FAO ANIMAL PRODUCTION AND HEALTH PAPER 98

Small-scale poultry processing

CONTENTS

---

by
D. Silverside
M. Jones

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

M 24

M-24
ISBN 92-5-103145-2

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechani- cal, photocopying or otherwise, without the prior permission of the copyright owner. Applications for such permission, with a statement of the purpose and extent of the reproduction, should be addressed to the Director, Publications Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00100 Rome, Italy.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS Rome, 1992
© FAO

FOREWORD

Poultry production is big business throughout the world. It has become a standard form of cheap protein. It is also a highly competitive industry and feed suppliers, producers, processors, manufacturers of equipment etc have all appreciated the economies of scale and gone on to develop bigger and more automated systems of operation than ever before to supply an insatiable market.

The production of poultry on a small scale is very important in less developed countries,

particularly in places some way from the main commercial and industrial centres. There continues to be a need for small scale processing facilities. Unfortunately many manufacturers of small scale equipment have not survived with the march of time and commercial developments. This book has been written however, to show that it is still possible to establish a small operation with the appropriate equipment and facilities.

Slaughter of poultry in suitable surroundings by hygenic methods is essential for the production of wholesome meat, extension of the shelf life of the product, reduction of post harvest losses and protection of public health. This book addresses these issues and hopes to persuade the producer of poultry on a small scale that it is worthwhile to establish the proper facilities.

The book is divided into five parts. The first puts poultry into context by giving a general background and description of poultry production and processing throughout the world. The second chapter outlines the general principles of planning, economics, design and construction of small scale poultry processing plants. The concept of the three models is developed and plant layout and construction details, including that of effluent treatment are given. The third chapter describes how it is intended that these models are to be operated. It covers most aspects of poultry production from transport of the live bird to the factory, to the dispatch of packed poultry to the market. Chapter four is devoted to health, hygiene and routine maintenance. These three subjects are put together to emphasise the routine nature of these important aspects of food production. It gives some emphasis to the microbiology of production systems but leaves the veterinary aspects of poultry health to the veterinarian. A schedule of activities is given in the hope that the production of clean, wholesome poultry in a clean factory will be assured with minimal delay in operation. The final chapter discusses the theory of marketing and offers some advice on the importance of planning a proper strategy. It should give an introduction to market development.

The reader is advised to seek comprehensive advice if he wishes to build new facilities or redesign existing buildings. The book is but a guide-line to poultry processing and cannot be written with every circumstance in mind. Nevertheless it has a tropical flavour and attempts to be realistic in its approach to the tropical situation.

Acknowledgements

Some of the information presented in this book stems from the publications listed in the Further Reading section to which the reader is directed.

The authors also acknowledge gratefully the contributions made by the companies, Poultryman Machines, Botley (Southampton/UK) for drawings on pages 16, 40, 41, 44–49, 51, 53–57 and 100–104, Cope and Cope, Reading/UK for the drawings on page 43, and the British Chicken Information Service, London, for photographs 1–10 in Annex 6 "Poultry Portioning", as well as Ernest West & Benyon, Bromley (Kent/UK) and Environmental Engineering, Spalding (Lincolnshire/UK) for their contributions on refrigeration and effluent treatment equipment.

Hyperlinks to non-FAO Internet sites do not imply any official endorsement of or responsibility for the opinions, ideas, data or products presented at these locations, or guarantee the validity of the information provided. The sole purpose of links to non-FAO sites is to indicate further information available on related topics.

CONTENTS

TABLES

ANNEXES

DRAWINGS

CHAPTER 1
INTRODUCTION TO THE POULTRY PROCESSING INDUSTRY

Poultry Production

As poultry production is a prime example of a vertically integrated agricultural industry, with intensive rearing systems of birds of efficient feed conversion ratios and products of handy size and ready marketability, it is not surprising that it is currently showing the strongest growth in output of any category of meat. World-wide, it is a huge industry. Estimates of poultry populations are detailed in Table 1. The largest increase in poultry populations between 1979 and 1989 are in N&C America, S America & Asia. As a general rule, poultry populations in developing countries are rising at a faster rate than in developed countries.

TABLE 1

World population of poultry in selected regions ('000's)

	1979	1987	1988	1989	% increase 79–89	% increase human pop 79–89
Africa	560	837	867	873	56	38
N&C America	758	1715	2089	2125	180	16
S America	552	843	896	961	74	22
Asia	2816	4347	4500	4702	67	22
Europe	1265	1373	1392	1394	10	3
Oceania	56	73	84	73	30	17
USSR	953	1174	1177	1207	27	10
Developed Countries	3135	4362	4780	4810	53	8
Developing Countries	3826	6001	6226	6525	71	25
World	6962	10364	11005	11335	63	20

Source: FAO Production Year-book

Source: FAS Production Year book

Because poultry has a very short life cycle and poultry products are traded internationally, data on regional flock sizes are difficult to interpret. Estimates of world poultry meat production in metric tonnes are detailed in Table 2.

The largest increase in poultry meat production took place in S America, particularly in the mid 1980's. The increase in developing countries has generally been higher than in developed countries but the impact is reduced because the increase in human population has been greater. Poultry production is three times population growth in developed countries but only double population growth in less developed countries.

TABLE 2

Poultry meat production (1000 t)

	1979	1987	1988	% Increase 1989	79–89	% increase human pop 79–89
Africa	1090	1620	1658	1708	57	38
N&C America	9896	11026	11474	12087	22	16
S America	1608	9154	9480	10088	526	22
Asia	6350	7987	8304	8587	35	22
Europe	6812	8043	8237	8254	21	3
Oceania	283	439	468	460	63	17
USSR	2000	3127	3235	3250	62	10
Developed Countries	19639	23386	24118	24731	26	8
Developing Countries	8400	12216	12795	13086	56	25

World	28039	35603	36913	37817	35	20

Source: FAO Production Year-book

Poultry Consumption

Estimates of world poultry consumption are detailed in Table 3. Levels of poultry consumption are increasing throughout the world and the increase in developing countries is about double the world average. This has been achieved through increased local production which has kept pace with demand.

TABLE 3

World poultry meat consumption (kg per head of human population)

	1979	1987	1988	1989	% increase 79–89	% increase human pop 79–89
Africa	2.49	3.00	2.94	2.90	16	38
N&C America	26.76	26.23	27.07	27.96	4	16
S America	6.58	32.1	32.43	33.81	414	22
Asia	2.68	2.92	2.97	3.04	13	22
Europe	13.37	15.19	15.39	15.52	16	3
Oceania	12.96	18.03	18.91	18.47	43	17
USSR	8.12	11.64	11.94	11.73	44	10
Developed Countries	16.65	18.67	19.12	19.45	17	8
Developing Countries	2.77	3.35	3.41	3.42	23	25
World	6.47	7.09	7.20	7.25	12	20

Source: from FAO Production and Trade Year-books

The recommended average daily intake of protein is 0.6g/kg body weight or 12–60g per day depending on age and weight. Poultry products such as chicken have a high protein content.

Table 4 shows the % protein content of some common foods and their consumption. The table shows that the less developed countries appear to consume sufficient protein. A better interpretation would be that there is sufficient protein available for all to eat. In practice, protein distribution is skewed in ldc's so that some areas have plenty whereas others have very little.

TABLE 4

% Protein content and consumption of some common foods

Food type (Protein source)	% Protein	Consumption in kg dry matter/head/yr 1989		
		Developed	Developing	World
Chicken	19			
Duck	11	3.70	0.65	1.38
Turkey	21			
Beef	21	5.68	0.83	2.00
Pork	25	8.14	1.87	3.36
Sheep	23	0.26	0.18	0.29
Fish	17	3.14	1.14	1.62
Milk	3.5	10.70	0.90	3.25
Egg	12.8	1.96	0.51	0.86
Rice	7.6	1.54	9.23	7.39

Wheat	8.4	26.1	9.68	13.70
Pulses	6	1.01	0.56	0.67
Groundnuts	25	0.49	1.27	1.09
Soya Beans	40	19.33	4.76	8.22
Potatoes	2.1	3.39	0.40	1.11
Total		85.44	31.98	43.56

Source: from The Report of the Scientific Review Committee, 1990, Health and Welfare, Canada

Although this document concerns slaughter and processing for meat production, poultry are also kept for their eggs. Eggs are a highly versatile food containing many essential nutrients. They are classified in the same protein food group as meat, poultry and fish (see Table 4). In developed countries *per capita* consumption of eggs has remained almost static over the last ten years but in less developed countries has risen by 37%, about 1.5 times faster than population growth. This has been achieved through improvements in local production rather than increased importation. This indicates a sharp increase in poultry husbandry skills and readiness to undertake intensive production. The flocks used for both table and hatchery egg production are found in significant numbers and eventually end up at poultry processing plants.

The outlook for world poultry production is for continued strong growth. Poultry production is projected to continue to expand in N&C America and the EC. Further growth in Asia, particularly Thailand, is expected as a result of strong demand from Japan and the development of the EC market. Growing domestic demand in Brazil & China should result in higher production levels. In the old Soviet Bloc and eastern Europe, production is projected to fall as a result of reorganisation following market liberalisation. Demand in less developed

countries will continue to grow at least apace with population.

TABLE 5

World consumption of hen eggs in shell (kg per head of human population)

	1979	1989	% increase 79–89	% increase human pop 79–89
Africa	1.97	2.35	19.27	38
N&C America	14.35	12.99	-9.46	16
S America	5.19	7.06	35.87	22
Asia	3.34	4.46	33.34	22
Europe	14.26	14.38	0.83	3
Oceania	11.74	9.51	-18.97	17
USSR	13.89	16.23	16.79	10
Developed Countries	15.06	15.34	1.86	8
Developing Countries	2.88	3.95	37.20	25
World	6.12	6.67	8.94	20

Source: FAO Production & Trade Year-books

Poultry Rearing Systems

There are many species and breeds of poultry which are used by man. Some are of more importance than others. The domestic chicken (*Gallus domesticus*) has assumed World-wide importance and accounts for more than 90% of the world's poultry flocks. Ducks account for about 5% of the world's poultry flocks and turkeys for about 2%. Table 6 details % world

distribution of the three most important poultry species during 1989.

Other poultry species of lesser world importance are geese, guinea fowl, doves, pigeons, pheasants, quail and ostriches. It is estimated that together these species account for less than 3% of the world's poultry flocks.

TABLE 6

1989 % World distribution of the three most important poultry species

	Chickens	Ducks	Turkeys
Africa	8	3	2
N&C America	19	3	37
S America	9	2	4
Asia	40	87	5
Europe	12	5	31
Oceania	1	-	1
USSR	11	-	20
Developed Countries	43	7	89
Developing Countries	57	93	11
World	100	100	100

Source: FAO Production Year-book

Poultry raising is classified into intensive or extensive systems. Where movement is restricted and birds are kept close together at elevated temperatures, broilers grow rapidly to market

weight. In these intensive rearing conditions chickens (broilers) are ready for slaughter in 8–12 weeks and weigh 1.6–1.8 kg. Ducks or ducklings are ready in 8–12 weeks and weigh 1.7–4 kg. Turkeys are ready in 12–30 weeks and weigh 4.5–15 kg.

Intensive rearing systems are usually constructed on hen houses of 8 × 25m which contain 1000 birds per unit. Each producer has many units and contracts to sell his birds at a given weight on a given day. His day - old chicks, feed supplier, veterinarian, transport of birds to the abattoir etc are all programmed to meet a predefined production schedule. These intensive systems are highly programmable, predictable and cost effective.

The intensive system of poultry production prevents or minimises exposure to natural conditions. The extensive system permits the fullest exposure to natural conditions. Where the flock is allowed a free range, feed inputs are used by the bird for exercise and maintenance of body temperature before meat production. Social interaction and the stresses of everyday life use up food energy. This may be regarded as an inefficient production system.

Where extensive systems are practised, the birds are left to scratch for food. This appears cheaper than intensive systems but slaughter weight/time is much more difficult to predict and the system generally can not be used as a basis of contract between producer and meat packer.

In the developed world it is estimated that in excess of 95% of the worlds poultry flocks are reared under intensive conditions. In the developing world the extensive systems are the most usual practices. While this may be due, in some instances, to a lack of poultry management skills, knowledge, infrastructure, capital etc, it may be a natural reaction to the tropical climate.

Poultry have an internal body temperature between 41.2 and 42.2°C, which is about 2–3°C

higher than that of mammals. Chicks have a body temperature about 2–3°C lower than that of an adult bird but the adult temperature is reached within about a week of hatching. The major problem poultry have when exposed to temperature extremes is to maintain efficient functioning of their metabolic processes. The relatively high body temperature maintained by poultry means that they are significantly more vulnerable to extremes of heat. This is because they maintain a body temperature only 3–5°C below the temperature at which protein inactivation starts. In poultry production, birds kept within the range 21–26°C at humidities within the range 50–90% will give the highest levels of food conversion into growth. However, at higher temperatures (about 30°C) humidities within the range 30–70% have been shown to reduce growth rate.

Under intensive rearing conditions poultry can suffer extreme levels of stress due to the environment in which they are reared. The close proximity of birds raised in an intensive system inevitably affects their social organisation. Poultry can suffer damage in various ways including disease, attack by predator, cannibalism and feather packing all of which can lead to a reduction in productivity and income. Under extensive conditions social organisation generally remains well structured and much of the damage and stress associated with intensive rearing is absent.

While there is a strong market demand and a continuing increase in production skills, further expansion of the industry is dependent on continued and improved availability of capital (for infrastructure, marketing and working), poultry feedstuff of the appropriate quality, integration of all systems from egg fertilization to consumption of product, management and business acumen, skilled labour, marketing (in terms of quality, consistency and continuity of product) advice and provision of quality, disease - free chicks.

Poultry Hygiene

Poultry rearing hygiene

Disease is a major hazard in poultry rearing, particularly with the growth in numbers of large scale processing enterprises. Hygiene is a most important factor in disease prevention. Efficient cleaning can eliminate over 90% of all diseases and there are other measures which can be taken to prevent disease and its spread among the flock. These are given in Chapter 4.

Preslaughter inspection

Whereas it is not practical to expect a veterinarian to examine each bird on the farm before it leaves for the poultry processing plant, it is the producers responsibility to ensure that the birds are healthy as far as the producer can tell. Sick birds should not be sent for slaughter. They should be disposed of at the farm under veterinary supervision if possible. The circumstances of the sickness should always be reported to the veterinarian.

Vehicle and transport hygiene (including cages)

Transportation of live birds to the slaughterhouse involves the possibility of contamination, especially if cleaning and disinfection is insufficient and the same cages are used for several different flocks. There are several precautions that should be taken regarding vehicle and transport hygiene. Cleaning and disinfection of cages should be carried out after use and if cages are not used for some time then the process should be repeated as contamination may occur in storage. The vehicles which carry the modules or cages should also be cleaned and disinfected after use.

Personal cleanliness and habits

Good personal cleanliness and habits are of the utmost importance in maintaining high

standards of hygiene in a poultry processing operation. Staff are involved at all stages of processing and the provision of cleaning facilities and materials together with a policy of staff training in hygienic practices will form the basis for achieving high standards of hygiene.

Marketing of Live Poultry

Harvesting and transport systems

There are many systems for poultry harvesting. The most common method for small scale operations is for broilers to be caught by hand and then carried to the transport by one or both legs. This procedure requires great care as it can cause dislocation of the hip - joint, internal bleeding and even death.

In larger scale operations, herding, sweeping and vacuum systems of harvesting have been developed. In the first, birds are herded into a mechanical handling system by catchers onto a conveyor belt The birds are then blown into a crate. The sweeping system uses a machine fitted with a central boom and sweeper arms fitted with rotating, foam rubber paddles, which gently sweep the birds onto an inclined conveyor. The vacuum system relies on gentle suction from the floor. Crates are then filled by a mechanical device.

Some birds are marketed as individuals but others are contained in crates which are either loose or fixed to the truck or as a module of 4–16 crates carried by fork lift truck to the vehicle.

Transport to market

Poultry are transported to market in various ways. In rural areas live birds are taken to market by individuals, using any form of available transport. Farmers or small cooperatives may organise transport on a more formal scale using trucks and pick-ups. Large scale poultry

processing companies generally have their own transport as part of their intensive rearing operation or outside haulage contractors may deal with this aspect of their processing operation.

Display methods

At the general market, birds are usually displayed tethered, hung by their legs or in their crates. Live poultry is bought by the consumer who may take it home to be slaughtered, it may be slaughtered at the market stall or in a specially designated place nearby. These slaughter methods have hygiene and health implications which this document seeks to address.

Sales methods

On a small scale level at market, birds may be sold by the producer to individuals or butchers. Farmers or small cooperatives may sell their produce at market by auction or direct to slaughterhouses or meat processing companies under contract arrangements. Poultry processing companies involved in rearing, processing and marketing poultry are generally not involved in the sale of live birds at market.

Poultry Slaughter and Marketing

Systems of operation of poultry processing plant

Large scale poultry enterprises contract farmers to produce birds for them. They contract or own transport to get the poultry to their processing plant. The large scale processor operates his own abattoir where he slaughters, processes, grades, packages, stores and distributes poultry either for his own use or under contract to other large organisations, such as supermarkets. The large scale operator employs his own staff, is responsible for procurement,

(or contracts this to a specialist) and is responsible for waste disposal. The whole operation is highly efficient and integrated with all parts of the poultry production, processing and sales industry.

Medium scale operators use similar facilities and staff to slaughter for several organisations who have responsibility for procurement and transport. They may prepare a product to a customers specification.

Small scale poultry processing enterprises, the subject of this document, may use their facilities and staff as described for the medium scale operators. However, the operators may allow the producer or butcher to slaughter his own livestock or contract labour to do so on his behalf. It is best for the small scale operator to employ his own labour or contract this to a well respected contractee and charge the customer a slaughter fee. The customer takes away his poultry and is able to sell it as he wishes, either through direct sales to the consumer or by wholesale to retail outlets or to other poultry users, such as fast food establishments or poultry product manufacturers.

Ownership of birds

Birds are usually raised as the property of the poultry producer such as an individual farmer, farmer cooperative, meat processing company or poultry processing company. Legal ownership rights usually change when birds or carcases are bought or sold. When birds are sold by contract or auction the producer usually relinquishes all rights of ownership. Small scale producers are sometimes integrated into large poultry processing enterprises by contract, which may result in birds being the property of the large enterprise throughout ie the producer is contracted to grow the birds without actually owning them. However, if poultry producers hire abattoir facilities and/or staff to slaughter their own birds, rights of ownership

may be retained. The birds are then marketed as a completely processed product or they are sold to a food marketing company. Large scale poultry processing companies usually retain all legal ownership rights until the product is sold to a food distributor or shop. In some cases company ownership rights are relinquished only when the product is sold to the consumer.

Ownership is important because the system of payment to the producer at the point of change of ownership can act as an incentive to grow better poultry. Live birds can be sold by the head (no added incentive) weight (a fair system with minimal incentive) by carcase weight (fair, providing an incentive if a weight/price scale is introduced) or carcase weight combined with a grade to which a price is attached (providing maximum incentive).

Production methods

Modern abattoir poultry processing is generally almost fully automatic. In large and medium scale operations, staff hang birds upside down by their legs from an overhead conveyor which then carries them through a highly organised processing system. They are electrically stunned and killed, scaled and defeathered by machine. In larger scale operations automatic evisceration machinery is used. In medium scale operations of up to about 1000 birds/hour, evisceration, neck and gizzard removal is manually carried out with the aid of labour saving tools and equipment. Automatic weighing and grading systems are also available and packing is semi-automatic with a packing machine controlled by an operator.

In small scale poultry processing operations, slaughter is carried out manually using simple processing equipment. Stunned poultry are held in a bleeding cone, with the head & neck pulled downwards through the opening in the cone. With a typical turnover of up to 500 chickens per hour, plucking is effected dry, most often by hand on a special machine. In operations over about 50 birds per hour, a wet scald system may be used. Pin feathers may be

removed by hand or hand held to a simple machine and evisceration is carried out on an overhead rail, carousel or table unless the poultry is to be sold New York Dressed ie defeathered only.

In all operations, carcases are spray washed and chilled rapidly before dispatch or further processing. Carcases and their giblets are reunited in some plants before they are packed, chilled or frozen. Some carcases are processed further into portions or poultry products.

Type of product

Processed poultry is prepared in many forms. Poultry is mainly available fresh, frozen or canned, sometimes in combination with spices and other foods eg chicken curry, as whole carcasses, parts such as leg, breast or wing deboned or bone-in. Poultry meat is also converted into manufactured food products, either alone or in combination with other ingredients eg pate, sausages, cured roll, cooked and raw, ready battered for the fried chicken trade.

Packaging

Poultry packaging protects the product from contamination, damage and moisture loss. It can also extend the shelf-life of the product, improve product presentation and consumer appeal. Packaging methods, are discussed in more detail in Chapter 3.

Refrigeration

The primary aim of meat refrigeration is protection against spoilage by micro-organisms. Refrigeration also gives a measure of protection against other forms of meat deterioration such as fat oxidation. Refrigeration is of great importance both during and after poultry

processing. This is explained in greater detail in Chapter 3.

Transport to market

Transport of the processed carcasses, parts or products is usually by refrigerated truck. However, where refrigeration is not available the product may be processed at a time when they may be easily sold at market quickly or to coincide with a festival or celebration. In this case transport may be an unrefrigerated truck or motor vehicle, horse & cart, bicycle or even by man on foot.

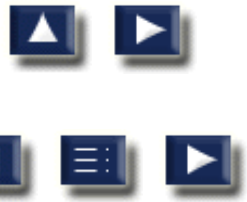
Display & sales

Poultry products are displayed in several different ways. Whole carcasses are often displayed unrefrigerated at market in the open hung by their legs or on a stall or shop display, particularly in the developing world. This is not to be recommended. Refrigerated products are displayed in shops and other retail units unpackaged or over-wrapped on plastic trays. In some are as meat is sometimes sold from mobile refrigerated shops. Products are usually exchanged for cash at the point of sale. However, poultry producers may have contracts with poultry processing enterprises, local hotels or restaurants where a lump sum payment is made. In developing countries small scale producers may sell by bartering for other consumable items.

Customer use

Poultry is one of the most widely accepted meat foods in the world and is not subject to any religious restriction. Consumers recognise poultry as a relatively cheap protein source. In developing regions, poultry meat may be seen as food for a special occasion, but figures indicate poultry meat consumption is increasing in these regions. Poultry may be reared and killed in time for a celebration or special event. In some regions turkeys and geese are reared

for thanksgiving and Christmas celebrations, although successful marketing has made it a popular choice at other times of the year. Chilled and frozen carcases or parts can be stored for longer periods and use becomes more convenient and regular. Some regions of the world have a preference to particular type of poultry; for example, in Asia, ducks are most popular. The type and use of food products made from poultry meat is also increasing throughout the world. These include roasts & rolls, turkey ham, smoked turkey and stuffed breast portions such as chicken Kiev. Changing lifestyles have brought about an increase in the number and type of poultry fast food products. In the developed world the number of women in the workforce has increased and home cooking from basics has been greatly reduced. Products such as fried chicken and chicken nuggets are sold by fast food franchises, particularly in N. America, Europe and Asia. In Japan yaki-tori is a very popular fast food product consisting of grilled chicken cubes on a skewer with yaki-tori sauce. A visit to the large towns and cities of the developing world will demonstrate that these products are transferring quickly.



CHAPTER 2
DESIGN AND CONSTRUCTION OF SMALL POULTRY PROCESSING PLANTS

1 GENERAL DESIGN PRINCIPLES

Planning

The reasons for planning a small scale poultry processing plant in the tropics usually come about as a consequence of a desire to make improvements on an existing system. The first stage of planning therefore, is to collect information regarding the exact nature of the project in terms of numbers of slaughterstock to be processed, management system required, costs of materials, services and labour, attitudes of the local population, markets to be served, type of product to be prepared, methods of waste disposal, availability of building materials, equipment and spare parts, specialised labour requirements, indeed everything required to complete a feasibility study. The feasibility study is usually conducted by technical and financial personnel. The expertise may be available locally but if not, can be commissioned internationally.

Economics

The economics of establishment and operation of the venture are usually among the first considerations when designing poultry plant. Small scale plants set up to the highest standards may not be financially viable operations. If this is so, some attempts should be made to quantify the social, hygiene and environmental benefits of the project to make an economic case for its establishment.

The following is a summary of the more important capital and operating costs of a poultry processing plant which should be taken into account when consideration is given to such a project:

Capital costs:

- **Land**
- **Buildings**

- **Plant and equipment**
- **Installation**
- **Contingencies**
- **Working capital**

Operating costs:

- **Personnel**
- **Maintenance and spares**
- **Water and sewage**
- **Electricity**
- **Fuel oil**
- **Short life operating equipment (2–3 years)**
- **Packaging materials**
- **Insurance**
- **Sundries (stationery, detergents etc)**

The size and equipment to be used in the factory will depend not only on the scale of operation

to be undertaken but also on the degree of productivity and nature of the end product. Consider the two examples which are given for operations of similar scale:

a. **labour - intensive production of a wide range of products**

b. **high technology production of a narrow range of products.**

Although the capital costs in the first example may be lower than those in the second (due to lower technology of the equipment), the recurrent costs, particularly those of labour) may be higher. Also, the buildings may need to be proportionally bigger to accommodate staff.

Because more people are employed, the first example has a requirement for a higher training input of production line workers than the second but the second has a greater requirement for highly skilled engineers to keep the factory working.

Because of the increased use of human resources, the first example introduces the possibility of greater variations and inconsistencies of product than the second, especially with respect to wholesomeness of the end product, its appearance and shelf life. The high technology example should produce material of consistent commercial quality. However, the need for maintenance and hygiene of the equipment introduces the need for maintenance and cleaning schedules of particular detail to ensure that complicated machinery is made ready for the next day's production.

Management

The exact management system which is to be operated must be established early in a building project as this will have a bearing on its design and the equipment to be installed. It should be clear from the outset if the project is to operate within the system established for the Public

Service, along the lines of a commercial abattoir (whether in the Public Service or not), or if it is to be wholly private. The system of management of staff must be considered from the outset. The system of labour to be employed must be determined eg employed staff (time, piece, bonus rated etc) contracted staff, as a public facility etc or a mixture of systems.

To assist with the design of the facilities, management information should include:

- **The number of birds to be slaughtered, their type and weight and over what time period**
- **The availability of slaughterstock and its seasonality**
- **The ownership of the birds at each stage eg will the abattoir buy the birds from producers, will it slaughter for producers or wholesalers, will it sell the birds to wholesalers or through its own outlets. These factors influence the carcase identification systems and office requirements**
- **The nature of the product to be prepared (New York Dressed, whole hot poultry carcases, whole chilled carcases, whole frozen carcases, chilled or frozen joints etc)**
- **What parts of the carcase are considered as edible and inedible. eg chicken feet, unused in many parts of the world are considered a delicacy in others. This will assist with by - products and effluent plant design**
- **The slaughter system to be considered appropriate eg will the birds move along and overhead railway system to the processing machines or will the staff carry the birds to the machines**
- **The level of technology to be employed**

All the above factors will influence the technology and economics of the systems finally employed.

Location of Plant

In an ideal situation, poultry should be produced in feed production areas, usually to be found in rural districts. The poultry should be slaughtered nearby and preserved so that the product, when it is of highest value and lowest weight is carried to the market. In this way, transport costs and bird mortality are kept to a minimum and economical use can be made of slaughter by - products in agricultural production. In practice this is not always possible eg where birds are produced in small numbers under an extensive system (not necessarily in the rural areas); the market requires fresh, unchilled meat; transport, with its refrigeration, is unreliable. For many reasons, poultry may need to be slaughtered nearer to the market.

The site for a poultry processing plant should be chosen with care. Primarily, consideration should be given to the provision of services. Adequate water, electricity, gas, oil and telephone should be to hand. Labour to manage, operate and maintain the plant is also essential. These staff need not necessarily be drawn from an existing labour pool of experienced slaughter staff since training in production methods must be given on modern equipment. Maintenance staff will need access to tools, materials and spare parts. The site should have good vehicle access, for road communications and, if appropriate, rail and river connection. Access by emergency services should also be considered.

The space requirements of the poultry processing plant is important. Ample areas should be available for parking, turning, waste disposal systems, and ancillary buildings and functions is required. As a general rule, the buildings should occupy about 20% of the total ground area. An eye should be given to future expansion of the building and its facilities.

The best sites are those situated on a gentle slope which, if this is not to be a completely rural site, should be to the lee of any built - up areas. Care must be taken if the poultry processing plant is to be built on an industrial "estate". Contamination of the poultry may occur from the odours, fumes, smoke, steam or particulate matter eg flour millings, sawdust etc from other manufacturing processes as could contamination by the poultry of other industrial processes eg dairy or confectionery industries. Proximity to other abattoirs or meat processing factories is best avoided. However, the potential for sharing the poultry and other meat processing facilities eg by - products processing, effluent disposal etc, may be a factor in the economics of establishment of the poultry plant. In this case, especial care should be taken to prevent cross contamination of one product by the other.

The ground of the chosen site should have good load - bearing characteristics to support the building itself and adequate drainage. The drainage is necessary for rainwater to run off. It is not to be used as a substitute for a proper effluent disposal system. The effluent disposal system should be designed so that the ground water or other water source used for residential, industrial or, indeed, the poultry processing plant itself is not contaminated. Nevertheless, one of the most important services to the plant is effluent disposal and its effective handling is facilitated through an adequate gradient and soil type. This is discussed later in this chapter.

Whatever site is chosen, the proposal to build a poultry processing plant, no matter how small, should be discussed with the local dignitaries and population to seek their approval. Some obvious sites may have to be rejected as it may be consecrated, used for local recreation etc.

Facilities Required

Consideration should next be given to the type and number of facilities required. This may

include reception area, slaughterhall, dressing rooms, chilling and freezing facilities, processing rooms, chill, frozen and dry storage rooms, dispatch areas, by-product processing rooms, laundry, ice production rooms, offices, changing rooms and toilets, messing facilities, first aid rooms, crate and vehicle wash areas, effluent treatment, workshop, boiler and refrigeration rooms. Depending on the system of operation, not all will be required but more than one will be needed in others. The system of management may also include facilities to operate a shop, wholesale market etc.

Flow Diagram

Using this information, a flow diagram should be drawn up, bearing in mind the management system to be employed. A typical system is given in Annex 1. Some of the services have been included to illustrate the growing complexity of the system. To each of the processes, the number and sizes of the rooms should be added.

Equipment and Machinery

The machinery to be used in the plant should be decided on the level of technology best suited to the management system chosen and the estimated maximum throughputs envisaged for the foreseeable future. Equipment is usually bought to last for ten years after which time it is worn out, obsolete or redundant but this will depend on:

- the likelihood of having funds to expand further in ten years' time. If it is unlikely that the plant will be able to re - equip in ten years, the time frame may be expanded. This will also depend on:

- the history of the poultry production and processing industries. The time frame can be adjusted to address the confidence shown in these industries, its continuing economic

viability and the economics brought about by the purchase of new equipment.

- **the history of equipment maintenance and breakages etc. in other processing industries. If maintenance is known to be good, the time frame can be extended. If not it may be reduced and the level of technology adjusted to suit the circumstances.**

The manufacturers' specifications should be checked to determine:

- **the designed throughput of the equipment**
- **the space requirements to operate the equipment**
- **the robustness of the equipment**
- **its specification in terms of power ratings and consumption, pressures, speeds, temperatures etc**
- **that the equipment meets the legal and safety requirements laid down in law or, in its absence, that of straightforward common sense**

Hygienic Principles of Design

Clean and dirty areas

The architectural drawings should give attention to the hygienic principles in design. Points to watch are that “clean” and “dirty” operations are kept separate and carried out in dedicated facilities. This means that separate rooms are required for:

- **reception of birds,**

- **slaughter, scalding and defeathering**
- **evisceration, washing and giblet processing**
- **chilling**
- **cutting and packing**
- **freezing and storage**
- **dispatch**
- **by - product processing**

A diagram showing separation principles is given in Annex 2.

Product flow

The plans should show a smooth flow of product along the processing line, with minimum distances between all operations including those which require other materials to be used in the process eg the ice harvester should be near to the chiller tank, the packaging materials should be close to the packaging machine. There should be minimum interference between other operations and cross flows of operations and operators should be kept to the absolute minimum.

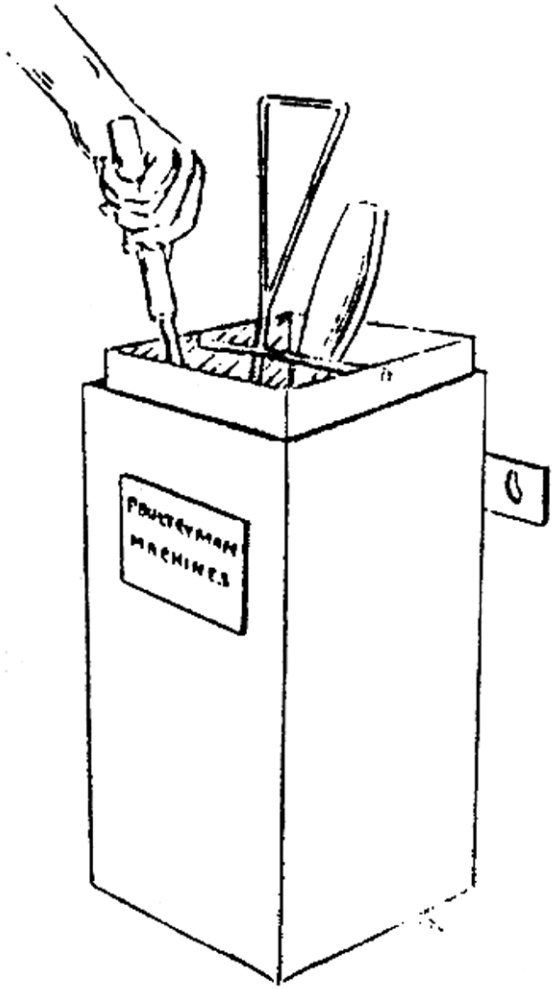
Equipment

The general guide - lines for equipment design, manufacture, installation and operation are long and detailed. The equipment generally available is usually of sufficient standard if

obtained from a reputable manufacturer. The following description outlines the general principles to be followed, particularly where local manufacture or fabrication is planned.

The equipment to be used in a small scale poultry processing plant in the tropics must be strong and effective enough to last for at least 5 years. Replacement is often difficult (usually through lack of funds) so it should be obtained with a view to longevity easy maintenance and repair. The equipment must be maintained to a schedule, which should be established before installation and based on the manufacturers information. In the tropics, it will almost certainly be used on birds of different sizes and weights, if not different species from that chosen for the original project, so equipment should be selected with a view to adaptability as far as possible. The equipment must conform to local standards of construction and safety. It should have proper safety guards, maintained in full working order. The equipment must be designed to be cleaned properly after use. It must have smooth surfaces, clean welds, an absence of bolts and irregular protuberances, made preferably in stainless steel or at least galvanised steel which has been hot - dipped after manufacture. The use of paint and mild steel is not recommended as it will easily flake in the atmosphere and contaminate the carcases.

In the interests of hygiene, stairways, overhead gangways, platforms, steps etc should be made of aluminium alloy checkerplate which can be cleaned much more easily than iron grills. Wash hand basins, which should be made in stainless steel rather than china, should be provided with cold and hot water at 82°C and operated by foot, knee or arm. Sterilizers for knives and hand tools and equipment should be used. They may be attached to the wash hand basin and these also should run at 82°C.



Sterilizer unit

Mobile equipment or that used part - time or irregularly should be stored in proper facilities out of the way when not in use.

All equipment should be installed at a sufficient distance away from walls to permit installation, operation, cleaning and maintenance. If not sealed to the floor, it should be raised 200mm to

facilitate cleaning underneath.

Drains

Floors should have falls in the region of 1:60 so that waste water flows away rapidly but not so steeply that it causes difficulty in walking, movement of other traffic or positioning of static equipment. Drains, which may be open channels covered with a well fitted grill, should flow from clean to dirty areas. Drainage pipes should be at least 150mm in diameter so that they will run freely and not block with the large weights of feather, fat and faeces which pass over the floor. Drains should be screened at the exist to the building. Effluent disposal systems should be designed to suit the nature of the waste and its volume. This will depend on the system of operation and management chosen above.

Floors, walls and ceilings

There is a temptation to economise on the quality of wall and floor structure and finishes. This is false economy. Poultry blood, fat and other tissues are very corrosive. The work involved is heavy and intensive. Any economies made will rapidly show and constant maintenance will be required if good hygienic standards are to be maintained. The floors and walls must be easy to clean, smooth, impermeable and acid resistant. The floors must be non-slip to prevent accidents and should be coved with the walls. The walls should be coved and rounded to each other to prevent accumulation of dirt and water. The walls and floors may be finished in tile but this should be completed in materials of very high quality and laid with excellent standards of workmanship. A simple granolithic screed, spread across the floor and up the walls is relatively cheap, durable and hygienic but lacks visual appeal. The temptation to finish walls in domestic paint should be avoided as this discolours and flakes, thereby contaminating the poultry product. There are suitable epoxy resin finishes in white which may be applied if appearance is

important. These are sometimes referred to as a "liquid tile". Walls should be finished to a height of three metres. Where product or equipment comes into regular contact with the walls or floors, reinforcement will be needed. This should be established before operation commences since it may be difficult to fix hygienically after production has been underway for several weeks.

Ceilings should cover the undersides of the roof structure, exposed pipework, electricity cabling and other service runs. They should be smooth and impermeable to water, free from condensate and unpainted so that they will not flake. True, suspended or false ceilings should be at least 500mm above the highest piece of equipment to allow for installation, maintenance and cleaning. Care must be taken to inspect the space above the ceiling for accumulation (and removal) of dirt, insects, birds etc and their nests.

Doors and windows

Windows should be encased in non-corrosive material eg metal alloys, not wood, and should have sloping sills so that items of clothing, knives, bottles etc cannot be stored. Doors should have alloy frames and impermeable surfaces. The whole building should be proofed against insects, rodents and birds.

Service runs

Service runs and ducting need special attention. Pipework runs should be simple and straight, preferably buried in the walls or floors, or run down an outside wall before it passes into the room in which it is required. Pipes buried in the wall should be in stainless steel where they emerge into the room as they tend to corrode at this point making repair very difficult and expensive. Pipes which run inside a production room should be stainless or galvanised and

mounted in wall spacers so that they are 50mm from the wall. Suspended pipework should not be located over product lines. Should they attract condensation, leak, need repair etc, production and product quality will be affected. If necessary, pipework and ducting should be suspended from trapeze hangers. Electrical runs should also be buried or run in conduit. Switches, lighting fixtures and other electrical fittings and fixtures should be of waterproof standard, able to withstand the unintentional play of a hose pipe or steam lance if they cannot be situated outside production areas.

Lighting

This has to be of a standard for both general work and for meat inspection purposes. Daylight is the cheapest form of lighting but it is sometimes difficult to provide sufficient in all areas. In Europe, windows are not favoured as they let in dirt and insects, and let out heat. In the tropics it would be churlish not to use the light which is so amply available. Lighting should be about 220 lux in working areas and 540 lux in inspection areas at a height of 1.2m from the floor. Note the advice regarding the need for waterproofing electrical fittings given above.

Ventilation

Adequate ventilation is essential in tropical meat processing rooms. The air temperature and humidity of the air can be very high and its extraction imperative if comfortable working conditions are to be maintained. Condensation is a problem which must be addressed. The Venturi effect, where one wall, heated by the sun, causes an updraft of air which is voided through a slot in a pitched roof is preferred but care must be taken to prevent entry of birds, insect and rodents. Artificial extraction of air is expensive but may be necessary especially in countries where temperatures fall considerably overnight and open ventilation systems would be inappropriate. The equipment used for ventilation should be considered as internal

equipment and conform to the standards set out above. In general rooms, six changes of air every hour are sufficient for comfort but in processing rooms, particularly where there is steam production, this may need to be increased to 20 or more.

Facilities Required in Specific Areas

General Building

The building

The building and its roof should be an adaptation of local architecture so that it fits in with its surroundings and causes no visual offence. The adaptation should consider the climate and other environmental characteristics of the region while addressing the hygiene concepts of its operation. For example, in earthquake zones, the building should be strengthened to locally recommended levels with reinforced concrete ring beams and no tiling to the walls. Desert areas will need special dustproofing. In areas subject to very wide variations of temperature and humidity, the buildings will have to be suitably adapted, perhaps with heating and ventilation.

