in very low incidence of beetle pest. Major season for the fish processing were August to June and the peak season January to April. In addition to Vypin fish processing was also carried out in Munambam, and Kunhithi.

Insects collected from the storing sheds: *Necrobia rufipes*, and *Calliphora* sp., *Species H* (Elateridae) (Plate IX, Photograph 64).

Fishes processed for human consumption: Vaala *Chirocentrus* spp, Manthal C. semifasciatus; Kora *Sciaenids* spp.; Pallikkora *Ottolithus* spp.; Kadal bral *Rachycenton canadus*; Mackeral *R. kanagurta*, Olanchi Manungu *Engraulis* spp.; Nandan *Ambasis*; Etta *Arius* spp., etc

**Azeekkode**

Azeekkode beach was well known for fish drying practices until recently. As the government has declared the beach as a tourist spot and banned fish processing on the beach, fishermen engaged in fish drying related job are facing unemployment and there were widespread discontent over the new policy of the government. The government order came as an unexpected blow to the already ailing dry fish industry in the region. Until 2006 there were about ten sheds. Sardine and other relatively cheap fishes were extensively dried and exported from here to different parts of the country.
Trichur

Chavakkad

Entire beach stretches for about 10 kms and extend up to the Ponnani coast. Sardine processing was carried out on a large scale.. There were about 60 chappas along the coasts of Puthankadappuram, Edakkayur, Manthalamkunnu, Adathode, Palappetti. Indiscriminate use of insecticides during fish processing may be the reason for the relatively low pest attack. Laboratory studies have also pointed to this possibility.Major exporting centers are Tamilnadu, Andhra Pradesh, and Karnataka etc. Drying fishes for human consumption stopped due to unavailability of the high quality fishes and consequent hike in the price. Infection reaches its peak during monsoon season due to improper drying. Approximately 600 families were directly or indirectly connected with the dry fish industry.

**Major fish drying centers were:** Puthankadappuram, Edakkayur, Manthalamkunnu, Adathode, Palappetti, veliyamkode (which merge with Ponnani coast), and Nattika.

**The common insects observed along with the dried fish were:** *N. rufipes, Calliphora* sp.,*and Dermestes* spp., *Species A* (Histeridae) (Plate VIII, Photograph 57) and *Species K* (Ephydridae) (Plate IX, Photograph 67).

**Fishes processed:** Mackeral *R. kanagurta*, thala *Trichurus lepturus*; natholi *S. indicus*; mullan *Leognathus* spp.; manthal *C. semifasciatus*; malan *Mugil* spp.; veluri *Escolosa thoracata*,

Malappuram

**Tirur, Tanur and Parappanangadi**

Vast stretches of beaches help in easy fish drying. About forty chappas were located all along these beaches. The chappas were temporary structures
made of bamboo poles and thatched roof. The sides were covered with pleated palm fronds. Fish was dried directly on the sandy beach. The beetle pests (both larvae and adults) in large numbers were found in the moist sand beneath the coir mat inside the chappa. The pests moved easily from here in to the sacks packed with dried fish when it was stored here. During peak season, about three trucks/week leave from each coast to different destinations. No obvious application of insecticides were noticed (laboratory tests also confirmed this.) which render the dried fish prone to intense pest attack. An interesting observation was the presence of *N. ruficollis*, which is the first report of this dry fish pest from India. Histerid beetles have been reported as predators of *D. maculatus* (Haines and Rees, 1989). Unlike in the southern districts where small scale drying is common, fish drying here is monopolized by a few people employing large number of labourers. About two thousand labourers were engaged here in the fish drying and related works. Sardine was the most common fish available for drying. Fishes for human consumption were rarely processed here due to non-availability and unaffordable price of the highly priced varieties. Fish oil extracting centers were found to operate on these coasts and oil extraction is being done on a limited scale. A couple of years back, large-scale extraction was being done, but because of the problem of waste disposal and consequent opposition from local population it has been scaled down. Mostly sardines are used in oil extraction (Plate VI, Photo 48; Plate VII, Photo 49). A large number of *N. rufipes* possibly feeding on the dried oil were found on the wooden planks-used to cover the concrete tanks in which oil extraction was done- piled outside the extraction shed.

