Final Technical Report

Building Cost Effective Control into the Fishery Chain

Improving Livelihoods Through Better Control

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Adaptation of a predictive cost model to determine the cost of control in identified critical loss areas within the fish processing chain

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Members of the fishing community

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Section 0 – Summary of Project Impact

0.0 Executive Summary

The purpose of the project was to develop the local capacity to adapt and implement cost effective control measures targeted at critical loss areas within defined fisheries chains. The survey work and predictive software tools have provided relevant technical and cost information for decision makers. Informed advisors and policy makers have therefore promoted effective strategies to control loss and maintain quality. Commercial decision-makers, local advisors and fishing communities also benefited through the provision of tools which enabled cost analysis of relevant control options which encouraged adoption of better practice.

One of the most significant outputs of this project has been the development of capable local teams respected by stakeholders throughout the chain. The improvement in the quality and profitability of the sector in Uganda is a clearly demonstratable output of this project. The usefulness of the approach is demonstrated by the application of the tools in further projects supported by UNIDO\(^1\) and incorporated into the policy and planning process in country e.g. the Ugandan 5 year medium term research plan.

0.1 Did it work? - Economic Impact

At the outset of the project, average reject rates recorded at Ugandan landing sites were between 9 to 12% for Nile Perch. The adoption of icing and better handling practices in earlier stages of the chain has subsequently reduced this reject rate to below 5% and often nearer 3%. A 9% increase in quality material for export on the annual 100,000 ton fishery industry added $2.7 million dollars to the country revenue with fish valued at $3/kilo.

The cost impact of the closure of the fisheries in 1998 (Bagumuire 2000)\(^2\) was estimated to be $30 million per annum. The export association (UFPEA) reported a major impact on the fisheries livelihoods of 500,000 dependants throughout the chain as fish prices were reduced by 70% when fishery was denied access to major market. The re-opening of the market was based upon demonstratable effective control within the primary and factory segments of the chain, which were supported by this project and recognised by the sector. Factory gate prices have now been seen to rise by 50% as the market has re-opened

The project outputs provided the participating factories with formally documented cleaning controls and a cost estimate for their revised cleaning programme. The advisory service (NARO) have designed procedures for validation of cleaning controls and produced a national guidance document on best practice for food factory cleaning. The work in Ghana resulted in economic gains for the fishermen, fishing mummies and the captains as the quality was seen to rise.

0.2 Has government re-acted? - Policy Impact

The Ugandan law applying to the fish factories now requires that every factory use these sanitation controls. Validation of cleaning programmes has also been required by government policy and is now verified during routine Government Inspection\(^3\). The need for proper icing and handling has been included as an Ugandan policy requirement within the primary end of the chain and will be increasingly scrutinised by the inspection service. The regulatory authority in Ghana is also planning to make the intervention (lining of the hold) a policy requirement for vessels wishing to supply the export market.
0.3 Has the sector improved? - Technical Impact

The initial project reports documented economic, technical, social and environmental constraints within Uganda and Ghana. These reports defined the existing control systems and costs and were produced by the local teams guided or led by MDA. Factory operators in Uganda had no formally documented systems of cleaning did not know the cost of their cleaning and were unaware of the effectiveness of the existing control measures. The country had also experienced closure of their fisheries during the project by the EU claiming failures in factory sanitary control. Ghana had similar problems in relation to icing and handling controls on board the artisanal fleet.

The fishermen in Uganda have largely adopted icing as routine practice. The factories have also adopted all of the necessary sanitation protocols including regular checks to make sure their control system works. The Ghanaian fishermen are also interested in adopting the modified holds and have modified their capture practices to avoid excessive time for fish in the sun.

The modified Ugandan icing and sanitation controls have recently been evaluated by the EU and found to meet their international export requirements thus enabling re-entry into the market. The handling, icing and cleaning controls were reported to have significantly improved since 1997.

0.4 Has the local team developed – Capability Impact

This project was designed to enable the local advisory and research groups to provide advice and guidance to their industry and fisheries sector. The local team in Uganda expanded to 4 members and is now capable of supporting the development of cost effective controls throughout the food sector. The project team adapted and documented the operation of specifically designed databases, which estimated or predicted the cost to achieve given control. The databases were then modified and tested by the teams under field conditions. Predictions were verified theoretically and practically in the field.