Roof

In humid equatorial zones, the building should be adapted to the problems of sharp cloud-bursts, with sloping roofs, wide eaves, deep gutters and downpipes, and substantial storm drains to take away rainwater rapidly. High apex roofs are considered best for hot areas. Flat roofs are unsuitable generally, even though they may be cheaper than the alternatives. Thatched roofs are also not suitable since they house birds and insects and are a fire risk. By the same token, an asbestos roof is considered a health risk and cannot be used either.

Walls

The nature of the materials used in construction of the outside wall should reflect the climate and environment. In the humid tropics, a damp proof course may be necessary. The outside walls may need to be made in a low absorbent material like highly fired brick, marble or other local stone rather than soft blockwork with a cement render which will stain and decay rapidly.

Insects

Insect levels are high in many tropical countries and particularly so around abattoirs where there is often an abundance of static water and nourishment for their survival. Buildings must incorporate suitable screening, remembering that insects, having gained entry should not find difficulty in finding a way out. The screens used must be hygienic, and cleaned frequently if necessary. Inside the building, particularly in production areas, electrical insect attractants with an electrified grid to kill flying insects are particularly useful.

Wood

Some insects live on wood which soon decays and is therefore unsuitable for outside use. Wood and other absorbent materials are not to be used anywhere inside the building for any purposes.

Water and steam

All water entering the abattoir should be of potable quality. Ideally, water should meet the guide-lines set by the World Health Organisation. These are long and involved. For practical purposes, it sets a bacteriological quality (of zero faecal and other coliforms/100ml sample), a chemical quality for nine inorganic and 18 organic substances and a recommendation about

aesthetic and organoleptic qualities. The water supply should be chlorinated so that there is a residual concentration of 0.5ppm free chlorine after 20 minutes contact time. It should be supplied at a minimum pressure of 15psi (1 Bar). There should be sufficient water stored for one normal days production, should there be an interruption of normal water supply. Water consumption may be calculated at 25–35 litres/bird slaughtered.

In small plants, it is possible to heat water for scalding and cleaning by electricity, gas or by solar heaters at the place where it is to be used. Savings in water and energy can be effected by provision of low volume, high water pressure systems (LVHP) for product cleaning and plant sterilization. A high pressure system of suspended hose lines at strategic points in the factory will assist high product standards and minimal water consumption provided they do not touch the floor and do not leak. A mobile steam cleaner is very effective in cleaning small plants, particularly where cleaning agents can be added to the water flow. In larger plants this may not be economical and operation of a boiler house to generate steam is desirable. For this, a separate boiler house should be build and provision for fuel, water and steam storage will be necessary. An adequate number of steam hose points and steam lances should be provided at appropriate points in the factory so that flexible hosepipe runs are no more than 15m long.

Drainage

The abattoir should have at least three systems of drainage.

- **Storm water drains, used for that purpose only, may be open in places and should flow into the appropriate outlet. They should be designed to withstand the maximum expected precipitation. The meteorological office or local architectural offices will usually be able to provide details. The drains should be designed to be kept clear and they should be cleaned regularly. In areas where rainfall is frequent, heavy and relatively non-seasonal, this**

usually presents no problems. Where there are distinct wet and dry seasons, storm drains should be specially managed to ensure that they function efficiently before the first rain is expected.

- **Drains carrying human waste, again used only for that purpose, should pass by closed 150mm pipe, through a series of gullies and manholes where necessary, into the town sewerage system, where it should be properly treated. If no town sewers exist, the waste is probably best treated by means of a septic tank and soakaway along the lines of domestic waste treatment. In small abattoirs, elaborate treatment systems are probably not necessary.**

- **Effluent treatment is a specialised topic which will be discussed later in this document. At this point, it is sufficient to say that the drains should flow from clean to dirty areas within the building. Blood and large particles should have been removed before they leave the building. Once the drainage system leaves the building it should be in 150mm or greater pipework and pass through a series of gullies and manholes until further treatment, some distance from the building.**

Outside Areas

The area outside the building should be sealed to a distance of at least 3m from the building. Beyond this, a clear, non-dusting finish should be used to 10m. Overhanging trees and vegetation should be cleared to 10m. Potential bird and animal habitats and resting places should be avoided such as trees, wires and the eaves of buildings. Any plantations made to provide a function, service or landscape should be of a type unattractive to local wildlife. For example, bats and monkeys are attracted to fruit and this type of tree should not be chosen. Trees which are particularly unattractive to hawks, crows, vultures and other carrion feeders

are recommended.

If the plant is to operate at night, consideration must be given to external lighting. While this is needed for functions performed outside, the lights will attract many night insects. Lighting should therefore be situated on the fence directed towards the building rather than on the building and directed out.

Livestock Reception Area

Like all areas in the poultry processing room, the design of the reception area must reflect its function and management. Livestock is considered dirty. Poultry has a mixture of dirt, faeces, mites and insects embedded in its feathers. The poultry itself may have a microbiological infection. The vehicle and the containers are usually dirty from travel and previous use. The person bringing the stock may be unclean from travel and he/she may have brought his/her family, including the dog from home to the abattoir. It is good practice, therefore, to provide a separate entrance for livestock. Access to the rest of the building by the persons bringing the birds should be prevented. Washing facilities for vehicles and other livestock carriers should be provided. Hot water under pressure and drainage should be supplied. The area should have the geography and space to allow vehicles to manoeuvre and store both full and empty crates or livestock containers. The birds must be stored under cover to await slaughter.

Reception Loading Area

The reception area may also double as the loading area; in small processing plants this is most suitable. Space must be allowed to label and sort stock, man-handle livestock containers and store them when empty. Access to the equipment to hang birds immediately before slaughter should be provided. Livestock handlers should be provided with wash hand basins in the

reception area.

The Slaughterhall

The slaughterhall has the potential for being among the dirtiest of rooms in the abattoir. It may contain flapping birds (they do not all settle), steaming scald tanks, flails or whirling rubber fingers removing feathers, dirt, faeces and insects from the newly dead carcases. This situation forms an effective, contaminating acrosol which settles on all the structures, equipment and personnel. When viewed in this light, its design and management principles become apparent. The room must be separated from the rest of the processing rooms as must the staff who work in it.

The room must be big enough to accommodate all the equipment and personnel with adequate circulation space. The layout, using the principles set out above, should allow 12 or more seconds for the birds to settle before low voltage stunning and sticking, two and a half minutes bleeding and up to three minutes scalding at 53°C before defeathering.

Blood released from the birds must be properly handled. It has a high Biological Oxidation Demand and should not pass into the effluent disposal system. If the quantity of blood is small, it can be scooped up and disposed of directly. Other systems involve the use of pumps of vacuum to a tank in the offal room.

The arrangement of the defeathering area must relate to the management system and number and type of equipment in use. If the defeathering machinery is based on a series of pluckers operating on birds suspended from an overhead rail, the length of rail involved will relate to the number of birds to be plucked in a given time, the speed of the rail and the efficiency of the plucker. Such detail is usually worked out by the manufacturer. In systems where scalded

carcases are held against a rubber drum with fingers, the position of these will depend on the system to be operated and the number of machines to be used. This relates to the capacity of the machines and the number of birds to be plucked in a unit time. For example, to defeather 200 birds/hour can be achieved by using two pluckers each with an operational capacity of 110/hour or four with a capacity of 60/hour. (These are maximum capacities and allow for some production and unexpected shortfalls). There are advantages to using more machinery of lower capacity in the tropics where throughput may vary considerably from day to day and the number used and staffing levels can match the day's throughput. Also, should one machine be out of service, there are three others (in this case) to help achieve three quarters of the daily throughput as opposed to half with the higher capacity system. Of course four operators will be required to use the lower capacity system and a large building will be required to accommodate the equipment. The risks and economics of the situation must be assessed when the system is chosen.

The floor in this area must be smooth and well drained. Feathers which have been removed from the birds and fall to the floor must be screened from the drains to prevent blockage. This is best achieved by fitting a grill over the channel drain. Wet feathers are particularly difficult to manage but it is essential that they are confined and placed in drained containers on a regular basis in the interests of hygiene and safety.

The defeathering area should leave space for an operative to remove the pin and other remaining feathers by hand and singe the carcase to remove the last feathers and hair.

Defeathering is followed by spray washing in cold water. This area should be properly drained.

If chilled, the carcases are now known as New York Dressed and may be marketed as such. There is much to be said for marketing poultry in this condition at the start of any processing

venture. The product is more hygienic than a badly produced eviscerated carcase, will keep for a day or so if kept cool or may appeal as a product only a little removed from that sold by other marketing methods (live or fresh killed but not plucked).

The room will require full ventilation to prevent condensation build-up. A complete change of air each minute is required.

Evisceration and Chilling Room

This must be a separate room. Clean carcases are opened to expose their viscera which contain spoilage and, perhaps, pathogenic bacteria. Great care must be taken not to contaminate the carcase when they are removed. Special facilities are required.

In larger abattoirs, evisceration is performed automatically by machines designed for the purpose. In small processing plants, carcases hanging from overhead rails or hooks are eviscerated by operators using hand tools. About 1 metre/person must be allowed to permit workers to operate on this line. Inspection takes place in this room also and about 3 metres must be allowed for this.

The offal should be dropped into a trough of about 1 metre wide which slopes backwards to the beginning of the line. Offal flow is assisted by the end of line carcase washer.

In the smallest abattoirs, evisceration is performed either on a carousel which operates a little like an overhead rail and offal trough or on tables. This method must be carried out with great care as there is considerable scope for contamination of the carcases and their cross-contamination if the tables are not properly organised.

As evisceration involves removal of material containing considerable numbers of micro-

organisms, contamination of the carcases is possible. This may lead to reduction of shelf life. Cutting carcases while they are hot is not considered practical so for both reasons, it is essential to cool them rapidly and hold them under chilled or frozen storage.

A cold spray to remove gross contamination is followed by one of several methods of cooling. The usual method is one of immersion in a tank of water which is cooled (perhaps with ice) and chlorinated. The volumes and temperatures of cooled water used in cold water chilling systems are usually calculated by the manufacturers of the equipment. The USDA regulations demand that there should be a minimum of 2.251 of overflow for each bird. Calculations of the ice, water and chlorine requirements of that system are difficult. Although there are empirical formulae to calculate them, the results usually underestimate the quantities required and the carcases often finish up insufficiently chilled or left for too long in the tank. As a guide, 0.4kg to 1 kg of ice per 1 kg of poultry is used to chill carcases, usually towards the higher end of the range in the tropics. For estimating purposes, 2kg ice/bird slaughtered should be allowed. Use of an insulated slush ice tank will reduce ice consumption.

There are several designs of chiller for hot carcases. These include the continuous drag chiller, slush ice chiller, concurrent tumble system, counterflow tumble system and rocker vat system. Although of differing designs, principles remain broadly similar. The chill system is designed so that ice or ice cold water is fed into the end of the tank or system that the carcases leave. The cooling medium is set to flow towards the carcase entry so that it is in counterflow to the product. There may be a series of tanks through which the birds pass rather than one tank. Often there is some mechanism, eg an auger or the overhead railway system itself which propels the bird from its entry into the coolant to its exit. The ice melts and overflows into the drain at the carcase entry point. The water must be completely changed at least every four hours as it becomes contaminated with blood and carcase material. Chlorine must be added regularly to maintain a total residual level of 50ppm.

As an alternative method of chilling, carcases may be cooled in air at ambient with a forced draught of about 1m/sec followed by spray chilling in water chilled to 2–4°C. Approximately 2.51/bird is required to chill the carcases to 7°C.

The evisceration room should have sufficient space to allow workers and equipment to move around. Personal hygiene facilities are required eg wash hand basins and paper towels or hot air blowers. As the carcases are in a cleaned state, all metal work in the room should be in stainless steel with a specification as set out in the paragraph describing equipment above. The room will be hot and humid, so adequate ventilation is important. A complete change of air each minute is recommended.

In the diagrams in the annexes, the chilled birds emerge in or immediately adjacent to the packing area; this is in the "clean" area.

Packing Room

Poultry which has been chilled by a wet process must be packed rapidly and either dispatched rapidly or frozen. Chilled poultry leaving the ice tank must be hung and allowed to drain for several minutes, preferably into a suspended trough to prevent unnecessary moisture on the floor. The room should be air-conditioned, constructed and finished to full hygienic standards.

Poultry may be graded by class, weight and appearance. They may be packed whole (with or without giblets) or cut into halves, quarters, pieces or deboned partially or completely before packing or processing further. The process employed will depend on the market to be satisfied. Account must be taken of regional preferences eg feet and/or heads may be left on (not recommended) or wings and feet packed separately. Cutting and further processing may be carried out either by simple hand tools or machinery within a full range of sophistication. All

machinery must be hygienically constructed and capable of being properly cleaned.

The packing room must have sufficient space to stand packing tables and equipment, immediate storage of packing materials and trolleys for moving material into the chillers or freezing system. Its size will depend on throughput and the nature of the operations to be performed. The room should be light, quiet, well organised so that grading, weighing, cutting, wrapping, marking, packing into secondary containers (eg cardboard cartons) are easily achieved. Passage to the cold storage should be rapid, thereby preventing the carcase from warming unduly. The room should contain hygiene facilities for staff (eg wash hand basins and towels) and adequate drainage for washing down.

Chilling Rooms

Packed poultry may be stored in chill rooms for early dispatch or frozen and stored for dispatch as required.

Poultry which has been eviscerated and chilled in slush ice, followed by chill storage above freezing has the shortest shelf life of all methods of production. Chilled poultry can be stored at 2–4°C for one or two days at maximum before dispatch to retail outlets. Poultry may be kept a day or so longer if stored at -1°C. Poultry kept in frozen storage (-20°C) may be kept for up to 6 months. Sufficient storage space must be provided for the system of operation to be used. It must include adequate circulation space for staff and vehicles.

As turn-round is fairly rapid in chill storage, single height stores are adequate. The ceiling height need be little more than 3.5m. Consideration must be given to the foundations of the building which must bear great weights, stresses and strains. The installation must have adequate insulation to withstand high external temperatures an adequate vapour barrier and

protection from physical damage by equipment. A curb between the inside walls and pallets of 150mm should be provided to facilitate air movement and to prevent damage by materials handling equipment and the packaged products. Air curtains should be provided at the doors to help contain the cool air within the chill room.

The product should be stored with adequate dunnage to take advantage of an air flow of about 1m/s. There should be adequate light to read labels and boxes but not so much that it causes significant heat generation. The room should have facilities for easy storage of the product on pallets or shelves. Stock control should be very well organised. There should be floor drainage so that the room may be frequently, regularly and adequately washed down.

The cold stores should be arranged so that the product may pass easily to the dispatch bay or freezer rooms.

Freezing Rooms

Poultry may be frozen by one of several ways. The usual system is to place the wrapped carcases or portions into metal trays and place them in a blast freezer for 2–3 hours at -40°C. The air flow is maintained at about 2–4m/s. The process is followed by storage in a freezer store at -20°C or below for a period up to six months.

There are alternative methods of freezing. Regular packages lend themselves to plate freezing. In this system, “bricks” of meat packages are sandwiched between two plates. There are several plates and each will sandwich several packs of poultry. The plates are brought down into direct contact with the pack and refrigerant is run through so that the packs reach -18°C in about 1 1/2 hours. The packs are then removed, placed in boxes and stored at -20°C.

Other freezing methods include adding refrigerant directly to the pack. The two best known

examples are liquid nitrogen and solid carbon dioxide. They are not used frequently in the tropics because of their poor availability, irregularity of supply and high recurrent costs, which may be up to three times as expensive as conventional refrigeration. Nevertheless, it is mentioned as there are circumstances which suit this freezing method and the capital outlay is much less than conventional systems.

The frozen product should be stored at -18°C or below. Although single height stores of up to 3.5m high may be adequate in small scale processing plants, in larger factories the freezer stores may be up to four pallets high. Consideration must be given to the foundations which must bear greater weights, stresses and strains than the chill rooms. The installation must have adequate insulation not only to withstand high external temperatures but prevent freezing the soil underneath. This can cause frost heave and physical damage to the store. The store must have an adequate vapour barrier, protection from physical damage by equipment and a curb of 150mm on the inside walls to facilitate air movement and prevent damage by materials handling equipment and the packaged products. Freezer stores should have an alarm system to attract help should staff be locked into the store accidently. Air curtains should be provided at the doors to help contain the cool air within the room.

Loaded pallets should have adequate dunnage to take advantage of a light air flow. As the room is kept well below freezing temperatures, there will be the inevitable build-up of ice throughout the store, and around and just inside the door, particularly in humid climates. The fabric of the store should be such that this ice can be removed easily and without damage, so that doors can be closed completely to maintain a constant temperature. There should be adequate light to read labels and boxes but not so much that it causes significant heat generation. The room should have facilities for easy storage of the product on pallets or shelves. Stock control should be very well organised. Freeze stores are emptied most infrequently so there is no need to provide a formal drainage system. However, when the

stores are emptied, the opportunity should be taken to clean them. A considerable volume of melt will be produced, which may contain drip from product, rubber from wheeled and human traffic, dirt from packaging and pallets etc. The design of the stores should ensure that this melt is hygienically removed.

The freeze stores should be arranged so that the product may pass easily to the dispatch bay.

Dispatch

The dispatch bay should be located near to the storage area and arranged so that loading is conducted speedily. This will prevent unnecessary rise in temperature of the product. Refrigerated dispatch bays are unnecessary in small scale plants. The system of dispatch of product needs careful consideration at the design stage. Should dispatch be planned by means of pick-up, large vehicle, private vehicle or as individual packs from a retail shop, the facilities should be designed accordingly. Considerations should include the slope of the site, height of floor pan of vehicle, use of fork lift vehicle or pallet truck, hand loading, gravity, conveyor etc. Numbers of vehicles collecting poultry at any given time will affect its size eg a bay to accommodate one vehicle twice each day to remove the whole days production for dispatch to a wholesale market will be smaller than a bay used by 20 small pick-up trucks, one from each supermarket in the town, all wanting to collect poultry at 0800 each morning in time to open shop at 0900. Consideration should also be given to parking and manoeuvreing of collection vehicles.

Dry Stores

Bulk supplies of wrapping materials should not be stored in poultry processing rooms. They should have separate facilities in a room off the packing room, and preferably with a door to

the outside for deliveries.

The size of dry stores will depend on the type of product prepared, type, size and number of boxes/materials to be stored and their delivery schedules. This is important in the tropics where cartons may be produced in batch operations by a factory dependant on the availability of raw materials or where packaging materials are imported in large quantities on an infrequent or irregular basis. Space must be provided in the store for personnel to identify, sort, collate and collect the materials needed for the occasion.

Provision must be made to manage the dust associated with storage of dry materials. Extractor fans and airlocks are suggested for some areas of the world where dry dust may become airborne easily. In humid climates, the nature of the packaging materials to be used, box designs, adhesives etc must be carefully considered. A soggy box which is poorly glued will not hold the product. Much damage may result from poor storage conditions and, under certain circumstances, the provision of an air conditioned room or one with a modified atmosphere should be considered. The room should be proofed against entry of insects. Packaging materials make excellent breeding grounds and homes for insects if the stores are not well managed. Adequate lighting and stock control are necessary.

Offal Room

The offal room is probably the dirtiest room in the factory and must be designed to address the problems. Inedible offals, in the form of feathers, heads, feet, viscera etc and condemned carcases must be disposed of in facilities especially designed for the purpose. The room should be located next to the defeathering and evisceration areas. Waste products should pass into the offal room from these clean rooms and pass directly out of the building without passing through any other. Offal usually arrives in the room along trenches and chutes with

considerable quantities of water. Water and offal are separated before the offal is placed into some form of container before its disposal. The water drains to the floor before it passes to the effluent treatment plant.

The room must be properly isolated from the rest of the building, properly finished, impervious to water to 3m or more from the floor and adequately drained. The floor must be maintained to a high standard and not be slippery. The doors must have bulwarks to prevent waste water from leaving the room. It should be adequately lit and ventilated.

Staff employed in this room should not be permitted to enter any other processing room.

Staff Facilities

Staff facilities comprise changing areas, toilets, showers, washing facilities, lockers and bins for dirty laundry. Separate dining facilities for the consumption of food may be necessary in some locations but probably not in small processing plants.

The design of staff facilities needs much consideration. Separate facilities are required for men and women. Live bird and by-products handlers should also have separate facilities. This is not always possible in small processing plants. In either case, the factory should be designed so that these personnel have direct access between their changing facilities and work areas without passing through the clean areas of production.

The layout of facilities should comply with local legislation. This should include conditions regarding access to operational rooms. Staff arriving for work and leaving at the end of the shift should be able to enter the changing facilities directly and not pass through production areas. Although the rooms should be sited near to the area of greatest number of working personnel (usually the evisceration room), staff not permitted to pass through the nearby room

should be able to get to work by a short, logical route. The staff facilities should not open directly onto a production area. There should be some form of air lock.

Changing facilities should comprise a locker for each member of staff and sufficient toilets, showers and wash hand basins for the number of staff employed. The toilets and changing rooms should be separated by a partition from floor to ceiling. The use of paper towels is to be encouraged and proper dispensers should be provided. Benches and storage for footwear must be provided.

The room should be light, well ventilated, insect proofed and fitted with an extractor fan to exhaust air to the outside. Sufficient hot and cold water should be provided for staff to wash their hands and face frequently and shower once each shift. Litter bins should be provided.

Factory workers must neither eat nor smoke in meat production areas. There should be provision made for these activities which do not contravene the spirit of hygienic principles. An area, perhaps designated a recreation area, could be provided outside but under cover, with wash hand basin, tables, chairs, ashtrays, litter bins etc so that eating and smoking is contained.

Hand and Boot Wash

Before entry into the processing rooms, and usually just outside the staff facilities often in a corridor, a boot wash facility should be provided. This need be little more than a tap to which short hose with a car-wash-type brush is attached hanging over a stainless bar, itself over a drained trough. The worker lifts and places his foot on the bar, which is about 300mm from the floor, to clean his boot. It is customary to provide a wash hand basin next to the boot wash with hot and cold water, paper towels and a litter bin.

Laundry

All workers should change their protective clothing at least once each day. In small processing plants, staff are often expected to launder their own clothes. Managers face difficulties if staff have no clean protective clothing. Provision should be made, therefore, for all laundry to be washed by paid staff or under contract to ensure total cleanliness. In the tropics it would not be unusual for a relative of one of the production staff to undertake the task. This should be carried out on site but away from the main building. A small room or lean-to should be provided with a sink, hot and cold water, clothes line etc. Requisites such as soap powder and scrubbing brushes should be provided. It is not unusual to see the family laundry on the line with working clothes and, provided this is not to excess, can be part of a management arrangement to attract suitable staff.

Offices

Offices and their furniture should be provided for the manager, office staff, veterinarians and so on, according to the local custom and legislation. The number, type, style and size of office accommodation will depend on the nature of the business, the numbers of birds slaughtered, the number of clients, both supplying and being supplied and the culture of the region. It is important to provide accommodation which is comfortable for the office staff so that personnel of the right calibre will work in what is a relatively unattractive industry.

Inedible by-Products and Waste Disposal Facilities

Solid by-products

Broiler carcase yield is approximately 65% of liveweight which means that approximately 35% of the liveweight of poultry comprises feathers, blood, viscera, feet, head and trim which is

available for solid by-products. The liveweight of the bird will vary with the production systems employed and the market demand. Similarly the weight of solid by-products will vary with the degree of dressing required by the market or, where birds are slaughtered for an owner rather than purchased by the processing plant, the weight of material the owner may wish to take or leave after slaughter. This section will assume that the average liveweight of the bird is 1.5kg and 35% of this weight will require disposal. Additionally, the feathers contain about 75% water. As the dry feather weight is about 4% of liveweight, the quantity of by-products produced by the three model plants is calculated as follows:

- 50 birds/day — 30kg/day
- 200 birds/day — 120kg/day
- 350 birds/hour or 2500/day — 1400kg/day

It should be noted that in the first model, the birds will be New York Dressed, so that only blood and feathers will be available. This will amount to about 10% of body weight or 7.5kg/day.

By-products material should be handled carefully. It should follow marked routes in the plant and be contained. This containment includes troughs, pipes and trunking, bins and bags, skips etc. Waste materials should not be left on the floors, swept into a corner or piled outside. Once it has left the factory, its containment should continue. These materials left lying on the ground, whether the pavement is sealed or not, is unhygienic and attracts vermin, birds and other wildlife.

Inedible material is divided into two classes; that which is condemned as unit for consumption in any form and that which is otherwise healthy. Inedible material should arrive at a disposal point in separate containers. Condemned material should be kept in special containers, appropriately marked. It should be incinerated, if such equipment exists locally, or buried with

lime and/or disinfectant to a depth of at least 2m, at some distance from the abattoir but within the compound. Under no circumstances should it be left open and disposed of in such a way that it remains available to humans, dogs, animals or birds.

For the first two models, the total weight of solid by-products is too small to justify, either physically or economically, serious capital investment to process this material further. Its disposal, nevertheless, presents a problem which needs proper management. There are three main methods of disposal:

- **Burial or incineration as if it were condemned**
- **Cooking and feeding as swill to pigs**
- **Cooking, drying, grinding and using as fertiliser.**

Before any of these methods is used however, the cost of the intended process should be examined closely as they are very inefficient in the use of fuel.

Poultry waste should be cooked in a purpose built room separate from the main building where the poultry is kept and slaughtered. It must have its own floors, walls, roof, services and entrance and be constructed so as to keep animals, birds, insects and vermin at bay. The rooms should have a clean rendered finish and be capable of disinfection and cleaning. The building should have separate rooms for the reception of the waste and another for cooking and storage of the swill afterwards.

Raw offals should be handled separately from feathers. Feather meal is more difficult to handle and use. Considering the amounts available, ie 5 & 20 kg/day for the first two models, perhaps direct burial is the most suitable disposal method.

Swill must be prepared daily and immediately after slaughter. Raw offals should be boiled at 100°C for at least one hour before allowing them to cool. Fat should be skimmed from the surface and stored in clean drums until sufficient has accumulated for sale. The equipment for this operation for Models 1 & 2 is very simple. A properly made, thick, open pot, the size of a 44 gallon oil drum will suffice as a cooking vessel. The volume produced daily in Model 2 would half fill the vessel. After cooling, the swill may be fed directly to pigs, or minced and fed as a slurry, after vitamin fortification. It is a variable product but this will be reduced if only poultry offal from the processing plant is used. In some countries, offal may be treated off the compound, although this is not an advisable practice. In these circumstances, other materials may be used in the swill but its composition will be variable.

In dry climates, the minced product may be sun dried on open concrete beds and used as a fertilizer. Care must be taken to ensure that the product is not contaminated by insects, birds and mammals. The dried product should be broken up or ground before bagging, marketing and final use.

Model 3 presents a dilemma as the weight of the waste amounts to a quantity approaching a commercial operation in some countries but not in others. At a production weight of less than 1.5 tonnes/day, economic viability is not assured, indeed daily batch weights of three to five tonnes are not always economically successful.

There is no reason why swill cannot be prepared at the throughput generated from Model 3 but it is very expensive on fuel and, like the product above, has a very short shelf life. The offal produced is equivalent to filling completely seven, 44 gallon oil drums. The equipment needed for this operation could be a series of 14 drums as described for use in the first two models. It may be necessary to invest in a proper cooking vessel from the manufacturers of such equipment. There are three varieties to chose from. The first is a steam jacketed vessel which

cooks the material in its own moisture. It is a “dry” cooking method. The second system injects steam into product and is a “wet” cooking method. The third combines the two processes. None of the systems will raise the temperature above about 97°C so the cooking period will have to be extended beyond one hour. The process requires a steam generator. As the equipment has taps and valves to run off generated water and fat a whole range of vessels, pipework and other equipment will be required to service the main cooker. The volumes produced call for an organised distribution and sales system.

The alternative is to cook the offal in an industrial offal rendering plant (melter) to sterility (about 2.5 – 3 hours). The system is vented to remove moisture, the fat drained off and the product centrifuged or pressed by screw to remove the remaining fat. The dry product is then milled and bagged. Energy is used more efficiently than open cooking but the capital cost of the equipment is very high both to purchase, maintain and keep in spare parts. The smallest conventional melter has a charge capacity of 3.5 tonnes but smaller ones can be made to specification, at a cost. A throughput of 10 000 birds/day should generate sufficient waste to charge fully the smallest plant. The equipment requires skilled operation staff.

There are other methods of commercial by-product manufacture (eg continuous and recycling systems, each claiming savings on energy and resource inputs) but all have the same drawbacks in terms of capital outlay, maintenance and staffing requirements. At the throughputs mentioned, some producers find burial the most cost effective solution to offal disposal problems. A novel system proposed in the early 1980's is to mince the offal through a 4mm plate, acidify with 3% formic acid and store at tropical temperatures mixing daily for about seven days. The resultant viscous liquid may be fed to pigs after formulation with other nutrients. The acidified material will store almost indefinitely.

Effluent treatment

Waste water treatment is a study in itself and beyond the scope of this document. It is mentioned here to give some idea of the range of systems used for environmental protection.

The effluent produced by the three processing factories in this document will vary with the nature of the product. The first plant will produce effluent mainly from bird droppings, blood, washdown of the dry-plucked bird, washdown of the plant and staff facilities. The second and third examples of processing plant will produce effluent from the defeathering operations, evisceration, cooling, carcase wash, factory washdown, refrigeration plant, staff facilities etc. Each plant will have its own type of effluent quantity and quality. Table 7 gives an idea of the quantity and quality which might be expected from each of the plants chosen for this document:

The volume of the first two plants is such that the effluent should be screened through a comb to remove gross particles and subjected to settlement/flotation in a baffled tank (see Annex 7). This should remove about 40% of the BOD_5 from the liquor by producing floating and sedimentary matter. The resultant liquid can then pass into either sewage discharge (if available) or a septic tank system followed by a ground soakaway, provided that the soil is able to accept such quantities of water.

TABLE 7
Effluent characteristics of the three plants

No Birds/day	50	200	2500
Flow, m^3/day*	1.5	7	100
COD, mg/1	2500	3200	3200
BOD_5, mg/1	2000	2500	2500
SS, mg/1	1000	1500	1500

TS, mg/1	1500	2000	2000
FOG, mg/1	200	600	600
Temp, °C	25	25	25

Effluent from the largest plant presents a problem which requires much more processing than the other plants, mainly because such a volume would be difficult to dispose of other than in a sewer, water course or irrigation system. Effluent should be screened using a stationary, rotary cylindrical, brushed or vibrating screen to remove gross solids. The fats should then be removed in a fat trap or settlement/flotation tank as described above. It may be desirable to install a system using dissolved air flotation (DAF) with or without chemical flocculation where there is a shortage of land. The fats are separated from other suspended matter by floating to the surface of the liquor attached to fine air bubbles. This forms a scum which can be separated later. The use of flocculants, for example, iron salts, alum, sodium carbonate, calcium carbonate, lignin sulphonic acid, sodium lignosulphonate etc is that the process is easier to control than DAF on its own. The effluent is now ready for discharge into a sewer or agricultural land as part of an irrigation scheme.**

Further treatment of the effluent is necessary if it must be discharged to a water course or the quality does meet standards set by the appropriate authorities. Effluent will need to be treated by micro-organisms, either by an anaerobic or aerobic system.

Anaerobic systems are conducted in a closed container where there is an enforced absence of oxygen. In this system, the solids break down to form water, carbon dioxide, hydrogen, hydrogen sulphide and ammonia gasses and volatile fatty acids. The volatile fatty acids undergo further reaction to form methane and carbon dioxide gasses. This is the principle behind the biogas plant, which produces inflammable gasses used for cooking and light in

warm countries. The anaerobic system is not recommended in poultry plants as the effluent is low in carbohydrates and high in nitrogenous compounds. Reaction containers are therefore malodorous and not very productive.

Aerobic treatment is also conducted in a reactor but air containing oxygen is either forcibly administered by pump or the effluent passes down a trickling filter so that it comes into contact with atmospheric oxygen. The system encourages the growth of micro-organisms and the carbohydrates are oxidised to carbon dioxide and water. The nitrogenous wastes are converted to nitrates and sulphates. The incoming effluent displaces treated material which flows over a weir to settling tanks. Some of the solids are returned to the oxygenation vessel to maintain the microbial culture in peak condition while the sludge is disposed of after further treatment, if necessary. The effluent should then be of a quality to be discharged into a water course. This may be done providing permission is first sought from the appropriate local authorities. They may wish to conduct regular analyses of the treated effluent to maintain quality standards. The sludge may then be disposed of in land fill sites, dried and incinerated or spread on agricultural land. Land disposal carries the risk of infection of grazing stock. Grazing should be avoided for 3 months from spreading.

*** Flow:!Volume of effluent to be treated**
COD: Chemical Oxygen Demand
BOD Biological Oxygen Demand
SS Suspended Solids
TS Total Solids
FOG Fat, Oil and Grease

**** The plant is expensive to buy and operate.**

Where there is space and a warm climate, secondary treatment is sometimes carried out in an aerobic or oxidation pond system. These ponds can be used for both secondary and tertiary effluent treatment for "polishing" to a level where it may reach drinking water standards. Ponds are generally long and narrow. Effluent enters quietly at one end and leaves from the other. The flow is such that there are no dead areas. The ponds are lined with an impervious layer and about 1.5m deep. Algae are encouraged to grow by removal of scum, debris and overgrowth. The algae produce oxygen which oxidises the solid materials rather like the aerobic processes mentioned above. A quality gradient is set up along the length of the pond and fish are introduced at the outflow end. The system is delicate and not open to serious abuse. Inflow quality should be reasonably constant and the loading should be less than 450 kg BOD_5/ha/day. The pond size should allow for a residence time of at least seven days. Tertiary ponds for "polishing" should be loaded at no more than 70 kg BOD_5/ha/day.

Finally other forms of waste effluent should be treated separately. Storm water should be directed to surface drainage, water courses or whatever is appropriate for the locality. Human effluent wastes should be treated as domestic waste, since the volumes are likely to be small. This may involve disposal to a mains sewer or septic tank before disposal by soakaway.

2 PLANT LAYOUT AND CONSTRUCTION DETAILS

Introduction

The poultry industry is very highly integrated in many countries. The date on which the next batch of day-old chicks are required is conveyed to the hatchery. Broiler production has almost standardised on the number of birds/broiler house so the number of day olds for the order is known. Feed manufacturers provide exactly the right amount of the right type of feed for the venture on time. The growth time for the chicks is known so the date of slaughter is

contracted automatically. The clear out/clean up time for the broiler house is programmed for the next batch of day-olds to be delivered and in production with no idle time. At the poultry packing house, standard sized birds are delivered according to a contract date and time. They are suspended almost immediately on arrival and slaughtered and processed without delay. Processing speeds are variable but 2500 to 4000 birds/hour are not out of the ordinary. There is evisceration machinery which works at over 6000 birds/hour, and slaughter lines which work at 12 000/hour.

Considering the scale mentioned above, the throughput which forms the basis of this document takes on a new significance. Manufacturers of equipment for poultry processing on a very small scale are few and far between since poultry producers are very much aware of the economies of scale (and are involved in a fiercely competitive industry) and the manufacturers have more interest in the very large scale of opertions.

Development of the Models

Three scales of operation have been chosen to described the construction and operation of small scale poultry processing plants. The first, 50 birds/day, is intended to be an improvement on backyard slaughter. It presents a plan to improve hygiene and product quality on existing systems of small scale production. It can be equipped to process up to 100 birds/hour. The second, 200 birds/day, assumes that the system of operation of the first has led to an increase in demand for the product and there is a need for expansion of operations. It also presents an opportunity to describe other types of equipment and operational systems which can be scaled up to 500 birds/hour. Model 3 is the smallest practical on-line system and offers an alternative to the "manual" production methods described in the first two models. The three models are based on buildings which exist today in developing countries. They show full operational facilities. Other plans, found in Annex 8, show standard layouts of the slaughter facilities only

but serve to demonstrate the wide range of facilities which may be required to fit most circumstances overseas where small scale poultry processing factories are required.

Model 1 Very Small Scale Abattoir - 50 birds/day

Economic viability at a production level of 50 birds/day is unlikely to be achieved and therefore social, environmental and public health considerations should be studied (and possibly quantified) at the feasibility stage if the project is to proceed. At this scale there is plenty of scope to increase throughput with a little thought, possibly up to 100/hour. It is difficult to design a smaller plant. A plan of the processing plant is given in Drawing 1. The equipment used, its specification and the staffing requirements are given in Annex 3.

It is the intention that all poultry produced within the plant will be slaughtered, sold and eaten the same day. It is assumed that the area has no history of processed poultry, so the plant is designed to produce New York Dressed birds using a dry plucker. Expensive ice production or refrigeration capacity are neither required nor installed. Dry plucking has several advantages over wet methods. The birds may by plucked "hot" or cold and the microbiological problems associated with scalding and increased surface moisture are not encountered. In New York Dressed birds, contamination and spoilage by visceral microflora is greatly reduced and the shelf life of the carcase is greater than it would be had it been eviscerated and not refrigerated. Dry plucked birds can be kept at tropical ambient temperatures for a few hours only but a couple of hours longer than eviscerated carcases.

As the viscera are left intact, waste materials comprise feathers and waste water only.

The plant is designed as part of a progressive package to be adapted as the market expands.

Model 2 Very Small Scale Abattoir/Processing Room - 200 birds/day

In this model, it is assumed that the locality has a marketing history of processed poultry and is now ready for eviscerated carcases. Reference to Drawing Nos 1 & 2 shows Model 2 to be an expansion of Model 1. Economic viability is not assured.

As the throughput and type of operation has expanded the machinery is changed to include a soft scald system with a bowl plucker, although dry plucking could have continued. Evisceration is carried out and the carcases cooled in either a tank of water cooled by a refrigerated unit attached to the tank or a static tank containing slush ice.

The model is drawn up to show how whole poultry carcases may be packed into bags and chilled. At a later stage of development, chicken portions may be prepared and all the products frozen prior to dispatch.

Details of the abattoir are given in Drawing 2. The equipment required, their specifications and the staffing levels needed to operate it are given in Annex 4. The plan is for the birds to be brought from one large and several small producers and each producer choses to sell his own poultry. In this case, there is a need to label each bird individually and to charge each producer a slaughter fee. This is a difficult operation and needs a larger office and more administration staff than the system where the abattoir management buys the birds from the producer, or the birds belong to a few producers in large numbers.

In this model, the feathers, heads, feet and viscera are to be removed. These materials make up about 25% of the weight of the bird as solid waste which needs disposal. In the drawing, the materials are taken away in a skip for further processing.

Model 3 Small Scale Abattoir - 350 birds/hour

The third example of small scale poultry abattoir chosen for this document will slaughter 350

birds each hour. This scale may approach economic viability in some areas of the world but if not, environmental, social and public health considerations should again be assessed at the feasibility stage.

Slaughter throughputs of between 350 and 500 birds/hour can be processed on simple "static" lines as described for models 1 & 2. Drawings of the equipment and layout required have been included in Annex 6. At about 350 birds/hour, the overhead conveyor system may be appropriate as it allows for greater expansion of the throughput should this be desired at a later stage. Details of the design of the abattoir are given in Drawing 3. Model 3 has been drawn up to show a system of slaughter using an overhead conveyor. The equipment required, their specifications and the staffing levels needed to operate it are given in Annex 5.

The processing plant will slaughter poultry, chill carcases prior to cutting them into portions for freezing. Daily dispatch is planned, as installed freezer capacity is sufficient for only 1 1/2 days production. There is some scope for the preparation of chilled poultry. The birds will be bought by the factory and sold either to wholesalers or buyers of at least 20% of the days production. This reduces the administrative load to manageable levels.

Concerning operation, two types of plucker are proposed, either a bowl or a drum/flail system following soft scalding at 52°C. Evisceration is carried out on an overhead rail system. Since the weight of the by-products will amount to about 750kg/day, feathers, heads, feet and viscera pass to a truck for disposal rather than undergo further processing. However, some suggestions are made later about the possibilities for offal use.