During 2006 when bird flu struck the chicken farms of Tamilnadu, dried fish stocks piled up here (as in majority of the large scale fish drying centers), due to the low demand for chicken incurring huge loss. Situation has
improved and the fish processing has continued unabated since then. Fish oil extraction is being done here although on a limited scale.

The chappas piled with sacks of dried fish were found to be heavily infested with *N.rufipes Calliphora* sp. and *Dermestes maculatus*.

**Other beetle species observed in association with dried fish were:**
Species A (Histeridae) (Plate VIII, Photograph 57), Species B (Histeridae) (Plate VIII, Photograph 58), Species C (Histeridae) (Plate VIII, Photograph 59), Species K (Ephydridae) (Plate VIII, Photograph 67), Species H (Elateridae) (Plate IX, Photograph 64), Species F (Carabidae) (Plate VIII, Photograph 62), Species I and J (Tenebrionidae) (Plate IX, Photograph 65,66), Species G (Anobiidae) (Plate IX, Photograph 63), Species E (Scaraboidea) (Plate VIII, Photograph 61) and Species D (Dytiscidae) (Plate VIII, Photograph 60).

**Fishes dried:** Sardines *S. longiceps*; mackerel *R. kanagurta*; natholi *Stolephores indicus*, manthal *C. semifasciatus*.

**Ponnani**

Ponnani is a major fish-drying center in Malappuram district. Jangar and Marappalam are the two major fish drying centers. Fish reach at Jangar port and the major part is dried on the vast stretches of beach available there. A portion is taken to Marappalam where they are dried and stocked in sheds. Dried fish from the Jangar region are also stocked in the sheds at Marappalam. There are about 45 sheds at Marappalam which are different from those found at Puthiyappa, Tanur, Tirur and Parappanangadi. All the sheds were concrete structures with tiled roof (Plate VI, Photo 46). The floor of the shed was partially concreted. Fish salting was also carried out inside the shed, which encloses a number of tanks for the fish processing in saturated saline water. The fish drying yards were located in between the stocking
sheds at Marappalam where as vast stretches of fish drying yards along with thatched stocking sheds (Plate VI, Photo 44, 45) close to the sea shore were located at Jangar port. The sheds were very long structures. The premises of the drying yards as well as the stocking sheds were found to be heaped with the fish refuse which contributed to the insect infestation in the area. Accumulated fish waste near the stocking shed form a perfect breeding ground for insect pests when there is no fish stock in the stocking shed (Plate VI, Photo 43,47). Unscrupulous application of BHC has been observed in this area. Processors mix BHC with the sand upon which the fish is dried. The floor of the shed and dried fish filled sacks were also found to be dusted with BHC. Our laboratory tests have confirmed the presence of insecticides in the sand collected from this location.

Fishermen of about 500 families were directly or indirectly involved in the fish drying and related works. The sharp decline in the fish catch over the years has negatively impacted the dry fish industry. The fishermen community faces unemployment. High percentage of illiteracy and inability to do any other skilled job has prevented the younger generation from getting employed elsewhere. Chellu fetch only half the price of the sardine in the market. About 8-load/ week were exported to the neighbouring states such as Tamil Nadu, Andhra Pradesh, and Karnataka.

The major fish dried was: sardine *S. longiceps* and ‘Chellu’ which is a mixture of small sardine *S. longiceps*, squilla, crab, and small prawns was another major commodity for processing.