The team in Uganda have used the experience of this project to successfully bid for UNIDO projects in the same area. The current UNIDO projects have, and will continue to build on the DFID icing project. (UNIDO Project Ref. No XA/UGA/98/617 and US/UGA/98/106) The Ice-IT and Log-IT databases are now being used within the UNIDO projects to measure the micro-economic impact of new boat design and operation to the factories.

0.5 Can the approach be transferred – Changes in Ghana and Morocco

The Ghanaian team leader visited Uganda to review the approach in 1999. The approach to auditing factory-cleaning control was then successfully undertaken and tested at Divine Seafood in Ghana. The existing protocols for undertaking technical audit, trials and cost calculations were repeated and modified. The Ghanaian team focused on the icing work, which had begun in Uganda. They then reviewed the existing controls present in their fisheries chain and selected handling, better insulation, and improved icing as a focus of their intervention work.

The modified boat holds were then produced after testing of different designs using mini-holds. The prototype hold was found to be subject to rusting and the metal lining became separated from the wooden base. The next version was of a better construction and has been welcomed by the local fishermen. The economic benefits of the lined holds has been demonstrated in trials with gains of at least 15% being recorded (Akrofi and Sanchez, 2000). The Ghana team also documented the controls...
in fish handling and icing activities through an extensive technical survey executed throughout Ghana based on the Uganda approach.

This project was linked through associated research to other activities. The Director of Fish Inspection (Tangiers) has been closely involved in the approach and has employed the tools and techniques to significant effect in Morocco. The methodology has also been demonstrated to target groups in 1998 (Namibia), 1999 (Denmark) and 2000 (Ghana) at a series of practical workshops. Finally the tools and approach are currently being taught and employed within the MSc in Food Standards based at the University of Hull by the MDA team.

0.6 Has the knowledge been disseminated - Changes in the Stakeholders

The local stakeholders have been routinely kept informed in each country through the project team and their agreed activities. The Ugandan team have held regular meetings with their stakeholders and have modified their work programme in line with comments from fishermen and factories. This approach was also reflected in the team in Ghana were fishermen and fishing mummies were part of regular steering group discussions. The international team and local project groups have also resented at local, national and international meetings and workshops. The final event planned for Ghana involved presenting an overview of the tools and approach to an interested regional group.
Section 1 – Background and Preliminary Research

1.0 Background

World-wide production of fishery products is around 100 million tons per annum. A proportion of this fish is used for industrial purposes (e.g. fishmeal) and the rest for human consumption. Of the fish destined for human consumption, there are significant “losses” at various points of the marketing and distribution chain. These losses are of most importance to the developing countries; of the top 40 nations, which derive animal protein from fish, only one is a developed country (Japan).

Post harvest losses occur at every point in the marketing chain, from catching to consumption. The losses can be in terms of volume, quality or value. Although post-harvest losses are believed to be a major problem in many less developed countries, there is very little reliable or detailed information available. This presents a problem for policy makers in determining priorities for research and intervention. Appropriate methodologies for identifying and addressing post-harvest losses in fisheries have long been recognised as a key research priority.

A major research effort was started in 1993 to develop systematic methodologies to measure the losses, focusing in terms of value in a range of artisanal fisheries in one sub-Saharan African country, Tanzania and to use that information to generate effective methods for loss assessment in other fisheries systems and in other countries.

The main part of this complimentary project work has focused on investigating and costing control measures. Quantitative and qualitative survey methods were developed and used with the subsequent production of a considerable amount of technical and economic data. This enabled modelling of the cost of intervention to provide advisory agencies, industry and government policy makers with a tool to allow a prediction, at the macro and micro-level, of cost interventions in the chain.

Clearly, once a loss has been identified, the most important question that arises is “What do you do about it?” In nearly all cases, the major factor in determining the type and level of intervention was economics. Thus, decision-makers need a tool to assess the “cost” of recovering the lost “quality” of the fish resource. Once this information is available in a useable format, an appropriate, and very likely sustainable, intervention can be implemented.

In the genesis of this Quality Costing Model, it was decided that the widely adopted quality assurance and Hazard Analysis Critical Control Point (HACCP) approaches lent themselves to the development of this model (WEFTA, 1995).