Three carcase chilling systems are proposed. The first is to chill in cooled (refrigerated) water, the second in slush ice followed by drainage on a rack. The third system involves cooling the birds on a rack in an air chiller. The systems are fundamentally different and will require

economic analysis before the best system can be advised. Factors to be considered include the capital and recurrent costs of the equipment, its maintenance and spares, the regularity of use, the size of the load regularly slaughtered, microbiological status of the carcase and the weight changes which take place during the two different methods of processing.

Notes on the Drawings

There are some points to note about all sets of drawings. The number of doors to the outside have been reduced to the minimum in the interests of security. In Model 2, a door could be constructed to the outside in the evisceration room in those regions where security is not of great concern.

The dirty and clean operations are separated. “Clean” and “Dirty” workers are separated and there are “windows” through which product passes but personnel cannot. The staff facilities are separated by a corridor and processing rooms do not open directly to the outside. Staff facilities share plumbing runs with others, the laundry in one case and the crate wash in the other. The dry stores are accessible both to deliveries and for the packing room. The machine room is separated from product rooms. Maintenance and service engineers do not need to enter clean production rooms unnecessarily.

The product flows smoothly through the rooms which are separated into reception; slaughter, scalding and defeathering; evisceration, washing and giblet processing; chilling; cutting and packing; chilling and freezing; dispatch.

The equipment, given in the lists in Annexes 3, 4 and 5, is mainly from a specialist equipment supplier but some items are of local fabrication. The general manufacturing principles to follow are given earlier.

Note that the drains flow from clean areas to dirty. Note also the position of service points, particularly wash hand basins, water, steam, electricity, lighting, fans for ventilation and ice.

CHAPTER 3
OPERATION OF SMALL SCALE POULTRY PROCESSING PLANTS

General Operational Procedures

The objective of a centralised poultry processing plant of any scale of operation is to produce material at a price which customers can afford, which is hygienic, wholesome, attractive and saleable, of consistent appearance and quality, and with a realistic shelf life. The economics of establishment and production of the poultry processing plant is outlined in Chapter 2. The main aspects of health, hygiene and sanitation is discussed in Chapter 4. The appearance of the final product is discussed below. Throughout the whole of the operation of poultry processing, these factors must be borne in mind.

Bird species

The equipment described here is for broilers, chicken, turkey and geese. Other species may have special requirements. For example, stunning time may need to be increased for larger birds, quail, guinea fowl and game generally should be dry plucked. There are special plucking

machines for duck.

Appearance of the final product

Assuming that a consumer wishes to buy poultry, the choice of a particular product is based on its price and appearance; its convenience, shelf life, nutritive and culinary characteristics are usually based on purchasing experience. The appearance of a particular pack may also attract an undecided customer shopping for a meat product for the family.

The appearance of the product shows its size, shape and the amount of meat in relation to its fat and bone; these factors are controlled by breeding and selection of the bird and selection of the carcase at the processing plant. Product presentation ie packaging, is discussed as part of processing later in this chapter. Product appearance also shows meat colour and this, curiously, indicates to the consumer a degree of freshness and wholesomeness*. Consumers will accept poultry which is white or of a colour which is generally accepted as "right". Consumers do not like excessive reddening and darkening of the meat, bruising, blood clots, broken bones, remains of organs and feathers, and blood drip in the pack and will reject it. These factors are affected by both pre- and post-slaughter handling which are discussed below.

Assuming that the colour, shape, size and price are acceptable, the consumer takes home the product and prepares a meal with it. At tasting, the qualities of texture, flavour and juiciness are judged. These three characteristics and that of colour are influenced by both pre- and post-slaughter handling of the bird and its carcase. As general rules, pre-slaughter handling should be carried out to cause minimum stress to properly fed but fasted birds; post-slaughter handling should emphasize clean, speedy production with rapid chilling and prompt dispatch of product.

* This may not be an accurate conclusion. A well presented, wholesome-looking pack may be positively dangerous, whereas a poor-looking pack can be of excellent quality.

Transport and reception of live birds

Feed should be withheld from poultry for at least four hours before birds arrive at the abattoir for slaughter. Depending on distance from the slaughterhouse, poultry should be taken off their feed and water one to four hours before they are loaded and taken for slaughter. This ensures that the birds are significantly empty and their faeces are dry. If the period is extended to, say, 10 hours, the faeces becomes more fluid and the chances of cross contamination between birds during transport is increased.

Birds should be picked up gently by hand and carefully loaded into their crates. This is to avoid bruising of the flesh and breakage of bones. An excited bird may overheat which may lead to meat quality and keeping problems later. A crate of 0.8 × 0.6 × 0.3m, will hold about 10 – 12 birds. In the tropics, it is essential that the birds are not overcrowded and liable to overheat. Larger birds should be allowed more space than smaller birds.

The transport vehicle should be situated in the shade. The type of transport used will depend on the number of birds to be carried and the distance. Whether the crate is loaded on to the carrier of a bicycle, the tray of a pick - up truck, small general purpose vehicle, low loader or huge dedicated transport system, the same principles apply. The crates should be loaded onto the transport with care and properly secured. This means placing them gently on top of each other and tied to the structure of the vehicle. The crates should be stacked to allow each bird plenty of air. Adequate ventilation will reduce transport stress of the livestock. Closed sided vehicles are therefore unsuitable. The crates should be kept in the shade during transportation which should be carried out in the cool of the day. For this reason, early morning carriage is

recommended.

The actual movement of the vehicle is important to reduce transport stress of the young birds. The best poultry will be produced if the vehicle is driven with skill. This means that the birds will not be subject to excessive vibration, acceleration, breaking, swerving and concerning at speed. In some countries, a "careful driver bonus" is offered if the vehicle is driven carefully.

On arrival at the abattoir, the crates should be carefully unloaded from the transport in the reception area. To keep the birds quiet, the lighting in this area and the hanging area should be subdued. After unloading, poultry should be kept for the minimum time before slaughter. It should be left in the crate, under cover, until required.

The empty crates should be returned to a wash area where they and the transport should be cleaned and disinfected before leaving the compound.

Evisceration

The system of operation used in the production of poultry depends very much on the nature of the market and what it requires. This varies very much throughout the world. The systems described here are for a completely cleaned out bird with head, neck and feet removed. The heart, liver, neck and gizzard are wrapped and returned to the bird as giblets and placed inside the carcase. Variations on this theme must be left to the individual operator.

Packaging

Successful and appropriate packaging is necessary to assist with preservation of the product, protect it from physical damage, confine the product so that it remains intact and will pack better into larger containers, and add visual appeal so that customers will wish to buy. The

package must look good in itself, so not only must it be potentially suitable and attractive but also must be applied with care. Good packaging is expensive so it must be wholly appropriate for the market. The choice is very wide. Experience shows, however, that simple, cheap packaging is all that is required in the tropics and for the sake of this document is all that will be mentioned here.

There are three types of packaging of interest to the poultry producer at these levels of throughput:

- **Over - wrapping: This is carried out on expanded or rigid plastic trays. The tray is over - wrapped with a clear film of high oxygen and low water vapour permeability. This method is the most popular but relies on good refrigeration and efficient distribution and product turnover.**

- **Bag wrapping: Whole birds or portions packed on trays are placed in a clear bag which has a high oxygen and low water vapour permeability. It is sealed at the neck.**

- **Vacuum Packaging: The use of gas-impermeable plastics reduces evaporative losses, prevents further microbial contamination and reduces proliferation of microbes already present, due to the natural production of carbon-dioxide as a result of tissue respiration. It is mainly used for the distribution of cut portions to butchers.**

In some markets, the addition of a special absorbent pad of tissue is required to take up extra moisture.

Refrigeration

Having produced a perishable commodity, it is necessary to maintain its quality by using an

appropriate technology right through to the moment it is to be used. In this exercise, (apart from the New York Dressed) the poultry carcases are refrigerated immediately after evisceration. This method of preservation is seen as the best way to preserve it right into the consumers kitchen. It is necessary therefore, to develop a cold chain. The usual way to do this is to chill after slaughter, continue with chilled storage or freeze at the packing plant, distribute by refrigerated vehicle, off-load into a cold store or freeze room, display in cabinets under refrigeration and wrap the product as a form of insulation as the buyer leaves the shop. In this way the product is not left unrefrigerated for any unnecessary time. The industry has a responsibility to ensure that facilities exist into the retailers premises and to advise the customer of preservation techniques for the meat. This may mean asking the customer to use the product within a few hours.

Dispatch

Dispatch should be carried out quickly and efficiently. The vehicle collecting products from the poultry processing plant should be refrigerated or insulated. If the latter, it should be cool on arrival at the plant. This usually means it should arrive and depart early in the morning, convenient also for the subsequent retail trade. Once the formalities, paperwork etc have been settled, the last thing to do is load the vehicle. The vehicle doors should be opened, the chilled or frozen cartons taken directly to the vehicle, stowed, and the doors closed immediately after. The vehicle should then drive without delay to the shop, market etc where formalities should be completed before the doors are opened or after efficient removal of the cartons into a prepared cold or freezer store.

Specific Operational Procedures

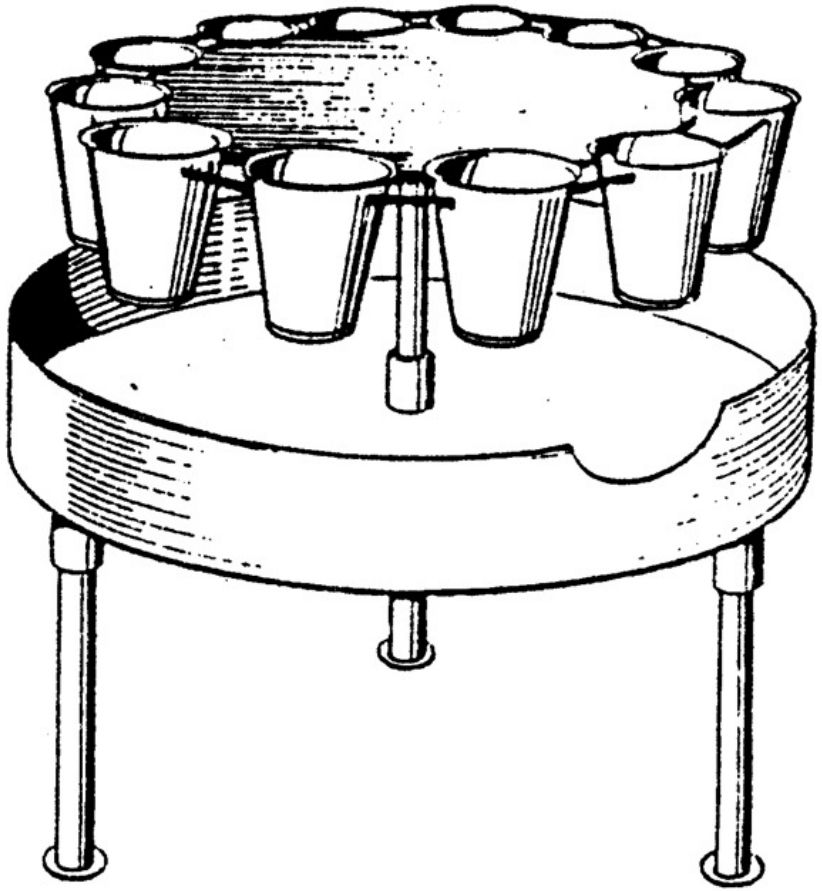
To assist with the following descriptions of slaughter and further processing, reference should

be made to the appropriate drawings in the Annexes.

MODEL 1 – 50 BIRDS/DAY

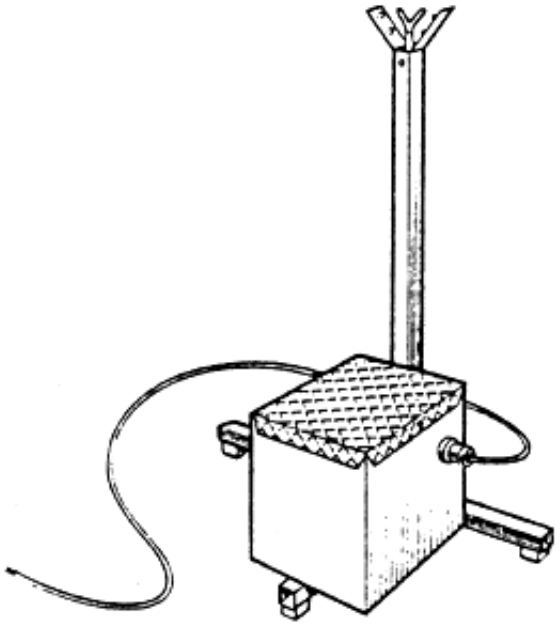
Stunning and slaughter

In some systems, birds are removed from the crates and hung on an overhead shackle where they are stunned by a low voltage system before placing in the bleeding cones.

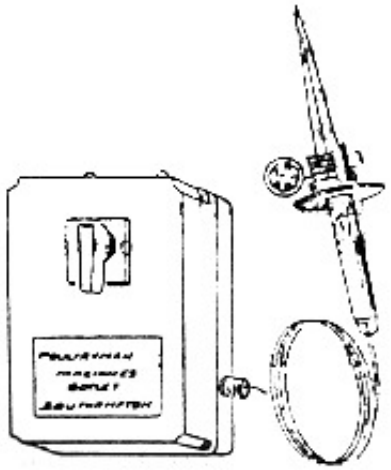


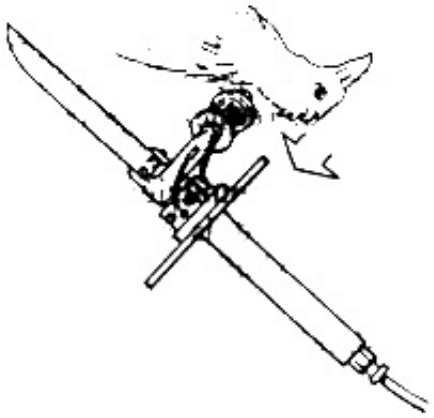
Bleeding cones

Once it has stopped struggling, the bird is stunned with electrodes which may be either free standing or attached to a knife.



Free standing stunner





Stunning knife

In other systems, birds are placed in the cones of the killing stand one by one and allowed to rest briefly before stunning. The head of the bird is held in one hand and the electrodes are applied. The switch is operated and the current allowed to pass through the head for about ten seconds. This induces a form of tranquillization. The bird rests perfectly still. This ensures that the feathers do not tighten and are therefore easy to remove. A knife is then used to cut the blood vessels in the neck. Practice is required to develop the technique.

The head of the bird is held in the left hand so that the left side of the neck is uppermost. The cut is started by placing the blade of the knife just behind and below the ear lobe. With the slightest downward pressure of the right hand, the knife is pulled forward for a short distance just behind the jaw bone, at the same time rolling the head slightly with the left hand to the left and inserting a little upward pressure. As soon as the cut is completed, the head is twisted slightly to see that blood is gushing out from the cut. The trachea, (wind pipe) must not be severed or the neck bone cut into as this leads to incomplete bleeding and makes plucking more difficult.

If the bird is to be used for the New York Dressed method of preparation, the cut is made inside the mouth so that there is no visible wound. The anastomosis between the two jugular veins at the base of the skull is cut.

There are other ways of stunning a bird before slaughter but they do not produce the best quality carcase. The usual way is to break the neck. Both legs are held in the left hand and the neck is held just below the head between the first and second fingers of the right. The bird is "stretched" and the head bent backwards until the neck is dislocated. The bird is then placed in the cone and the blood vessels cut with a knife.

Another stunning method is to place the bird in the cone and apply a sharp blow to the head with an iron bar or similar. There is a chance of missing however, or incompletely stunning the bird. The technique should not be used by unsupervised, inexperienced slaughtermen.

A fourth way is to place the bird in the cone and then decapitate it swiftly and completely. Although this would appear to be a quick and most effective way of slaughter, the oesophagus is left in the neck to contaminate the carcase and the head is removed, rendering a true New York Dressed carcase open to more rapid spoilage.

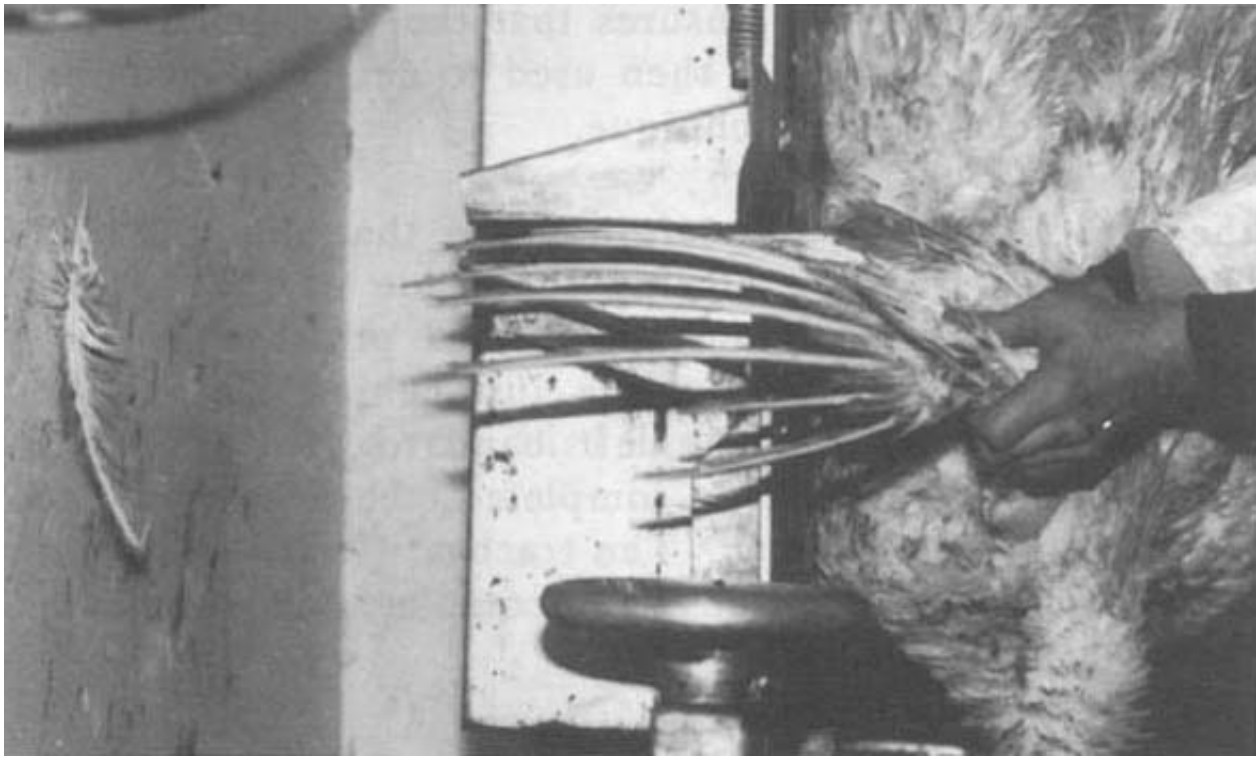
In Moslem countries, stunning is not permitted. In these circumstances the suspended bird is simply bled by cutting directly across the exposed throat at the base of the skull.

Birds should be allowed to bleed for 1 1/2 to 2 minutes before dressing starts.

Defeathering

After the bleeding period, the carcase is removed from the cone without delay and passed through the hatch, on to a holding table. A second operator takes the carcase and pulls the

flight and tail feathers by hand. In turkeys and larger birds, a special machine may be necessary to remove these feathers (see photograph). The body is then applied to the dry plucking machine.

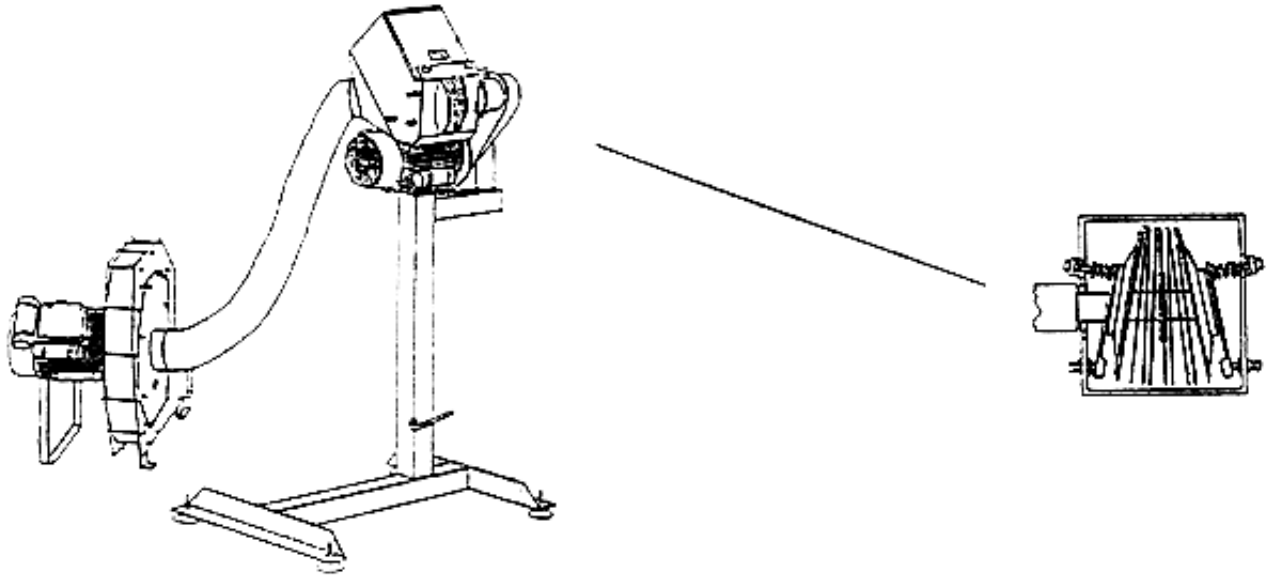


Removal of flight feathers

This machine comprises a 1.1 kw (1 1/2 hp) motor driving a shaft supported by a bearing assembly. The shaft drives a plucking head by a belt. The plucking head consists of a series of rotating plates held at an angle by a thrust plate at each end of the plate bearing. As the discs rotate they close, drag in the feathers, grip them and pull them from the bird. As they continue to rotate, they separate, and release the feathers into a collection bag to the rear of the machine. Many dry pluckers, particularly those used in higher throughput factories, are

connected to a large-bore tube connected to a fan. This draws the feathers away from the plucking head and into a suitable receptacle.

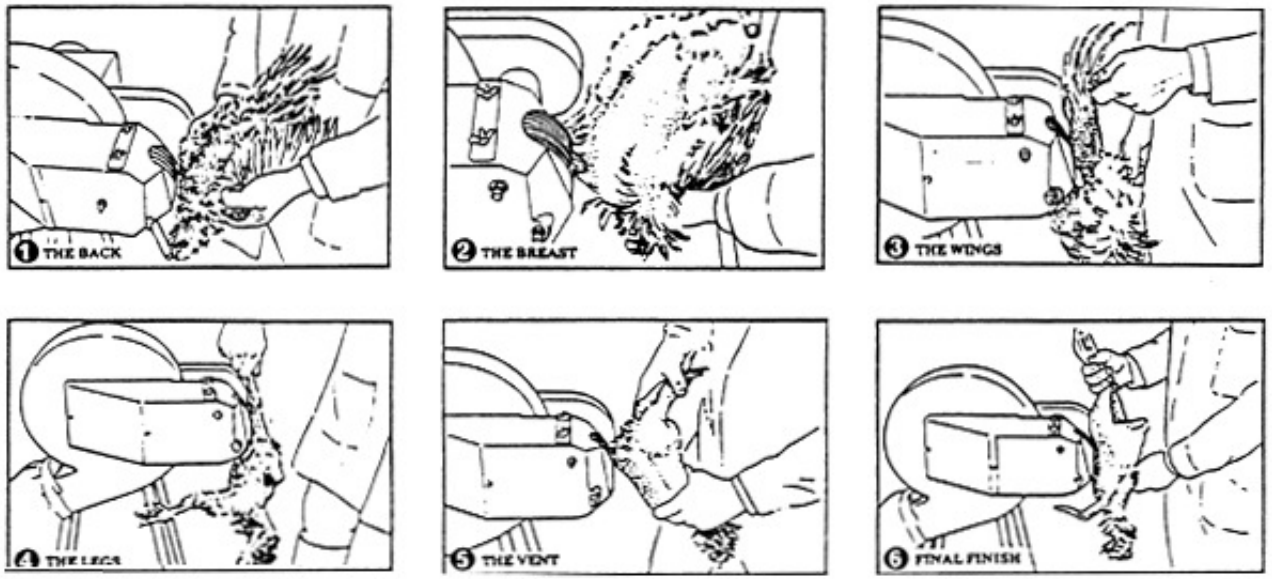
The plucking action is gentle and, provided the skin is stretched tightly no damage should occur. It is important to work methodically and speedily.



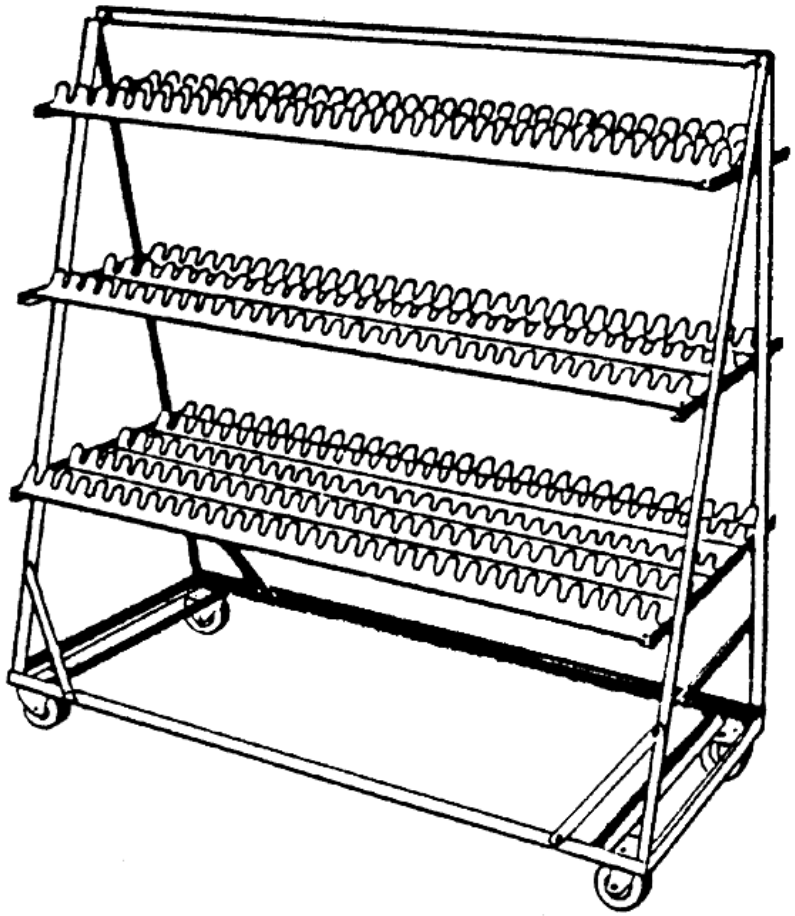
Dry plucking machine and plucking head

The back of the bird is presented to the plucking head. Holding a wing in each hand and supporting the neck, the back is plucked completely. Holding the legs in the right hand and the neck in the left, the skin is stretched tightly across the breast before presentation to the plucking head. The complete underside of the carcase is plucked. Next, the back of each wing is presented to the plucking head. After plucking, the bird is allowed to drop to pluck the inside of the wing. The bird is held by one leg and allowed to swing so that this leg can freely rotate against the plucking head until the feathers are removed. This is repeated for the other leg.

The area around the vent is plucked by holding the carcase in the left hand, breast uppermost and, with the right hand pulling both legs back towards the operator. The lower part of the carcase and the vent is thus presented to the plucking head. Finally, unwanted stubs are presented to the plucking head to finish the operation completely. Please see the following pictorial sequence:



The bird is then considered as New York Dressed. It should then be hung on a mobile rack, washed thoroughly in cold, chlorinated water, allowed to drain fully and air cooled for 15 minutes or so. If a refrigerator or cold store is available, the carcases should be placed in it immediately after draining. Carcases should be dispatched as soon as possible after plucking.

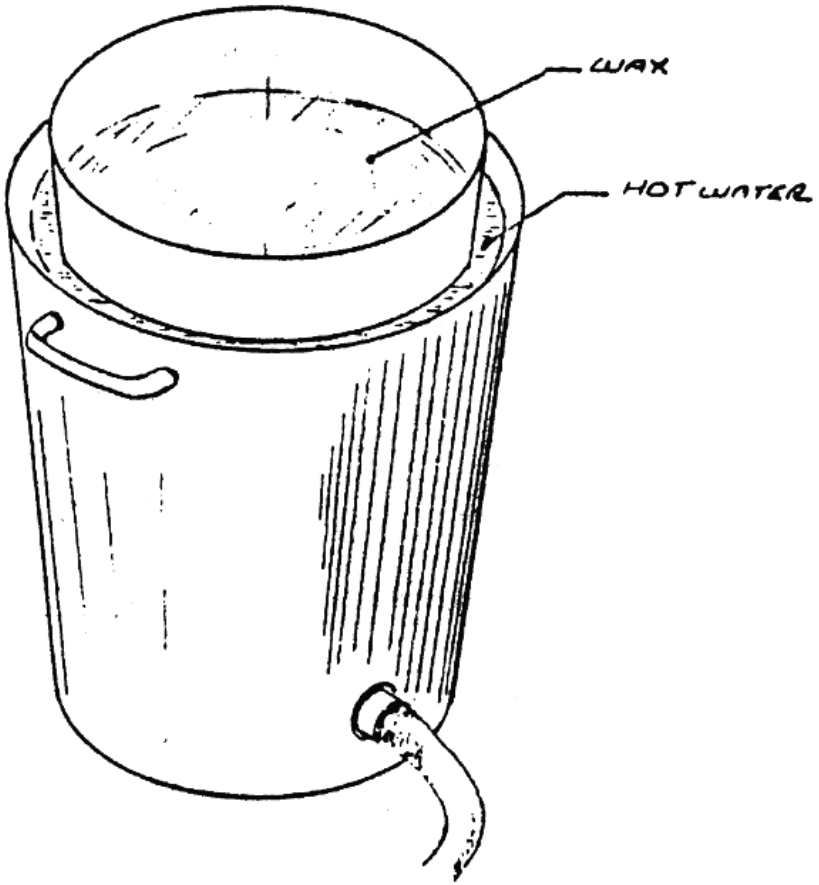


Mobile hanging rack

At the end of each working period the feathers should be taken through the door to reception and disposed of in a manner described in Chapter 2.

Ducks, quail, turkeys, geese or game may be wax finished. After dry plucking, the carcase is steeped in a tank of wax at a temperature of 54°C (130°F) and suspended from a rail until cool. The wax is removed by hand or by a wax stripper, which is like a drum plucker. The wax may

be collected and reclaimed in special equipment. About 60% of the original wax will be recovered.



Wax tank

Refrigeration

No refrigeration facilities have been installed in the smallest packing plant. Facilities for this scale are expensive to commission, operate and maintain. Experience has shown that there is

consumer resistance to refrigerated meat in some areas of the world particularly where it is produced on a small scale. Experience has also shown that the faith shown by some managers in the capability of refrigeration goes beyond reasonable limits; the meat is kept there too long with subsequent product deterioration.

Having said this, the smallest plant has accommodation for refrigeration if this is seen as essential. The room before the loading bay is meant to be light, cool and well ventilated but there is no reason why it should not be refrigerated. It is believed that all birds should and will be taken away from the factory as soon as possible after slaughter.

MODEL 2 – 200 BIRDS/DAY

Stunning and slaughter

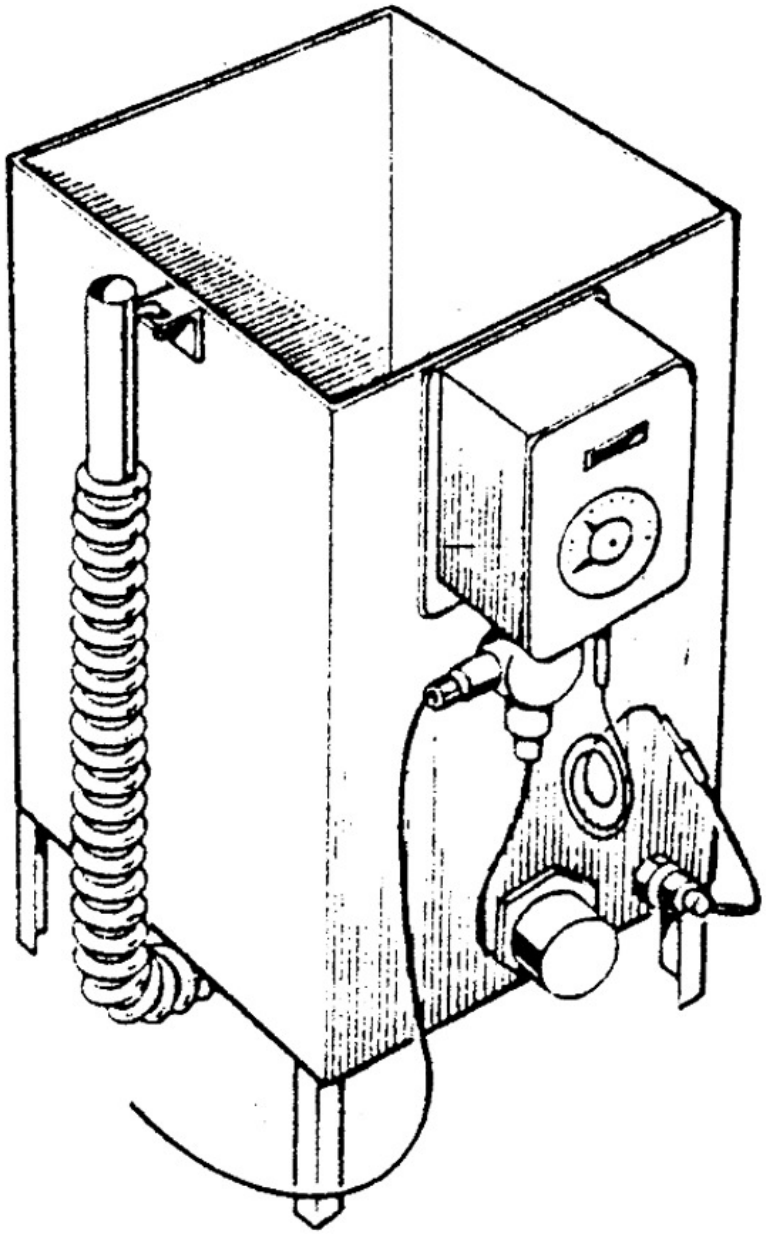
Birds are stunned and slaughtered in a manner described for Model 1.

Defeathering

After the bleeding period, the carcase is removed from the cone without delay and passed through the hatch, on to a holding table. The flight and tail feathers may be removed by the machine described for Model 1. The operator will then scald and defeather the carcase.

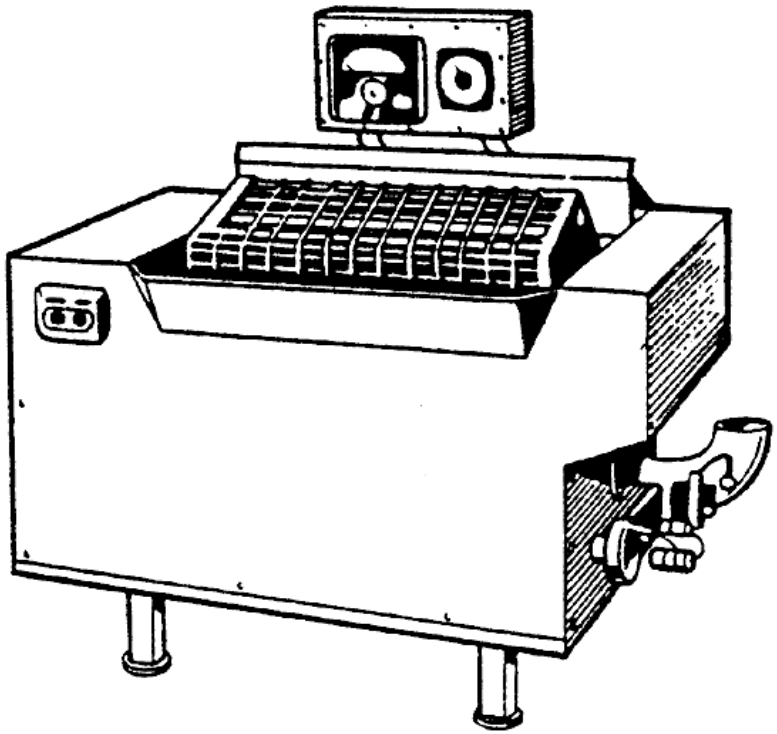
The bird is lowered into a tank of water heated to a temperature of 51.5°C (124°F). This temperature is critical and must not exceed 53.5°C (128°F) under any circumstances. This may cause irreversible discolouration of the carcase. At a temperature of 60°C (140°F) the epidermis may be removed and considerable discolouration may be seen if the bird is allowed to dry out. The bird may be agitated now and again and feather release should be tested by occasionally pulling at a few feathers. The feathers may be released fully between 15 seconds and 2 1/2

minutes.



Carcase scalder

There is a small-scale scalding machine available which automatically agitates the carcase in the water. After bleeding, the bird is placed in a cage or basket attached to a horizontal shaft located over the scald water. Several birds may be placed in the same cage. The door of the cage is closed and the machine switched on. The axle rotates and the cage is drawn through the scald water. The machine may be governed by a timer. After scalding the carcases are removed and plucked.

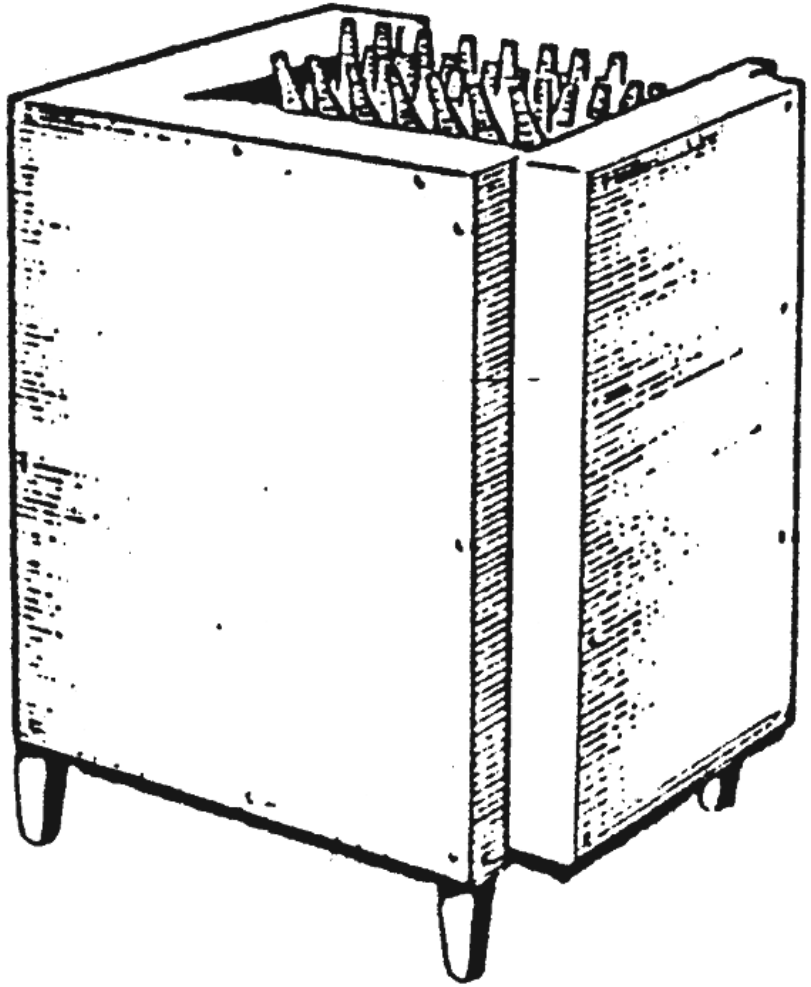


Agitating carcase scalding tank

There are three ways in which feathers may be removed completely. The first, for broilers only,

is by hand. The feathers are simply pulled from the carcase and placed in a feather bin. The method takes a lot of time, requires a large number of operators and is very messy. Hand plucking is generally not recommended.