The major pests observed here were: *Necrobia rufipes*, *Calliphora* sp., and *Dermestes maculatus*. Other insects collected from the dried fish stocks were Species H (Elateridae) (Plate IX, Photograph 64), Species F (Carabidae) (Plate VIII, Photograph 62), Species I and J (Tenebrionidae)
Kozhikode

Puthiyappa

The presence of a fishing harbour, makes sure of the availability of the fish for drying throughout the season (August to May) and make it one of the major fish drying centers in Kerala. There are about fifty Chappas here, which are very badly maintained. There are no drainage facilities and wastewater gets logged making the surroundings of the chappa very unhygienic. Most of the chappas are walled structures with cement flooring and thatched roofing. But the crevices on the floors and walls (Plate VII, Photo 52, 53) due to damage to the plastering were used as resting places by the insects when fish was not stocked in the yard. Hence, a residual population of the pests is always present in these yards and they start a new cycle of infestation when fish is stocked in these sheds. Fishes were dried in the open sandy shore as well as on specially prepared yards with cemented floor (Plate VII, Photo 51) which does prevent pest attack during drying, but this advantage is offset due to the badly maintained stocking sheds which provide conducive conditions for pest attack (Plate VII, Photo 50). Properly dried fishes were filled in the sacks (Plate VII, Photo 54) and exported to adjacent states depending on the demand or else stored in the chappa. Sardine is the most common fish dried here which are primarily meant for poultry feed. Fishes for human consumption were also dried and exported to national and international markets. Salting in tanks followed by cleaning and drying was another technique observed here. Some fishermen here have taken up marketing of dried fish for human consumption in a big way. Attractive and hygienic vacuum packaging of the products practiced by some people will help in increasing the market share of dried fish. About 4000 labourers are directly or
indirectly employed in the fish drying and associated work. Use of insecticides is almost negligible as shown in our laboratory studies, where larval mortality was also not significant.

**Common insect pests observed in Puthiyapa:** *N. rufipes, Calliphora* sp., and *D. maculatus* Other associated insect species were Species A (Histeridae) (Plate VIII, Photograph 57), Species B (Histeridae) (Plate VIII, Photograph 58), Species K (Ephydridae) (Plate IX, Photograph 67), Species H (Elateridae) (Plate IX, Photograph 64), Species I (Tenebrionidae) (Plate IX, Photograph 65), Species G (Anobiidae) (Plate IX, Photograph 63) and Species E (Scaraboidea) (Plate VIII, Photograph 61).

**Fishes dried:** Sardine *S. longiceps*; Mackerel *R. kanagurta*; nathal *Stolephores indicus*; shark *Carcharius* spp.; thala *Trichurus lepturus*; puffer fish *Tetrodon* spp.; mullan *Leognathus* spp.; manthil *C. semifasciatus*; adavu *L. delicatulus* etc.

**Kasaragod**

The fish-drying season here begins in August and last until the arrival of monsoon. There were about sixty fish stocking sheds. About 5000 individuals are directly or indirectly engaged in fish processing. In this area, about 90% of small scale drying is done by women (Plate VII, Photo 56). Fish oil extraction was done in a big way and there were well-equipped fish oil mills for doing full-scale oil extraction (Plate VII, Photo 55). The fish drying was done on the vast sandy beaches. Fishes were spread on coir/jute mat for drying and were well protected by the nylon net. On an average 15 truckloads of fish are transported from here in a week. Relatively low-level pest infestation in the field could be attributed to the rampant use of the DDT and other insecticides. One sack was filled with 30 kg of dry fish. One load consisted of 300 to 315 sacks.
Common pests observed were: *N. rufipes*, *Calliphora* sp. and *D. maculatus*. Other insects collected from the drying centres were Species K (Ephydridae) (Plate IX, Photograph 67), Species H (Elateridae) (Plate IX, Photograph 64), Species J (Tenebrionidae) (Plate IX, Photograph 66).

The major fishes processed were: sardine *S. longiceps*; mackerel *R. kanagurta*; Natholi *Stolephores indicus*; mullen *Leognathus* spp.; manthal *C. semifasciatus*; adavu *L. delicatulus*; malan *Mugil* spp.; etta *Arius* spp.; veluri *Escolosa thoracata* and kora *Sciaenids* spp.

**Summary**

Traditional fish processing is an important livelihood activity for large numbers of poor people in many tropical developing countries. Traditionally processed fish includes fish that are salt dried, wet salted, dried without salting and smoked. Despite a general decline in traditional fish processing over recent years, there remains a strong market demand for traditional fish products which continue to ensure livelihood and food security for a substantial number of poor dried fish producers and consumers.