The project therefore developed methods to identify, document and cost appropriate control methods within the fisheries chain. The first phase of the project was planned to investigate, document and cost sanitation control systems in fish processing plants in Uganda. Previous work had been completed in this area and the related loss prediction area by NRI under project no. R5027. This project built on the losses work, which demonstrated a need for effective control systems. The economic engineering team based at FAO in the Department for Fisheries had also completed significant investigations over 20 years and collaborated with the project team (Lupin et al Technical Manual 351).

They assisted in the design and testing of the models and the validation of the field-work.
The project helped to resolve the problem of losses of fish and fish quality in Ghana and Uganda. This was shown to directly benefit the fisherfolk and the processors through better yields, so making better usage of resources available. FAO had estimated that a significant shortfall (19 million tonnes) in fish protein by the millennium, with low income groups facing the severest deficit.

This project adopted a systematic approach to the selection and analysis of key control measures within the fisheries chain. A HACCP based approach was employed within the early phase of the project whereby a systematic analysis of key control points within the fisheries chain was undertaken in collaboration with the local partner. A review of previous approaches to control at these points and why they had been unsuccessful was also included. Cause and effect analysis techniques were used to determine the reasons why given control strategies were unsuccessful and to select the best control strategy.

The critical control measures were identified and the key performance indicators selected to ensure that controls were effective technically and financially. The performance indicators were also tracked and validated through formal audit procedures. The accuracy of the cost predictions was also checked and the data sets reviewed to assess the project impact.

Unlike other research activities the micro-economic barriers to adoption of controls was a major focus of this work The resulting software tools enabled the local advisors to provide cost estimates of a given change in control to be made. The control measures targeted the major sources or reasons for loss at a given step in the chain.

1.1 Project Purpose

The purpose of the project was to develop the local capacity to adapt and implement cost effective control measures targeted at the critical loss areas within the defined fisheries chain. The understanding and practical development of methods and utilisation of the predictive costing software enabled the policy makers to promote effective strategies to control loss and maintain quality. Commercial decision-makers, local advisors and fishing communities also benefited through cost analysis of their relevant control options, which encouraged adoption of better practice.

1.2 Project Summary

Project teams were set up in Uganda and Ghana and operational methods put in place. The teams collected data from pilot sites and using the data collected a preliminary predictive database was designed. During the project the Ugandan team was expanded to include a microbiologist, a fisheries management member and a food scientist. All members received training in the software tools and in technical audit skills. Successful review meetings were held throughout the duration of the project involving a wide range of stakeholders.

The icing work in Uganda and Ghana continued to promote the use of cost-effective practices, which led to significant reductions in landing site and factory rejects. Software tools were developed to manage and capture information from the icing trials and cost the benefits.

The Ugandan team completed the documentation of the factory cleaning controls and published a booklet to support industry in building better controls. The temperature control and handling work in
Uganda resulted in the team being contracted by UNIDO to investigate further aspects of improved control. Both the Ugandan and Ghanaian members made presentations at FAO expert meetings; this highlighted their confidence in the programme and the practical nature and benefits of the project to their countries.

Full-scale sea trials in Ghana and the installation of software in three operational factories in Uganda provided positive feedback. Further factories in Uganda have requested software tools and fishermen in Ghana are now asking for lined holds. Subsequent trials have been designed to offer the level of validation necessary for technical publication. This trial data and other feedback from users has therefore enabled the final refinement of the software products to be undertaken prior to the closing meeting which took place in Ghana in September 2000.
Section 2 – Research Activities

2.0 Research Work Phase One

The objectives of the early phase of the work between 1995 and 1997 was to (WEFTA, 1995)9:

- Establish a standardised protocol for costing control and monitoring options, and costing internal and external failures in a given fisheries chain
- Utilise existing information to cost these parameters and construct a database
- Develop a questionnaire and interview approach to effectively survey small fish processors to assess quality system understanding and costs
- Construct a database of hazards, controls and failures from pilot companies
- Evaluate software packages to assess nature of customer complaint and cost of complaint
- Evaluate existing HACCP based systems to assess the effect of internal and external failures

2.1 Development of the Costing Approach

The 1990 British Standard, BS 6143 “A Guide to the Economics of Quality”12, was employed as the reference standard for costing prevention, appraisal and failure (PAF) in the project. BS 6143 provides the following definitions:

- **Prevention cost** - The cost of any action taken to investigate, prevent or reduce the risk of non-conformity or defect.
- **Appraisal cost** - The cost of evaluating the achievement of quality requirements including e.g. cost of verification and control performed at any stage of the quality loop.
- **Internal Failure Cost** - The costs arising within an organisation due to non-conformities or defects at any stage of the quality loop, such as costs of scrap, re-work, re-test, re-inspection and redesign.
- **External Failure Cost** - The costs arising after delivery to a customer/user due to non-conformities or defects, which may include the cost of claims against, warranty, replacement and consequential losses and evaluation of penalties incurred. The prevention element of the PAF cost model has been related to the seven HACCP principles in the development of prevention based HACCP plan (Table 1).
Table 1 Comparison of HACCP Plan Principles Vs BS6143 Cost Definitions

<table>
<thead>
<tr>
<th>HACCP Definition</th>
<th>Control Measure</th>
<th>Monitoring Method</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preventative Cost</td>
<td>Appraisal</td>
<td>Failure</td>
</tr>
<tr>
<td></td>
<td>Development Cost</td>
<td>Operating Cost</td>
<td>Development Cost</td>
</tr>
<tr>
<td>HACCP Principles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Conduct analysis.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Identify CCP's</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Establish and operate target levels &amp; critical limits</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4. Establish and operate monitoring system.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5. Establish and operate corrective action.</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>6. Establish and operate verification.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7. Establish and operate documentation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

2.1.1 Practical Costing of HACCP Systems

Specifically, the cost of planning, developing and implementing a particular control measure, including any relevant investment, is one cost. Additionally, the ongoing cost of the resources to operate and maintain the control is also categorised under the prevention cost label. The appraisal element of HACCP was categorised and costed under the HACCP principles 3, 4, 6 and 7. The initial cost of establishing the target values and critical limits for specific control measures - e.g. control of temperature will be the basis of the monitoring activity. This approach was used by the team to undertake the cost survey of the Canadian fisheries sector between 1997 and 1999 (Dillon et al, 1999).1

The development and implementation costs of the monitoring system are therefore noted along with any associated investment costs. The cost of operating, maintaining and verification of the monitoring system are categorised as running costs. HACCP Principle 6 - corrective action, encompasses the activities, which will be measured as failure cost- both internal and external failures can be related to this principle. Again, the initial setting up cost is measured and ongoing running costs recorded.

2.1.2 Costing supporting control systems – Cleaning Controls

The cost to achieve “verified “ cleaning plans was a key outcome of this programme. Early ancillary work was reported in the benchmarking activities undertaking in Canada (Dillon, et al Benchmarking food Safety, 1998).14 Spencer-Garrett (1991)15 has previously reported and discussed many of the stages in properly developing, implementing and operating seafood HACCP systems, but little published data has been reported on aspects of economic benefits of HACCP. This has been partially resolved by the publication of Unnevehr (2000)16 which has explained the economic impact but provided little useable methodology for field workers. Casswell and Collatore17 had clearly reported on the cost benefit work undertaken in the American seafood sector. FAO had been involved in two main publications – one by Cato, J and Dos Santos18 reviewing impact of closure of
Bangladesh Shrimp industry and the other by the leading Argentinean research group (Zugurraurdi et al, 1999) involving Hector Lupin.

Specific US data described the systematic measurement of the economic impact of HACCP employing a standard protocol (Spencer-Garrett, 1989,1991)\textsuperscript{20,15}. The reports detail the cost of correcting deficiencies identified during plant audits under both sanitation and process control critical control points. The UK work adapted the US approach to costing as follows.

### 2.1.3 American approach to costing controls at CCP’s

![Figure 1. Standard Costing Method](image)

- **US Data**
- **Process CCP deficiencies and problems**
- **Alternative methods for resolving these deficiencies and problems**

**Annualised by applying a capital recovery factor based on the expected life of the investment plus a nominal interest rate of 10%**

- **The least cost method for overcoming each of these difficulties**

- **Variable cost i.e. water/gas/electric, materials, packaging, ingredients, and maintenance**
- **Fixed costs i.e. wages/salaries, depreciation, equipment**

- **Investment costs**

- **Entered into database**

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**Figure 1. Standard Costing Method**

**2.1.4 Use of American data for the model**

Further data was obtained to develop the model by applying the standardised costing methodology for published seafood HACCP plans or HACCP plans supplied by operating companies. The validity of the data was assessed by cross referencing with selected pilot sites who were involved in measuring the costs of specific aspects of the HACCP plan over the duration of the planning, development and HACCP implementation cycle. The validity of the data sets for small businesses has again been addressed by the design and use of a questionnaire and interview programme to both assess the existing emphasis of their quality assurance programme and the typical costs of control and failure.