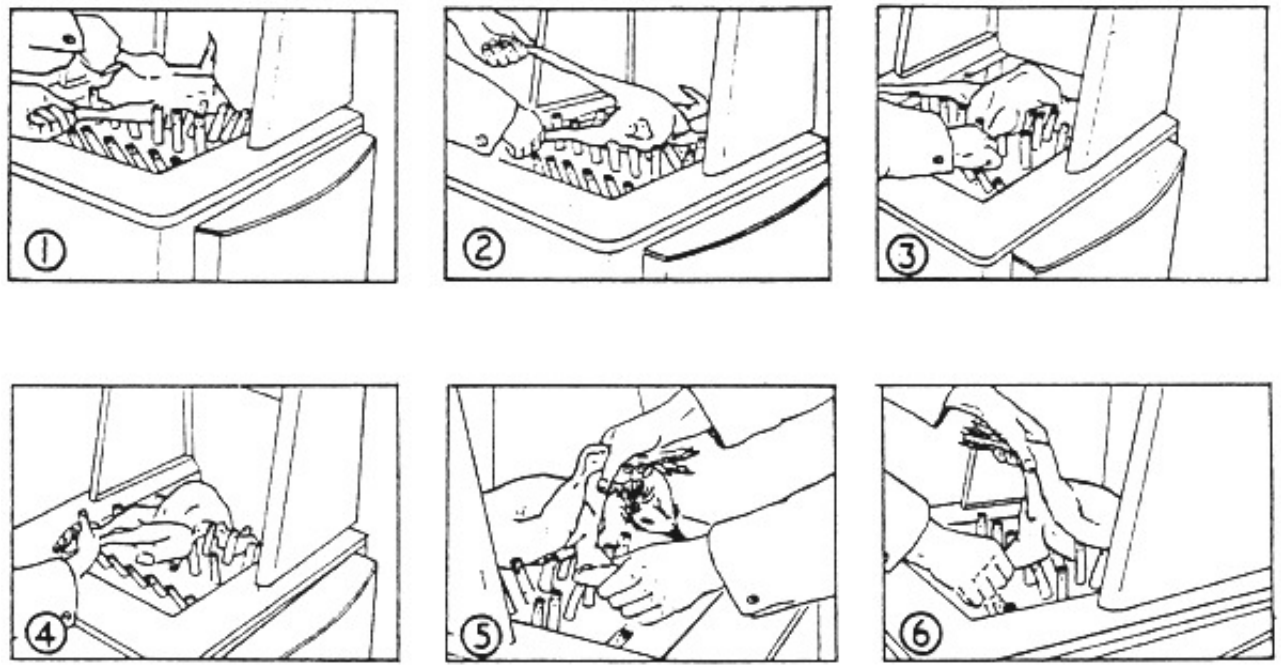
The second method is by holding the carcase against rubber fingers protruding from a continuously rotating horizontal drum. The drum rotates away from the operator and the feathers follow until they are thrown clear towards the back of the machine.



Drum plucker

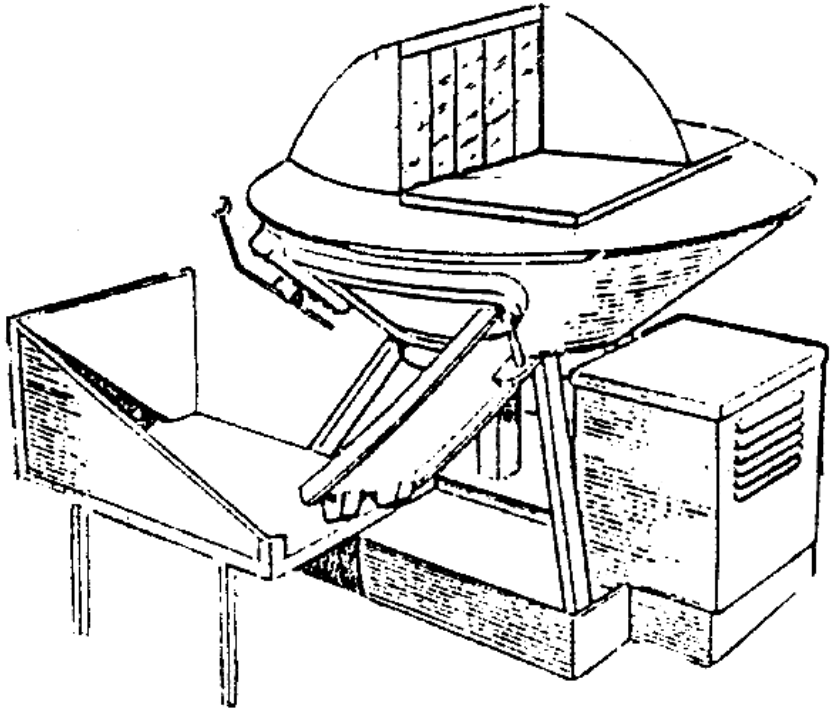
The bird is held with a leg in each hand and laid firmly on its left breast on the rotating rubber fingers. It is agitated backwards and forwards to pluck the left breast and thigh. The bird is turned over to pluck the right breast and thigh. Both legs are taken in the left hand and the tail feathers gripped in the right hand before pulling them out with a twisting movement. The legs

are held well apart in both hands. The bird is placed on its back on the drum and the pelvis and the back plucked. This action is continued by placing both legs in the right hand and applying a slight pressure using the left hand to the breast. The head in the left hand is placed with the legs in the right. Using the left hand to pull out the left wing into a fan, it is pushed down and inwards to strip the feathers. Change hands to pluck the right wing. The operators hands must be kept well clear of the rotating drums. Please see the following pictorial sequence:



Use of the drum plucking machine

The third method uses a bowl plucker and is depicted here and in Drawing 2 in the Annexes. Scaled birds, to a weight specified by the manufacturer, are placed in the bowl plucker chute which passes into the body of the machine.

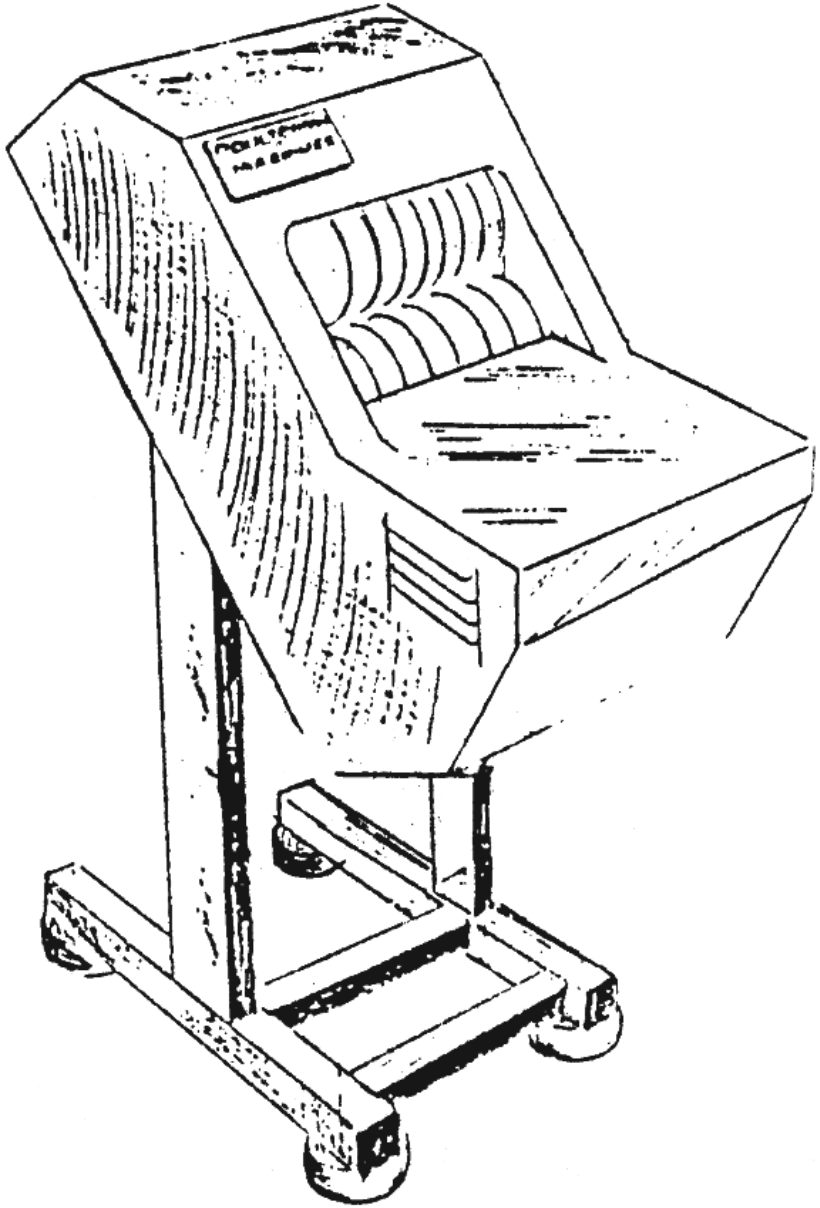


Bowl plucking machine

After about 35 seconds, the machine is stopped (a timer can be fitted) and a door to the bottom of the machine is opened. The plucked carcases emerge ready for further processing. The time taken in the bowl plucker will depend on the nature of the bird, its age, condition etc. It is not absolutely necessary to scald birds before they enter the bowl plucker. Cold water may be introduced into the machine instead. The finish of the bird may not be as good, however, as that from scalded carcases.

After removal from the bowl plucker, some flight and tail feathers may remain on the carcase. These are removed by hand by an operator who then hangs them on a mobile rack and washes each immediately and thoroughly in cold chlorinated water. After draining, they are pushed through to the evisceration room.

Birds may be processed by another machine, called a finisher, which stubs wings and hocks. It comprises long rubber beaters attached to two horizontal shafts which rotate at a brisk pace. This machine can save the tedious work of three or four staff in larger scale operations.



Carcase finisher

The feathers from both the drum and bowl pluckers are usually thrown to the floor and require

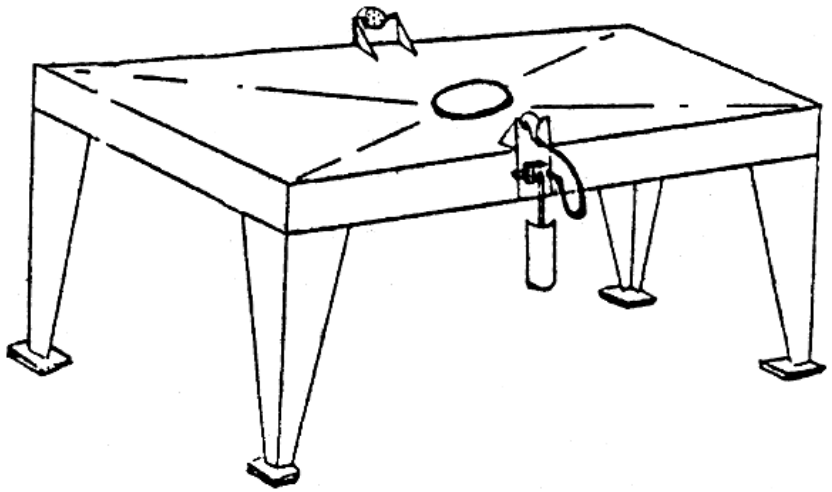
frequent removal. They are wet and most of them are relatively easy to pick up and place in the feather bin. It is the relatively few which collect in corners and around the legs of the standing equipment which cause most problems. Feathers are removed from the plucking area through the door to the reception area for disposal by one of the methods described in Chapter 2.

The bowl plucking machine is under-used at this scale of operation but produces a superior product to that of the drum plucking method for only little extra cost.

Evisceration

Birds arrive in the evisceration room on a mobile rack. Each rack holds about 40 carcases. There are two methods of evisceration. The first method described takes place on a table.

The carcases are removed from the rack one by one and placed on the evisceration table. The bird is placed on its back with the head hanging over the edge of the table towards the operator. A pictorial sequence of evisceration, trussing and portioning is given in Annex 6.



Carcase evisceration table

The head is removed with a knife and placed in the offal bin. The neck skin is cut from body to head. The neck is cut away from the carcase, trachea (windpipe) and crop. It is placed on a tray on the table away from the work area. The crop is placed in the offal bin.

The bird is then turned round and a sharp knife used to cut round the vent. The incision must be made carefully so that the intestines are not cut. The opening must be big enough to place a hand inside the carcase. The carcase is held firmly with the left hand (assuming the operator is right handed) and a drawing tool is placed through the cut. It is held against the breastbone of the bird and, when the end is reached, pulled down and back towards the operator so that the offal is drawn outside.

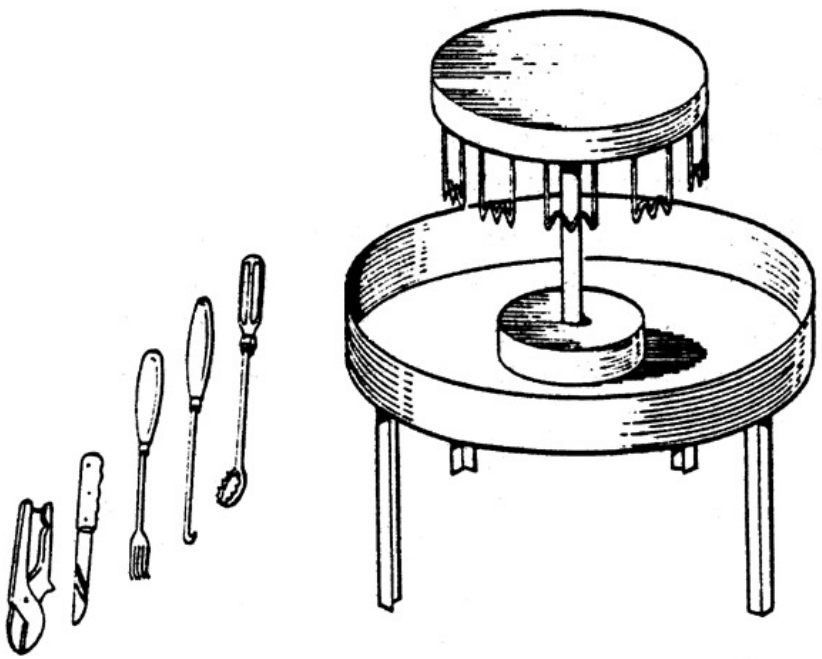
The liver, heart and gizzard are then cut away and placed in the appropriate trays on the table. The inedible offal is placed in the offal bin. The inside is then inspected for any remaining, unwanted tissue. The birds are then washed in cold chlorinated water and chilled in cooled water or slush ice.

Every so often, the edible offal (heart, liver, neck and gizzard) should be moved across to the giblet station and processed in a manner described below.

Table evisceration is not particularly clean and is actively discouraged or legislated against in some countries. Its major advantage is that it is cheap and uses very low technology. A recent development for small scale operations is the introduction of the carousel system of evisceration. It comprises a circular tray of 1.25m in diameter at waist height. A wheel is located above this tray at a height of 1.5m from which is suspended a series of poultry hangers. One to five operators stand around the carousel and eviscerate the poultry while it is

suspended. This second method is described. For a throughput of 200 birds/day however, only one or two operators are required.

Carousel and evisceration tools



The carcases should be hung with their backs towards the operators. At the carousel, the first operator cuts the skin down the back of the neck, pulls it out and detaches it from the crop and trachea (windpipe). The crop is removed and dropped into the evisceration tray. A cut is then made round the vent with a sharp knife, taking care not to cut the intestine and making sure the cut is large enough to insert a hand inside the carcase. The next operator inserts a drawing tool through the incision keeping it pressed against the breastbone (which is away from the operator) until it reaches as far as it will go. Holding the carcase horizontally and firmly with the left hand (assuming right-handedness) the tool is pulled down and out so that the offal is drawn outside the bird. The offal is allowed to hang down the back of the bird ready for inspection.

After inspection, the third operator should cut off the liver, heart and gizzard and place them in the appropriate gizzard trays. The inedible offal is then detached allowing it to fall into the evisceration tray. The tray has a waterspray to wash the inedible offal into the offal truck situated underneath. The fourth operator should inspect the carcases and remove any lungs and other unwanted material using the serrated lung removal or other appropriate tool. The head is then cut off and dropped into the evisceration trough and the neck removed with the secateurs. It is then placed in a giblet tray.

The giblet trays holding the edible offal should be moved to the giblet station where the livers, hearts and necks are washed. The gizzards are opened with a sharp knife and then washed. The inside "skin" is removed by knife. This is not easy and, depending on the bird, it may be necessary to scald the gizzard in boiling water first.

After the offal has been cleaned and washed, it is then sorted and placed into small plastic bags and placed on trays in the chill room.

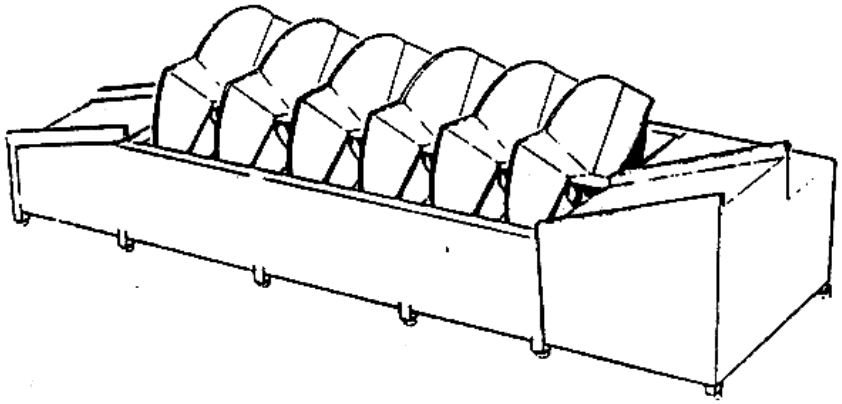
At the end of a production session, the inedible offal is wheeled away from the room through the plucking area to the outside to be disposed of in a manner described in Chapter 2. If an outside door is constructed into this room, it may be removed through this route.

Cooling

If necessary, the birds are removed from the carousel. The feet may be cut off and placed in a suitable receptacle.

Empty carcases are placed into a cooling bath at the end nearest the evisceration room. The bath contains water, chlorinated to a minimum level of 50ppm, which is either cooled by a refrigeration unit attached to the bath or slush ice. As more carcases are placed in the bath

they move each other along and warm the water. As the water warms or the ice melts, more is placed in the bath at the packing room end. This comes from the refrigeration machinery which runs continuously or from the nearby icemaker. The bath should be set so that it overflows at the evisceration room end. If ice is used, approximately 2kg will be required to cool each bird. The occasional assistance with movement of the carcases through the cooling medium by hand will ensure that some do not get left in the tank for an excessive period. Note also that the tank should be emptied and refilled every four hours as it becomes contaminated with blood and carcase materials (see Chapter 2).



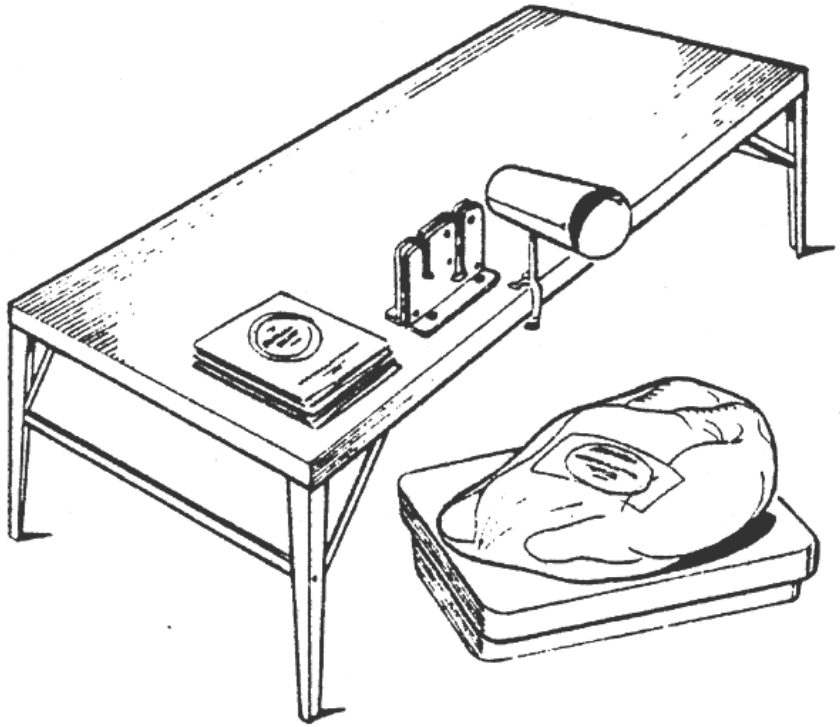
Spiral chiller

The carcases will take about 20 – 30 minutes to cool. At the end of this time they should be removed and hung on a rack to drain completely. The time for the birds to drain will depend on the microclimate and circumstances in the poultry packing plant but, once established, should not be exceeded under any circumstances. An air conditioned room in most tropical areas may operate at about 25–27°C and as the carcases are relatively thin will soon reach this temperature if left hanging for an excessive period. The cost and effort expended in cooling the bird will then have been wasted.

Packing and grading

For the sake of convenience, it will be assumed that whole birds only will be prepared at this throughput and the carcase will undergo further preparation at higher throughputs. Further preparation, however, may be made at any level of operation.

Giblets, wrapped as sets in plastic packets, are brought to the dressing table one tray at a time. The chilled washed carcases are removed from the rack and placed on the packing table. They are inspected for damage, poor dressing and possibly graded. The grading at this stage will be concerned with defects. These will include colour faults, bruising, blood clots, broken bones, remains of organs or feathers. If they are not to standard, corrections are made (eg removal of the odd feather, piece of lung tissue etc) or the carcases are returned to the chiller for other remedial action.



Packing table

A packet of giblets is placed inside the abdominal cavity. String is used to truss the bird so that its legs, wings and breast are held in position and shown to best advantage. There are many ways to do this, one example is shown in the photographs.

Whole birds are neatly placed into a plastic bag so that the wings fit into the corners. A bag is placed over the guides of the bagging chute which serves to keep the bag open. The bird is slid down the guides and the packed carcase automatically slides off. The neck of the bag is twisted and the twist is forced through a slot in the sealer. A plastic tie is attached to the bag. Bags should not be secured with stationery staples.

Some customers require that the poultry is graded further. This might be confined to weight and perhaps some idea of meat to bone ratio. Poultry may also be priced or labelled with information which meets the local legislation plus that which the owner requests. In this instance, the owner should supply the label or agree to its appearance with the packer who will purchase and charge.

The packages are then placed into a cardboard carton or in a stainless steel mould on a trolley ready for the chill or freezing cycle. The metal tray must be of a dimension which will fit the inside of the cardboard carton. This is particularly important if the product is to be frozen. Once frozen, the meat is removed from the tray and placed directly into its cardboard carton. This will be impossible if the block is of the incorrect size. The advantage of freezing inside a metal tray is that when filled, the cardboard box itself will be in good shape, attractive, stack well and resistant to damage in subsequent handling.

The cardboard carton should have a polythene laminate inside to protect the cardboard from taking up moisture from the product. This will leave the box soggy, particularly in chilled poultry, or the product may stick to the box leaving brown cardboard on the pack. This looks bad on displayed products. Freezing meat inside its cardboard box is that it reduces subsequent handling and continues to insulate the meat between removal from the blast freezer and subsequent storage.

Refrigeration

The facilities installed for the poultry processing plant include a chill room, blast freezer and freezer. This allows maximum flexibility for product preservation. Poultry should leave the packing room in a thoroughly chilled condition and this should be maintained until it reaches the consumer.

Packaged poultry can be taken into the chill room and stored overnight before dispatch the following day. The dimensions of the room allow for a full days production with some excess to hold stock if transport is delayed a little. Care should be taken to ensure that the store is managed according to the general principles laid down in the appropriate section in Chapter 2. Some of the poultry may be preserved frozen. The intention is that trolleys of packaged birds will be held in chill to await completion of the earlier blast freezer cycle. The trays will then be loaded into the freezer according to the manufacturers instruction and the machine switched on. The blast freezer operates at a temperature of about -40°C and the air speed is of the order of 2–4 m/s. Freezing will take about 2–3 hours. After this period, the machine is switched off, the freezer unloaded and the products quickly placed into cardboard cartons (where appropriate) and stored in the freezer room. This room operates at a temperature of about -20°C. The product will enter at a temperature of -40°C on the outside of the pack and -10°C on the inside. The freezer room allows the pack to equilibrate. The boxes should rest for about 24 hours before dispatch.

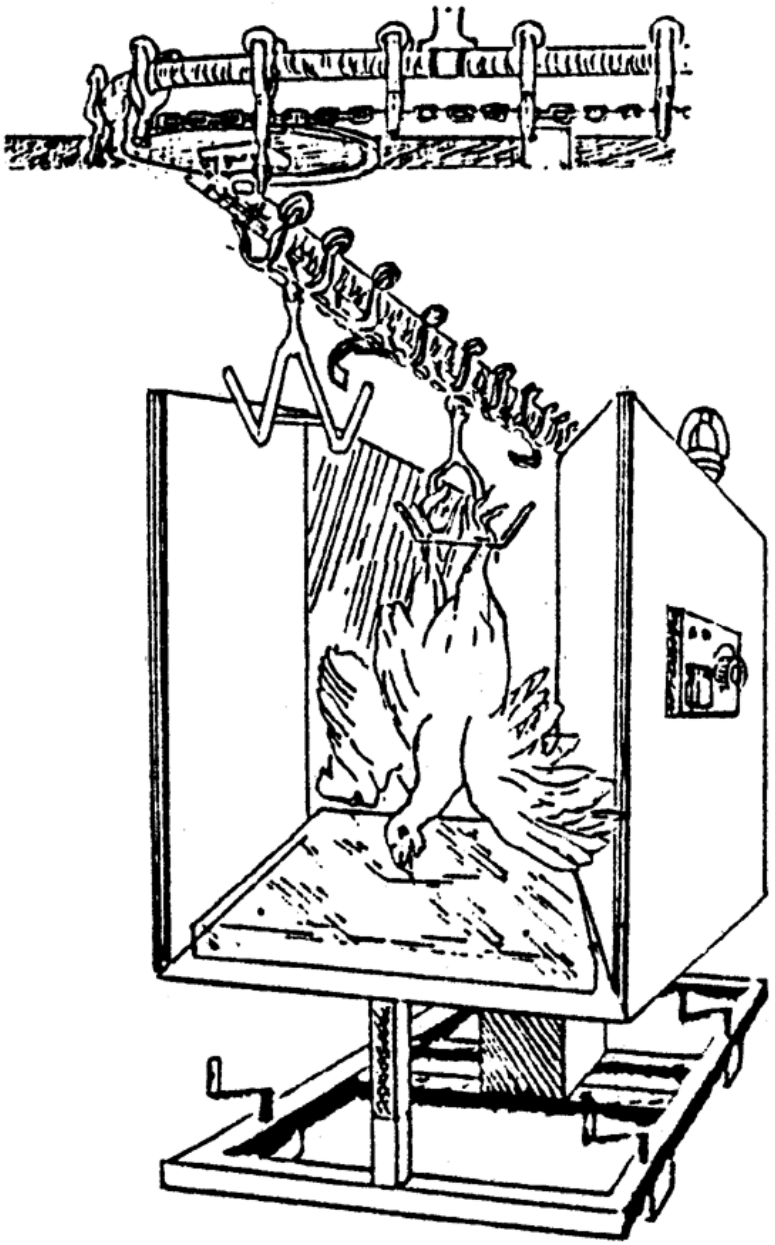
MODEL 3 – 350 BIRDS/HOUR

Stunning and slaughter

Birds are removed carefully from their crates by holding both legs and placed carefully on the overhead rail. The operator briefly holds the legs or runs his hands down the body to help quieten the bird. The overhead rail is moving at between 0.6 to 1.4m/minute. As the shackles are at 0.2m intervals, it is necessary to fill every shackle to ensure maximum production of 350 birds/hour and be able to control all subsequent operations. eg detail staff, use constant quantities of ice etc.

The birds are allowed to settle, and may be stunned using a method described earlier.

There are other forms of stunning apparatus but their use can be limited in the tropics. The most frequently found system is the brine bath which acts as one electrode and a metal bar in contact with the shackle which acts as the other. The bird is automatically lowered to the bath by a fall in the overhead rail and is stunned as soon as the head touches the brine. A guide ensures that the head comes into contact with the brine. The system works best where all the birds are of the same dimensions. This is not always found in small scale operations in the tropics and in multi-species abattoirs. Another system uses an electrified plate which is placed across the line of travel and set to come into contact with the head of the suspended bird as it passes. Sometimes a flow of water passes over the plate to improve its conductivity. The problems rest with the dimensions of the bird and the possibility of the bird receiving a shock and pulling its head away from the electrode. In these circumstances, it fails to stun the bird.

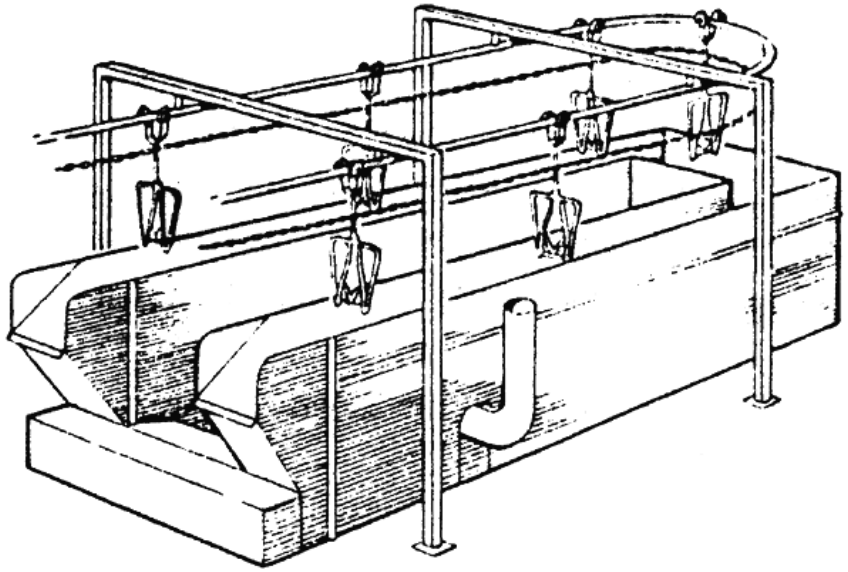


Water bath stunning cabinet

Birds are bled by a method described earlier. They should be allowed to bleed for 1 1/2 to 2 minutes before dressing starts.

Scalding and defeathering

The overhead rail moves the birds from the stunning/bleeding area and lowers them into a scalding tank. The speed of the rail ensures the birds are scalded for the right length of time and are sufficiently agitated in the scald water. A thermostat ensures that the temperature of the water is maintained at 52°C.



Cascade scald tank

After the birds have passed through the scalding tank they are removed from the overhead conveyors for plucking. The tail and flight feathers may be removed by the machine described above in Model 1. At a rate of 350 birds/hour hand plucking is totally impractical and machinery

must be used. Two methods of plucking are described.

The first, using a drum plucker, requires a team of four operators and a drum of 1.5m in length. It comprises a horizontally mounted stainless drum from which many long rubber fingers extend. The drum rotates briskly away from the operator. This drum should have a second rotating drum with rubber fingers positioned above the other so that it is oriented rather like an old fashioned mangle. The drums should be set to leave about 10mm clearance between rubber fingers with both drums revolving. The carcase is simply introduced and turned and agitated until all soft feathers are removed. The operators hands must be kept well clear.

The second method of removing feathers is that of bowl plucker described earlier and used in Model 2. Whereas the machine was under-used in the previous example, the operation at 350 birds/hour is close to maximum operational capacity.

The cost variation between the large double drum and bowl plucking machines is marginal but the product from the bowl plucker may be better.

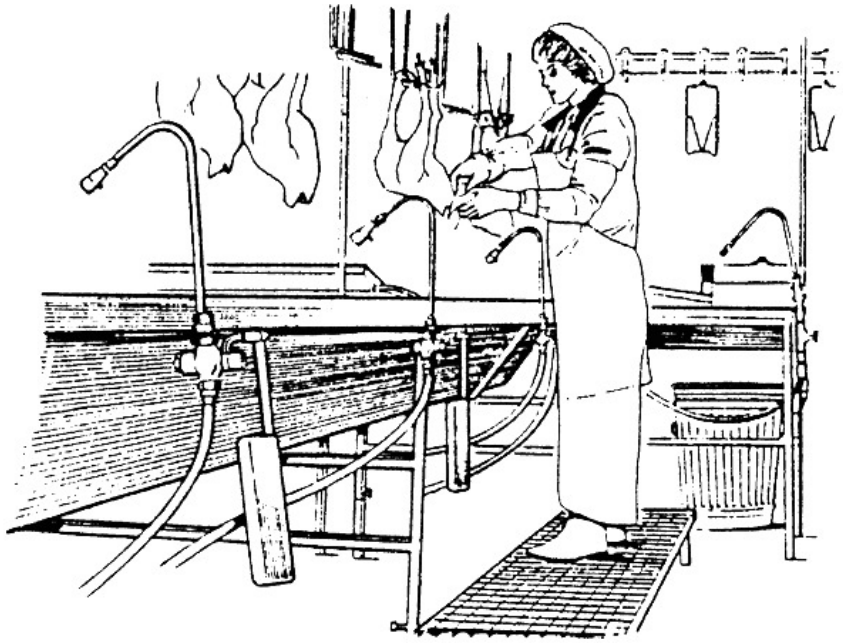
After removal from the bowl plucker, some flight and tail feathers may remain on the carcase. The carcase is placed on a pinning table where two staff remove any unwanted feathers. Alternatively, a finisher (see Model 2) may be used. The carcases are then hung onto another overhead conveyor which carries them on into the evisceration room. They are placed with the back towards the operators who will eviscerate them.

The feathers are collected frequently and periodically and placed in a feather bin. They are removed from the plucking area through the door near the bowl plucker for disposal by a method described in Chapter 2.

Evisceration

Birds arrive into the evisceration room through a hole in the dividing wall which separates it from the plucking room. They should then be eviscerated in the manner described for the carousel used in Model 2.

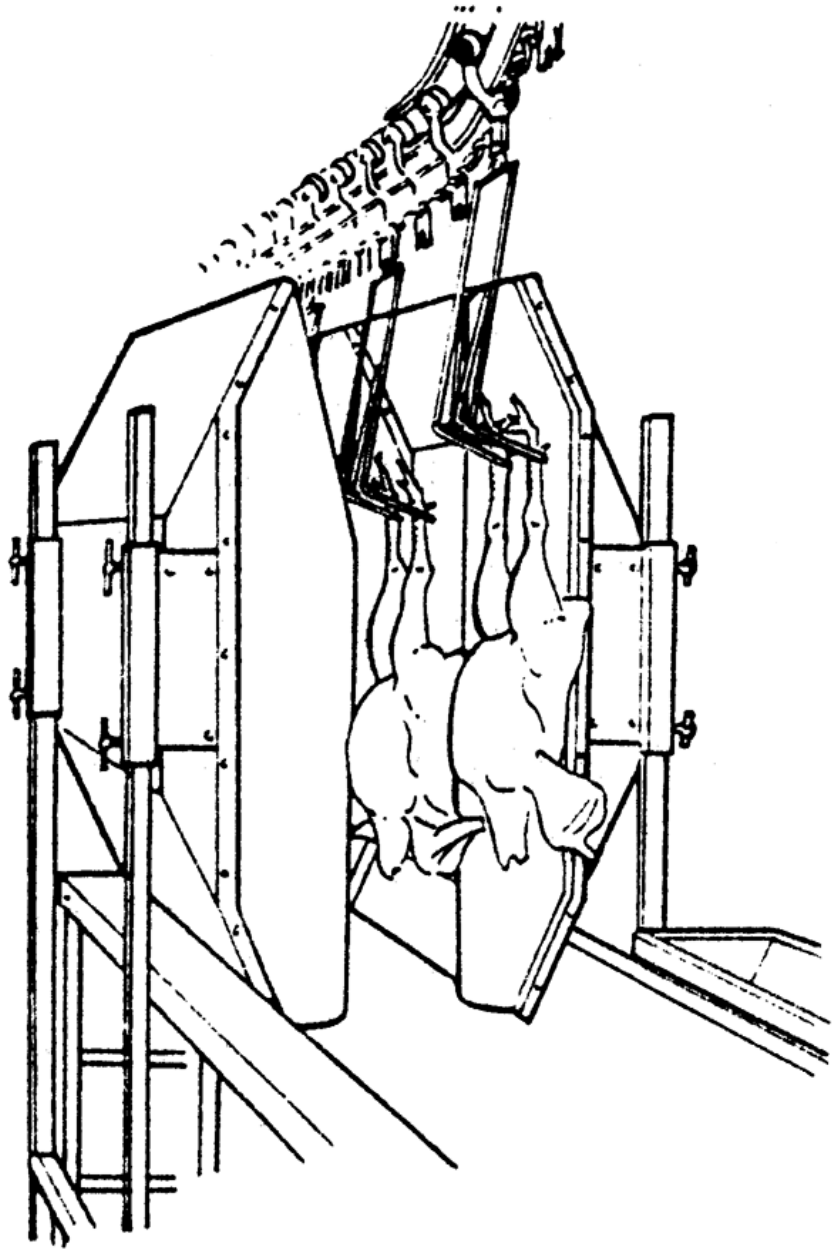
The evisceration table in this model has a trough rather than a circular tray. The trough has a waterspray to wash the inedible offal into the offal truck situated at the end of the evisceration trough.



Evisceration trough

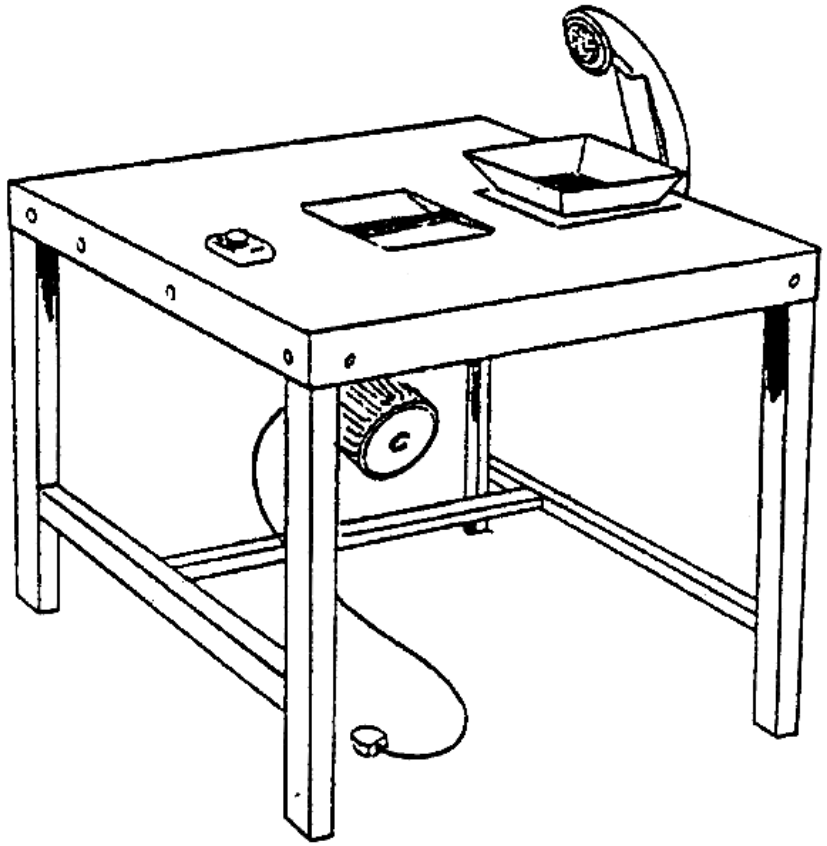
The birds, which are still hanging from the overhead conveyor, then pass through the quick-clean bird washer or a washing cabinet. The first comprises two roller brushes mounted horizontally in line with the conveyor. The outside is shielded so that the wash water is

contained within the cabinet. Chlorinated water is introduced through built in spray nozzles and, as the brushes rotate, they scrub and wash the carcase. Passage takes about one minute. The washing cabinet is similar except that it has a series of water spray heads instead of the brushes. After they have emerged, one operator takes the carcases off the rail, cuts off the feet, (placing them in a suitable receptacle) and either hangs the carcases onto a rack for air cooling or places them into the cooled water or slush ice tank.