For poor in fishing community, fish processing offers an opportunity for income generation that requires relatively low investment. Being a traditional household-level activity, it is relatively easy for poor to acquire the skill and social approval necessary to take up fish processing.

Large scale as well as small scale traditional fish drying was observed all along the coastal belt in Kerala. A large majority of people involved in traditional small-scale fish drying are women. Small scale fish drying is common in the southern districts of Kerala, viz. Thiruvanthapuram, Kollam, Alapuzha, Ernakulam and Trichur. Whereas, the large-scale fish drying was carried out by men and women together. In almost all fish drying centers across Kerala, large stretches of sandy shores facilitate fish drying. Chappa
(thatched huts as well as concrete structures) form the temporary stocking place. Hundreds and thousands of fishermen along with a large section of the society work hand in hand and find their livelihood from the fish dying industry.

Traditional fish drying is adversely affected by insect infestation. *N. rufipes* is one among the major pests of dry fish and a major cause of harvest loss of traditionally cured fish in Kerala. For small-scale processors it is a particularly serious problem that threatens livelihood security, and often has a far-reaching consequence upon socio-economic well being. Various insect pests were found to attack the fish at different stages of processing. Consequently the pest population of a particular processing center was found to vary. Other undesirable factors, which adversely affect the traditional fish drying industry, include monsoon rains, inadequate processing and storage facilities and limited access to transport.

Use of the coir mat for fish drying in the Alappuza coastal area and concrete flooring for fish drying in the Puthiyappa reduce chances of insect infestation to some extent.

Unscrupulous use of insecticides was observed in almost all coastal areas except Puthiappa, Tanur, Parappanangadi and Tirur, which pause serious concern for human health. Untidy and unhygienic conditions in the fish curing centers not only promote insect infestation but also raise serious health problems among the fishermen community.

Highly priced fishes such as Naimeen *Rachcentron canadus*, shark *Carchariumus* spp, mackerel *R. kanagurta*, Natholi *Stolephores indicus*, adavu *L. delicatulus*, thala *Trichurus lepturus* etc were dried for human consumption where as relatively cheap and surplus fishes such as sardine etc were dried and sold as poultry feed. Major export destinations are the adjacent states.
such as Tamil Nadu, Andhra Pradesh, Karnataka and other states like Maharashtra, Gujarat, and Madhya Pradesh.

A periodic decline in the fish catch threatens the traditional fish drying industry in Kerala. Widespread pollution of the water body and the trawling has resulted in the depletion of the marine fish resources.

**Factors which can influence \textit{N.rufipes infestation levels}**

Factors associated with the processing methods used and external conditions at the processing site increase the chances of \textit{N.rufipes} attacking the fish. This may be because the conditions favour the survival of the eggs or larvae, or because the fish is more attractive to the female \textit{N.rufipes}.

**Factors associated with the processing methods**

**Preparation**

Removing the scales of fish before drying will deny oviposition sites for the beetles (in the present study it was observed that \textit{N.rufipes} laid eggs mostly under the scales where enough is available). Quality of the raw fish is important. Only fresh fish should be processed. Processing partially spoiled fish will increase the likelihood that \textit{N.rufipes} will attack the fish after sun drying, as it provides more crevices for egg laying.

**Drying and stocking**

Infestation was found to be prevalent more among the fishes, which are dried upon the ground and stored in temporary sheds (for eg; Puthiyappa, Tirur, Tanur and Parappanagadi etc). Infestation could have been less if the fish were dried upon the raised racks. Drying the fish upon raised racks also improves the rate of drying, as the air can circulate around the fish and can reduce indirect infestation. Drying fish directly upon sand or loose earth as is
done at many drying centres across Kerala is an even greater problem because
the larvae are able to burrow into the sand or earth when temperatures are
high and move back into the fish again once the temperature begins to fall.
Drying fish on sand or loose earth therefore actually helps the larvae to
continue infesting the fish.