**2.1.5 Development and testing of the Questionnaire /Survey approach**

The questionnaire adopted in this work was also applied in Canada and modified and used by the Welsh research group in their review of HACCP in Butchery sector. The UK team also designed a
modified database to capture and analyse the costs to this sector (Mortlock, Griffith et al, NSF 2000)²¹.

2.2 Research Work Phase Two

The preliminary research work undertaken in Phase 1 had enabled the design and testing of the approach. The following discussion describes the building and testing of the initial databases. These have been significantly modified for field use, see Appendix 2, but it is important for the reader to understand the process by which the final databases (Cleanse-IT, Ice-IT and Log-IT)²² were created.

2.2.1 Step 1 Establishment of a standard protocol for costing controls and monitoring options.

A review of existing costing approaches was undertaken, which initially highlighted the research and applied work of the National Fisheries Education and Research Foundation in America from 1989 to 1991. This work had established costing protocols and standardised a basic methodology for assessing the costs in implementing specific controls within a wide range of fishery operations. This was adapted and used, after analysis against an established costing standard (BS 6143) which describes the Costing of the Economics of Quality¹².

The relationship between British Standard BS6143, which describes economic cost of controls, and the recognised food control systems i.e. Hazard Analysis Critical Control Point Systems, was established, and this became the focus of the development of the database.

2.2.2 Step 2 Construction of a Pilot Database

Data collected in America in conjunction with other secondary data was used to develop the initial pilot database. This was based on a control system, which followed the internationally recognised HACCP approach. Modifications were made to the standard HACCP approach, so that significant loss causing hazards could be analysed. Such hazards were typically associated with the quality and safety of products. Dillon et al (1995)⁹ had reported on the early progress of this database. Further modifications were again reported and discussed at the Washington Fish Inspection Conference in 1996²³. The loss assessment work in Tanzania by Ward et al²⁵ also focused on the collection of control cost data and the design of the database. The outcome was a software package that could be used to determine relevant costings, but could also act as a focus for the implementation and measurement of the potential economic benefits of a control system.

The database had two fundamental sections. The first allows the user to choose the control that requires costing. The second section allows the costings to be defined, using a series of lookup tables, allowing customisation of the cost model for the chosen control, which is covered within the generic cost of control route, or the specific applications route of the predictive cost model.

2.2.3 Development of predictive capability

The work on developing an information database (basically Stage 1) was transformed into a predictive cost model within Stage 2, where the relevant cost or technical equations were embedded within the programming of the database. The user defines the Unit operation, Hazard, Hazard Source, and Control Measure, and then evaluates the relevant cost options, by entering the specific
data into the generic control costing route or by specifically using a developed application e/g sanitation or ice calculator. These cost options allow the user to define a range of costings for a control measure to reduce a given critical loss - i.e. capital, labour, materials and training, either generically or specifically. For example, if sanitation was selected, then effective control could be achieved using more labour, or alternatively by using specific cleaning equipment or chemicals. The user can vary these options according to the availability of resources, materials and equipment, therefore using specific knowledge to cost an appropriate control.

2.2.4 Step 3 Collection of cost data

Data was initially collected using a questionnaire and interview technique, to further refine the framework by agreeing the major cost centres and allocating monitoring activities as an option for selected control measures. The questionnaire was modified significantly to capture both qualitative and quantitative data, and eventually employed the framework from the manual of the Canadian Quality Management Programme. Information was collected from the UK fish processors at two levels - level 1 indicated where existing control was placed and where failure typically occurred, and level 2 involved the processor completing costing tables for specific control or failure scenarios.

An example scenario described the failure of a physical hazard control point, which resulted in glass breakage in a cold store. The company then costed the materials, labour and loss of product within the recall and disposal of the fish in this particular failure scenario.

2.2.5 Step 4 Refinement of the Database

Over a period of two years the database engine was developed through information from NMFS in America, pilot companies, and discussion with key staff at the Natural Resource Institute. A significant development in focusing the project occurred towards the end of 1995, when the data from FAO was provided in the Fisheries Technical paper 351 (Lupin et al, 1995). The FAO group had adapted economic engineering, which requires knowledge of engineering and microeconomics, and applied this to the fishery sector covering the rationale for the selection of the technical options for control systems in relation to commercial feasibility.

2.2.5.1 Separation of the Database into the Sanitation Calculator and Ice Calculator

The FAO work led to the development, initially within a single database, of a specific predictive cost calculator for ice usage. This was used to cost the control options for icing fish and became a stand-alone application for the fish sector in general. Ward (1996) shows an example of the importance of proper icing in loss reduction in a cause and effect relationship between prawn losses and icing, with losses associated with poor ice at specific points in a given chain. The Ice Calculator database has been developed, allowing the costing of the amount of ice required to keep fish at the optimum temperature. This allows the transfer of information into cost figures.

Full details are provided on the CD (see Appendix 3), which contains an overview of the early manual and worked examples

All relevant data was entered to produce a calculation. Once this has been entered the View Calcs button will bring up the details of the calculation.
The user was able to quickly evaluate the effect of various changes on the final outcome.

*Figure 2 Overview of Previous Software*

![Diagram showing the process of using the ice calculator](image)

This tool calculated the amount of ice required to cool the fish stated and the amount of boxes needed to transport the ice and fish. These totals were then transferred to the cost of control screen and the appropriate cost centres.

Ancillary costs were entered for equipment; environment, labour, materials and training courses were entered, providing the information for the costings calculated later. The user entered data on the set-up screen, allowing the definition of temperature of product, external temperature, weight of product, storage container description, ice type and the product species.

The inclusion of all this information is required by the ice calculator to cost a given icing option before an overall costing is done.

The original ice calculator programme allows the user to evaluate the effect of types of fish box, transport time, ice type, external and product temperature, and the type of fish, on fish-to-ice ratio and the number of boxes.

Then, by selection of given variables, the cost options for the investment in ice boxes, quicker transport or other variable can be determined to reduce current losses - up to 40% in some factories.

### 2.2.6 Step 5 Verification of the accuracy of cost predictions

Once costs were calculated they were verified for accuracy. This verification of the accuracy of predictions was divided into 3 stages- not all are relevant for every prediction. We will use the ice
prediction as an example, although similar verification is necessary for sanitation or general costings.

2.2.6.1 Stage 1 Theoretical

The ice consumption in icing fish can be divided into three terms. The theoretical consumption calculation was verified and discussed with the FAO team for accuracy during a visit in 1997.

\[
\text{Total Ice} = (1) \text{Ice to cool to } 0^\circ\text{C} + (2) \text{Ice melted for Thermal Loss} + (3) \text{Ice handling Loss}
\]

**Ice to cool to 0°C**

<table>
<thead>
<tr>
<th>Fish Species</th>
<th>Specific Heat of fish (kcal/Kg °C) = [Fish SH Value]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean Fish</td>
<td>0.80</td>
</tr>
<tr>
<td>Medium Fatty</td>
<td>0.78</td>
</tr>
<tr>
<td>Fatty Fish</td>
<td>0.75</td>
</tr>
</tbody>
</table>

\[\text{[Fish Temp]} = \text{Temperature of the Fish before icing (Taken as an Input)}\]
\[\text{[Total Fish]} = \text{Total amount of fish for transporting (Taken as an Input)}\]
\[\text{[Latent Heat of Fusion of Ice]} = \text{usually taken as 80 kcal/Kg}\]

\[
\text{Ice to } 0^\circ\text{C} = ( \text{[Fish SH Value]} \times \text{[Fish Temp]}/\text{[Latent Heat of Fusion of Ice]} ) \times \text{[Total Fish]}
\]

2.2.6.2 Stage 2 Applied

A spreadsheet (Table 2) was developed to perform similar calculations and match with the answers produced by the database. This was also used for the sanitation data sets that held a high level of unknowns. Reasons for errors were noted, and the method of data capture or entry modified, to prevent similar mistakes occurring.

**Table 2 Spreadsheet**

<table>
<thead>
<tr>
<th>Ice Req.</th>
<th>Fish Type</th>
<th>Fish Specific Heat Value</th>
<th>Fish Temp</th>
<th>Latent Heat of Fusion (Ice)</th>
<th>Total Fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kg</td>
<td></td>
<td>kcal/Kg °C</td>
<td>°C</td>
<td>Kcal/Kg</td>
<td>kg</td>
</tr>
<tr>
<td>150.00</td>
<td>Lean</td>
<td>0.8000</td>
<td>15</td>
<td>80</td>
<td>1000</td>
</tr>
<tr>
<td>146.25</td>
<td>Medium</td>
<td>0.7800</td>
<td>15</td>
<td>80</td>
<td>1000</td>
</tr>
<tr>
<td>140.63</td>
<td>Fatty</td>
<td>0.7500</td>
<td>15</td>
<td>80</td>
<td>1000</td>
</tr>
<tr>
<td>200.00</td>
<td>Lean</td>
<td>0.8000</td>
<td>20</td>
<td>80</td>
<td>1000</td>
</tr>
<tr>
<td>195.00</td>
<td>Medium</td>
<td>0.7800</td>
<td>20</td>
<td>80</td>
<td>1000</td>
</tr>
<tr>
<td>187.50</td>
<td>Fatty</td>
<td>0.7500</td>
<td>20</td>
<td>80</td>
<td>1000</td>
</tr>
</tbody>
</table>

2.2.6.3 Stage 3 Pilot sites
Data from pilot sites in the UK were matched with predicted costings e.g. amount and cost of cleaning chemical used, and anomalies were then reviewed and the software appropriately modified. Issues which were highlighted through live assessment of pilot sites included; omitted capital equipment, inaccurate amounts of material or labour usage, and changing cleaning procedures throughout the week. This information resulted in review and programme modification.

A recognition of the wide variation in approaches adopted by companies in operating a similar effective control measure e.g. cleaning a piece of standard equipment, has been reflected within programme flexibility. However the ability to “predict” an accurate cost was questioned – industry believed provision of the least cost for effective clean could be a better option.

The accuracy of completed questionnaires in collecting costing data has been verified through telephone discussions and specific site visits. Data entry was also checked for accuracy, and the predicted costings agreed to be reasonable in nature. The initial verification steps were completed and the software was passed to the field team for validation in Uganda and Ghana (Tuna 97)

2.3 Sanitary Control

Initially, five companies were involved in the Ugandan project work. All of the companies were involved in producing frozen and fresh Nile perch fillets for the European market. The initial focus of the work was sanitary control although, both control at the landing sites and time/temperature controls were subsequently investigated. The work commenced in July 1997.

Initial data has indicated the following:

- Verification visits demonstrated that all of the plant does not operate effective cleaning systems
- Awareness and understanding of cleaning is poor and therefore cleaning is often ineffective

Primary costing data was collected and the cost of a standard cleaning procedure defined to enable prediction. Reject losses in the chain were a major concern in Africa and the implementation of better time/temperature control was previously reported by Ward (1996) to offer cost benefits to both purchaser and supplier.

The reject rates of Nile Perch in 1997 varied between 3% and 30 with an average of 12%. The use of ice at $1 / kilo should prove to be cost effective and will be the focus of the work undertaken in Ghana from early 1998 but undertaken in Uganda to develop the protocols.

2.4 Effective Sanitation

The initial stages of data collection in Africa demonstrated the variety of different ways standard procedures can be interpreted. The general method for assessing cleaning was visible; the procedures between factory only vary slightly. Large differences existed between dilutions, amounts applied and dwell time.

The areas of potential cost saving and improved effectiveness currently revolve around doing it right and in the right sequence. The method of sanitising during production, more often than not, involves containers (buckets, bowls etc) with several litres of pre diluted solution. This is thrown over the surfaces to be sanitised, and production continues. Initial tests showed that the dwell time
was minimal and, due to the oily surface, tended to be ineffective. Other techniques involved soaking in a dip tank, however it was also observed on several occasions that the surfaces ended up dirtier after sanitising due to the irregularity of changing the solution in dip tanks.

A basic calculation was undertaken to estimate usage, taking a processing area of 10 stations, approx. 4 litres of 20ppm used 5 times per hour per station. This adds up to 10 x 4 x 5 = 200 litres per hour. The dilution is made from 4% chlorine solution, which equates to 100ml per 200 litres. Over a shift (usually 8-10hrs) and accounting for spillage, normally 2,000 litres were used. This is about 1 Litre of 4% chlorine (approx. $2 a litre). Using sanitiser in this way, tends to be wasteful, inaccurate and often ineffective, with splashing on to the product not uncommon. The worker also stops what they are doing to perform this ritual.