Spray wash cabinet

The giblets and gizzards are handled in the same way as for model 2 except that an automatic gizzard skinner is used. The gizzard is held down over the serrated rollers which then removes the skin. The operator must take care that his hands do not come into contact with these rollers.



Gizzard skinner

After the offal has been cleaned and washed, it is then sorted and placed into small plastic bags and placed on trays in the chill room.

Cooling

Three systems of cooling are shown for this scale of operation. The first two, those of cooled water and slush ice cooling, follow much the same principle as that for Model 2 except that the cooling tank should have some form of device to direct the carcases through the tank. (Such devices were previously called “spin chillers”). Also, if used, ice should be added automatically from the icemaker to the cooling tank.

The second system involves the use of a chill store.

The birds should be hung with their legs removed, onto a marked cooling rack. Each rack holds about 150 birds and should take about half an hour to fill. They should be allowed to hang in the air for about 15 minutes to dry and then placed directly in a cold store. It is important that the birds are dry before they enter as this will not happen in the cold room where the relative humidity is high.

The chill store will require special management to ensure that the racks already inside are removed in the order in which they entered. In this way each bird will get a constant amount of cooling.

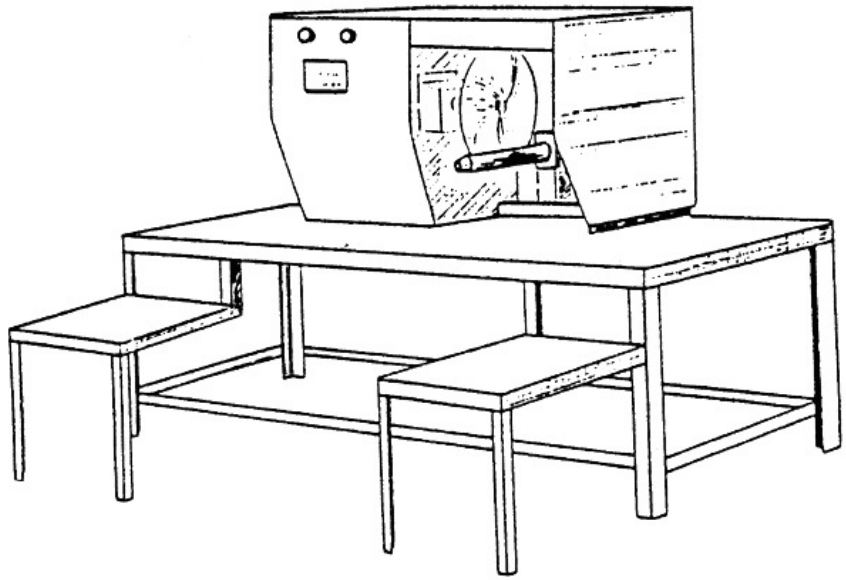
The chill store should be designed to cool four racks, each of 150 birds (say 300 kg) ie a total of 1200kg, from 35°C to 5°C in two hours.

Once cool, the birds must be processed speedily as they will soon rise in temperature (see Model 2).

Cutting

Carcases may be prepared as whole birds as described for Model 2. Other methods of preparation may be undertaken according to customer requirements. This may include cutting into halves, quarters, legs, thighs, wings, breasts, drumsticks or complete deboning. Photographs of a potential cutting method is given in Annex 6.

The instruments used in preparing chicken portions include cleavers, knives, secateurs and special machinery, an example of which is shown below. This machine has an arm which points horizontally towards the operator. It has a groove on the top into which a rotating knife fits. The carcase is pushed over the arm into the knife and the two pieces fall to the side.



Portioning machine

Deboning at a throughput of 350 birds/hour is not to be recommended. It produces bones and trim for which a system of disposal is required. The quantity produced will be small and complete burial is the only realistic disposal method. Nevertheless, where it is a requirement,

complete deboning is carried out using a knife. Deboning by hand, using no implements at all, is possible. It is quick and clean but takes a lot of skill.

Packing and grading

Poultry portions are treated in much the same manner as the whole birds but the use of trays is much more prevalent. Drumsticks, chilled or frozen in a loose plastic bag have little visual appeal whereas the same product neatly arranged on a tray with a clear overwrap has a much better chance of sale.

Again, The packages are placed on a stainless steel tray on a trolley, or into a cardboard carton ready for the chill or freezing cycle.

Refrigeration

At this scale of operations, chill storage facilities are not provided as it is assumed that all birds will be frozen. If there is a requirement for chill storage, the building can be redesigned easily to accommodate such facilities. The system of operation will be similar to that described for Model 2.

There are some differences in operation at the increased scale, however. Instead of storage at chill temperatures before loading the poultry into the blast freezer, marked trolleys of packaged meat are taken straight from the packing room into the blast freezer room. Here they are held until frozen before removal and storage in the freezer. There is an area where the metal trays can be emptied and the product placed in cardboard outer covers. A high degree of management of product is necessary to ensure that each trolley receives the appropriate time of blast freezing. Too little time will lead to deterioration of the product. Too much is a waste of resources.

CHAPTER 4
HEALTH, HYGIENE AND ROUTINE MAINTENANCE

Poultry Rearing Hygiene

The production of healthy poultry depends on the maintenance of health and hygiene throughout the entire production system. This includes the maintenance of health at the point of production of the live birds. The following are examples of measures which can be taken to ensure good hygiene and to prevent disease at the farm:

- **The processing operation should be located as far away as possible from other similar operations**
- **Poultry houses and all equipment should be scrubbed clean with a high pressure hot water cleaner, detergents and disinfectants such as chlorine based chemicals, formaldehyde, 2% caustic soda solution or 1% quaternary ammonium compounds solution between raising batches of poultry**
- **Chicks or eggs should be purchased from disease free flocks**
- **Birds of one age only should be reared in each house. Birds of different ages can infect**

each other and young chicks are particularly vulnerable to adult disease

- **Feed should be procured in proper packaging or by bulk transport**
- **The diet should be well balanced in sufficient quantities and obtained from a well known source**
- **Dirty litter & droppings should be removed from the poultry house**
- **Overheating and overcrowding of the birds should be prevented**
- **Poultry houses should be well ventilated; this is important in maintaining correct housing temperature and humidity.**
- **Clothing, footwear, cleaning facilities & materials should be provided and laundered for all staff and visitors.**
- **A foot-bath should be installed containing disinfectant (such as an Iodofor) at the poultry house entrance and its use made compulsory.**
- **Veterinary advice should be sought at the first sign of disease in the flock. If this is not available, the producer may be obliged to slaughter in order to prevent serious recurrence of the disease in subsequent flocks**
- **Dead birds should be removed as soon as possible from the rearing houses and disposed of by incineration or deep burial**
- **Although the poultry sheds are designed to prevent their entry, rats, mice and insects are**

difficult to keep at bay. They should be destroyed if they infest the poultry house and feed store as they are carriers of disease

- **Cats, dogs and other animals should be prevented from entering the poultry house. Children should be discouraged from entry also unless they are attending to the birds or under instruction**

External contamination

There are several sources of external contamination which should be prevented, reduced or controlled. These include:

- **Visiting vehicles which could carry infection causing, microbes and spores. A delivery point should be located away from the poultry house and feed store to reduce contamination levels**
- **Poultry crates or modules which are used constantly for transporting birds outside the poultry farm. These should be properly cleaned using disinfectant**
- **Visitors must wash their hands and use the overalls & footwear provided**
- **Staff should be actively discouraged from keeping poultry at home**

Inspection of Live Birds before Slaughter (*ante mortem* inspection)

In poultry processing, *ante* and *post-mortem* health inspection of birds is essential. In the tropics, this is usually carried out by a qualified veterinarian, meat inspector, public health inspector, environmental health officer, police officer, customs officer or whoever may be

appointed within the legislation. These trained, qualified staff usually operate under the Veterinary Services or Ministry of Health, depending on territory. This is needed to protect the health of the public and enable the veterinarian to monitor the health status of the flock. Remedial action on a wider scale may be taken if necessary.

Poultry intended for slaughter should undergo *ante-mortem* health inspection within 24 hours of slaughter and this should be repeated if the birds are subject to delay. *Ante-mortem* health inspection at the poultry processing plant may be restricted to detecting injuries received in transport if the poultry have been inspected fully at the farm of origin within the 24 hours immediately preceding the *ante-mortem* health inspection and found to be healthy.

The *ante-mortem* health inspection should determine:

- **whether the poultry shows symptoms indicative of a disease which can be transmitted to humans or animals. These diseases or conditions include some forms of Newcastle disease, Fowl Plague, Rabies, Salmonellosis, Pasturellosis, Ornithosis and others.**

- **whether the poultry shows symptoms of a disease or of a disorder affecting their condition which may make the meat unfit for human consumption.**

Microbial Implications of Slaughter And Processing

Although domestic poultry have social habits which include preening of feathers and attention to personal cleanliness, these are not well developed. Poultry normally co- exist with considerable numbers of micro-organisms, insects, parasites, dirt, dust, faeces, all manner of filth and feedstuff among their feathers and on their skin. The skin protects the main body from microbial invasion but if this is damaged, it may lead to infection of the underlying tissues, organs and body as whole reducing the value of the carcase. Similarly, the alimentary

tract contains a very large number of organisms usually held in a sensitive balance which, if upset, can lead to digestive problems resulting in a change of faecal consistency. This may assist in the spread of alimentary infection to other birds in the flock and, as will be described below, to human beings.

Many precautions can be taken to assist with the microbiological condition of poultry and the poultry meat they produce. These precautions should start at the producers premises where young birds are raised. The producer should take note of the advice offered by the veterinarian or extension officer about design, operation, management, cleanliness and general health of the flock and its housing. Great attention should be given to seeking veterinary advice should the flock become sick. Poultry housing should be properly separated from other animal housing, human habitation and their animals. It should be kept clean while the birds are growing and thoroughly disinfected once the birds have gone for sale and slaughter. The containers for the birds should have been disinfected before birds are placed in them and the vehicle should have been similarly treated. Attention should be given to the cleanliness of the livestock handlers, their clothing and footwear. They should be discouraged from keeping their own poultry at home (see Chapter 1).

Live birds should be handled quietly, kept off the ground and slaughtered using properly designed, maintained and cleaned equipment in a properly designed, maintained, cleaned and managed building. Attention is drawn below to the concept of cross contamination of poultry carcases by micro-organisms. The most important areas to monitor are the reception areas for the live birds, the scalding tank area, the defeathering machine (which can harbour undetected micro-organisms for years) and the chilling tank.

Given the nature of the bird as described in the first paragraph, it is not difficult to see the consequences of birds flapping, touching and struggling in confined spaces in the likes of the

reception and slaughter areas of the processing plants. Wash water from scalding and plucking contains many micro-organisms which can be distributed by aerosol as well as in flowing water. Poultry are processed rapidly and eviscerated through a small opening in the body cavity. The alimentary tract can split easily, spilling its contents over the carcase on both the outside and inside. Process water, such as used in washing, chilling and further processing can become contaminated easily. From the whole process, surfaces in the building and on machinery can become contaminated as can the hands of processing operators and their processing implements. Each has the potential to contaminate the poultry carcases further.

The consequences of carcases contaminated with micro-organisms on product quality and consumer health are well documented. They fall into two main categories. Those which cause spoilage of the meat and those which transmit pathogenic micro- organisms to the consumer.

There are many forms of spoilage organisms but Pseudomonads are the most important. They are found in large numbers on feathers but rarely in the alimentary tract. In the living bird, their activity is kept under control by the physical barrier of the skin, competition for suitable nutrients from other micro-organisms and the temperature of the skin which is too warm for their optimal growth. After slaughter of the bird, they are destroyed in large numbers by the scalding tank as most do not grow or survive above 28°C. Those that do however, can re-contaminate other carcases in subsequent processing operations. Unless carcases are washed thoroughly in super-chlorinated water and chilled promptly, the Pseudomonads may be present in sufficient numbers to overcome competition from other micro-organisms, and grow at their optimum temperature. Spoilage of the carcase may result.

Pathogenic organisms in poultry are responsible for gastro-intestinal disturbances in humans. *Salmonella* spp are found in the caeca of young birds and are transmitted from bird to bird at all stages of growth, handling and transport of the live bird via a faecal route. Cross

contamination may occur during processing at the abattoir. Under proper processing conditions, *Salmonellae* fail to grow rapidly in the processing plant and at temperatures below 7°C hardly at all. Rapid chilling of the carcase therefore, is recommended. *Salmonellae* may continue to thrive on carcases subjected to temperature abuse and may then become a hazard to health.

***Salmonella* spp attract the most publicity but are not the only organisms responsible for food poisoning. *Clostridia* spp, particularly *Clostridium perfringens* are also found in poultry arriving at the processing plant. They, too, are found in the caeca and colon of live birds. Although they infect live birds and cross contaminate at the processing plant like *Salmonellae* they are found, fortunately, in small numbers at the end of a processing operation provided operations are carried out efficiently. They do not grow well below 15°C and provided the bird is kept properly chilled and is well cooked at home, no real danger of food poisoning exists. However, some micro-organisms can withstand normal cooking temperatures and, if cooked poultry is left in warm conditions, can multiply quickly to cause food poisoning.**

***Staphylococcus aureus* and *Campylobacter jejuni* are also important micro-organisms in poultry processing. They survive within the body of poultry and readily cross contaminate other carcases during processing. Once again, prompt chilling is necessary if their numbers are to remain at safe levels after processing.**

Regrettably it is not possible to hope that a thorough final wash will be sufficient to clean poultry to a safe level of contamination. While many bacteria are washed away during processing, sufficient remain to cause problems if carcases are not properly handled. Washing is not a very effective way of removing bacteria. They are found in the bottom of feather follicles and many creases within the skin which hold water, positions which are difficult to clean and conditions conducive to microbial growth. Simple washing is insufficient to remove

all these organisms. Bacteria also attach themselves to the skin by a mechanism which is not fully understood. They form a film which is not removed by scalding or chlorination.

Operational procedures are introduced to overcome these problems. For example, dry plucking, followed by washing and rapid chilling or dispatch of New York Dressed birds is recommended in the smallest scale model of poultry processing discussed in this report (Model 1 – 50 birds/day). This system ensures the intestinal micro- organisms are contained until the carcase is ready to be cooked. Cross contamination with other carcases is prevented during processing. Special instructions on use of New York Dressed carcases must be given to the customer to prevent transfer of microbiological problems elsewhere. In practice these are thought to be fewer than might be expected. The second scale of operations discussed in this report (Model 2 – 200 birds/day) uses a system of wet scalding, defeathering by plucking machine and chilling in a tank of cooled or iced water after evisceration. Although potentially the most difficult system to control, the scale is such that all operations can be closely managed by technical staff. Cooling by ice cold spray (an alternative to cooling by slush ice) would be uneconomical. Carcase cooling in the third scale of operations, (Model 3 – 2500 birds/day), is similar to the second but offers a choice of three chilling methods after evisceration. Carcases may be spray washed followed by air chilling in a cold room (the preferred system of operation but requiring more management) or chilled in a tank of cooled water or slush ice. Once again, the scale should be such that the operation can be closely managed by technical staff using a properly established operational code of practice.

Inspection of Live Birds after Slaughter (*post mortem* inspection)

All parts of each bird should be inspected immediately after slaughter. To do this all parts of the carcase should remain identifiable until the inspector has declared the carcase fit. This is best done if the viscera is left attached to the carcase.

The *post-mortem* health inspection should include:

- **visual inspection of the bird**
- **palpation and incision of the slaughtered bird, where necessary**
- **investigation of anomalies in consistency, colour, smell and, where appropriate, taste**
- **laboratory tests, where necessary.**

The inspector is looking to see if the carcase is fit for human consumption. He may find an indication of:

- **death resulting from a cause other than slaughter (eg stress, physical damage)**
- **general contamination (eg dirt)**
- **major lesions and ecchymosis (cuts and bruises)**
- **abnormal smell, colour, taste**
- **putrefaction (decay)**
- **abnormal consistency**
- **cachexia (emaciation, scragginess)**
- **oedema (swelling)**

- **ascites (congestive heart failure)**
- **jaundice (liver infection, causing yellowness)**
- **infectious disease**
- **aspergillosis (fungal disease of the respiratory tract)**
- **toxoplasmosis (parasite disease)**
- **extensive subcutaneous or muscular parasitism**
- **malignant or multiple tumours**
- **avian leucosis complex. This is a viral disease responsible for:**
  - **Marek's disease (one symptom is swollen lymph glands) and**
  - **Leucosis (one symptom is enlarged liver and spleen)**
- **poisoning.**

If any of these conditions are found, the carcase should be set to one side and disposed of according to the nature of the condition. For example, should the bird have suffered a breast scab, then the rest of the carcase may be salvaged. If the carcase shows signs of jaundice, then it should be condemned and incinerated or deeply buried with lime. Other conditions are sometimes found and the qualified veterinarian will be able to recognise them and deal with them accordingly.

Staff Health

All staff who work in the poultry plant are handling meat which will eventually be eaten. The opportunity exists, therefore, for transmission not only of pathogenic organisms associated with poultry but also diseases associated with the operative. Poor handling techniques can also lead to cross contamination of spoilage organisms and reduce the shelf life of the product. As a consequence, there are several rules to be followed which can help to reduce these risks.

Every person who works where meat is handled should:

- **keep clean. This should include a daily bath. Particular attention should be paid to hands, fingernails, arms, face, hair and other exposed parts.**
- **wear clean light-coloured working clothes and headgear which can be easily cleaned. The clothes should have no pockets except for those staff who need to use equipment which they need to carry such as writing implements and thermometers. The pockets of these coats should be on the inside. Everyday clothes should not be worn in the factory. Hair should be kept under control, using a hair net if necessary. Impermeable boots should be worn and washed frequently, particularly when arriving, leaving and changing between normal working rooms. Protective and safety equipment such as wrist guards and chain-mail gloves may trap pieces of meat. They need frequent washing while in use and special cleaning at the end of the working day. The manufacturers instructions should be followed.**
- **wash and disinfect hands every time work is started or resumed, particularly after a visit to the lavatory, smoking, eating, coughing, sneezing (using a handkerchief), handling money, garbage or any dirty material. Hand washing should be carried out as a matter of routine at**

very frequent intervals, using hot water (43°C), soap and a nylon nail brush as appropriate.

- **wash and disinfect hands and arms immediately after contact with diseased poultry.**

Every person who works where meat is handled should not:

- **smoke or use tobacco while handling poultry meat or where there is poultry meat exposed. Tobacco should not be permitted in poultry processing areas.**
- **eat, drink or use chewing gum, chewing sticks, sweets or put anything in, or touch, the mouth, nose or ear in any room where there is poultry meat.**
- **scratch the head, handle money.**
- **urinate, defecate or spit except in a lavatory.**
- **wear loose or dangling clothing or jewellery which may be caught in machinery eg ties, necklaces or wear items which can harbour dirt or fall into the product, eg watches, bracelets, dangling earrings etc.**
- **bring glass into the processing room. This raises the issue of wearing of spectacles and contact lenses by operative staff. Contact lenses are not recommended for production workers since they are almost impossible to find should they fall out. Spectacles, on the other hand are unavoidable. The lenses should be checked for security in their frame and not worn if they become loose. The loss of the spectacles or the lens (pebble) must be treated seriously and the article found before production continues.**

No person should handle meat or be near it if:

- **suffering from a communicable disease such as typhoid and paratyphoid fevers, salmonella infection, dysentery, infectious hepatitis, scarlet fever or a carrier of these diseases.**
- **suffering from infectious tuberculosis.**
- **suffering from an infectious skin disease.**
- **suffering from gastro-intestinal disturbance, such as diarrhoea and vomiting**
- **doing anything else which may involve a risk of contaminating poultry meat eg handling offal, live birds or money.**
- **wearing an absorbent bandage on the hands, forearms or other exposed part of the body other than a waterproof dressing protecting a wound which is not purulent (discharging).**

Every person who is likely to handle meat should undergo an annual medical examination and receive a certificate from a qualified medical practitioner which states that there is no objection to that person handling poultry meat. The certificate, which is a confidential document, should be shown to and lodged with the manager of the poultry processing plant and may be shown to the official veterinary officer on request.

Plant Sanitation and Maintenance

These functions have been combined in this document to provide a regular schedule of activities.

Plant sanitation

During production, waste materials collect on the surfaces of the building and equipment. These are an ideal media for micro-organisms to grow. Growth will occur if the waste is not properly removed. The micro-organisms may be transferred from their growing place to the product through disturbance by people touching the dirt and directly touching the product. The product may also be contained by coming into contact with dirt and by incorrect cleaning procedures which simply move the dirt and micro-organisms about without destroying them.

As an activity, cleaning is a complete science in itself and well beyond the scope of this document. Nevertheless there are certain general principles followed which are universal to most food factories. These involve the use of the following which, in themselves, may be sanitizing agents:

- **steam 110°C**
- **hot water over 75°C**
- **warm water 45–75°C**
- **cold water up to 30°C**
- **foam**

These carriers may be used in conjunction with certain chemicals eg:

- **disinfectants**
- **detergents**

- **soap**

It is perhaps worth recording the main classes of sanitizing agents and some of their characteristics to give some idea of their usefulness in poultry processing plants.

Chlorine and chlorine-based products, including hypochlorite compounds: These are probably the most suitable disinfectants for food plants. They act rapidly against a wide range of micro-organisms and are relatively cheap. They are used in concentrations of 100–250 mg of available chlorine per litre. They are corrosive to metal and have a bleaching action. After adequate contact time, they should be rinsed off. They are readily inactivated by organic materials so they should be used after the premises have been cleaned rather than as an initial cleansing agent. They may leave an odour in the building which may taint the meat if not properly rinsed off after use.

Iodophor compounds: These are always blended with detergents in an acid medium. They have a rapid action and a wide range of anti-microbial activity. They are of intermediate cost. They are used in concentrations of 25–40 mg/1 of available iodine at a pH of less than 4. They give a visual indication of their effectiveness as they lose their colour when the residual levels have dropped to ineffective levels. They are not toxic when used at normal concentrations but since they can combine with substances in food to cause taint, they should not come into contact with food or their contact surfaces. They are corrosive and should be rinsed off after a suitable contact time. Like chlorine-based compounds, they are readily inactivated by organic materials so they should be used after the premises have been cleaned rather than as an initial cleansing agent.

Quaternary ammonium compounds: These have some detergent characteristics. They are non-toxic, colourless and relatively non-corrosive to metal. They are not as effective against gram-

negative bacteria as are chlorine-based disinfectants and iodophors. Thorough rinsing is necessary as the compounds adhere to surfaces. They are used at concentrations of 1:50 to 1:250, depending on the hardness of the water. They are expensive to purchase but are useful where it is necessary to use an alkaline disinfectant, where odour, taste and toxicity are to be avoided and persistence is required.

Amphoteric surfactants: These are of a comparatively new class of disinfectant with both detergent and anti-bacterial activity. They are non-corrosive, tasteless, odourless and of low toxicity. They are not as effective as chlorine-based or quaternary ammonium compounds. They are expensive and require good rinsing after use. They are effective against a wide spectrum of organisms.

The delivery of the sanitizing solutions may be achieved through the use of:

- **high pressure washers**
- **steam and cold water hoses**
- **various brooms, brushes, squeegees, scrubbing brushes, buckets and spades**

There can be no general recommendations made about use of the most appropriate sanitizing method for each situation. Similarly, the use of particular chemicals (brand names) cannot be recommended since they are a combination of chemicals with the potential for synergistic activity or reaction. They should be changed frequently. The reasons for this can be given in the following historical example:

In one factory a particular brand of disinfectant was used in the high pressure washer. The disinfectant was delivered through a fine nozzle which formed an aerosol. On the edges of the

spray, certain micro-organisms were subjected to very weak concentrations of the chemical and formed a resistant strain. The full user strength disinfectant was of little use and had to be changed.

All sanitizing agents should be handled in accordance with the manufacturers instructions. This includes the use of protective clothing, particularly overalls gloves and boots. This is important when using iodophor compounds as these agents may penetrate the skin, pass into the blood and accumulate in the thyroid gland.

In the tropics there is usually a severe shortage of sanitizing agents. The most frequently encountered are sodium hypochlorite (chlortabs), steam and sunlight. Severe mechanical effort in conjunction with cold water often remains the system of last resort. For the sake of simplicity, it will be assumed that these are the only agents for the foregoing. Poultry processing plants with access to a wider range of sanitizing agents should use them in accordance with the manufacturers instructions, change them when able and monitor both cost and efficiency.

Plant maintenance

In the context of the poultry processing factory, plant maintenance means that all equipment and structures are examined frequently and carefully, and serviced or maintained according to the manufacturer's instructions. It does not mean that repairs are made once things have gone wrong, failed, broken etc. Plant maintenance is necessary. A separate budget is required so that it can be carried out. It is intended that faults are found before they become critical and stop the production of poultry meat or affect its quality. Of course, machinery will break down unexpectedly and need to be repaired. There are several levels of repair which can be undertaken in the factory. For example, a broken poultry hanger can be straightened so that it

causes no mechanical problems during a production session. It should then be repaired fully before the next day's work as there will be a continuing loss of productivity.

Sanitation and Maintenance Schedules

The following gives some idea of the sort of schedule that could be drawn up and followed to maintain efficiency of the poultry processing plants discussed in this document. The operations are accumulative ie the operations recommended for one period include those given for the previous periods. Some plants will not have some of the equipment and facilities which require attention. It is taken as read that all plants carry out the appropriate maintenance for that plant

As needed (during operation)

- **Wash hands and arms as necessary.**
- **Remove build-up of feathers, feet and offal from working areas.**
- **Wash floor, walls and equipment with cold, but preferably hot, water which show signs of excessive contamination.**
- **Wash down clothes, aprons, knives etc which are covered with blood, faeces etc with cold, but preferably hot, water. Change clothes if necessary.**
- **Clear blocked drains (wash hands etc afterwards!).**
- **Undertake emergency repairs and maintenance.**

At the end of every slaughter session

- **Empty and renew cooling medium (cold water and slush ice coolers only).**
- **Remove feathers, feet and offal from working areas.**
- **Wash floor, walls and equipment with cold, but preferably hot, water.**
- **Clear drains (wash hands etc afterwards!).**
- **Wash down clothes, aprons, knives etc with hot or cold water as appropriate. Change clothes if necessary.**
- **Wash hands, arms and boots on leaving the room and re-entering.**
- **Undertake emergency repairs and maintenance.**

Daily

- **Staff to leave operational rooms, confine clothes to the laundry bins, take shower, leave the premises.**
- **Check that all electrical components and connections are suitably protected from water.**
- **Drain water from the dip tank and clean interior with high pressure (preferably steam) hose to remove loose debris and foreign matter.**
- **Remove any congealed blood from the blood trough and place in a portable container so that it does not enter the drainage system. Dispose of as recommended in Chapter 2.**

Clean the blood trough with a high pressure (preferably steam) hose.

- **Clear drains, pick up gross waste with a spade, brush and place in a bucket. Dispose of as described in Chapter 2.**

- **Generally wash and clean down plant, equipment and stainless steel surfaces. This should start with washing with cold water from a hose to clear away gross dirt. Surfaces of equipment should be scrubbed with nylon brushes using hot water and soap or detergent. Care must be taken to ensure that all the corners, welds, undersides and backs of equipment undergo this cleaning operation. The building and equipment should then be subject to cleaning with a pressure hose of steam or hot (82°C) water with detergent. The structure should then be disinfected by washing with dilute hypochlorite solution. After a suitable contact time (depending on time, temperature and concentration - see manufacturers instructions) the hypochlorite should be rinsed off thoroughly. The building should be left to dry completely as bacteria may grow in the wet pools left behind after rinsing. (Note: the process is called disinfection and not sterilisation, an impossible task in food plants). Care must be taken to ensure that all rooms, including staff facilities, and all areas of these rooms are cleaned. It is very easy to ignore “dead” corners which are little used but collect debris as a matter of course.**

- **Check and adjust all processing machinery in accordance with the manufacturer's instructions.**

- **Inspect the plucking machine and bird washer rubber flails for wear or damage and replace as necessary.**

- **Sharpen all knives and cutting edges used in poultry processing.**

- **Check refrigeration temperatures to see that they are within company limits for the time of day.**
- **Inspect, check and maintain operation of the refrigeration plant in accordance with the manufacturer's instructions.**
- **Check water storage tank.**
- **Check water chlorination levels.**
- **Launder the operative's clothes.**
- **Inspect the toilets and showers in the staff facilities and manager's rooms to ensure that they were cleaned as part of the routine cleaning of the other operational rooms.**
- **Outside, check that the drains and sewers are running freely and clear.**
- **Check the operation of the effluent treatment plant.**
- **Check that all electrical points, water and gas are switched off.**
- **Inspect the plant to make sure that everything is in good serviceable condition, including the operation of scales.**
- **Undertake essential repairs and maintenance in preparation for full production the following day.**
- **Empty tray of insect electrocutor**

Weekly

Clean cold stores, when empty.

- **Inspect oil levels in all gearboxes and top up if necessary.**
- **Check for leakage in oil seals on all equipment.**
- **Check rubber drive belts and chains for wear and tension. Replace/adjust as necessary.**
- **Ensure that all moving parts are free and smooth in operation. Free/lubricate/maintain in accordance with manufacturers instructions.**
- **Inspect all water, steam and boiler connections for leaks and rectify if necessary. Check operation of high pressure water cleaner.**
- **Generally inspect plant for wear and tear and mechanical damage and rectify if necessary. This to include shackles and poultry guides which sometimes need adjustment.**
- **Check that all electrical circuits are operational, lights function, fans turn etc. Rectify if necessary.**
- **Undertake full repair of equipment and plant for which a temporary repair was effected during operation but requires plant shut-down to complete. Never leave temporary repairs any longer than necessary, they usually interfere with production later.**
- **Check operation of water chlorinator and top up chlorine reservoir if necessary.**
- **Check stores for supplies of cleaning and packaging materials, and all other consumables.**

- **Read utility meters, check fuel levels.**
- **Check building for damage to structures eg walls and floors and effect repairs.**
- **Examine nesting and resting places for animals, birds, insects and remove. Check that wildlife proofing is intact and rectify if necessary.**
- **Check the storm drains for blockage, sand ingress to the building and its services, overgrowth of vegetation, anomalies in the compound, the soundness of the fencing and other security arrangements (lighting, gates etc).**
- **Inspect burial pits and arrange for maintenance or renewal if necessary.**
- **Undertake staff training, as appropriate, in hygienic operation and its importance to the development of the factory, the industry and the country.**

Annually

- **Staff medical.**

CHAPTER 5
POULTRY MARKETING

Role of the New Abattoir in a Marketing System

The construction of a new abattoir and processing room for poultry presents an opportunity for development of an improved marketing system.

Assuming that the new abattoir was built on the basis that it was wanted rather than imposed, it will act as a focal point for poultry processing. It is a place where producers will meet wholesalers, middle men and customers of all sorts and discuss progress in the marketing of the product. Whether trade in poultry is new or already established, the participants will maintain an awareness of market opportunities.

Although the very small scale operations of 50 – 200 birds/day probably offers little scope for a substantial change in marketing strategy, the 350 birds/hour model has distinct possibilities for expansion of an existing market. The following defines marketing, explains what it is and how it can be carried out.

The Definition of Marketing

Put simply, marketing is finding out what customers want and supplying it at a profit.

The process is customer oriented. The customer will not buy an unwanted product.

The product must be provided at a profit. Profit provides the incentive to continue with the business. The potential for increased profits offers the main incentive to develop and supply a variety of products to tempt the customer.

Marketing Activities

The activities involved in marketing include the collection, evaluation and dissemination of marketing information; planning and scheduling of production; forming contracts between buyers and sellers; constant improvement of all post-harvest activities; and co-ordinating inputs, including transport, processing, storage, credit, health care etc.

The Importance of Marketing

Marketing is important because of changing demographic patterns. Populations generally move from the villages into the towns, perhaps leaving fewer people in the main agricultural production regions. Combined with the general growth in population, this situation provides improved opportunities for rural communities to grow and sell more of their products, particularly in the towns, earning more money and being able to raise standards of living. The urban folk are able to make their contribution to society without the need to consider constant agricultural activity. Growing more food may be easier for those with land/facilities/cash but the farmer with a smallholding may find it difficult to take advantage of a larger market, particularly where there is competition from a larger producer. An improved marketing strategy, however, may enable him to reduce certain costs, perhaps by joining with others, leaving him with better profits.

Poultry as a Product

Before a poultry marketing strategy can be developed, it is well to understand and list the characteristics of the product. The following are examples. They may vary from one region to another:

- **Poultry consumption offends no religious sentiment.**
- **Its production is dependant on a wide variety of inputs eg**

- **Chick hatcheries**
- **Feed producers**
- **Veterinary services**

  Processing facilities
- **Transport**
- **Efficient cold chain**

- **Its production and consumption is generally non-seasonal.**
- **It is a perishable product which most usually needs refrigeration and considerable post-harvest care.**
- **It may be sold whole or in a wide variety of different parts. A different value can be placed on each part.**
- **It is eaten as a central part of the meal.**
- **Each part may be prepared for consumption in different ways according to a different recipe. It is invariably cooked and eaten with other food products and additives eg vegetables, spices.**
- **It is a basic food commodity inasmuch that it is a supplier of proteins and essential food nutrients to the human diet.**

- **It is not the only supplier of proteins and essential food nutrients to the human diet. It is in competition with other meats and protein sources including fish, eggs and dairy products.**

- **Its consumption level is dependant on price, income of buyer and the price and availability of competing alternatives.**

The Poultry Market

Having understood the product, it may be as well to understand and list the characteristics of the market. Once again, the following are examples:

- **Poultry should be supplied from an accredited abattoir.**

- **There are many contacts to be made in the marketing structure. For example, producers, buyers, sellers and customers. All have information indicating the product which the customer demands.**

- **Customers expect poultry to be a constant product, not chaning with season, time of day, severity of rains etc.**

- **The customers expect a constant throughput, not expecting serious shortfalls or gluts. Production schedules need full control.**

- **The product may be subject to the laws of supply and demand. An oversupply will lead to a fall in price and profitability. An undersupply may cause a rise in price but the customer may purchase other products to the detriment of later sales.**

- **Markets can be supplied under contract. For example, a particular buyer may want a**

constant order filled each week to a particular products specification for which he will pay a premium.

- **There is a standard of quality which the market demands. Customers will not return to buy more if the product is unwholesome. At point of purchase, quality relates to presentation as much as anything else. Assessment of quality by the customer may be fairly subjective if not almost unreasonable. Customers may look at the colour of the meat. They may also look at the colour of the wrapper.**
- **The market may respond to advertising.**
- **Test marketing the product may or may not indicate the results of implementation of a full marketing strategy.**

Marketing your Product

There are three steps which must be undertaken before a change in marketing should take place. These are:

- **Research and analysis of the potential market,**
- **Reaching a decision about what to do by way of making inroads into the new market and finally**
- **Converting that decision into practice.**

Research and analysis

The first step is to determine exactly what market exists and the problems and constraints on that market. Information should be gathered on the volumes traded (if any), its type (high volume/low margins or low volume/high margins), product traded (whole, in pieces, breaded, spiced, cooked etc) its numbers (ratio between the various sorts), weights of portions, style of packaging, how it is transported to the markets, how it is stored in the market before sale, if cold storage is available, if there are refrigerators in private homes on a large scale, the number of potential speciality markets (hotels, fast food outlets, prisons, schools, hospitals, private clubs, restaurants etc), who is supplying what to whom. The list is seemingly endless.

The second step is to determine what the markets want. The prices should be examined. If too high, an increase in supply may bring down prices a little but result in a much bigger turnover. This may indicate a large income elasticity to which an increase in production/supply is indicated to the benefit of all participants in the marketing chain. The market may want a different grade of poultry, cut differently (into drumsticks and thighs for example, rather than legs) improved shelf-life, different packaging (eg a film bag rather than a wrap; the bag may be re-used for a non-food item), changed use of the product in response to a current fashion, advertising campaign etc. Once again, the list is seemingly endless.

The third stpe is to examine the service the customers require. This relates to volumes of product, its price, its time of delivery (morning, evening), regularity (daily, weekly) and system of delivery, (ie in bulk, retail packs, ready to cook, returnable containers etc), its type of pack (easy to open), its type of labelling and so on.

For the fourth step, the potential entrant to the market needs to know where the poultry is sold successfully and unsuccessfully, what competition there is for the product, what margins are available, who are the main participants in the market (wholesalers, middle men etc). This may be made easier if a diagram is drawn to show how the market operates.

Finally, the market research seemingly completed, the information must be analysed with a view to finding a niche which the supplier can fill. This is one of the most difficult stages and the one on which the venture will be sustained or not. There are no answers which can be given in a book. If there were, the niche would be filled by someone else, making the advice appear dated very quickly. To make matters more complicated, the new venture may be subjected to competition. The entrepreneur will need to continue to keep an eye on the market and change his practices to keep ahead of the competition. His research and analysis should never stop. A successful market is built on information.

Decision making

The first decision is to accept the results of the analysis and chose the niche to be filled. This may be a circular process in that the niche identified may be so impractical to fill that it will be necessary to return to the analysis of the market research data. For example, it may be very profitable to supply a naval vessel with 3000 tonnes of poultry every six months. If the cold storage to hold the product for the production period while awaiting the irregular schedule of the ship was inadequate, however, the enterprise would not be practical.

The next move is to plan and integrate all the inputs, production and supply (both to and from), production scheduling, labour materials, services, transport etc. It may be a good idea to write down the proposed marketing chain in a graphic form to see where the difficulties lie.

Having found the niche, the venture should be costed. The costs may depend on the route chosen for the supply or production volumes. For example, it may be cheaper to combine forces with another supplier and contract a trasport company to get the poultry to market rather than buy and use a company vehicle. Whatever system is chosen it should be a practical way forward, the least complicated and one to give maximum returns or profit. it is well to

remember that to halve the profit margin (thereby reducing the cost to the buyer) and treble the supply will bring in greater returns than not changing pricing structure. It is also well to remember that if the supplier does not have the production capacity to meet the market requirement, the order may go to a supplier who can. Other aspects of costings must be taken into account. For example, the cost of special packaging, special equipment which may need to be purchased, extra costs for processing labour (eg cutting to a different specification). The cost of borrowing capital must also be included.

Implementation may require the services/skills and business of partners. This may be a bank, finance company, transport company, cold storage complex, poultry supplier, wholesaler, retailer etc. These must be chosen with care. A small transport company with low tariffs will be of no use if the driver is consistently late for collection of the poultry from the abattoir if it must be delivered to the shop at exactly 0800. To co-operate with the big transporter who charges more but gives a reliable service may be better than another concern which offers a higher margin but risks losing the business altogether.

It may be advisable to form a co-operative with other suppliers or from contracts with specialist markets to supply fixed quantity, quality and priced goods on a regular basis. These markets must be supplied to contract, which usually state the exact time, date, quantity, quality etc and expect a continuity of supply. To fail on the contract may invoke penalties. The supplier must be confident of fulfilling his side of the contract. Needless to say, a poultry processor in contract with a hotel, say, would also have a contract with a poultry producer who would also be expected to supply the stated quantity, quality etc to time.

Some buyers demand a particular product prepared to their unique specification as part of a contract. They may contract that the specification must not be divulged to another party or used if the contract is broken later. The buyers may also expect to visit the factory and make

recommendations about its condition, inspection etc. There is no harm in this. Beware, however, the buyer who wants a considerable volume of the factory output. if the factory gears up to meet the contract and the buyer defaults, the owner may have lost a lot of his investment and produce more than he is able to sell elsewhere. The buyer may return to demand a much lower price based on the weakness of the situation.

Every time a change in system is proposed there will almost certainly be cost implications. The proposal will need to be recosted time and again until the best system is found.