Where it is not possible to dry the fish off the ground, clean mats or
sheeting should always be placed beneath the fish to protect it from indirect
infestation. Drying the fish on cement platforms is another method to prevent
easy access and deny hiding places for *N. rufipes* and other pests. The
advantage of storing dried fish in concrete sheds with cement flooring and
well plastered walls and roof is that it does not provide crevices for the beetles
to hide when the shed is cleaned. Such hiding places will help the pest to
reinfect the fresh fish stocks. In temporary structures, the sandy floor, the
pleated coconut fronds— which forms the wall and the roof of the shed – and
the coir matting which covers the sandy floor, provides a temporary refuge for
the different stages of *N. rufipes* and it is easy for the pest to infest fresh stock
of dried fish when the sheds are stocked again.

The preset studies have also indicated that providing illumination in
the stocking sheds when the fish is stocked can reduce the fecundity,
longevity and food consumption of the pest thus reducing the infestation.

**External factors: -**

**Season:** During monsoon there is a marked decline in the *N.rufipes*
infestation. This may be due to the low temperature in the stocking sheds.
(The present study has indicated that development is slower, mortality high
and fecundity low at 25°C).
Hygiene standards at processing sites

Allowing fish waste and other refuse to accumulate at processing sites increases the chances of the fish becoming infested with *N. rufipes*. Apart from attracting adult *N. rufipes* into the area, this provides excellent breeding material, thereby supporting population replacement at the site, and increasing the risk of larval cross-infestation onto the processed fish. Processing sites should be kept free of fish waste and other wastes at all times. Fish waste should be collected and disposed off away from the processing area. Cement flooring and plastered walls at fish processing centers both for drying and storing were found to contribute in curtailing the infestation as it does not provide crevices, which can serve as refuges for *N. rufipes* when the shed is cleaned before restocking.

In areas where fish oil extraction is carried out the wooden planks used to cover the tanks should be cleaned of all oil flakes and dried in the sun before being used again. *N. rufipes* adults were found in large numbers on flake encrusted planks stocked in the shed.

Socio-economic conditions

The failure of processors to adopt remedial measures other than insecticidal control may be due to lack of technical knowledge or could be a considered response to the socio-economic environment within which they operate. If control measures are to be successfully introduced it is essential that any socio-economic constraints to their implementation are fully understood and taken into account.

The socio-economic conditions, which help in or hinder the introduction of improved technology, are:
The costs and revenues associated with improved techniques: - The revenues are associated with the quantity and price of the product sold. If there is any *N. rufipes* infestation there will be a loss of quantity during processing, so reducing infestation is certain to result in a gain in the quantity of the product. The average price per unit weight at which the fish is sold is also likely to be higher since there will be less low quality and more high quality product in the total output. This depends on the premium that consumers place on good quality fish. The purchasing capacity and preferences of the target groups of consumers determine the price of the product. Consumers of dried fish in Kerala are usually the middle class and the 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.

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 essentially an activity undertaken by poor people who are short of financial capital and whose ability to invest on improving their system is very limited. In order to maximize their returns, they are often forced to reduce expenditure and make compromises on quality.

It is probable that social pressures will exercise some influence on the working of the processors. For new techniques to be adopted, the processors have to be open to new ideas and willing to experiment.

Generally, fish processing is carried out in common property lands or open access lands, and very few processors own the processing areas where they work. So disputes may arise about construction of semi permanent structures on common land. Conditions that permit proliferation of *N. rufipes* infestation are the result of a whole range of factors that are often beyond the
control of individual processors. Hence all processors in an area should follow a uniform pattern of processing methods based on techniques to prevent pest attack. This suggests a need for more concerted actions, involving both the immediate stakeholders and relevant support agencies, to ensure that their problem is addressed.

Increased competition for fish and reduced catches also influence the ability of processors to maintain their traditional practices. With traditional fish processing itself increasingly coming under threat as fish catches themselves are threatened, the financial risk 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 \textit{N. rufipes} infestation and need to be taken into account when designing control strategies if sustainable livelihoods are to be improved.

In conclusion we can say that while the cost of interventions is not very high, the reduction in losses will be substantial. Improved quality of food will make sure that the fish sells faster in the market.