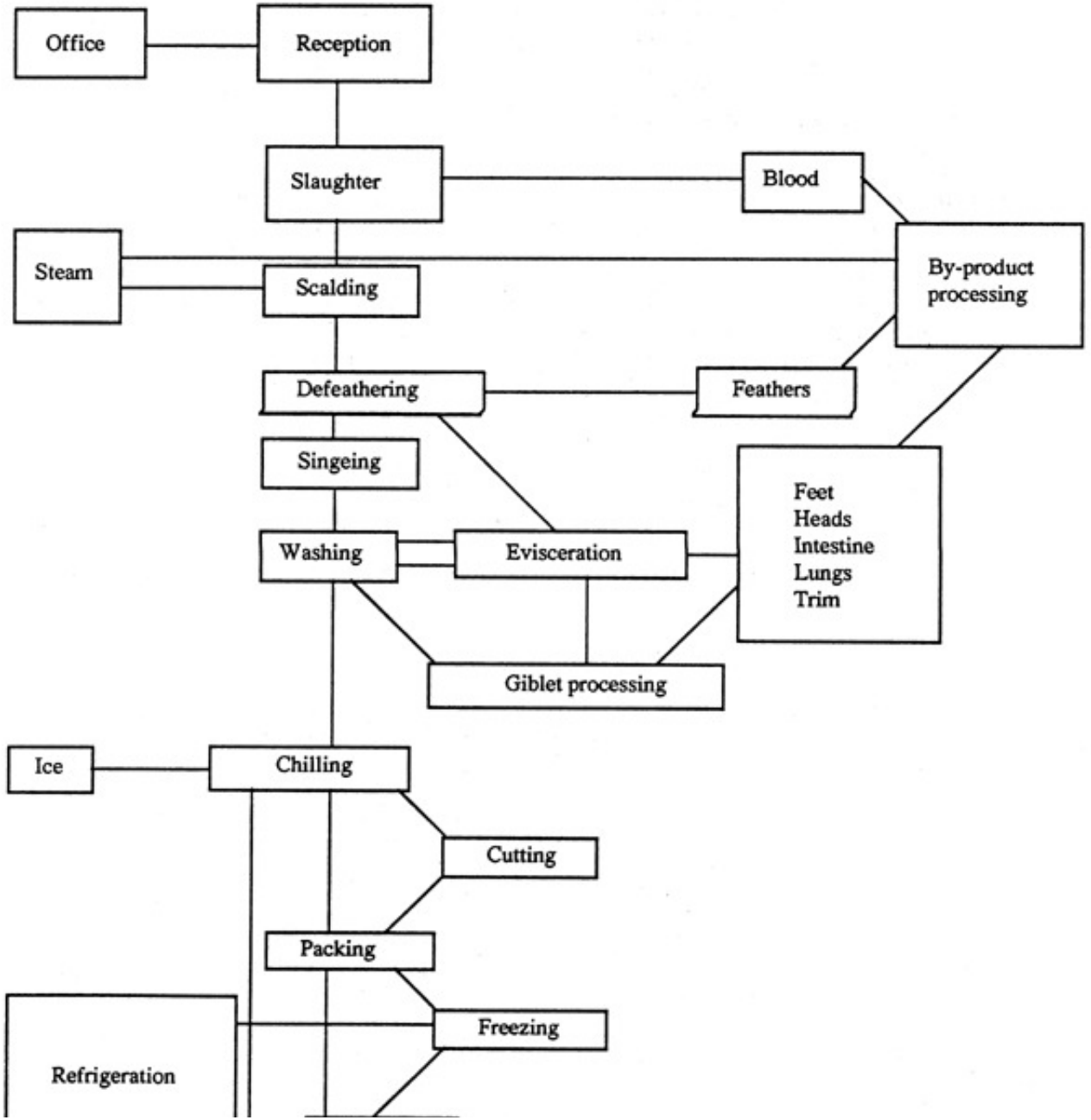
Finally, it may be desirable to test a market before making contracts with suppliers and buyers with untested goods or services. This is a perfectly acceptable way forward if handled properly.

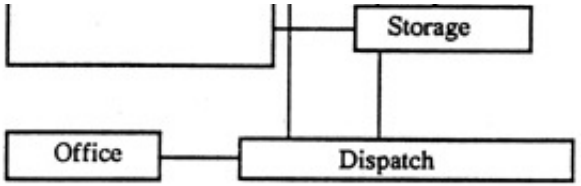
Implementation of decision

This is the moment of truth. All the decisions are made, the way forward determined, the contacts made and happy, perhaps the contracts cast in legal stone. There only remains general advice:

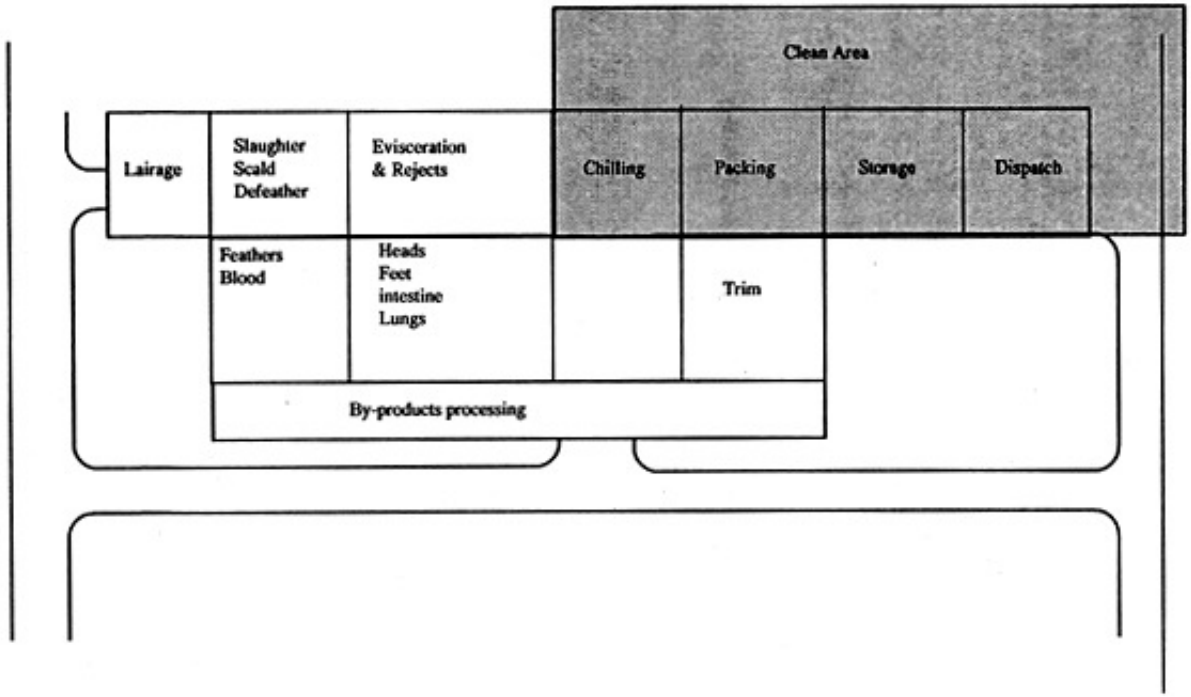
The product should be right in terms of quality, quantity, packaging, price, temperature, time and so on. In other words, the contract to the market, whether written or moral, should be fulfilled.

Annex 1 Poultry Processing: Flow Diagram





Annex 2 Separation of Clean and Dirty areas



ANNEX 3

EQUIPMENT FOR POULTRY PROCESSING UNITS

Model 1 50 Birds/day: NYD

Equipment summary

1. 4 Cone killing stand
2. Stunning/Sticking knife
3. Dry plucking machine
4. Holding table
5. Feather bins × 2
6. Mobile racks × 2
7. Wash hand basin × 2
8. Scale
9. Cleaning equipment/hose lines (High pressure power washer)
10. Insect electrocutors × 2
11. Electrical fittings
12. 12 Drainage fittings
13. Ceiling fans
14. Office equipment: Desk, table, chairs, filing cabinet, telephone etc
15. Changing room equipment: Lockers, benches, sanitary ware, showers etc

16. Laundry equipment: Sink, cupboard, clothes lines etc

17. Boot wash

Staffing

1	Reception/sticker	1
2	Plucker	1
3	Manager/dispatcher	1
4	Cleaner/labourer	1
5	Launderer	1
Total		5

Equipment Specifications

Killing stand:

Four cones to swivel about a central pillar and suspended over a blood trough. Total height about 1.2m, total diameter of 800mm, heavy duty hot dipped galvanised steel throughout.

Stunner/Sticking knife:

Low voltage stunning unit in self contained splash proof box approximately 0.25 × 0.25m. Fitted with safety trips which can cut out one or both contact pads in the event of a short circuit. The stunning prod consists of a stainless steel blade of 150mm length in a nylon non-slip handle and electrical contact pads.

Dry plucking machine:

Machine comprises a 1.1 kw (1 1/2 hp) motor driving a shaft supported by a bearing assembly. The shaft drives a plucking head by a belt. The plucking head consists of a series of rotating plates held at an angle by a thrust plate at each end of the plate bearing. As the discs rotate they close, drag in the feathers, grip them and pull them from the bird. As they continue to rotate, they separate, and release the feathers into a collection bag to the rear of the machine. The plucker is of adjustable height from about 1 to 1.5m. Voltage to local specifications, single phase.

Holding table:

1m × 600mm × 900mm height, heavy duty food grade stainless steel top and frame. Top to be slightly convex, no shelves, adjustable height feet.

Feather bins:

High density polyethylene, 1001 capacity. Tight fitting lid. Approx 2.5 × 0.6 × 0.6m.

Mobile rack:

The unit is shaped as an "A" frame mounted on four 120mm castors. The unit is approximately 1.2m × 600mm × 1.8m high. Horizontal bars hold 140 birds suspended by their feet. Hot dipped galvanised steel after manufacture.

Wash hand basin:

Heavy duty (not domestic) stainless steel with drainer. Hot and cold taps operated by knee or

arm lever. Approximately 750 × 450mm.

Scale:

Electronic top pan balance. Range 5kg × 10g. Water resistant. Voltage to local specifications.

High Pressure Power Washer

To produce a high velocity jet of hot water for cleaning purposes. An electrically operated pump passes water from a small storage tank through an electrically powered heat exchanger to raise the temperature of the water at the nozzle to 95°C. The pump also raises the pressure of the water at the nozzle to about 41 bar (600 PSI) at 95°C and 90 bar (1300 PSI) at the lower temperature of 68°C. Fitted with a detergent facility which permits the application of a range of detergents to increase cleaning efficiency.

Cleaning equipment

All cleaning equipment to be manufactured in plastic, nylon or stainless/galvanized steel (preferably seamless) these items should conform to hygienic standards. Comprising: a high pressure washer system with heavy duty industrial couplings, components and hose lines suspended overhead. Hose lines to be of heavy duty plastic with pressure release tap to withstand 6.8 bar. Industrial wet'n'dry vaccum cleaner, mobile bucket trolleys, mops and wringers, scrubbing brushes (with and without handles), stiff brooms and buckets (minimum capacity 13 litres).

Insect electrocuters:

An ultra - violet light source set within a metal case to attract virtually all flying insects. Once

the insect has been attracted to the unit, it comes into contact with an electrically charged grid where it is electrocuted and falls into a large collection tray at the base of the unit. Approximately 250 × 250 × 610mm, UV light output 160 Watts.

Electrical Fittings:

To IP 54/56/65 standard for safety. Equipment should be water resistant, heavy duty.

Drainage fittings

Heavy duty grilles, cast iron.

Ceiling fans:

Heavy duty (industrial) variable speed control, water resistant.

Office equipment:

Standard furniture, heavier duty preferred.

Changing room equipment:

Industrial quality.

Laundry equipment;

Industrial quality.

Boot wash:

Heavy duty, locally fabricated to fit chosen site.

ANNEX 4

EQUIPMENT FOR POULTRY PROCESSING UNITS

Model 2 200 Birds/day: Chilled whole poultry carcases

1. Poultry crates × 100
2. 8 Cone killing stand
3. Stunner/Sticking knife
4. Waterfall dip tank, with thermometer
5. Flight feather remover
6. Holding table, 2 × 1m
7. Bowl plucker or 1.5m plucker
8. Feather bins × 3
9. Mobile racks × 3
10. Evisceration carousel or Evisceration table
11. Evisceration tools, 3 sets

12. **Single sided giblet station × 1**
13. **Carcase washer**
14. **Sink unit/sterilizer × 2**
15. **Wash hand basin × 3**
16. **Icemaker, for use with ice tank only**
17. **Ice tank or Spiral washer chiller**
18. **Packing table × 2**
19. **Shelving**
20. **Offal truck**
21. **Scale**
22. **Dry store room**
23. **Cold storage**
24. **Blast freezer**
25. **Freezer storage**
26. **Insect electrocutors × 3**

27. **Electrical fittings**
28. **Drainage fittings**
29. **Ceiling fans**
30. **Office equipment: Desk, table, chairs, filing, cabinet, telephone etc**
31. **Changing room equipment: Lockers, benches, sanitary ware, showers etc**
32. **Laundry equipment: Sink, cupboard, clothes lines etc**
33. **Boot wash**
34. **Cleaning equipment/hose lines (High pressure power washer)**
35. **Bagging machine × 2**
36. **Bags, trays, film, cartons etc**
37. **Optional air conditioning**

Staffing

1	Reception/sticker	1
2	Scalder	1
3	Plucker	1
4	Eviscerator	1

5	Truss/Packer	2
6	Manager/dispatcher	1
7	Cleaner/labourer	1
8	Launderer	1
Total		9

Equipment Specifications

Cone killing stand, Stunner/Sticking knife, Holding table, Feather bins, Mobile racks, Wash hand basin, Scale, High Pressure Power Washer, Insect electrocutors, Electrical fittings, Drainage fittings, Ceiling fans, Office equipment, Changing room equipment, Laundry equipment, Boot wash, Steam cleaner: All as model 1

Poultry crates:

Commercial standard in heavy duty plastic to hold 10–12 live birds. Washable under high pressure

Waterfall dip tank, with thermometer:

A 1.22m waterfall dip tank which ensures the bird is immersed in hot water. Powered by a 0.75kw motor and heated by LPG or electricity.

Flight feather remover:

Two horizontal metal shafts of 300mm in length and 50mm diameter set at 2– 5mm gap are powered by a 1kw motor. As the shafts rotate, they grip the offered flight feathers and pull

them from the wings. The action is similar to that of a washing mangle. With safety guards/stops to prevent fingers and wing meat being drawn into the roller jaws.

Bowl plucker or 1.5m plucker:

Aluminium bodied plucking machine mounted on legs. Round plucking bowl contains two double, rubber flails which are rotated by an electrical motor of 4kw. Carcases to manufacturers weight specification are placed into the bowl and plucked in about 35 seconds.

Plucker comprises tank holding a horizontally mounted stainless steel drum of about 0.5m diameter. The drum holds protruding rubber fingers of about 200mm. The drum revolves briskly away from the operator taking the feathers from the offered carcase and throwing them to the back.

Evisceration carousel

A circular tray made of heavy duty aluminium of 1.25m in diameter at waist height. A wheel is located above this tray at a height of 1.5m from which is suspended a series of poultry hangers. One to five operators stand around the tray and each performs a part of the evisceration process. The wheel is turned by hand so that the next carcase is presented to the operator. Offal is dropped into the tray. The tray has a hole through which the offal passes into an offal truck.

Evisceration table:

2m × 1m × 900mm height. Heavy duty industrial stainless steel table with cutting board. A small hole is cut into the surface of the table, under which an offal truck or bin can be placed.

Evisceration Tools:

A set of heavy duty stainless steel tools for the removal of most of the organs from the cavities of the bird, the head, neck and associated tissues. A comprehensive set of tools comprise; fork/spoon, knife, hook(for roping), rollcut secateurs, hand singeing gun, stubbing knife, drawing tool and lung remover (serrated loop).

Single sided giblet station:

Comprising: Table, 3 giblet pans and 3 pan supports. Giblet pans, chopping blocks and cleaning screens are arranged over a large heavy gauge steel plate basin which is mounted on four substantial legs fitted with two spray traps for connection to mains water supply. Unwanted material is automatically washed away leaving the working surface clean and uncluttered.

Carcase washer:

water hose suspended from the ceiling with a gun-style water nozzle. Water is sprayed onto the carcase by operation of the trigger.

Sink unit/sterilizer:

For cleaning and sterilizing poultry processing tools and implements. Comprising; 1m long stainless steel sink unit with draining board and an electrically operated sterilizer constructed from heavy gauge stainless steel, 0.2 × 0.3 × 0.3m.

Icemaker:

Self contained stainless steel machine producing flaked ice at approx-25°C from a mains cold water supply. Production capacity 400 kg/day. Standard storage capacity 200 Kg. Dimensions(W × D × H)1.08 × 0.85 × 1.58m. Extra storage bins(0.38m^2) required to increase storage capacity to 500 Kg. Mains water, electricity and a drain required.

Ice Tank

Insulated tank to contain slush ice for initial cooling of poultry carcases. Dimensions 2.5 × 0.6 × 0.6m

Spiral washer chiller

Insulated stainless steel tank containing water previously cooled over an in- built refrigeration coil to 4°C. The refrigeration compressor, motor, valves etc are integral with the machine and to a capacity specific to the production system. A programmable timer is supplied to prechill the water in readiness for production. May be supplied with an auger to assist passage of carcases.

Packing table:

As holding table

Shelving:

Heavy duty (industrial) hot dipped galvanised or stainless steel.

Offal Truck

Heavy duty galvanised steel truck mounted on four industrial castors/wheels. Approximately(L × W × D) 0.6 × 0.6 × 0.45m. Comprising, galvanised steel basket inside the truck, into which offal is placed and a tap at the base for draining liquids.

Dry store room:

A dry, well ventilated and lit store room approximately 3 × 4m. Insect proof air bricks for ventilation fitted with industrial heavy duty shelving. Under extreme environmental conditions a dehumidifier or air conditioning unit may be required.

Cold storage:

Modular construction cold storage cabinet(2°C). Approx 2.5 × 3m. To cool 300kg of poultry carcases from 10°C to 2°C in 12 hours under prevailing environmental conditions. Power and drain required.

Blast freezer:

Self contained machine for freezing of up to 100 birds (150kg) from 2°C to- 40°C within 2 hours. Dimensions (w/d/h) approx 2045 × 3315 × 2590m. Power supply and drain required.

Freezer storage:

Modular construction walk-in freezer(-20°C). Approx 3 × 4m. To hold 450kg of poultry carcases at -20°C. Power and drain required.

Bagging machine:

An electrically operated machine for manual vacuum bagging/wrapping of birds one at a time in high shrink plastic film bags. Power required.

Bags, trays, film, cartons etc:

High shrink plastic film which prevents dehydration, acts as a moisture barrier and is permeable to oxygen, thereby maintaining meat colour. Also expanded polystyrene trays and plastic cartons for hygienic meat packaging.

Air conditioning

To suit local conditions

ANNEX 5

EQUIPMENT FOR POULTRY PROCESSING UNITS

Model 3 350 Birds/hour: Chilled whole poultry carcases and portions

1. **Poultry crates, × 1000**
2. **Complete hanging/sticking/bleeding/scalding equipment, comprising: loading bar, 15m overhead conveyor for killing and bleeding out, 75 S/S shackles, 2.5m bleeding trough and 3m waterfall dip tank.**
3. **Stunner/sticking knife**
4. **Flight feather remover**

5. **Bowl plucker or 1.5m plucker with booster flail**
6. **Feather bins × 3**
7. **Pinning table or finisher**
8. **Evisceration unit comprising: 16m conveyor line, 65 shackles, 3.7m evisceration trough and mobile offal truck.**
9. **Carcase washer**
10. **Giblet processing station, comprising table, 3 pans and 3 pan supports**
11. **Gizzard skinner**
12. **Mobile racks × 10**
13. **Evisceration tools, 4 sets**
14. **Secateurs**
15. **Boning knives × 48**
16. **Pinning knives × 24**
17. **Knife sharpener**
18. **Thermometer**

19. **Carcase washer**
20. **Sink unit/sterilizer × 42**
21. **Wash hand basin × 2**
22. **Icemaker for use with ice tank only**
23. **Ice tank or spiral washer chiller(both optional)**
24. **Refrigeration for carcases(optional)**
25. **Packing table × 2, 2 × 1m**
26. **Poultry portioning machine**
27. **Shelving**
28. **Scale × 2**
29. **Dry store room**
30. **Blast freezer,**
31. **Freezer storage**
32. **Cleaning equipment/hose lines(High pressure power washer)**
33. **Insect electrocutors × 5**

34. **Electrical fittings**

35. **Drainage fittings**

36. **Ceiling fans**

37. **Office equipment: Desk, table, chairs, filing cabinet, telephone etc**

38. **Changing room equipment: Lockers, benches, sanitary ware, showers etc**

39. **Laundry equipment: Sink, cupboard, clothes lines etc**

40. **Boot wash**

41. **Bagging machine**

42. **Trays, films, and cartons for packaging**

43. **Offal skip**

44. **Air-conditioning(optional)**

Staffing

Killing and Plucking

1	Unloading, handling and washing crates	1
2	Removing birds from crates and hanging onto conveyor line	1
3	Killing	1
4	Plucking machine operators	4

5	Pinning, inspection of plucked birds 2 and hanging plucked bird onto conveyor	
Total		**9**
Evisceration		
1	Slitting necks, detaching from crop and depositing into evisceration trough	1
2	Cutting round vents and opening aperture	1
3	Drawing out viscera but leaving it attached to the carcase	1
4	Removing liver, hearts and gizzards and placing them in the appropriate giblet trays. Detaching inedible offal and allowing it to fall into the evisceration trough	1
5	Inspecting inside the carcase, removing remainder of lung tissue, removing head and placing in evisceration trough. Removing neck and placing into the appropriate giblet tray	2
6	Cutting off feet and hanging carcase onto air conditioning racks	1
Total		**7**
Offal preparation		
1	Slitting and washing gizzards	1
2	Sorting and packing edible offal	1
3	Supervisor, moving full and empty offal trays and assisting	1
Total		**3**
Cooling		
1	Handling and moving air conditioning racks in and out of chill room, and to and from various work stations	1
Total		**1**

Packing

1	Putting chilled packed offal inside carcase	1
2	Tying down, banding or trussing	1
3	Putting bird inside bag	1

4	Weighing and placing preprinted weight label inside bag	1
5	Sealing bag and placing in freezer tray	1
Total		5
Supervisory and reliefs		4
Grand Total		**29**

Equipment Specifications

Crates, Stunner/sticking knife, Flight feather remover, Finisher, Bowl plucker or 1.5m plucker with booster flail, Feather bins, Mobile racks, Evisceration tools, Spiral washer chiller, Carcase washer, Sink unit/sterilizer, Wash hand basin, Shelving, Scale, Dry store room, High pressure power washer, Insect electrocutors, Electrical fittings, Drainage fittings, Ceiling fans, Office equipment: Desk, table, chairs, filing cabinet, telephone etc, Changing room equipment: Lockers, benches, sanitary ware, showers etc, Laundry equipment: Sink, cupboard, clothes lines etc, Boot wash, Trays, films, and cartons for packaging: As for 200 Birds/day.

Complete hanging/sticking/bleeding/scalding equipment, comprising: loading bar, 15m overhead conveyor for killing and bleeding out, 75 S/S shackles, 2.5m bleeding trough and 3m waterfall dip tank.

An oblong open structure in galvanised steel, measuring 7 × 1.5m comprising the superstructure to hold an overhead rail. The rail is about 2.2m from the floor. The rail holds a conveyor system of approx 15m in length comprising 75 stainless steel shackles supported by a rod and trolley system. The shackles are "W"-shaped and used for holding poultry by their legs. Each shackle is separated and attached to its neighbour at 0.2m intervals by a chain. This continuous loop is driven by a motor at a speed of 0.6–1.4m/min. A loading bar of 1.0m is positioned at the same height as the poultry shackle to steady it as the poultry is loaded. As

the shackles move round the system they pass over a 2.5m stainless steel bleeding trough at the second bend. This "L"-shaped structure is free standing on adjustable stainless steel legs. Continuing on its journey, the rail guides the conveyor downwards by about 0.5m for the dead poultry to pass into the stainless steel waterfall dip tank. This scalding tank is 3m in length and 0.6m wide. It is free standing on adjustable stainless steel legs. It has a drain and a system for maintaining its water level. The scald water is heated to temperature by electricity or gas. Finally, the rail rises to its original level before turning two bends to reach the loading bar again. See Drawing 3.

Pinning table:

1 × 0.6 × 0.9m height, heavy duty stainless steel top and frame with adjustable feet. For the removal of pin feathers from poultry.

Evisceration unit comprising: 16m conveyor line, 80 shackles, 3.7m evisceration trough and mobile offal truck.

An open structure in galvanised steel comprising the superstructure to hold an overhead rail. The rail is about 2.2m from the floor and is about 16m in length on a continuous loop which is roughly "L"-shaped. See Drawing 3. The rail holds a conveyor system comprising 80 stainless steel shackles supported by a rod and trolley system. The shackles are "W"-shaped and used for holding poultry by its legs. Each shackle is separated and attached to its neighbour at 0.2m intervals by a chain. This continuous loop is driven by a motor at a speed of 0.6–1.4m/min. The shackles pass over a stainless steel evisceration trough. This trough measures 3.7m × 1.0m and stands about 1m from the floor. It is a wide "V" shape in cross section and slopes to the mobile offal truck situated at one end. The trough is provided with water taps to assist with transport of the viscera to the truck. The trough holds three giblet pans mounted on supports.

The overhead rail then passes through the bird washer (which see) and over the pinning table to complete the circuit. The mobile offal truck comprises a perforated container of 0.5^3m, made of galvanished steel. The container is supported on a trolley of four wheels, a handle and a tap at base to drain liquids.

Carcase washer

To wash the carcase thoroughly both externally and internally after it has been completely eviscerated. Incorporating a water spray and two soft flail loaded spindles. The gentle sponging action ensures a clean carcase. Adjustable legs and an accommodation for various bird sizes. The two cleaning drums are rotated by two independent electrical motors. Alternatives include replacement of the flails with 12 angular adjustable spray heads. A pump ensures water at high pressure cleans carcases.

Giblet processing station:

Comprising table, 6 giblet pans and 6 pan supports. Giblet pans, chopping blocks and cleaning screens are arranged over a large heavy gauge steel plate basin which is mounted on four substantial legs fitted with two spray traps for connection to mains water supply. Unwanted material is automatically washed away leaving the working surface clean and uncluttered.

Gizzard skinner:

Two intermeshed serrated rollers powered by a geared electric motor remove the skin after the gizzards have been cut open and thoroughly washed to remove all the grit. This machine can be mounted either over the eviscerating trough or above the giblet station so that the skins are washed away as they are peeled off.

Secateurs:

Heavy duty stainless steel

Boning knives:

Heavy duty stainless steel, in a non-slip nylon handle

Pinning knives:

Heavy duty stainless steel, in a non-slip nylon handle

Knife sharpener:

Heavy duty

Thermometer:

Electronic battery or mains operated digital display instrument constructed in heavy duty, splashproof plastic with a 150mm stainless steel washable probe.

Icemaker:

Self contained machine producing flaked ice at approx -25°C from a mains cold water supply. Production capacity 5000 kg/day. Storage capacity up to 5000 kg. Dimensions (W×D×H) 1.72 × 2.15 × 1.85m. Plug in unit requiring only connection to water, power supply and drain.

Ice tank (optional):

Insulated tank to contain slush ice for initial cooling of poultry carcases. 5 × 1.4 × 1.4m

Refrigeration (optional)

To cool 4 racks of 150 birds (900kg of poultry carcases) from 35°C to 2°C in 2 hours under prevailing environmental conditions.

Packing table:

As holding table

Poultry Portioning Machine:

Electrically operated machine in stainless steel. Bird is placed onto guarded blade for portioning. With rest for bird placement.

Blast freezer:

There are two options:

- **Built in blast freezer room (as shown) to hold eight racks, equivalent to about 750–900 carcases or 1500kg poultry carcases.**
- **3 × standard blast freezing machines of 300 bird capacity (450kg). Mains power supply and drain required. Each standard unit is 2045 × 5070 × 2895mm (w/d/h). This would give greater flexibility and control over the processing operation.**

  Both units have an operating temperature of -40°C with average air speed of 2–4m/s to cool poultry from 5°C to -40°C in 2 hours under prevailing environmental conditions.

Freezer storage:

Modular construction walk-in freezer unit (-20°C) approx 9 × 4.5m. Power and drain required.

Bagging machine:

A vacuum packaging machine for bagging/wrapping birds in high shrink plastic film bags. Power required. Birds arrive by conveyor, with fully automatic wrapping and sealing for virtually continuous packaging.

Offal skip:

Standard skip to take 14001 of offal waste

Air conditioning

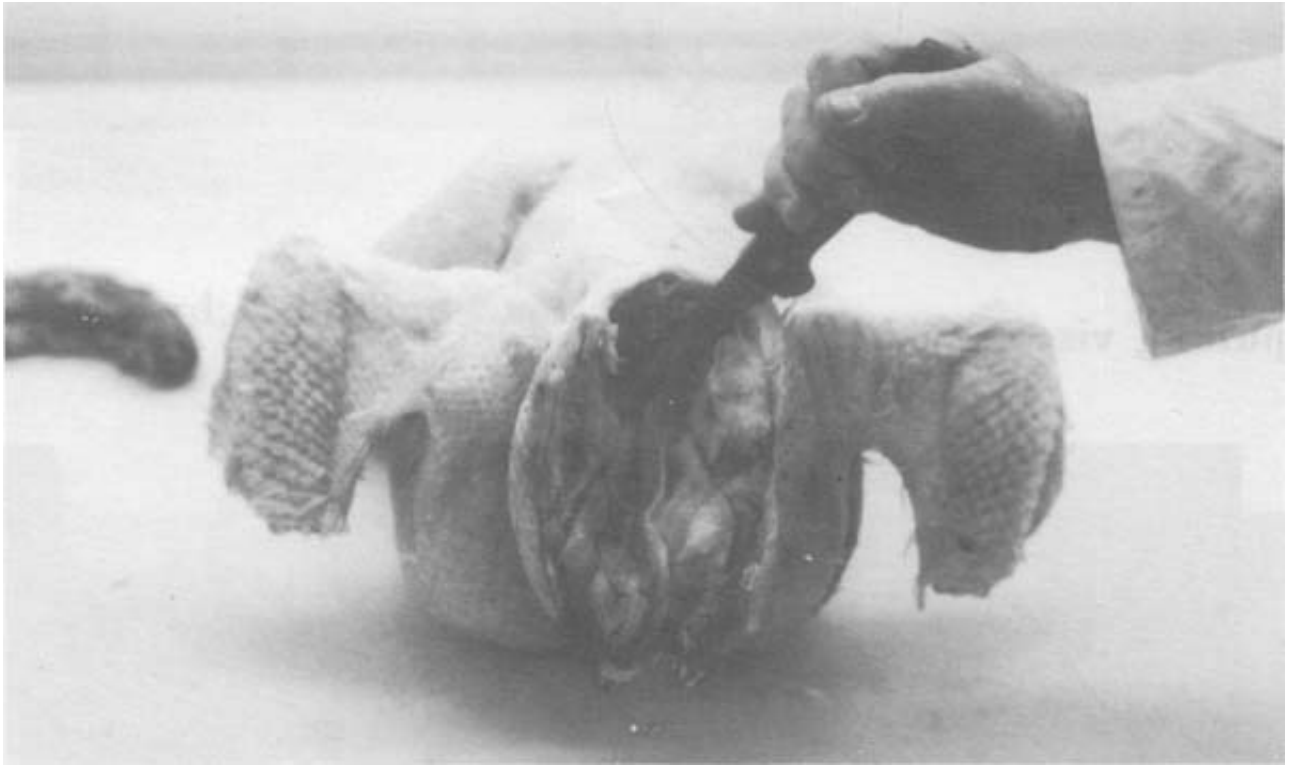
To suit local conditions

ANNEX 6

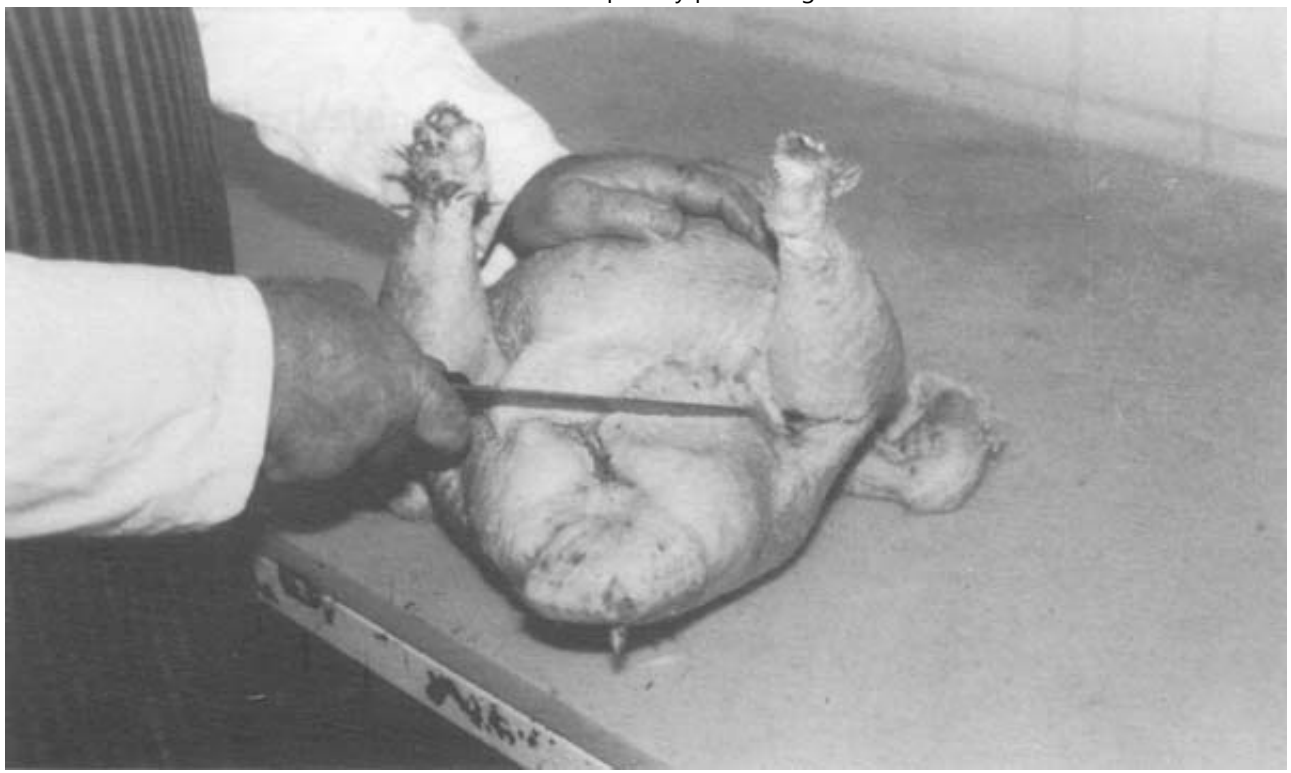
Evisceration, Trussing and Portioning Poultry Carcases

Table Dressing

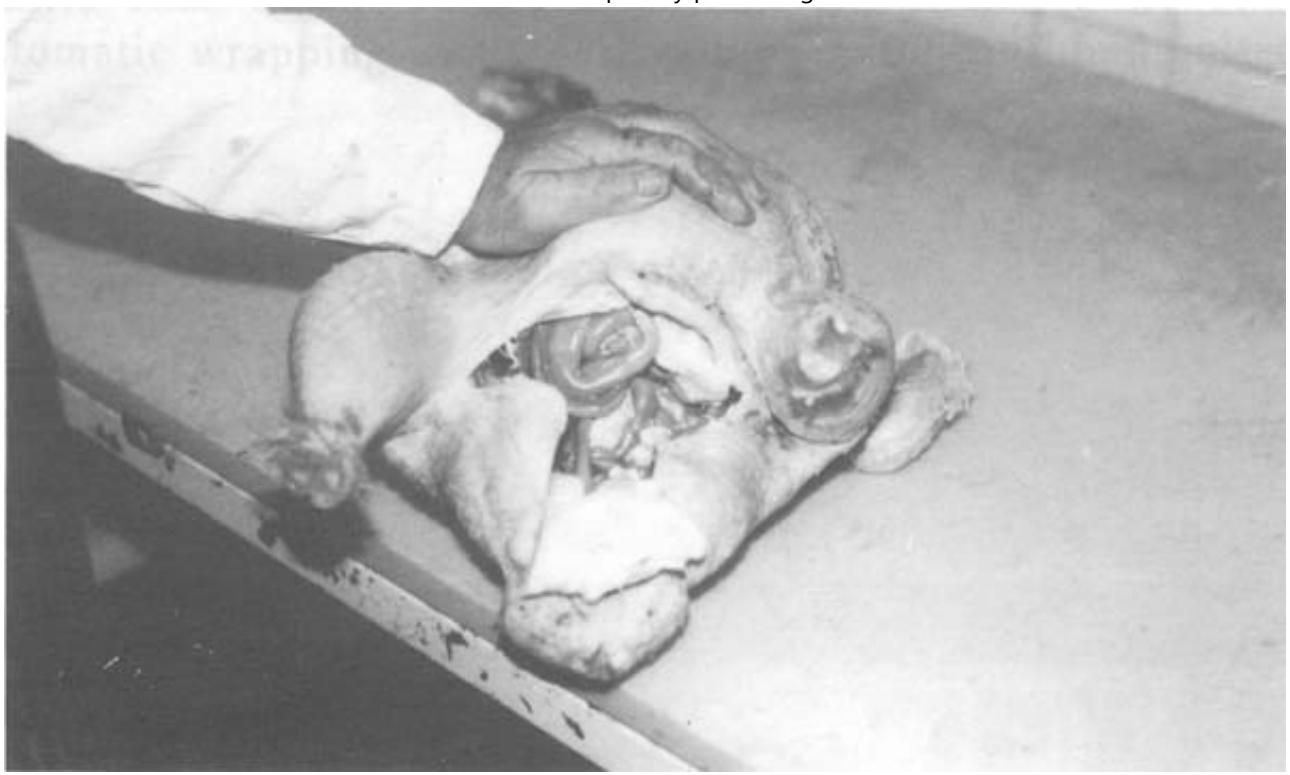
1 Remove neck



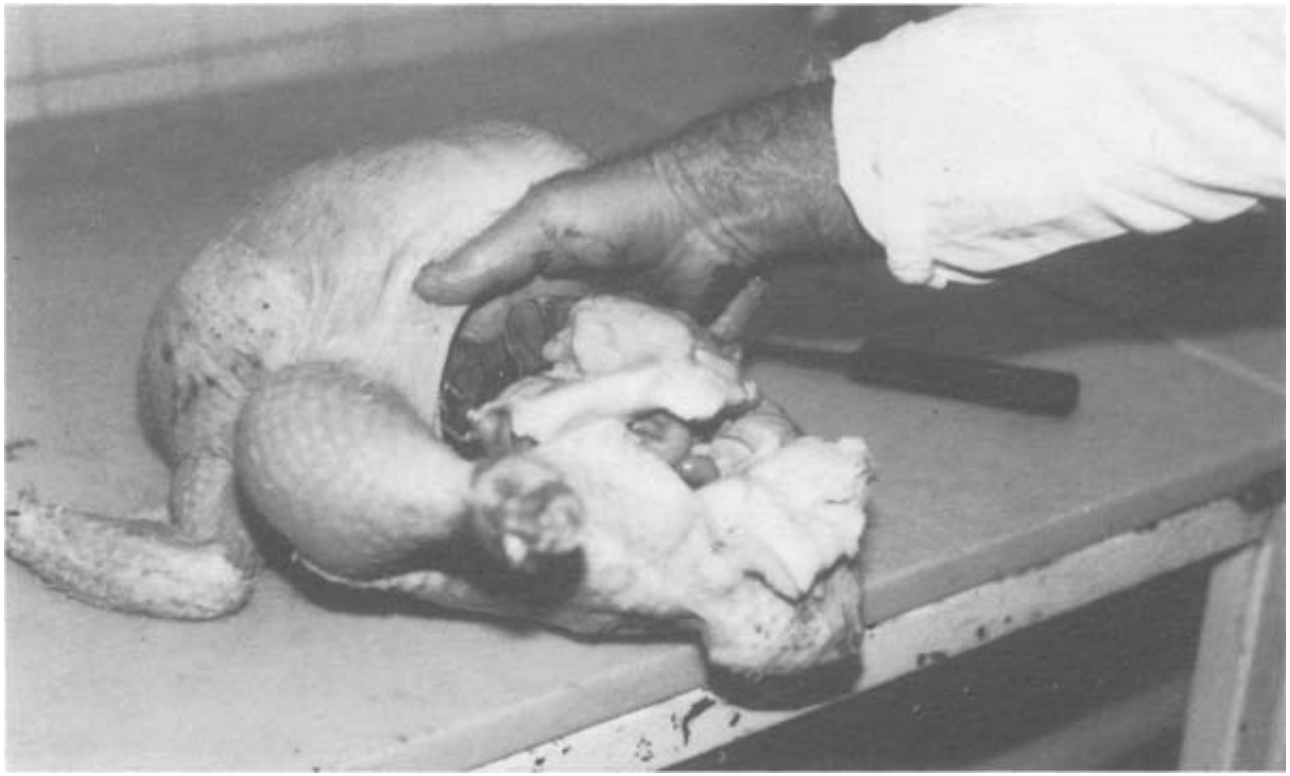
2 Cut across the vent



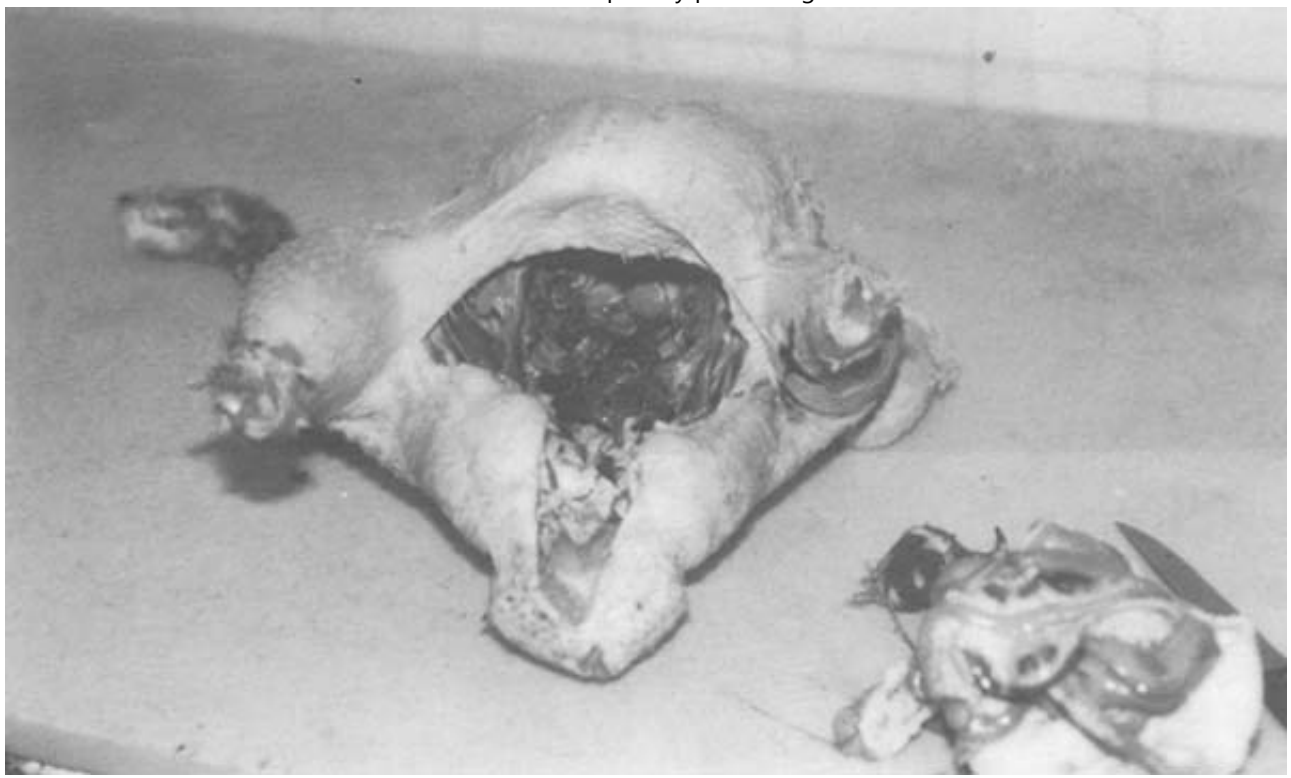
3 Carcase cut around the vent



4 Hand pulling viscera

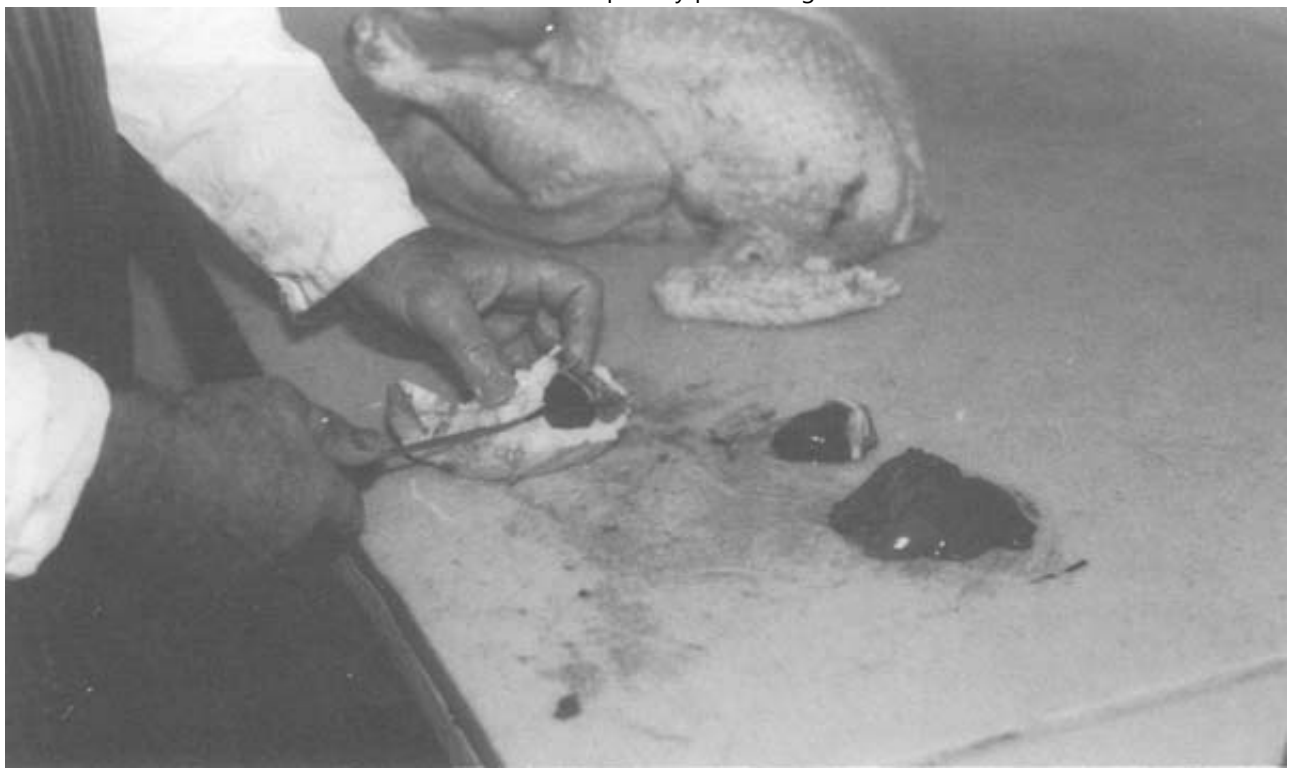


5 Empty carcase and viscera

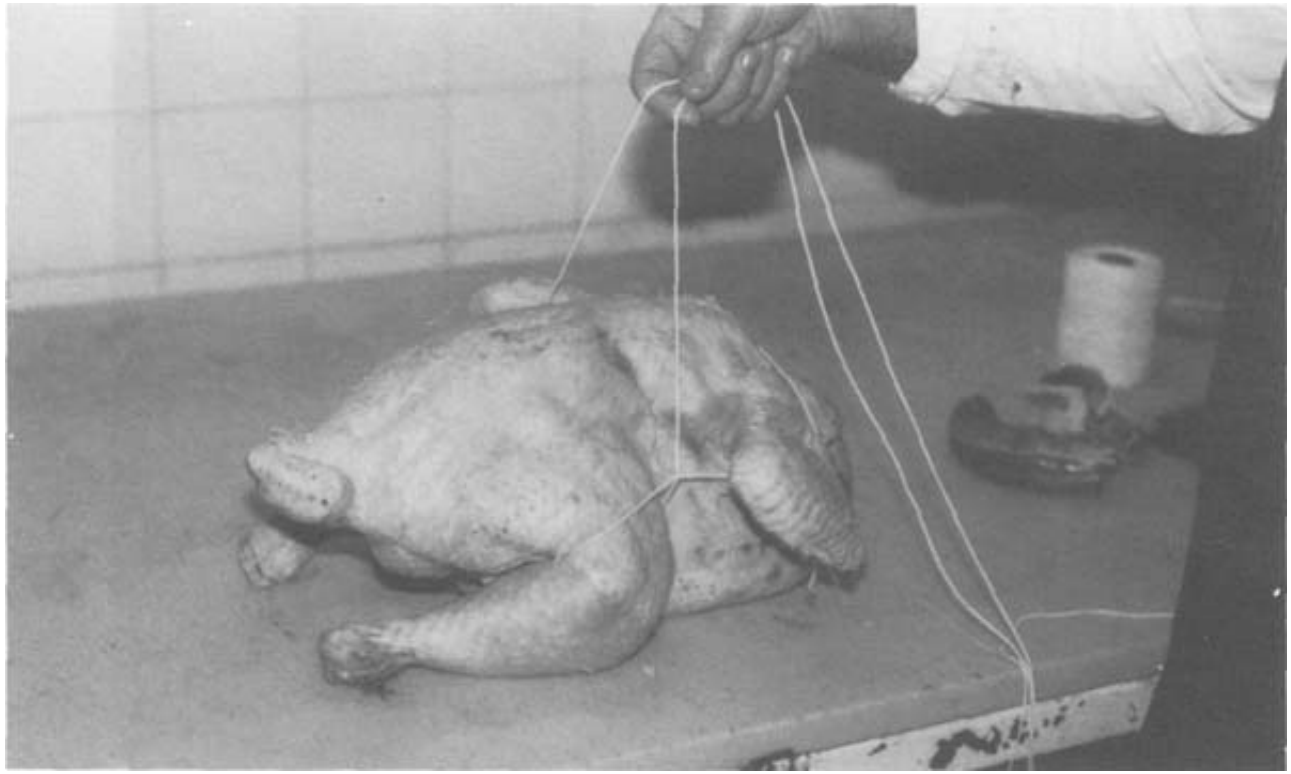


6 Viscera

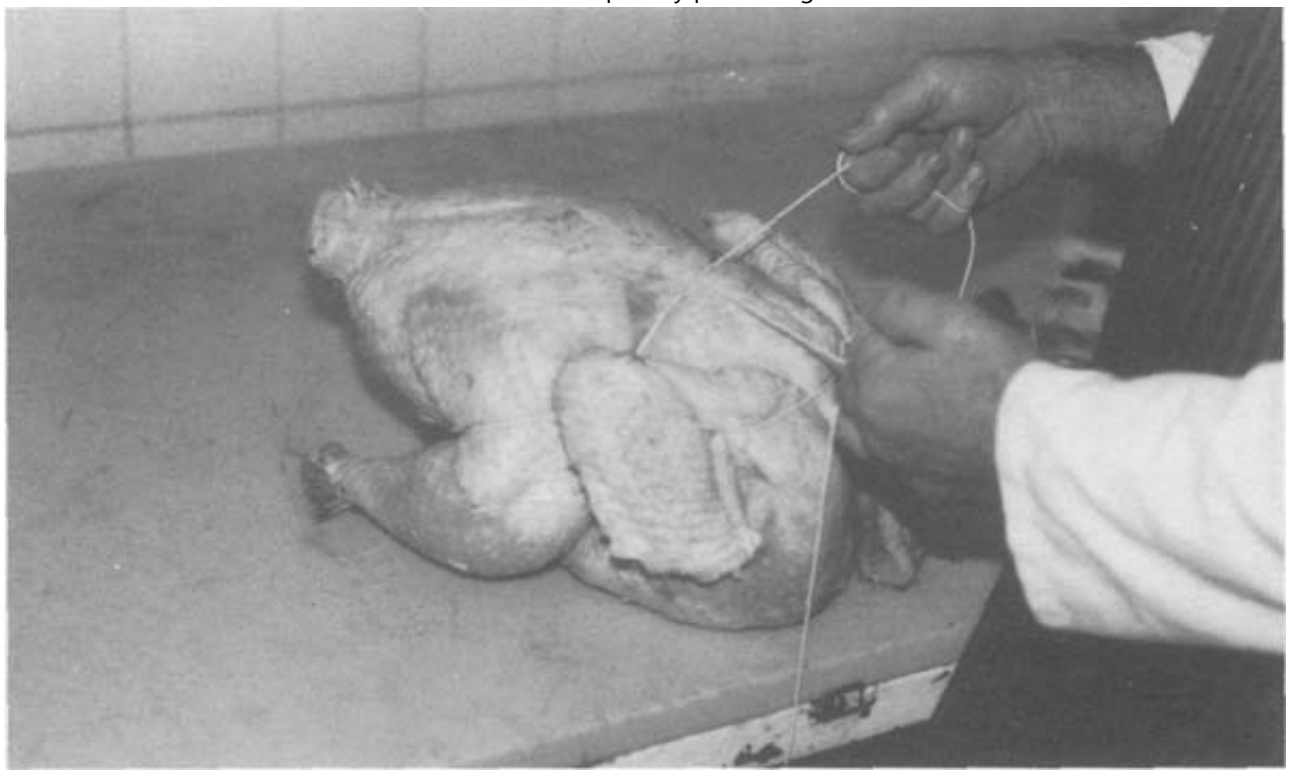
7 Slitting gizzard; heart and liver



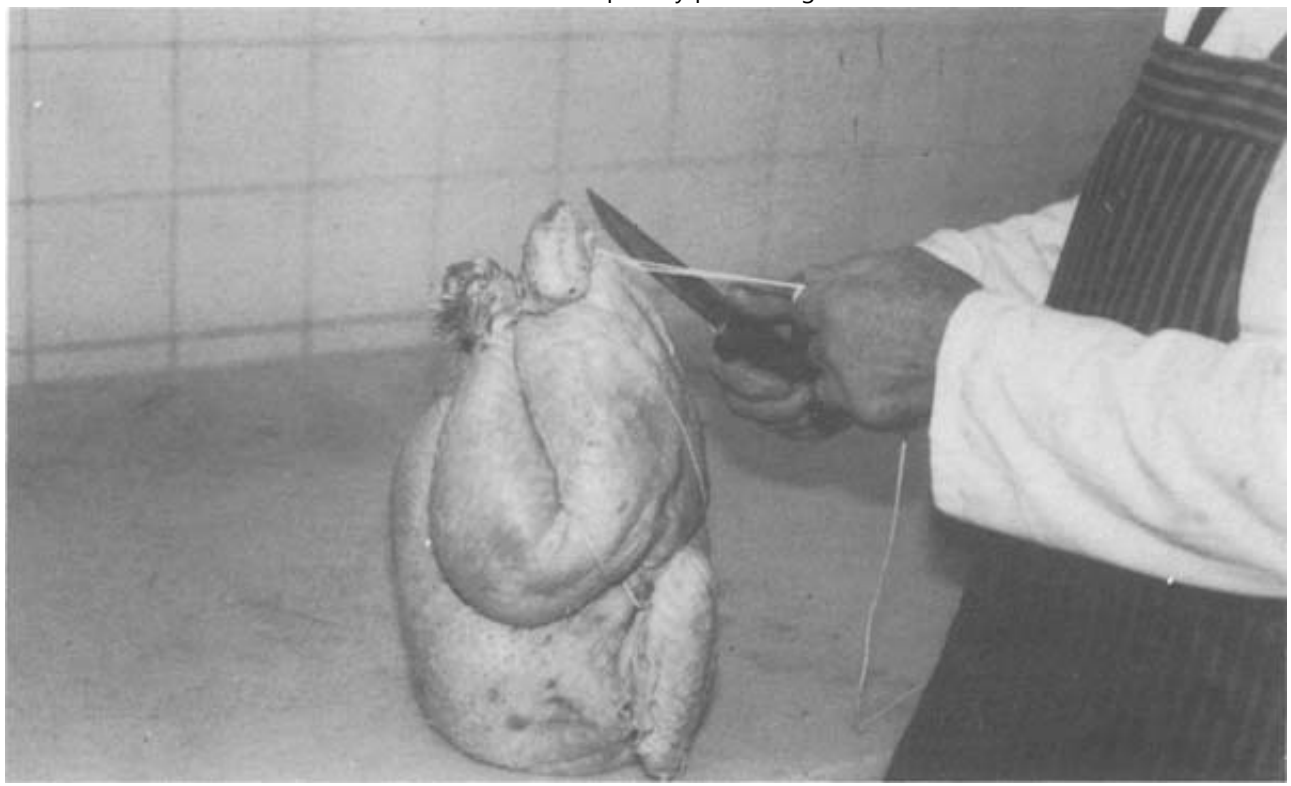
8 Trussing: First steps



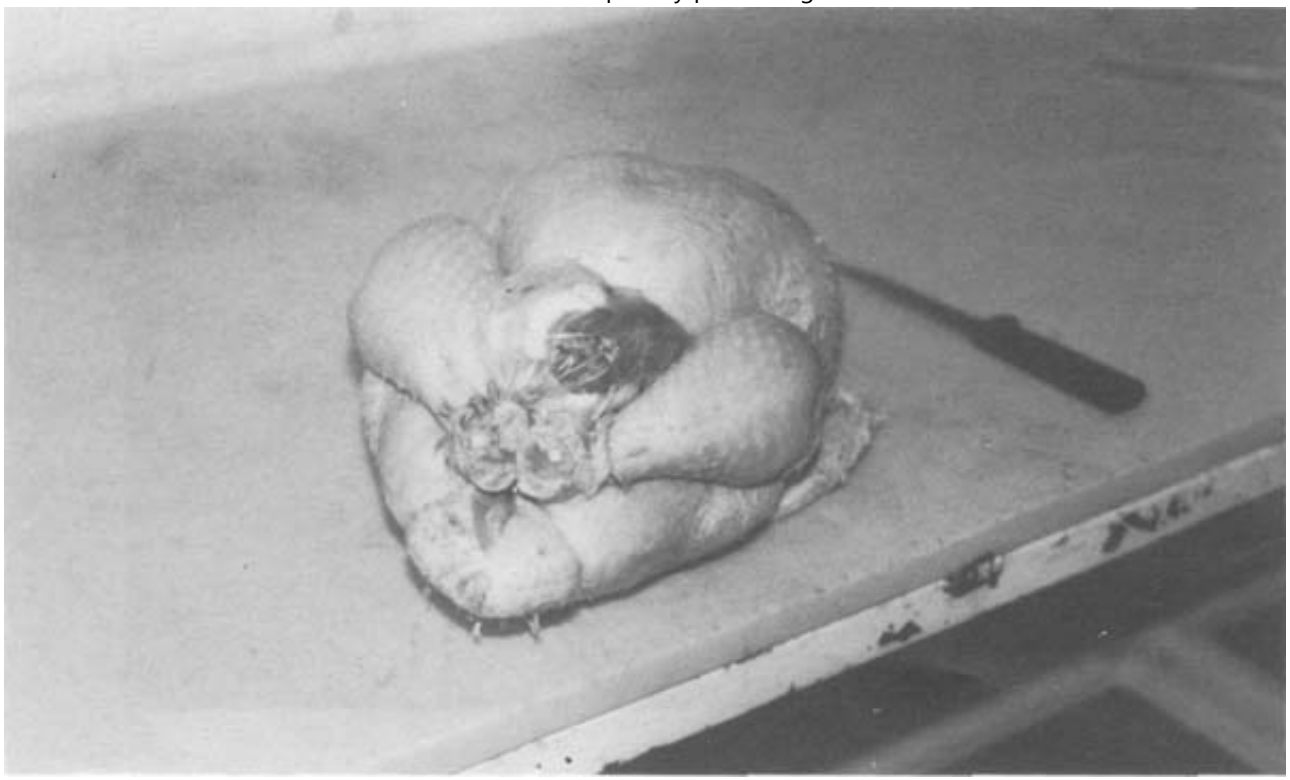
9 Trussing: Pull string tight and cross at back



10 Trussing: Tie off at Parson's nose



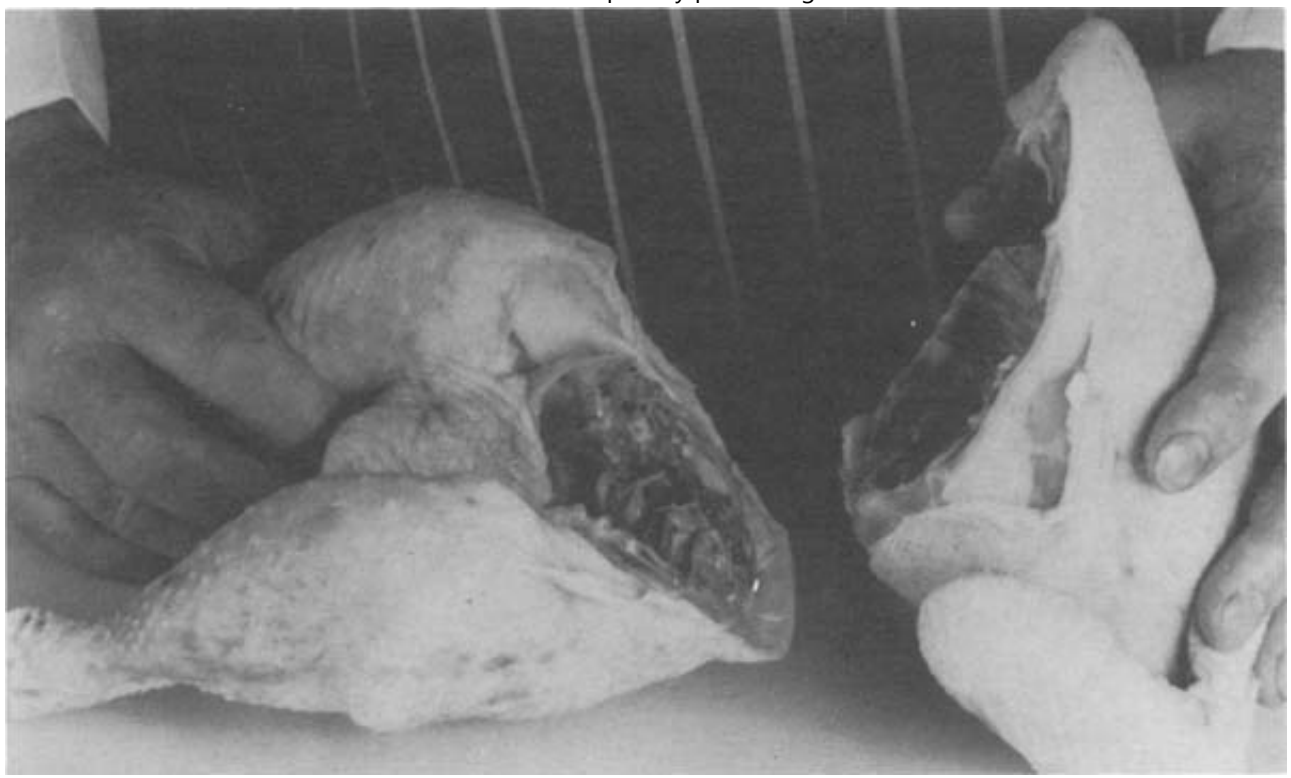
11 Trussed bird with giblets



Poultry Portioning

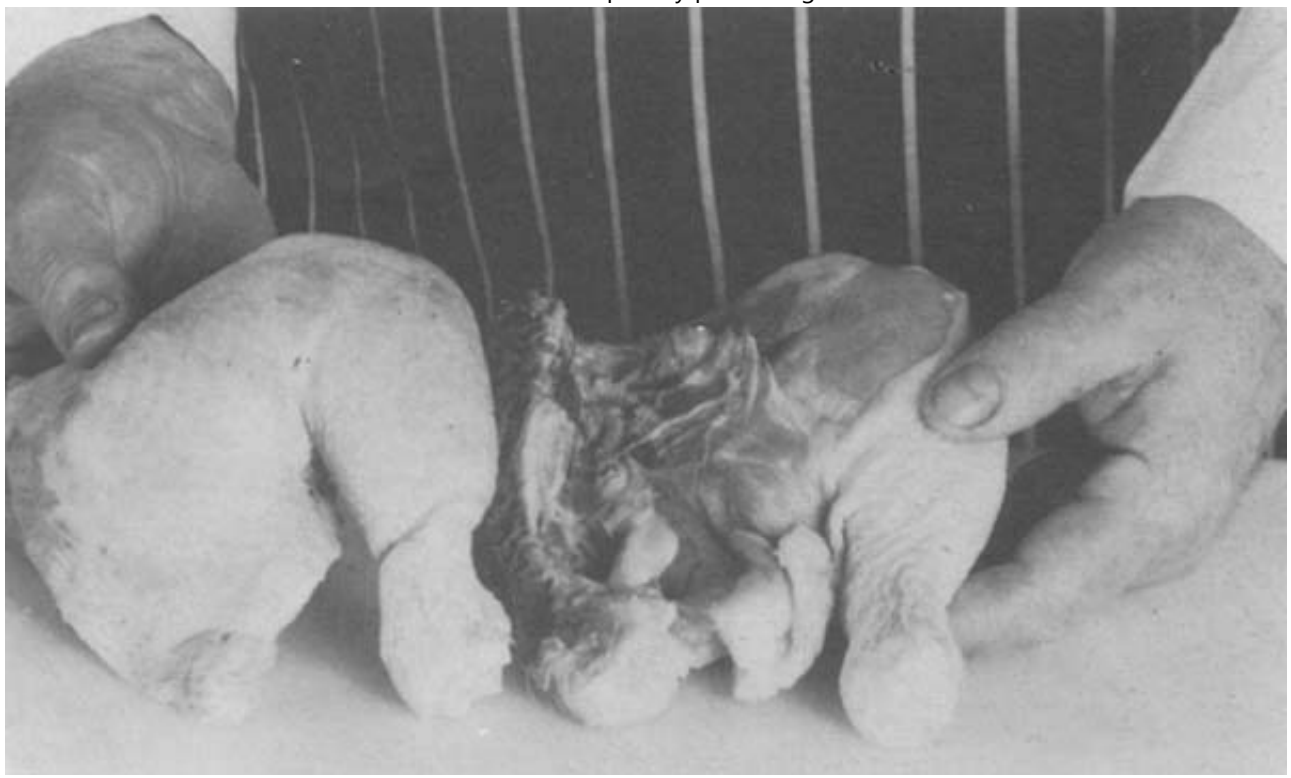
1 Half the chicken by cutting under the breast under the breast bone

2 Divide the legs and thighs from the breast



3 Quarter the legs and thighs

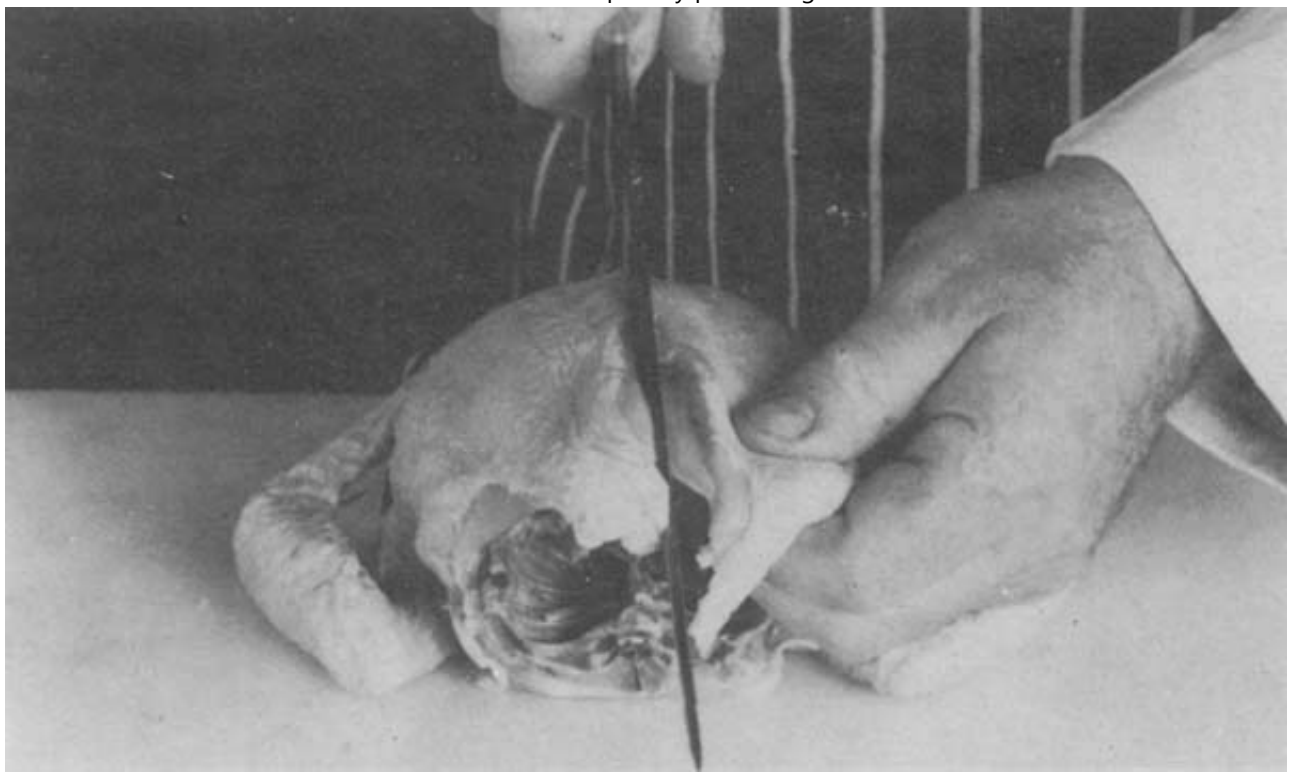
4 Thighs and drumsticks



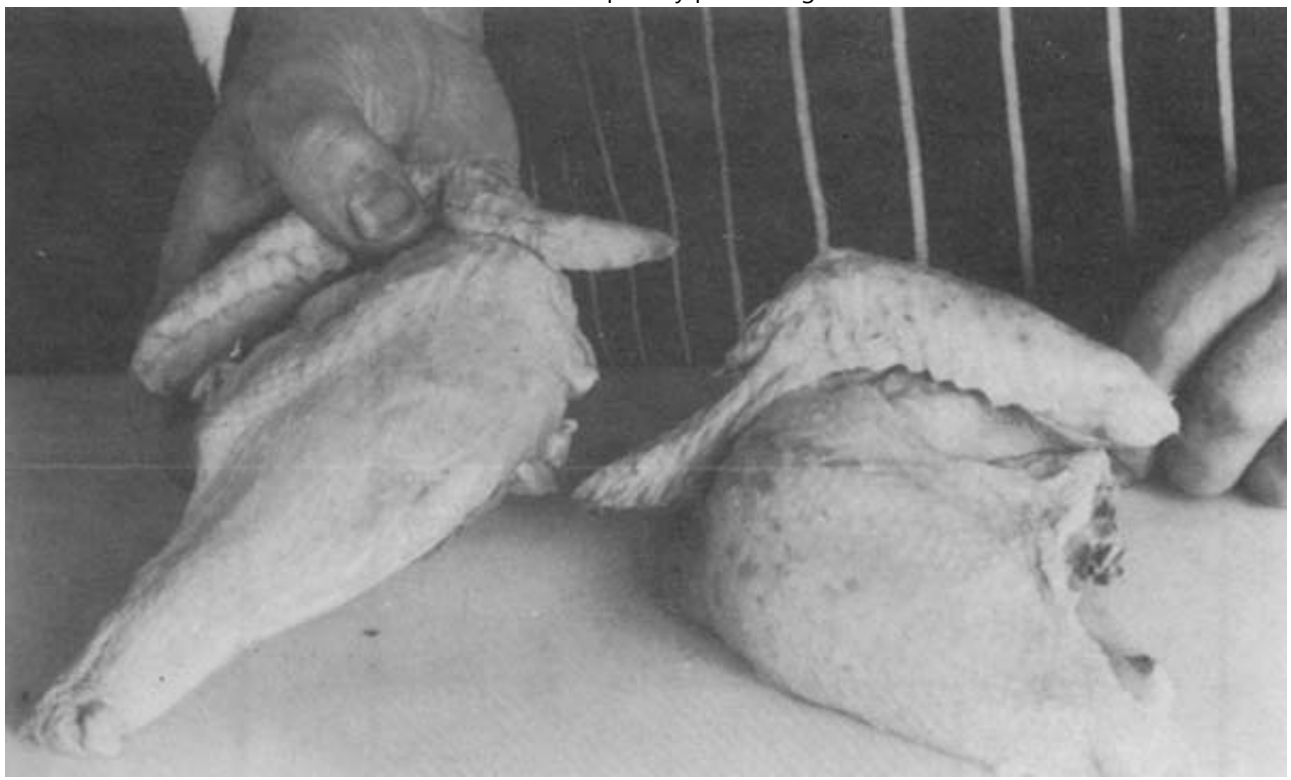
5 Cut the drumsticks from the thigh through the joint

6 Chicken thigh and drumstick

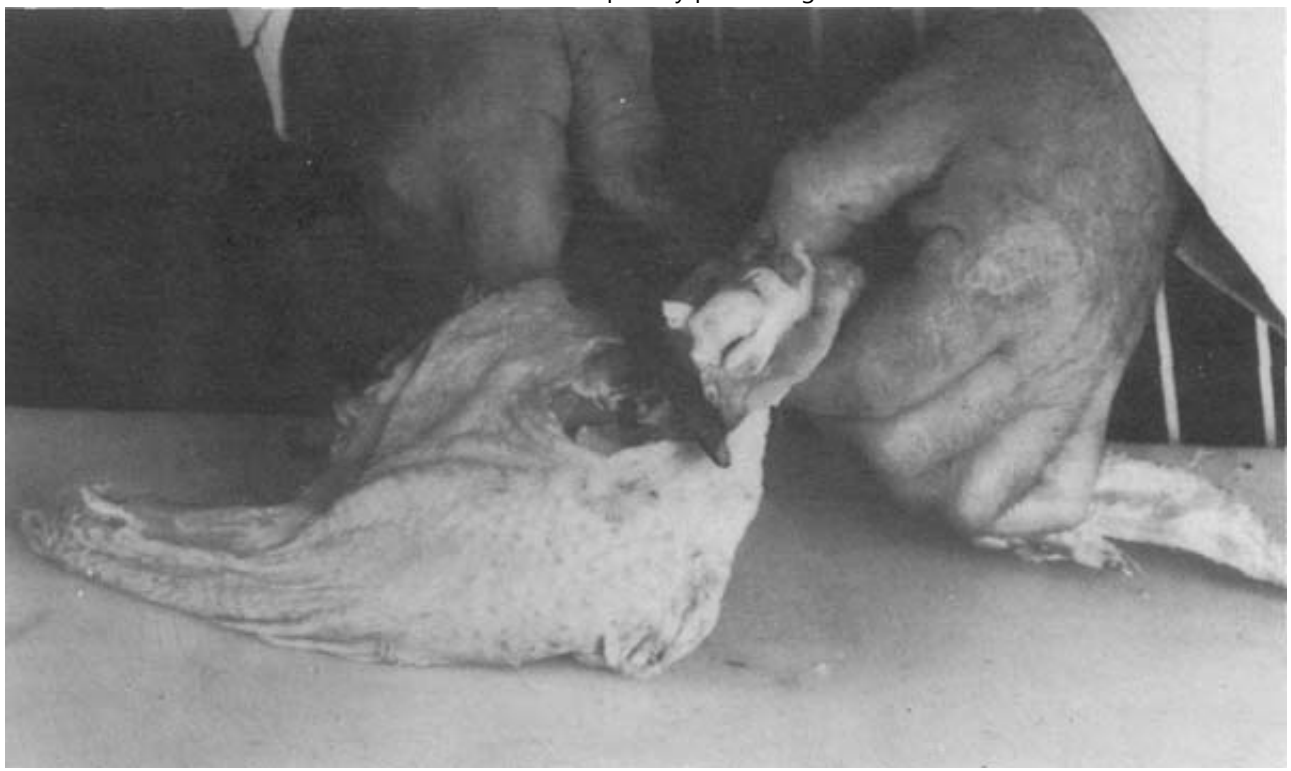
7 Split the breast down the middle, cutting through the breastbone



8 Breast quarters

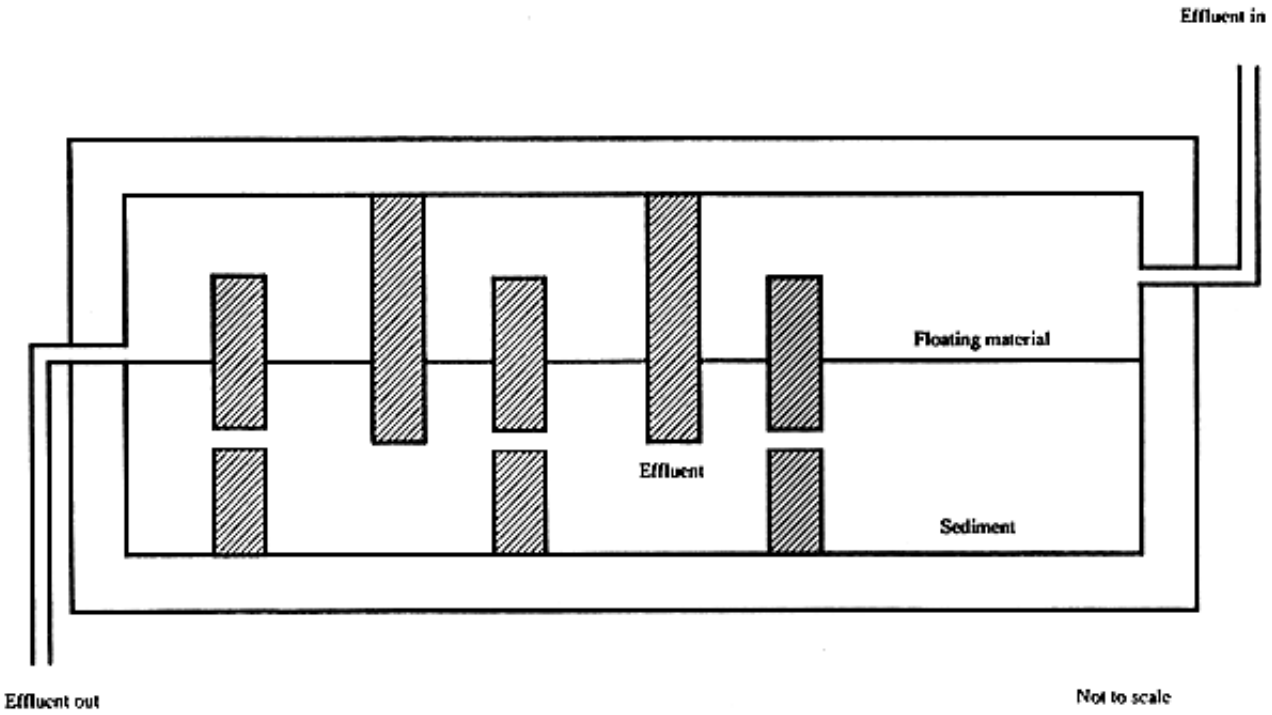


9 Cut the wings from the breast through the main joint



10 Chicken breast, thigh, leg and wing portions

Annex 7 Elevation of Baffled Sedimentation/Flotation tank

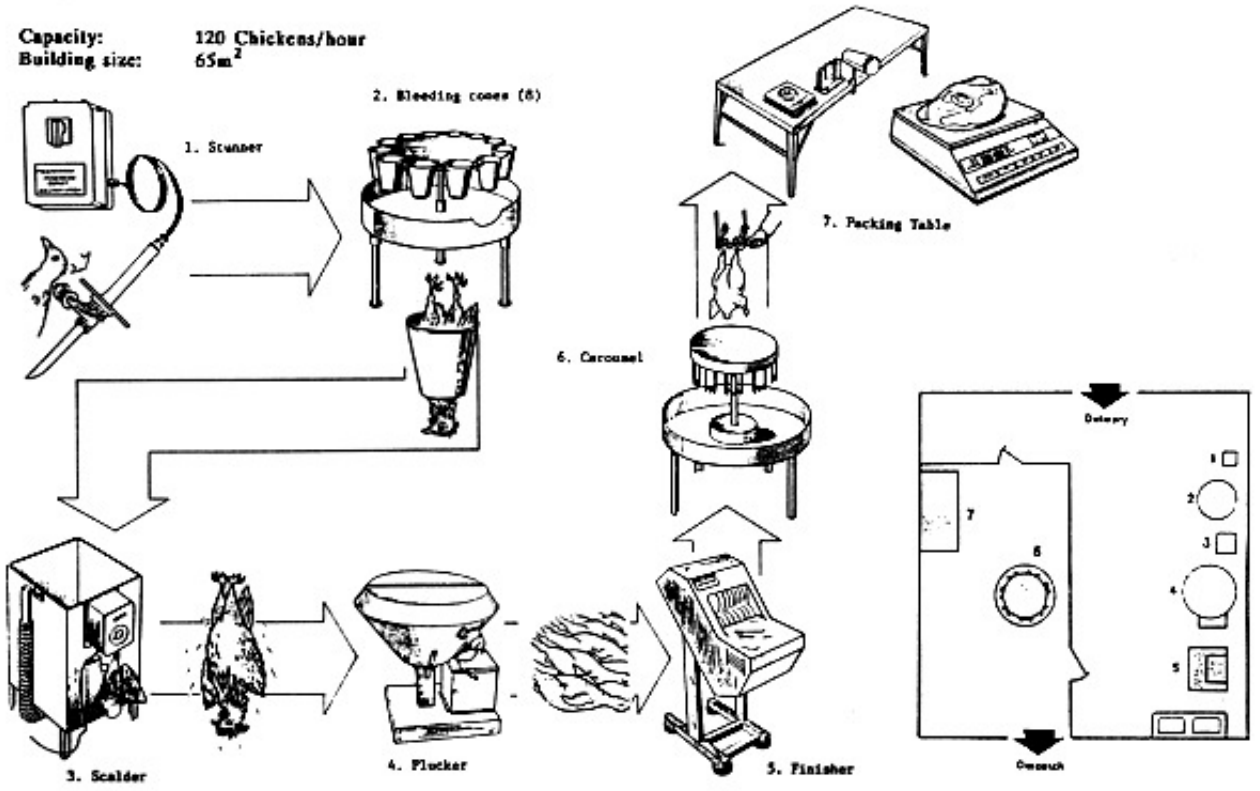


ANNEX 8a

Alternative Layouts For Small Scale Poultry Processing Plants

Capacity: 120 Chickens/hour

Building size: $65m^2$

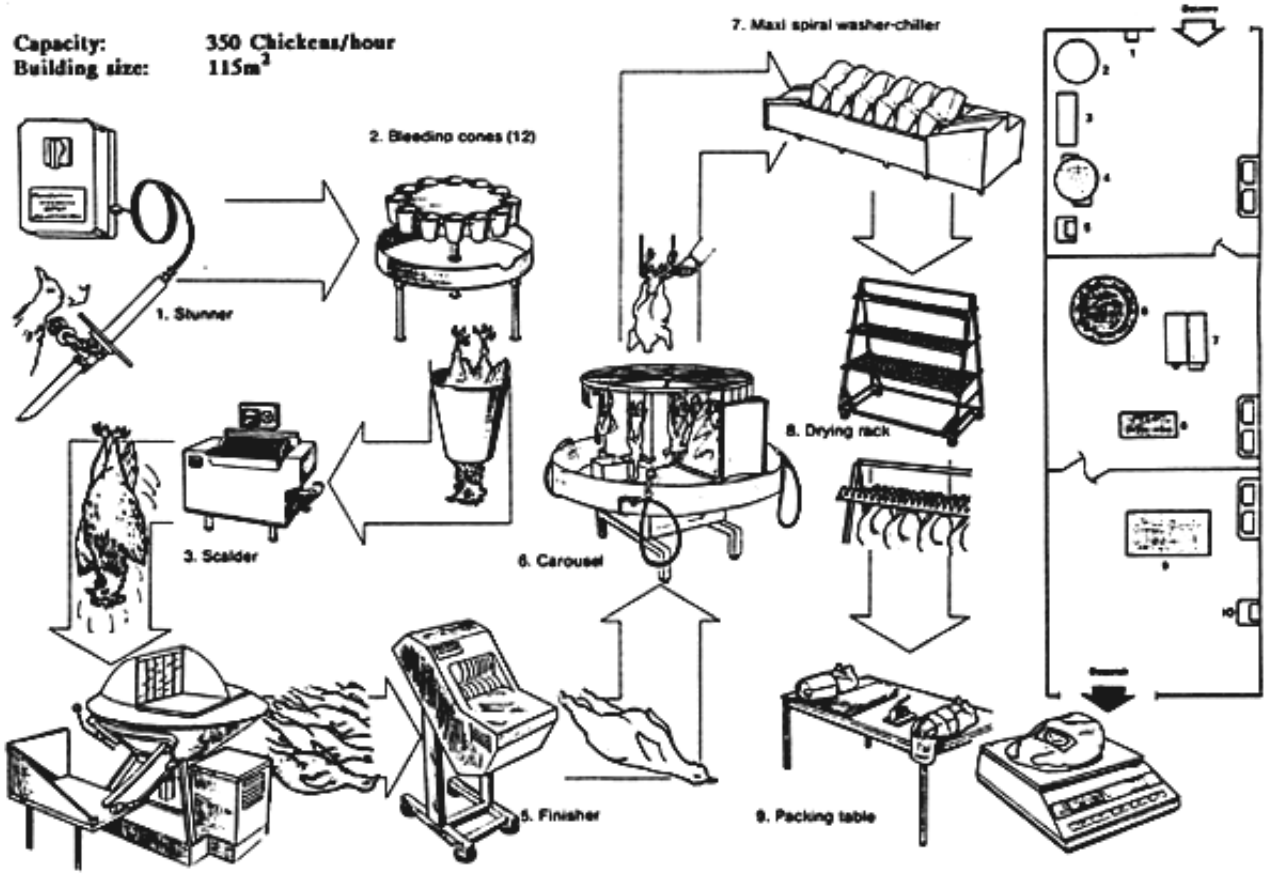


ANNEX 8b

Alternative Layouts For Small Scale Poultry Processing Plants

Capacity: 350 Chickens/hour

Building size: 115m²

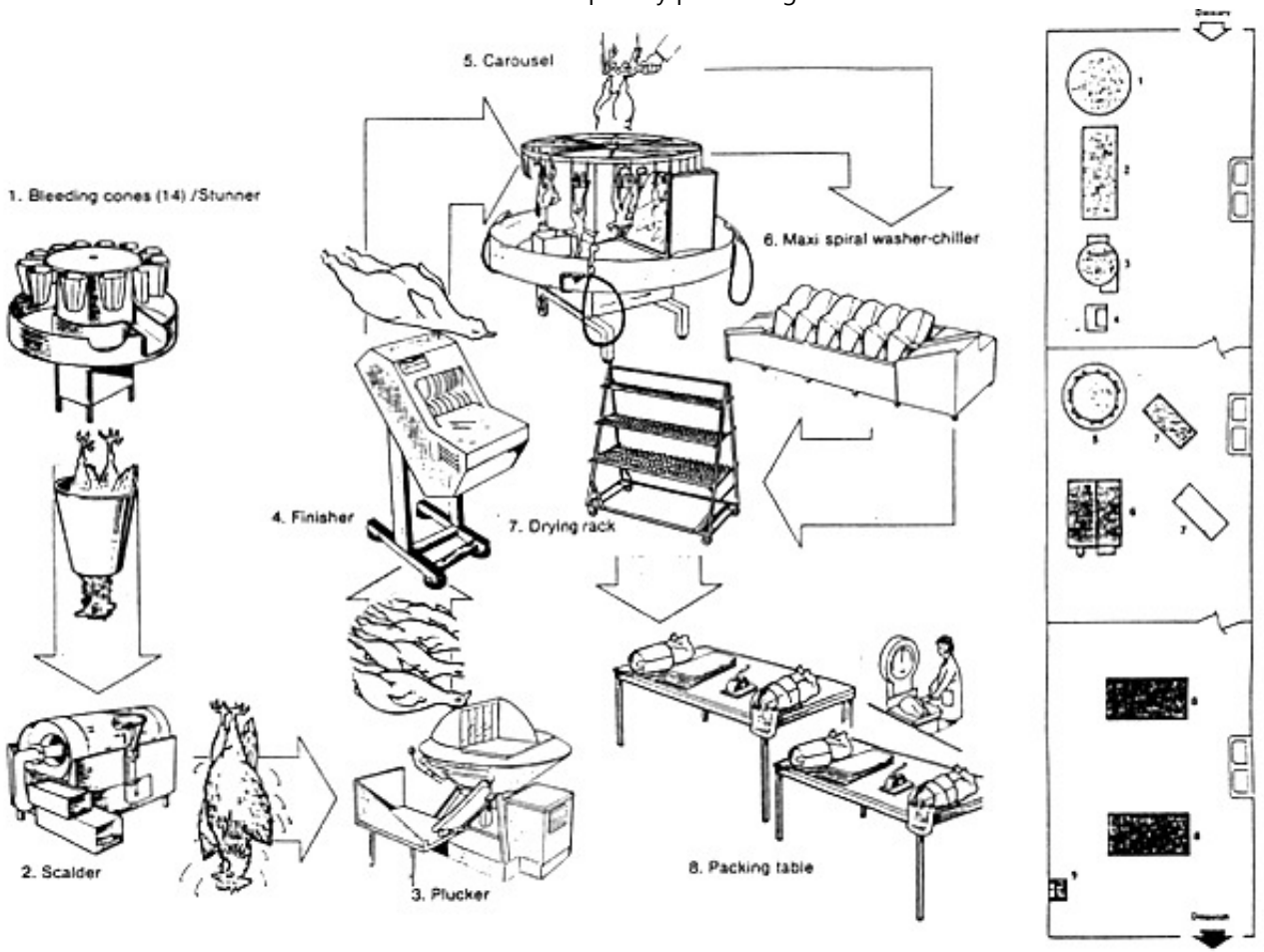


ANNEX 8c

Alternative Layouts For Small Scale Poultry Processing Plants

Capacity: 500 Chickens/hour

Building size: 235m^2

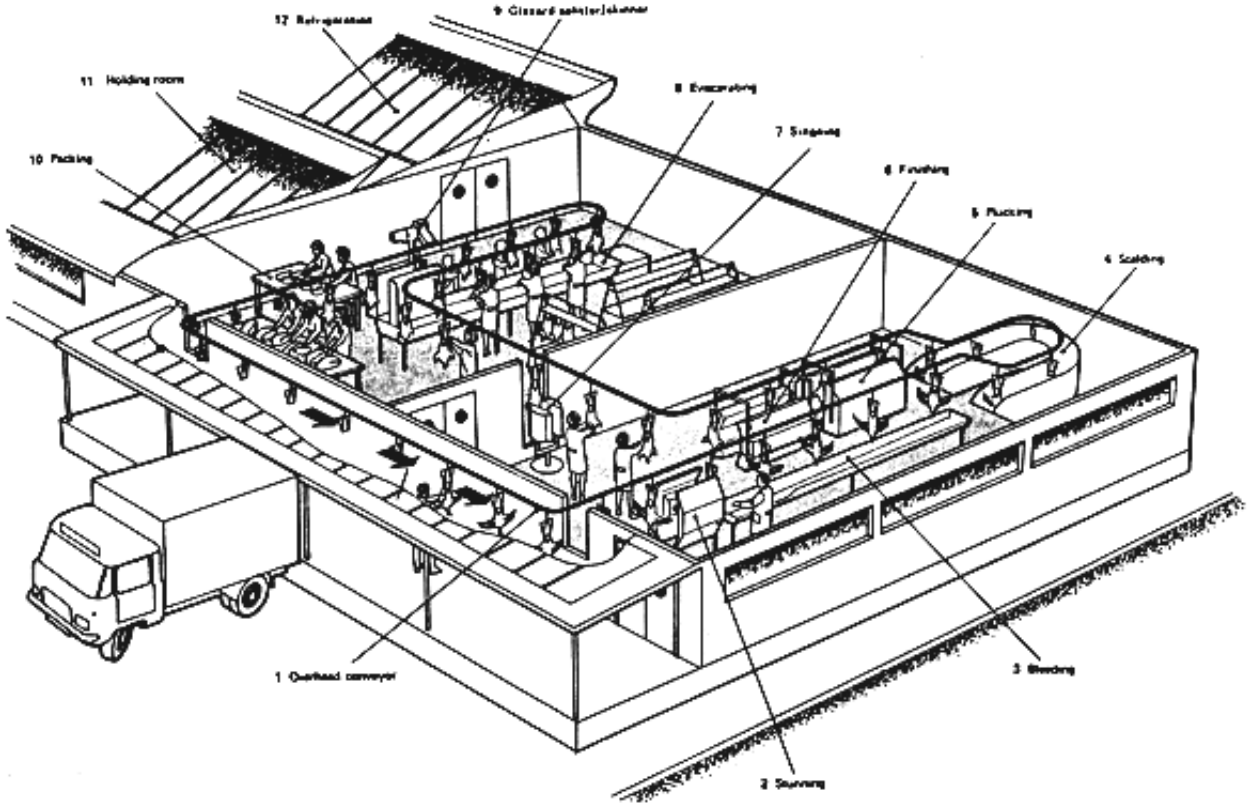


ANNEX 8d

Alternative Layouts For Small Scale Poultry Processing Plants

Typical Overhead Conveyor System

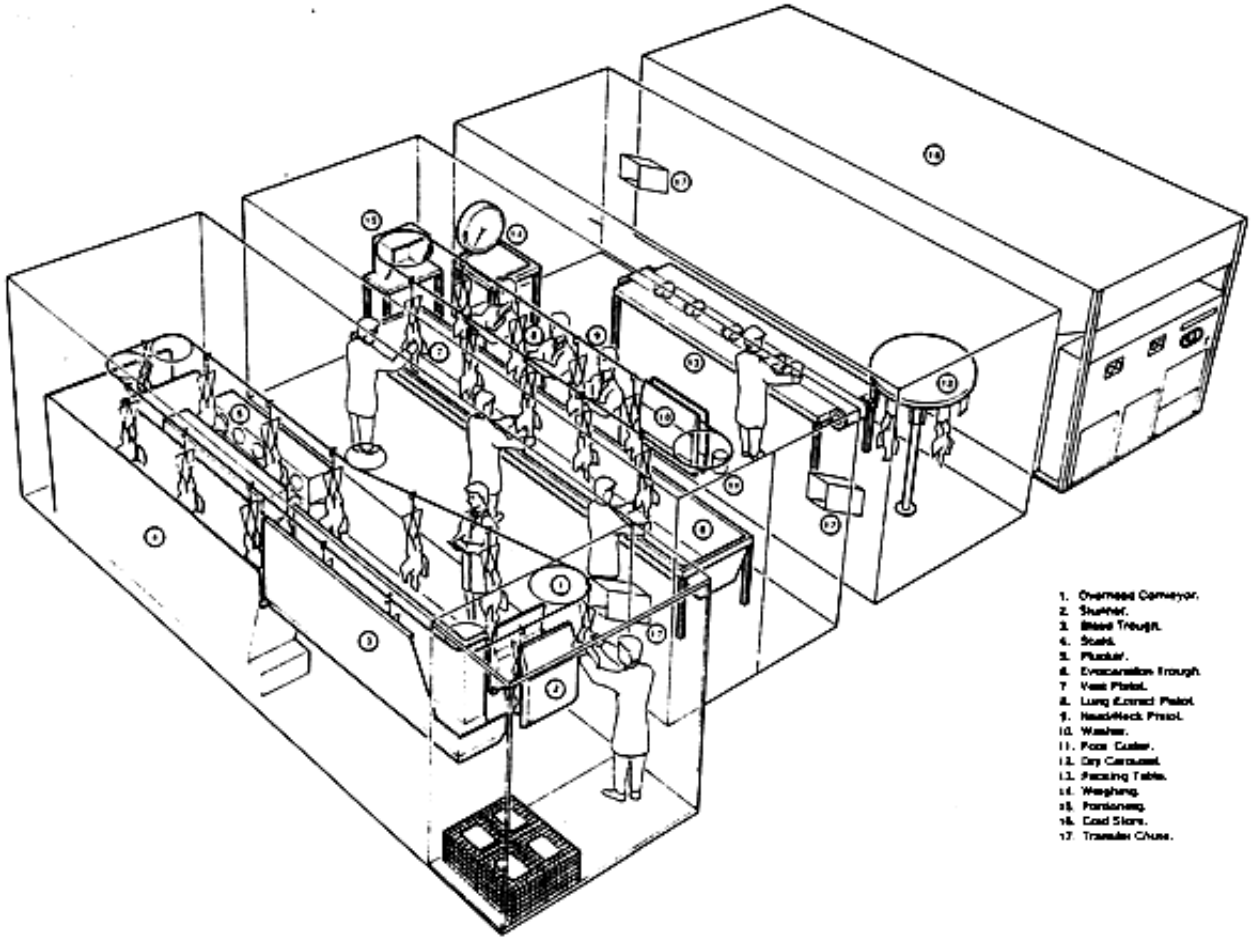
Capacity: from 500 Chickens/hour



ANNEX 8e

Alternative Layouts For Small Scale Poultry Processing Plants

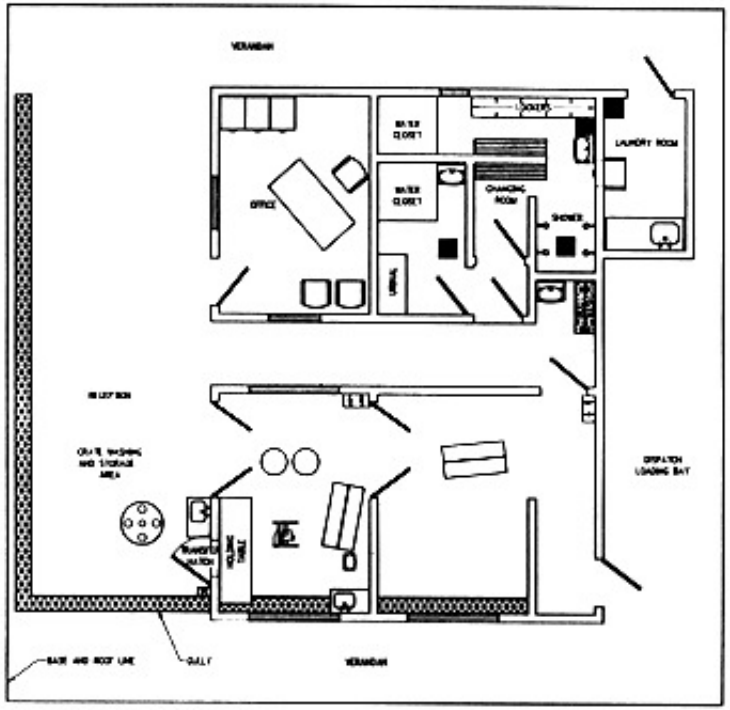
Podular System: Plant provided as a series of 40 foot containers fitted together on site to make the poultry processing plant



Capacity: up to 500 Chickens/hour based on a 2-container unit

DRAWING 1 50 BIRDS/DAY ABATTOIR

DO NOT SCALE

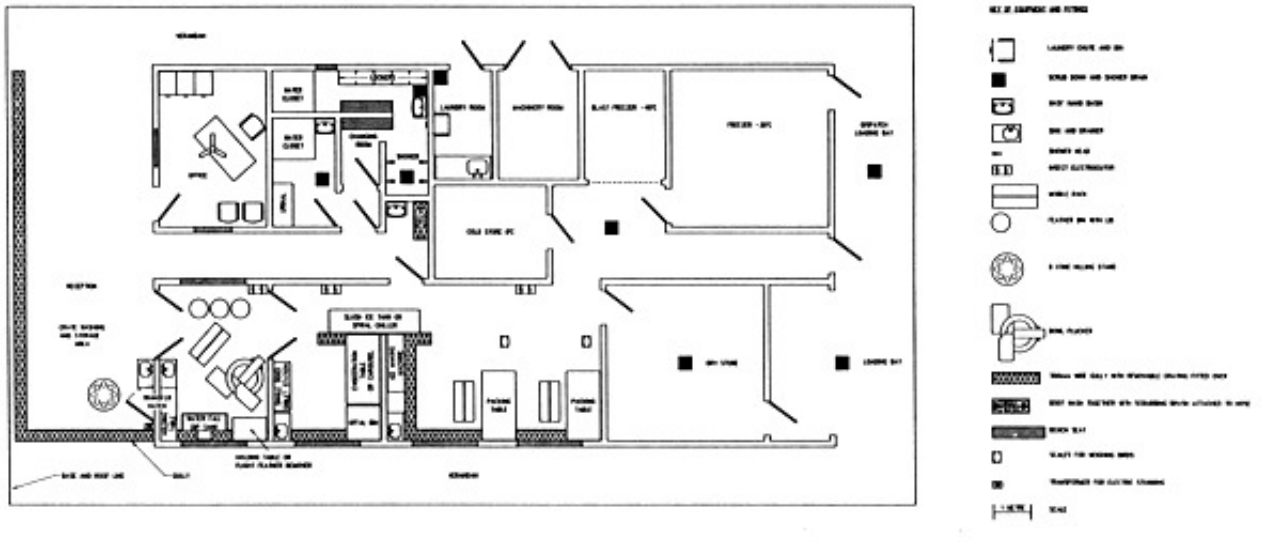


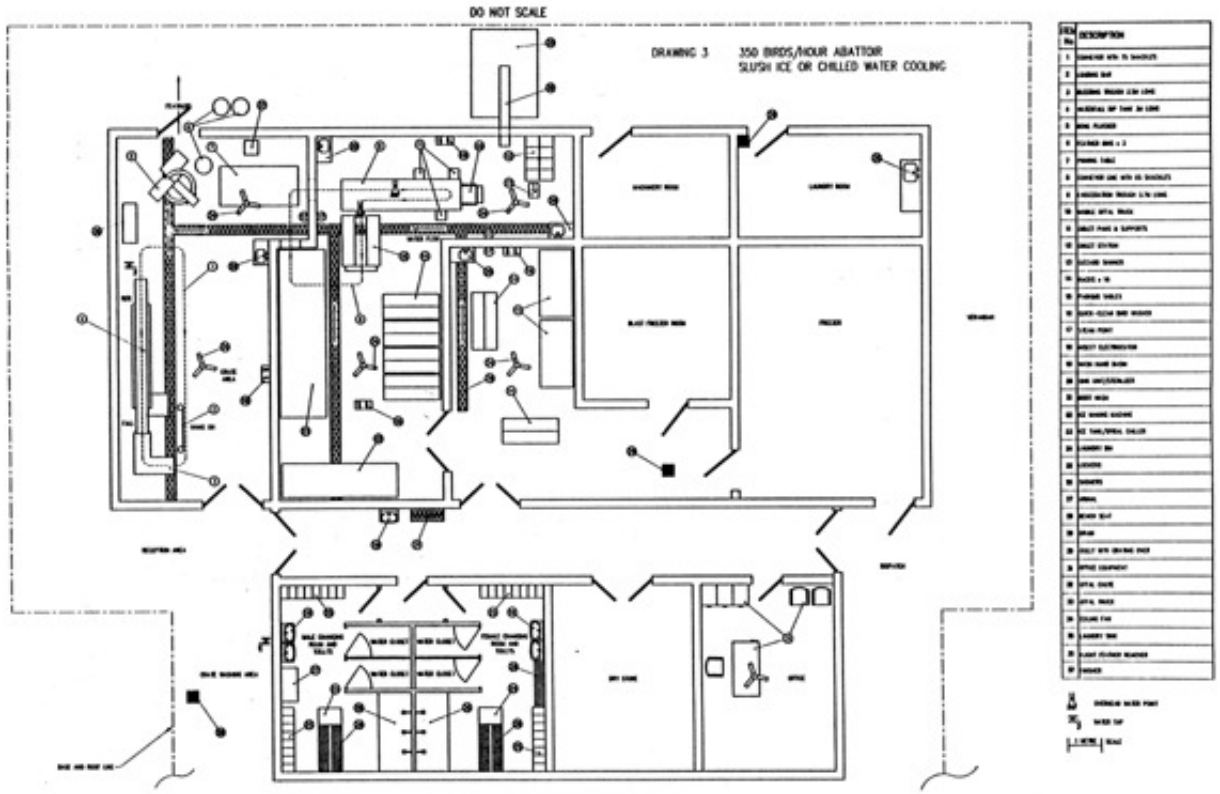
KEY OF EQUIPMENT AND FITTINGS

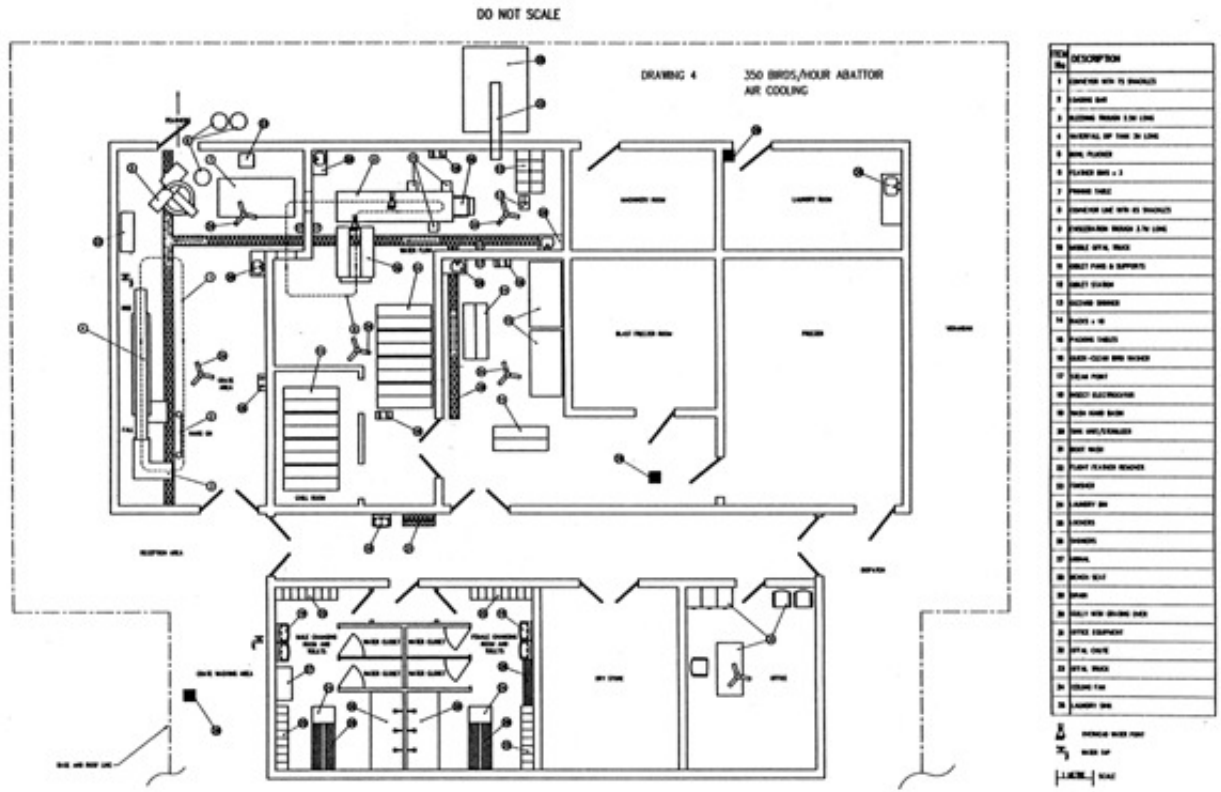
- LAUNDRY CHUTE AND BIN
- SCRUB DOWN AND SHOWER DRAIN
- WASH HAND BASIN
- SINK AND DRAINER
- SHOWER HEAD
- INSECT ELECTROCUTOR
- MOBILE RACK
- DRY PLUCKING MACHINE
- FEATHER BIN WITH LID
- 4 CONE KILLING STAND
- 300mm WIDE GULLY WITH REMOVABLE GRATING FITTED OVER
- BOOT WASH TOGETHER WITH SCRUBBING BRUSH ATTACHED TO HOSE
- BENCH SEAT
- SCALES FOR WEIGHING BIRDS
- TRANSFORMER FOR ELECTRIC STUNNING
- SCALE

DO NOT SCALE

DRAWING 2 200 BIRDS/DAY ABATTOIR




DO NOT SCALE
DRAWING 3
350 BIRDS/HOUR ABATTOIR
SLUSH ICE OR CHILLED WATER COOLING



Further Reading

Sainsbury, D. (1984) Poultry Health and Management. Second Edition, Granada Publishing Ltd.

Stadelman, W.J., Olson, V.M., Shemwell, G.A. and Pasch, C. (1988) Egg and Poultry-Meat Processing. Ellis Horwood Series in Food Science and Technology.

Kekeocha, C.C. (1984) Pfizer Poultry Production Handbook. Macmillan Publishers.

Oluyemi, J.A. and Roberts, F.A. (1979) Poultry Production In Warm Wet Climates. Macmillan Tropical Agriculture, Horticulture and Applied Ecology Series.

Portsmouth, J. (1983) Practical Poultry Keeping. Seventh Edition. Saiga Publishing Company.

Say, R.R. (1987) Manual Of Poultry Production In The Tropics. Published by CAB International.

Mead, C.C. (1989) Processing Of Poultry. Elsevier Science Publishers Ltd.

Edwards, D., Hector, D.A., Norman, G.A., Silverside, D. (1979) Slaughter facilities for tropical conditions: A guide to the selection and costing of appropriate systems. Tropical products Institute (TPI), G123.

Brant, A.W., Goble, J.W., Hamann, J.A., Wabeck, C.J. and Walters, R.E. (1982) Guidelines for Establishing and Operating Broiler Processing Plants. U.S. Department of Agriculture Handbook No. 581.

South African Bureau of Standards (1989) Code of Practice for Food Hygiene Management.

FAO Agricultural Services Bulletin 76 (1989) Horticultural Marketing: A resource and training manual for extension officers.

FAO Agricultural Services Bulletin 79 (1989) Handbook of rural technology for the processing of animal by-products.

Stab. Tipolit. U. Quintily S.p.A. - Roma
Via di Olimpia, 9 - Tel. 533408 Finito di
stampare nel mese di maggio 1992

FAO TECHNICAL PAPERS

FAO ANIMAL PRODUCTION AND HEALTH PAPERS:

1. Animal breeding: selected articles from World Animal Review, 1977 (C* E*F* S*)
2. Eradication of hog cholera and African swine fever, 1976 (E*F* S*)
3. Insecticides and application equipment for tsetse control, 1977 (E* F*)
4. New feed resources, 1977 (E/F/S*)
5. Bibliography of the criollo cattle of the Americas, 1977 (E/S*)
6. Mediterranean cattle and sheep in crossbreeding, 1977 (E/S*)
7. The environmental impact of tsetse control operations, 1977 (E* F*) 7 Rev. 1. The Environmental impact of tsetse control operations, 1980 (E* F*)
8. Declining breeds of Mediterranean sheep, 1978 (E* F*)
9. Slaughterhouse and slaughterslab design and construction, 1978 (E* F* S*)
10. Treating straw for animal feeding, 1978 (C*, E*, F*, S*)
11. Packaging, storage and distribution of processed milk, 1978 (E*)
12. Ruminant nutrition: selected articles from *World Animal Review*, 1978 (C* E* F* S*)
13. Buffalo reproduction and artificial insemination, 1979 (E**)
14. The African trypanosomiases, 1979 (E* F*)
15. Establishment of dairy training centres, 1979 (E*)
16. Open yard housing for young cattle, 1981 (E* F* S*)
17. Prolific tropical sheep, 1980 (E* F* S*)
18. Feed from animal wastes: state of knowledge, 1980 (E*)
19. East Coast fever and related tick-borne diseases, 1980 (E*)

20/1. Trypanotolerant livestock in West and Central Africa, 1980 Vol. 1 - General study (E* F*)

20/2. Trypanotolerant livestock in West and Central Africa, 1980 Vol. 2 - Country studies (E* F*)

20/3. Le bétail trypanotolérant en Afrique occidentale et centrale - Vol. 3 - Bilan d'une décennie, 1988 (F*)

21. Guidelines for dairy accounting, 1980 (E*)

22. Recursos genéticos animales en América Latina, 1981 (S*)

23. Disease control in semen and embryos, 1982 (E* F* S*)

24. Animal genetic resources - conservation and management, 1981 (E*)

25. Reproductive efficiency in cattle, 1982 (E* F* S*)

26. Camels and camel milk, 1982 (E*)

27. Deer farming, 1982 (E*)

28. Feed from animal wastes: feeding manual, 1982 (E*)

29. Echinococcosis/hydatidosis surveillance, prevention and control: FAO/UNEP/WHO guidelines, 1982 (E*)

30. Sheep and goat breeds of India, 1982 (E*)

31. Hormones in animal production, 1982 (E*)

32. Crop residues and agro-industrial by-products in animal feeding, 1982 (E/F*)

33. Haemorrhagic septicaemia, 1982 (E* F*)

34. Breeding plans for ruminant livestock in the tropics, 1982 (E* F* S*)

35. Off-tastes in raw and reconstituted milk, 1983 (E* F* S*)

36. Ticks and tick-borne diseases: selected articles from *World Animal Review*, 1983 (E* F* S*)

37. African animal trypanosomiasis: selected articles from *World Animal Review*, 1983 (E* F*)

38. Diagnosis and vaccination for the control of brucellosis in the Near East, 1983 (E* Ar*)

39. Solar energy in small-scale milk collection and processing, 1983 (E* F*)

40. Intensive sheep production in Near East, 1983 (E Ar * E*)
41. Integrating crops and livestock in West Africa, 1983 (E* F*)
42. Animal energy in agriculture in Africa and Asia, 1984 (E/F * S*)
43. Olive by-products for animal feed, 1985 (Ar* E* F* S*)
44/1. Animal genetic resources conservation by management, data banks and training, 1984 (E*)
44/2. Animal genetic resources: cryogenic storage of germplasm and molecular engineering, 1984 (E*)
45. Maintenance systems for the dairy plant, 1984 (E*)
46. Livestock breeds of China, 1985 (E* F* S*)
47. Réfrigération du lait à la ferme et organisation des transports, 1985 (F*)
48. La fromagerie et les variétés de fromages du bassin méditerranéen, 1985 (F*)
49. Manual for the slaughter of small ruminants in developing countries, 1985 (E*)
50. Better utilization of crop residues and by-products in animal feeding: research guidelines - 1. State of knowledge, 1985 (E*)

50/2. Better utilization of crop residues and by-products in animal feeding: research guidelines - 2. A practical manual for research workers, 1986 (E*)
51. Dried salted meats: charque and carne-de-sol, 1985 (E*)
52. Small-scale sausage production, 1985 (E*)
53. Slaughterhouse cleaning and sanitation, 1985 (E*)
54. Small ruminants in the Near East: Vol.I - Selected papers presented at Tunis Expert Consultation, 1986 (E*)
55. Small ruminants in the Near East: Vol II - Selected papers from *World Animal Review*, 1986 (E* Ar*)
56. Sheep and goats in Pakistan, 1985 (E*)
57. The Awassi sheep, 1985 (E*)

58. Small ruminant production in the developing countries, 1986 (E*)
59/1. Animal genetic resources data banks, 1986 (E*) 1 - Computer systems study for regional data banks
59/2. Animal genetic resources data banks, 1986 (E* F* S*) 2 - Descriptor lists for cattle, buffalo, pigs, sheep and goats
59/3. Animal genetic resources data banks, 1986 (E* F* S*) 3 - Descriptor lists for poultry
60. Sheep and goats in Turkey, 1986 (E*)
61. The Przewalski horse and restoration to its natural habitat in Mongolia, 1986 (E*)
62. Milk and dairy products: production and processing costs, 1988 (E* F* S*)
63. Proceedings of the FAO expert consultation on the substitution of imported concentrate feed in animal production systems in developing countries, 1987 (E*)
64. Poultry management and diseases in the Near East, 1987 (Ar*)
65. Animal genetic resources -of the USSR, 1989 (E*)
66. Animal genetic resources - strategies for improved use and conservation, 1987 (E*)
67/1. Trypanotolerant cattle and livestock development in West and Central Africa - Vol. I. 1987 (E*)
67/2. Trypanotolerant cattle and livestock development in West and Central Africa - Vol. II. 1987 (E*)
68. Crossbreeding *Bos indicus* and *Bos taurus* for milk production in the tropics, 1987 (E*)
69. Village milk processing, 1988 (E* F*)
70. Sheep and goat meat production in the humid tropics of West Africa, 1988 (E*/F*)
71. The development of village-based sheep production in West Africa, 1988 (E* F* S*)
72. Sugarcane as feed, 1988, (E/S*)
73. Standard design for small-scale modular slaughterhouses, 1988 (E*)
74. Small ruminants in the Near East - Volume, III: North Africa, 1988 (E*)

75. The eradication of ticks, 1989 (E/F*)
76. *Ex Situ* cryoconservation of genomes and genes of endangered cattle breeds by means modern biotechnological methods, 1989 (E*)
77. Training manual for embryo transfer in cattle, 1991 (E*)
78. Milking, milk production hygiene and udder health, 1989 (E*)
79. Manual of simple methods of meat preservation, 1989 (E*)
80. Animal genetic resources - A global programme for sustainable development, 1990 (E*)
81. Veterinary diagnostic bacteriology - a manual of laboratory procedures of selected diseases of livestock, 1990 (E* F*)
82. Reproduction in camels - a review, 1990 (E*)
83. Training manual on artificial insemination in sheep and goats, 1991 (E*)
84. Training manual for embryo transfer in water buffaloes, 1991 (E*)
85. The technology of traditional milk products in developing countries, 1990 (E*)
86. Feeding dairy cows in the tropics, 1990 (E*)
87. Manual for the production of anthrax and blackleg vaccines, 1991 (E* F*)
88. Small ruminant production and the small ruminant genetic resource in tropical Africa, 1991 (E*)
89. Manual for the production of Marek's disease, Gumboro disease and inactivated Newcastle disease vaccines, 1991 (E* F*)
90. Application of biotechnology to nutrition of animals in developing countries, 1991 (E*)
91. Guidelines for slaughtering, meat cutting and further processing, 1991(E*)
92. Manual on meat cold store operation and management, 1991 (E* S*)
93. Utilization of renewable energy sources and energy-saving technologies by small-scale milk plants and collection centres, 1991 (E*)

Proceedings of the FAO expert consultation on the genetic aspects of trypanotolerance, 1992

94. (E*)
95. Roots, tubers, plantains and bananas in animal feeding, 1992 (E*)
96. Distribution and impact of helminth diseases of livestock in developing countries, 1992 (E*)
97. Construction and operation of medium-sized abattoirs in developing countries, 1992 (E*)
98. Small-scale poultry processing, 1992 (E*)
99. Manual for the *in situ* conservation of livestock and poultry, 1992 (E*)

Availability July 1992
Ar - Arabic
C - Chinese
E - English
F - French
S - Spanish
*** Available**
**** Out of print**
***** In preparation**

The FAO Technical Papers are available through the authorized FAO Sales Agents or directly fròm Distribution and Sales Section, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy.