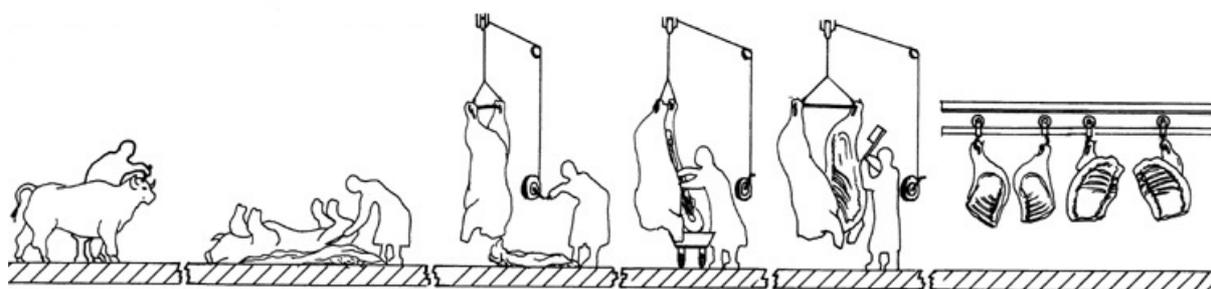


RAP PUBLICATION 2008/1

ABATTOIR DEVELOPMENT

OPTIONS AND DESIGNS
FOR HYGIENIC BASIC AND MEDIUM-SIZED ABATTOIRS



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RAP PUBLICATION 2008/1

ABATTOIR DEVELOPMENT

**OPTIONS AND DESIGNS
FOR HYGIENIC BASIC AND MEDIUM-SIZED ABATTOIRS**

Gunter Heinz

**Animal Production and Health Commission for Asia and the Pacific
Food and Agriculture Organization of the United Nations
Regional Office for Asia and the Pacific
Bangkok, 2008**

Foreword

In Asia and the Pacific region, consumers have become increasingly concerned with the improved safety of meat and are putting pressure on governments to initiate substantial hygienic improvements in the abattoir sector. To assist countries in the region, FAO initiated a technical mission to five countries to gather updated information and develop strategies to upgrade the abattoir sector, with a focus on small- to medium-sized slaughter facilities.

The abattoir sector in this region is composed of three markedly different groups. The first are the relatively new, well equipped and hygienically operating abattoirs that produce for export or domestic quality meat markets. The second are large abattoirs in major cities that were built a long time ago and function in an unsatisfactory state of repair, creating tremendous pollution problems primarily in the inner city areas and with products which often do not meet hygienic standards. The third and largest group is composed of small- to medium-sized private or municipal abattoirs. This group entails a wide scope of types and categories in terms of availability and quality of equipment and slaughter hygiene, ranging from acceptable handling procedures to absolutely disastrous and hazardous practices that result in heavily contaminated meat and serious food safety risks.

The overwhelming majority of private and public slaughterhouses in the region cater to traditional meat markets with “hot” or unrefrigerated meat. This is the sector where profound technical and hygienic improvements are needed in order to supply clean meat to consumers. Improvements are urgently required for practically all elements within the chain of handling slaughtered animals, slaughtering and carcass dressing as well as meat cutting and deboning.

This publication highlights the findings of the research mission and provides recommendations on technical improvements for simple and better quality slaughter facilities. In addition, it presents examples of practical solutions such as advanced line-slaughter systems, designs for booth slaughter, methods of abattoir effluent treatment and the like. Drawings and illustrations are included.

It is hoped that this publication will pave the way for cooperation at national and regional levels – by abattoir sector managers, the engineering sector and the veterinary sector – in working out strategies to upgrade the abattoir sector in the region.



He Changchui
Assistant Director General
and FAO Regional Representative for Asia and the Pacific

Executive summary

The abattoir sector has been neglected in most national livestock development programmes throughout Asia and the Pacific. But considerable consumer concern for the improved safety of meat is driving the pressure on governments to initiate substantial hygienic improvements. Member countries in the Animal Production and Health Commission for Asia and the Pacific (APHCA) increasingly have become interested in developing abattoirs for ruminants, pigs and other red meat-producing livestock.

To assist countries and assess the current and future needs of abattoir development in Asia and the Pacific region, the Food and Agriculture Organization of the United Nations (FAO) initiated a technical mission to five selected APHCA-member countries: Indonesia, Nepal, Pakistan, Philippines and Vietnam. The mission's aim was to gather updated information and create strategies for developing the abattoir sector, with a focus on small- to medium-sized slaughter facilities. The consultant in charge of the mission had previous experience in all APHCA-member countries. Thus, references in this report are not limited to the five countries he visited; rather, the report applies to the entire subregion.

There are many slaughterhouses and slaughter slabs in APHCA-member countries, most of them officially registered but some of them operating in a "grey zone". This means they have low- to medium-capacity and supply traditional meat markets with "hot" (unrefrigerated) meat. Without a cold chain component, these conditions demand short distances for transporting and short distribution times from slaughtering to the consumer. Thus, slaughterhouses must be located close to the markets.

The abattoir sector in APHCA-member countries presents very mixed images and impressions. There are the relatively new, well equipped and hygienically operating abattoirs that produce for export or for quality meat outlets domestically. But there are also large abattoirs in major cities that were built and equipped long ago and still function in an unsatisfactory state of repair, creating tremendous pollution problems due to their location, primarily in the inner areas of each city. Then there is a third, and the largest, group of small- to medium-sized private or municipal abattoirs. This group entails a wide scope of types and categories in terms of availability and quality of equipment and slaughter hygiene, ranging from acceptable handling procedures to absolutely disastrous and hazardous practices that result in heavily contaminated meat and serious food safety risks.

There is an increasing tendency in Asian countries – more pronounced in some than in others – to produce good-quality chilled meat for domestic sales. Such production, from a tiny portion to an estimated 15 percent of the overall meat market, depending on the country, is handled by the private sector. Among them, there is obvious awareness that only technically high-standard and hygienic abattoirs with refrigeration units can supply such markets. However, because of the lack of suitable meat sources from hygienic slaughter facilities, some outlets for prepacked chilled meat, such as supermarkets, are still supplied

with the hygienically substandard “hot” meat from traditional abattoirs. This is a very dangerous practice because meat in supermarkets or other quality meat shops undergoes prolonged storage periods, and there is a high risk of massive spoilage or food-poisoning bacteria growth – if the raw material was heavily contaminated, as is usually the case with meat from traditional abattoirs. Such practices can prove hazardous to consumers and must be discontinued. Meat to be sold chilled by supermarkets and quality meat shops must be refrigerated at the abattoir immediately after the slaughtering of animals.

The overwhelming majority of private and public slaughterhouses cater to the traditional meat markets with “hot” or unrefrigerated meat. This is the sector where profound technical and hygienic improvements are needed in order to supply clean meat to consumers. Improvements are urgently required for practically all elements within the chain of handling slaughtered animals, slaughtering and carcass dressing as well as meat cutting and deboning.

Severe shortcomings were noted during the research mission for this report in terms of:

- Animal welfare issues, in particular malpractices in prestunning of slaughter animals.
- Slaughter methods, which in many cases generate high levels of bacterial contamination due to the lack of proper slaughter and by-product handling facilities and careless slaughtering by workers.
- Meat cutting, deboning and transport, which are frequently done in the most unhygienic ways and in inadequate technical and transport facilities.
- Slaughterhouse waste disposal and effluent treatment, which is organized in an unsatisfactory way or not at all, which contributes to the poor quality of slaughterhouse hygiene.
- Meat plant cleaning and sanitation, which is mostly incomplete or impossible to carry out effectively due to the unhygienic structure of premises displaying inadequate building materials, floor and wall cracks and damages as well as heavy corrosion through the unavailability of anti-corrosive materials.
- Meat inspection and sanitary control, which is deficient in many slaughterhouses.

To start discussions and create awareness of the enormous tasks ahead, the main shortcomings observed during the research mission are highlighted in this report, followed by a series of recommendations on technical improvements for simple and better-quality slaughter facilities. Further strategies for the urgently needed upgrading of the abattoir sector have to be worked out on a national and regional basis through cooperation of abattoir sector managers, the engineering sector and the veterinary sector.

The first and strongest recommendation for improving the abattoir sector is to replace the booth-slaughter (and batch) system for bovines and small ruminants that are still widely practised in medium-sized and larger facilities with the more hygienic and easier to supervise line-slaughter system. The booth-slaughter (and batch) system is only warranted and hygienically acceptable in very small operations.

In addition to the recommendations, this report provides detailed examples of:

- technically and hygienically adequate solutions for simple and more advanced line-slaughter systems for small ruminants, bovines and pigs;
- designs for booth slaughter suitable for small-scale slaughter operations, including multispecies facilities;
- functional stunning and livestock restraining equipment;
- suitable equipment to facilitate meat inspection and recommendations on keeping meat inspection personnel up-to-date through periodical training;
- methods of meat plant sanitation, which requires building adequate structures;
- methods of abattoir effluent treatment with emphasis on biogas digestion, which is particularly suitable for small- to medium-sized abattoirs;
- cost estimations on the installation of slaughter lines of different types for bovines and pigs.

Summary country reports, prepared after the author's visits to a small proportion of the national abattoir sector in five selected APHCA-member countries, are attached as Annex B.

In this report, the terms "abattoir" and "slaughterhouse" are used interchangeably.

Most of the 114 drawings and photographs used in this report were produced by the author in cooperation with technical staff of the Animal Products Development Center in Manila, Philippines.

Illustrations or technical details from the following FAO publications were taken for use within this report:

- *Slaughterhouse and slaughter slab. Design and construction.* FAO Animal Production and Health Paper, No. 9 (Figs. 32, 93, 108).
- *Manual for the slaughter of small ruminants in developing countries.* FAO Animal Production and Health Paper, No. 49.
- *Construction and operation of medium-sized abattoirs in developing countries.* FAO Animal Production and Health Paper, No. 97 (Figs. 21, 104).
- *Manual para la instalacion del pequeno matadero modular de la FAO.* FAO Animal Production and Health Paper, No. 120 (Figs. 16, 96, 97, 98, 109-113).
- *Guidelines for humane handling, transport and slaughter of livestock.* FAO/RAP Publication 2001/4 (Figs. 67, 68, 114).

Some drawings were modified or redrawn from technical brochures published by the Italian abattoir equipment supplier Cogemate (Figs. 19, 37, 38, 55, 56, 94, 95, 101, 102, 103).

Acknowledgements

The author wishes to express his gratitude for the excellent technical and logistical support he received from veterinary authorities and meat experts from universities and national meat research and training institutions during his short visits to the five APHCA-member countries.

He also extends appreciation for the highly professional cooperation and technical support from the head and staff of the Animal Products Development Center in Manila, Philippines, in evaluating slaughter facilities, slaughtering practices and the design and drawing of model slaughter units.

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1. Slaughterhouses for red-meat animals in APHCA-member countries

Types and availability

Meat has always been a dietary demand in most Asian countries. Traditionally, red meat was supplied “hot”, or unrefrigerated, to consumers. This distribution system, which is still the dominant one in most Asian countries, had a strong impact on the slaughterhouse networks established for market supply and on the specific structures of the slaughterhouses: traditional slaughterhouses are typically small (see Table 1) with some exceptions, with basic slaughter equipment and no refrigeration. Somewhat recently, a limited number of modern slaughterhouses have emerged with line-slaughter systems, mechanical equipment and refrigeration units (Table 1).

There are an unusually large number of slaughterhouses, mostly of the traditional type, for cattle, buffaloes, small ruminants and pigs, in member countries of the Animal Production and Health Commission for Asia and the Pacific (APHCA). Indonesia tops the list with 800 officially registered slaughterhouses. The Philippines has 100 government-accredited facilities and at least 400 others licensed by local authorities. Thailand has 347 slaughterhouses with recently issued licenses and more than 100 with old licenses. Pakistan has more than 300 slaughterhouses run by municipal authorities and a small number that the private sector operates. In Vietnam, assuming a similar density of abattoirs elsewhere as in Ho Chi Minh City where 21 licensed slaughterhouses exist, there may be at least 100 registered slaughter facilities in the country. (No updated figures could be obtained from some countries.) No slaughterhouses (operational) or very few exist in Bangladesh, Bhutan, Nepal and Samoa (Table 1).

Compared with developed countries with similar population densities, APHCA-member countries have up to four times as many slaughterhouses as developed countries, where, in contrast, meat consumption is fourfold or more. This means that in developed countries, slaughtering is much more concentrated in large slaughterhouses, while there is a large number of small- to medium-sized slaughterhouses in the APHCA-member countries. This situation is due to the prevailing traditional meat-marketing systems.

Attempts to establish city abattoirs and structural changes

In the old days, the meat supply for population centres and rural areas in Asia derived from the traditional slaughtering of bovines, small ruminants and pigs on the bare ground or on simple paved slabs without any equipment other than knives and axes. The first effective attempts at establishing slaughterhouses in the APHCA region were in the major cities of some countries more than 50 years ago.

In many instances, the colonial powers of that period initiated the construction of large-scale slaughterhouses similar to the ones used in Europe. The method in use was the booth system in which several live animals were brought onto the slaughter floor, each to an individual spot (booth). They were then killed, bled,

dehided (flayed), eviscerated and then the carcass was split – in that “booth”. Most of that type of slaughterhouse still exists in APHCA-member countries, using the same outdated procedures. As cities have expanded around these facilities, they have become a tremendous source of pollution due to their highly inadequate waste treatment and pollution control.

After the colonial era, countries kept building large city abattoirs, using their own funding sources or with foreign donor assistance (Table 1).

Table 1: Review of abattoir development in APHCA-member countries

Country	Remarks
Bangladesh	Until recently, there were no established slaughterhouses – only slaughter slabs without proper equipment or roadside slaughtering on the ground.
Bhutan	There is an Australian-built, simple but functional, medium-sized cattle abattoir located in the main border city to India. This abattoir, although technically without major problems and fully operational, stopped production a few years ago mainly because of socio-cultural reasons. Beef and buffalo meat for Bhutan are imported from India. There was also a small-scale pig slaughterhouse built in the 1980s through an FAO project in the capital, Thimphu, which was dismantled some time after the project closed. There are no slaughterhouses operating in the country currently.
Cambodia	The French built the city abattoir in Phnom Penh during the colonial period, but it stopped operating when the market economy was introduced in the 1990s and smaller, private slaughter facilities could produce cheaper meat. But this has resulted in a significant decline in slaughtering and meat hygiene.
India	All major cities in India had central slaughterhouses, most dating back to the British period. Many of them are probably still being used but creating enormous hygienic and environmental problems. The only new slaughterhouse project was completed in the 1980s, which is the DEANOR abattoir in Mumbai. This is a huge facility with relatively simple equipment that allowed after its inauguration for hygienic slaughtering. Other major cities had plans for new abattoir projects but few, if any, have materialized.
Indonesia	The former centralized government initiated the construction of a high-capacity central abattoir in Jakarta, capable of slaughtering up to 2 000 head of cattle per night in two lines, using electric stunning (locally acceptable for Halal standards) and other modern equipment. The shift to a market economy and decentralization led to the opening of many small, private slaughter facilities with poor hygienic standards but which attracted the majority of livestock due to the lower cost. Although offering much better hygienic standards, the central abattoir in Jakarta now operates only at 10 percent of its capacity. Some municipalities (Bogor and Yogyakarta) recently built good medium-sized abattoirs with line slaughter for cattle. Both have not gone operational as yet because of disputes with the local butcher communities who prefer to continue slaughtering in the traditional way.
Iran	There is one or two large abattoirs for sheep and cattle in Teheran, although at one point there was discussion of relocating them outside the city.
Lao PDR	There is a New Zealand-built compact city abattoir with line slaughter in Vientiane, which since its inauguration (in the 1980s) has suffered from a lack of spare parts. The breakdowns led to the return of traditional slaughtering in some sections of the city. There are some very basic small-scale slaughterhouses elsewhere in the country.

Country	Remarks
Malaysia	The abattoir sector is generally well organized.
Mongolia	There was a government-run Socialist-style Kombinate ("Machimex") built with Russian assistance in Ulan Bator with high-capacity cattle-, small ruminant- and pig-slaughter lines, as well as refrigeration, meat cutting and meat processing units. The Kombinate became technically obsolete over the years and was sold to the private sector approximately eight years ago. Another modern facility with slaughter lines and meat processing was built in the late 1980s some 150 km north of Ulan Bator, with Finnish aid and technology. This plant suffered from lack of livestock and from its distant location from any main road. In recent years there was talk about privatizing the facility.
Myanmar	In Yangon, there are two relatively large, simply equipped municipal abattoirs, one for pigs and the other for bovines, located next door to each other. The facilities allow for slaughter in a vertical position and the production of reasonably clean meat.
Nepal	Several unsuccessful attempts at building abattoirs in Nepal have been made. The first was a highly sophisticated Danish-initiated abattoir in Hetauda City, in the centre of a livestock-producing region, with lines for bovines, small ruminants, pigs and chicken. It also offered refrigeration, cutting and further processing lines. Several attempts by the Government and the private sector were made to operate the plant, but all failed because the consumer market for meat was in the distant Kathmandu valley. High-tech production, refrigeration and the long transport made the meat too expensive compared with the traditional but very unhygienic slaughtering in Kathmandu. In addition, consumers were not used to chilled meat. Recently, two medium-sized abattoirs were built in the Kathmandu area (one already operating) but with unsuitable equipment that does not allow proper line slaughter and in unsuitable locations. A few simple and very small pig-slaughter facilities combined with meat shops opened up recently in the capital, all of them with significant hygienic problems. Currently, there is no properly functioning slaughterhouse in the country, and the traditional slaughter places presently used are absolutely unhygienic.
Pakistan	In Karachi, a modern Yugoslavian-built, large-scale abattoir with a line-slaughter system was established 25 years ago. To this day, the local butcher community refuses to use it. A semi-mechanical, large abattoir was built in Islamabad not too long ago, but it is reportedly not operational, presumably for technical reasons or non-acceptance by the slaughter personnel. In Lahore, the old central abattoir has not been improved or updated in decades, despite the increase of animal throughput: up to 800 cattle and 1 500 sheep and goats per day. The butchers use unhygienic floor slaughtering and dressing in these three cities. There have been plans to build a few private sector-operated, medium-size abattoirs; some are in the planning phase still while others have begun producing meat for export or supplying local high-quality meat shops.
Papua New Guinea	There are reportedly slaughterhouses of small to medium size serving cities and communities.

Country	Remarks
Philippines	Large city abattoirs never existed in the Philippines; a multitude of small- to medium-sized abattoirs, mostly for pigs but some bovines, supply the major cities. Their standards, although in many cases not fully satisfactory, have improved over the years as government authorities imposed a system of quality categorizing. Downgrading within the system is linked to economic losses due to trade restrictions. These consequences have caused many abattoir owners to modernize and follow the rules on hygiene. There are also a few high-standard abattoirs in the country, producing for quality meat outlets but looking to export as well.
Samoa	There is no slaughterhouse, although there are now plans to develop one. Locally produced meat derives from farm slaughtering.
Sri Lanka	There is an old colonial-style city abattoir for cattle in Colombo and several small pig abattoirs in a suburb. All are hygienically obsolete, and new construction is urgently needed.
Thailand	Large city abattoirs never existed in Thailand; a multitude of small- to medium-sized abattoirs, mostly for pigs but some bovines, supply the major cities. Slaughtering is mostly done in the traditional way (floor dressing). However, there are also a number of new private or government-owned abattoirs with line-slaughter systems with good hygienic standards.
Vietnam	There is one large-scale pig abattoir in Hai Phong, which was designed in the 1980s for export purposes and which uses a continuous-line slaughter system. The second abattoir with continuous-line slaughter of cattle and pigs is the VISSAN abattoir in Ho Chi Minh City, built in 1974 by the German Government. Elsewhere, semi-line pig-slaughter systems use traditional ways of moving the carcasses (dragging) from stunning and bleeding to scalding and scraping. In some abattoirs, eviscerating and splitting of the carcasses is done on overhead rails. However, there are still many pig-slaughter facilities using improper methods – all operations, from bleeding to splitting and further carcass cutting, take place on the floor. All cattle-slaughter facilities, except VISSAN, use the booth-slaughter system, mostly with serious hygienic problems. Three new abattoir projects in Ho Chi Minh City and one in Hanoi indicate the Government's interest in making fundamental improvements.

The central city abattoirs proved to be extremely useful in the past because they produced reasonably hygienic-slaughtered meat, at least in the population centres. This system worked particularly well in countries with a strong centralized government-controlled economic system, such as in Cambodia, Indonesia, Lao PDR, Myanmar, Mongolia and Vietnam. In particular, the newer central abattoirs were adequately equipped and the respective governments forced the majority of livestock to be slaughtered there, which allowed for effective animal health and sanitary control, including meat inspection.

After the introduction of the free-market economy and administrative decentralization in the 1980s and 1990s, which certainly contributed to general economic development, the structure of the city abattoir systems changed. Unfortunately, it changed much to the disadvantage and detriment of the sector. The free-market economy stimulated the mushrooming of many small private slaughter facilities, mostly with obsolete technical and hygienic equipment or practically none at all.

These small slaughterhouses operate more cheaply than the large abattoirs primarily because of the lack of expenditure on maintenance, hygiene measures and energy. Thus, the butchers or meat dealers are charged less and have won over a large portion of the business from the established facilities. Consequently, slaughter hygiene in general has declined and sanitary control, including meat inspection, has been difficult to organize or cannot be implemented at all.

There is growing awareness in APHCA-member countries that this development should be stopped. In some countries, some control has been put into place. In Vietnam's Ho Chi Minh City, for instance, all the obsolete slaughter facilities that were unable to comply with officially requested improvements were forced to shut down. Still, too many remain in operation throughout the region that do not comply with minimum requirements, and a clean-up of this sector is urgently needed for the sake of food safety and consumer protection.

Present status of the abattoir sector

The abattoir sector in APHCA-member countries generates very mixed images and impressions. There are the relatively new, well-equipped and hygienically operating abattoirs that produce for export or for good-quality meat outlets domestically. But there remain also the large abattoirs built long ago that are still functioning with the same initial equipment but mostly in an unsatisfactory state of repair. There are quite a number of small- to medium-sized private or municipal abattoirs that represent a range of availability and quality of equipment and hygienic slaughtering, from acceptable slaughtering standards and meat-handling procedures to absolutely disastrous and hazardous practices resulting in heavily contaminated meat.

However, it is not only the status of the abattoirs that determines the hygienic quality of the meat produced. The skills and attitude of the butchers, slaughter men and meat handlers impact considerably also. Of course, personnel cannot be blamed for not adhering to hygienic rules if the facility owners/managers do not provide them with reasonable working conditions, which includes provisions to ensure personal cleanliness and technical equipment to facilitate proper slaughtering and meat transport. But there is also a great deal of negligence and ignorance on the part of the slaughter personnel about basic hygiene rules, which considerably contributes to the poor-quality outputs of many abattoirs.

A key issue sustaining this situation in most APHCA-member countries is the renting of private or municipal slaughter facilities to butchers and meat dealers who bring their livestock to the abattoir, have it slaughtered by their own personnel and take the meat away in their own vehicles. This then means there are several teams of slaughter men active in one facility during one shift, each with their own working style (adherence, or rather lack of, to hygienic practices). More dedicated and responsible working attitudes are found in slaughter plants that use their own staff. Such permanent staff can be trained on basic principles of hygiene. Unfortunately, they are only available in a small number of private-sector meat plants, in particular the ones that produce for export or for the company's own meat outlet system.

Another issue that contributes to hygienic flaws and negligence in slaughtering and handling of fresh meat is the need to work in the night time. The traditional meat-marketing system, which is the marketing of "hot" or unrefrigerated meat,

requires a somewhat quick delivery time from the slaughterhouse through the wholesale and/or retail marketing phase to the actual preparation in the consumer's home. Thus, animals must be slaughtered at night in order to have the meat ready for the sales outlets in the morning.

Supervision and hygienic control systems, which are already difficult to implement in most Asian abattoirs during the day, function even less during the night. The hygienic problems of livestock slaughtering in the traditional system arise from the need to rush, as there are only a few hours between production and consumption of the meat. This necessity causes slaughter men and meat handlers to short-cut on hygienic procedures for the sake of reaching the meat market in time.

In developed countries, all meat is subject to a cold chain, with the refrigeration of all carcasses immediately after the butchering. For centuries, consumers in developing Asian and also African countries have remained accustomed to buying recently slaughtered, unrefrigerated "hot" meat. Some changes to this habit can be seen in APHCA-member countries with the emergence of meat sections in supermarkets or the establishment of quality shops where refrigerated meat is exclusively sold, and in the growing popularity for beef that has been aged for improved tenderness.

Abattoirs producing for export or quality meat shops with chilled meat operate during the day and without any time pressure. Their carcasses have to remain in refrigeration units for up to 24 hours for pigs and up to 48 hours for bovines for complete cooling. Hence, slaughtering can be conveniently conducted during a regular working day and the slaughtering processes can be carefully carried out. This developed-country approach will eventually be adopted by Asian countries, some sooner than others, with Malaysia and China already at the forefront. Experience has shown that consumers previously biased against chilled meat will accept it once its cleanliness is appreciated and if the price differences between hot and cold meat can be kept small.

However, night-time slaughtering practices cannot be changed in the short term in most APHCA-member countries because they are an integral part of the traditional meat-marketing system. And these systems are a result of the simple infrastructure prevailing in the meat sector in those countries. Because there is no refrigeration used, the meat requires short handling periods and short travel time (preferably during the low bacteria-proliferation phase of fresh meat, also called the lag phase, see Fig. 1) from abattoirs to meat markets and to consumers. Even if the meat gets heavily contaminated, spoilage by micro-organisms will not normally occur due to the short period between slaughtering and consumption. Another reason for the demand of freshly slaughtered meat is the popularity in many Asian countries of processed meat products, such as meat balls, meat loaves or emulsified sausage products, for which such "prerigor" meat is particularly well suited due to its pronounced binding capacity.

Growth phases of bacteria

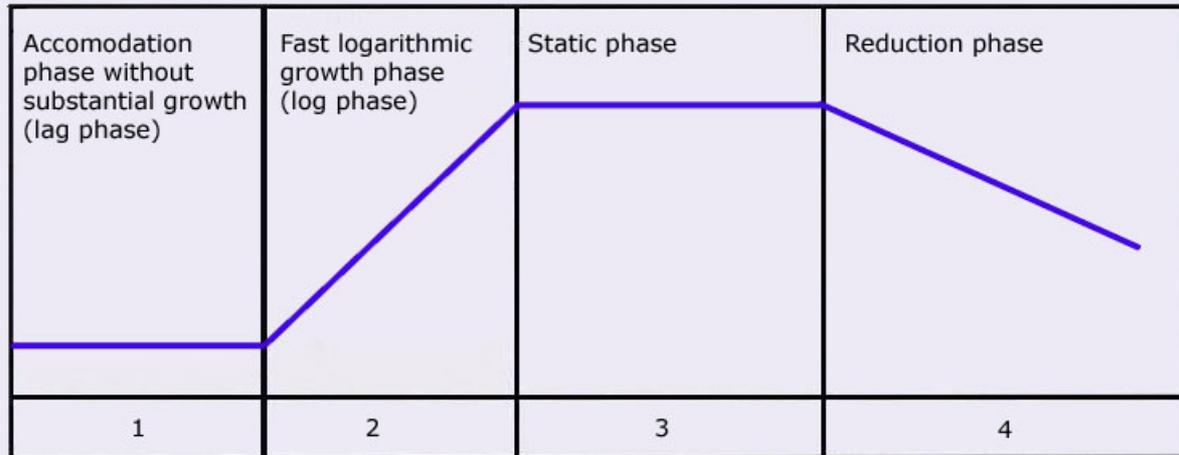


Fig. 1: Microbiological reasons for delayed bacterial spoilage of fresh meat: Microbiological growth is stagnant in the first period after contamination (lag phase). It starts in the second period, but the intensity depends on the temperature. Under ambient temperatures and with "hot" meat, growth will be very strong until spoilage conditions are reached (log phase).

2. Slaughterhouse hygiene problems and solutions

Scope of problems

Many of the APHCA-member countries have at least one good-quality abattoir. However, the quantity of meat produced in them is only a small fraction of the countrywide abattoir output, and the meat produced in those facilities frequently goes to export or to up-market sales outlets. In many of 12 APHCA-member countries there are some new abattoirs in construction currently that are encouraging. On the other hand it is still fact that the bulk of the meat sold within many APHCA-member countries most likely originates from unhygienic slaughtering and meat handling.

This report highlights examples of the current situation and ways to solve these problems. But it does not deal with residues in meat deriving from environmental pollutants, veterinary drugs, growth-promoting agents and illegal preservatives, which might be found in meat. The concern of this report is the excessive microbial contamination of meat that occurs during and after (transporting) routine slaughtering in many Asian countries.

One of the main principles of slaughter hygiene is to avoid contact between a carcass and the floor. The carcass needs to be off the ground as soon as possible during the first steps of the slaughtering process. This requirement is best fulfilled if carcasses are already off the ground at the point of bleeding. In the absence of supporting technical devices to hoist up carcasses for bleeding, that step can be done on the ground because the carcass is still fully covered by the skin. Once the protective cover of the animal skin is cut open or removed, it is absolutely necessary to prevent any contact with the floor.

Unfortunately, such optimal conditions are only the exception and not the rule in many slaughter facilities in APHCA-member countries, similar to the situation in most developing countries. Contact with unclean surfaces is the main source of meat contamination, and floors are among the most contaminated surfaces.

Main problems in small ruminant slaughtering

Slaughtering of sheep and goats is technically easy. Even with simple equipment it can be done in a clean and hygienic manner. The exception are sheep breeds with large amounts of wool, in which a great deal of cross contamination from hair to skin can occur if no proper equipment to assist the skinning process is available, such as a skinning line that suspends the carcass in a horizontal position using the four legs (Fig. 21).

Meat contamination of short-haired species during skinning and eviscerating usually can be kept minimal if simple equipment for carcass suspension is available, such as wall hooks or racks with hooks (in small operations) or hooks or gambrels attached to an overhead rail in larger operations (Fig. 16, Annex A5).

Hygienic problems in slaughterhouses for small ruminants are mainly caused by the absence of a carcass suspension system or handling negligence, such as:

- slaughtering on the floor without the possibility of hanging the carcass;
- hanging too closely together both un-skinned and skinned carcasses in the slaughter line, resulting in contact of hair or skin to already-skinned carcass parts;
- carcass suspension too low, with forelegs and shoulders touching the floor;
- careless evisceration that spreads intestinal content onto the meat surface.

Main problems in bovine and large ruminant slaughtering

Severe hygienic problems in the slaughtering of cattle and buffaloes in many places stem from the difficulty in handling these heavy carcasses where there is inadequate or no slaughter equipment available. Proper equipment for handling bovines includes manual or electric hoists for lifting up the carcass – getting it off the floor for flaying, eviscerating and splitting.

In traditional slaughtering, bovine carcasses are placed with the back on the ground. In this position the hide is loosened from the carcass, starting from the hind leg, belly and forelegs. The hide serves as protection of the meat surfaces from direct contact to the ground. Evisceration also takes place in this position. This procedure is the only possible method in rural slaughtering and may work reasonably well, if only one or two animals are slaughtered carefully and without time pressure. As soon as more animals are brought to be slaughtered in the same location, such as at a commercial slaughter slab in which workers are usually under time pressure, heavy bacterial loads on the meat through cross contamination cannot be avoided.

The following photo examples (Figs. 2–7) illustrate extremely heavy meat contamination during large-ruminant slaughtering, dressing and deboning due to ignorance or neglect of the basic rules of hygiene. Such practices, which are a threat to food safety and consumers' health, are unfortunately very common in APHCA-member countries.

Figs. 2 and 3 show cattle slaughtering entirely carried out on the ground, in many cases followed by carcass splitting, cutting and deboning on the same contaminated floor area. Bovine slaughtering on the floor is a major source of meat contamination. But doing the cutting and deboning there as well multiplies the bacterial load introduced into the meat. The newly created meat surfaces (from the cutting and deboning) become massively contaminated; due to the microbial lag phase (Fig. 1), rapid spoilage will normally not occur within the first few hours. Any prolonged storage under ambient temperatures will boost rapid spoilage. Moreover, there is also the high risk of contamination with food poisoning micro-organisms, such as Salmonella and enterohaemorrhagic E. coli (EHEC), which should be taken very seriously. EHEC infections of humans can occur with relatively low bacterial numbers of the relevant type of E. coli.



Fig. 2: Roadside cattle slaughtering: This method used to be the only source of beef in this particular country.



Fig. 3: Buffalo slaughtering on a slab: Slaughtering and carcass deboning is carried out with only a knife and axe on the ground, which is heavily contaminated with animal manure, intestinal content and dirty water. Buffalo dung lays in close proximity to the meat being deboned on the ground. This kind of slaughtering operation is the only source of meat for shops in the city where it is located.



Fig. 4: Restraining buffalo for bleeding on the ground: This takes place amid dressed carcasses and deboned meat on the same ground.



Fig. 5: Evisceration of buffalo carcass on the ground next to carcass parts of other animals



Fig. 6: Complete deboning of entire carcass: The process takes place on the same spot previously contaminated from the slaughtering of another animal.



Fig. 7: Meat contamination by flies

Even when simple hoisting equipment is available, the hygienic benefits of lifting a carcass off the ground are frequently spoiled by malpractices of butchers, such as by the lowering of the suspended carcass so that the neck and forequarter touch the floor. This lowering is done to minimize movements of the hanging carcass and to stabilize it with the floor contact for eviscerating and splitting (Figs. 8 and 9).



Fig. 8: Floor contact of forequarter during carcass splitting



Fig. 9: Meat of heavily contaminated forequarter with microbial spoilage after short period of unrefrigerated storage

Often, in the case of using hoists for relatively hygienic flaying, eviscerating and carcass splitting, the forequarters or even both fore and hindquarters are dropped to the floor after separating them from the suspended carcass sides. All efforts at having slaughtered and dressed the carcass hygienically are thus spoiled (Fig. 10).



Fig. 10: Dropping of forequarters on the floor after separating them from the carcass as it hangs on a rail

Main problems in pig slaughtering

Pig slaughtering is much easier than cattle or buffalo slaughtering because the carcass is not very voluminous. But it is still heavy enough to require equipment for lifting and suspending. Also, the pig skin is typically not removed because it is eaten along with the meat. With that protective covering in tact during the slaughtering, less of the meat surface is exposed and thus not subjected to easy contamination.

But contamination can occur during the removal of hair from the skin, which is done by scalding the carcass in hot water tanks. Two problems can arise in this process:

- Temperatures of the scalding water, which should be at 60°–62°C, are not sufficiently controlled and usually too hot because the heating is typically done by burning fuel wood beneath the tank (Fig. 11). In some cases, the water reaches the boiling point. Exceeding the required temperature damages the skin through protein coagulation, which provokes lesions during the subsequent scraping of the knife or machine. Micro-organisms can easily intrude into such lesions.
- Many pigs are put into the scalding water, which causes enormous dirt contamination. The necessary periodical refreshing of the scalding water is usually not done.

Pig slaughterhouse operators must be forced to keep the carcasses and the meat off the ground, starting with the scalding process. This can be done in the small-to medium-sized facilities with moderate investment (see pages 30-32). The solutions proposed in Figs. 49 and 50 in this report are absolutely adequate as long as such slaughter operations produce for the traditional “wet” (open-air, or fresh) meat markets. With some modifications, they also can be considered for more demanding chilled-meat production.

Tremendous hygiene problems with heavy meat contamination can occur if the entire pig-slaughter operation is carried out on the ground (Figs. 12–15), which is still the case in many pig-butcher facilities in APHCA-member countries.



Fig. 11: Traditional scalding vat: The vat is heated by fuel wood, which does not allow for temperature control. Only a small quantity of scalding water is available.



Fig. 12: Unhygienic slaughtering of a pig on the floor: One of the butchers steps on the carcass for assistance in opening it for evisceration.



Fig. 13: Carcass splitting on the floor



Fig. 14: Carcass cutting on the floor



Fig. 15: No separation of live pigs: Carcasses being dressed and meat being cut and deboned all in the same area.

3. Design and equipment recommendations for small- to medium-sized abattoirs

Introduction

The ideal abattoir operation uses the line-slaughter system. "Line slaughter" entails hoisting up the carcass at an early stage, preferably beginning with the bleeding. All subsequent slaughtering and dressing procedures are carried out with the carcass suspended on and moving along an overhead rail (or line). Line slaughter is suitable for bovines, small ruminants and pigs.

This method is in stark contrast to the booth-slaughter system common in the past. In the booth system, abattoirs or slaughter spaces are divided into many spots ("booths"), which allow for the simultaneous slaughtering of a certain number of animals ("batch"). A team of men attends each slaughtering spot. The animals in a batch are each taken to a defined floor area, slaughtered and dressed in that spot. The simultaneous slaughtering often creates congested conditions and hygienic problems. The equipment is typically limited, in some places only a knife and axe are used while others have hoists for lifting the carcasses. Skinning cradles for flaying are used with cattle, and they help keep the carcasses from floor contact.

Batch slaughter also remains a frequently used system in APHCA-member countries, especially for large ruminants. The old central abattoirs still in use were designed for this system and have not converted their 50-year-old technology. But even some relatively new medium-sized municipal or private abattoirs were designed for batch slaughter because it is cheap to construct compared with a line-slaughter facility. In some places, slaughter personnel who have long used the batch practice have been adamant in maintaining their traditional way and have refused to use the modern slaughter lines. Part of the problem has been that, in some cases, the newer line-slaughter system was not properly designed and thus difficult to operate. Such inadequate installations were abandoned by the workers who returned to the booth- or batch-slaughter systems.

In very small slaughter operations where the line system is not warranted, the principle of booth slaughter is acceptable and widely applied. In small-scale conditions, the slaughtering and dressing of animals on the same spot can be done hygienically if the necessary equipment, such as hoists and skinning cradles, are used together with an overhead railing to facilitate the dispatching of the carcasses. This refers in particular to large and small ruminants. For pigs, due to the need for scalding, a slightly different system has to be applied (see page 31).

Slaughter systems for small ruminants

Small ruminants, at least those breeds that are short-haired (most tropical breeds), can be hygienically slaughtered even in field or small-scale conditions. In the simplest case, the bleeding is done on the ground on a cover of banana leaves, on a table (Fig. 71) or something similar. Then a rack with standard hooks or gambrels (hanger-like hooks) is used to keep the carcass in a vertical position off the ground for skinning and eviscerating (Fig. 16 and Annex A5). The branch of a tree may be sufficient for slaughtering on a farm premise (Fig.17).

Small ruminants' skin, such as sheep skin, is usually firmly attached to the carcass and is usually not easy to manually pull off. The use of a knife is prohibited because of the risk of skin damage or damaging the superficial fascia (a fine membrane that improves carcass appearance and reduces surface shrinkage). Thus, it often requires the butcher to punch his fist forcefully between the skin and the carcass surface to detach the skin ("fisting"). Fisting is hygienically critical: The butchers must take care to frequently wash their hands and arms and not touch the dirty outside of the animal's skin while removing the skin this way. A proposed solution to fisting is the use of compressed air; a compressed air pipe is introduced between the skin and carcass surface and the air pressure gradually detaches the skin. The air must pass through a filter in order to reduce the micro-organisms present in the air, which otherwise can constitute a source of contamination.

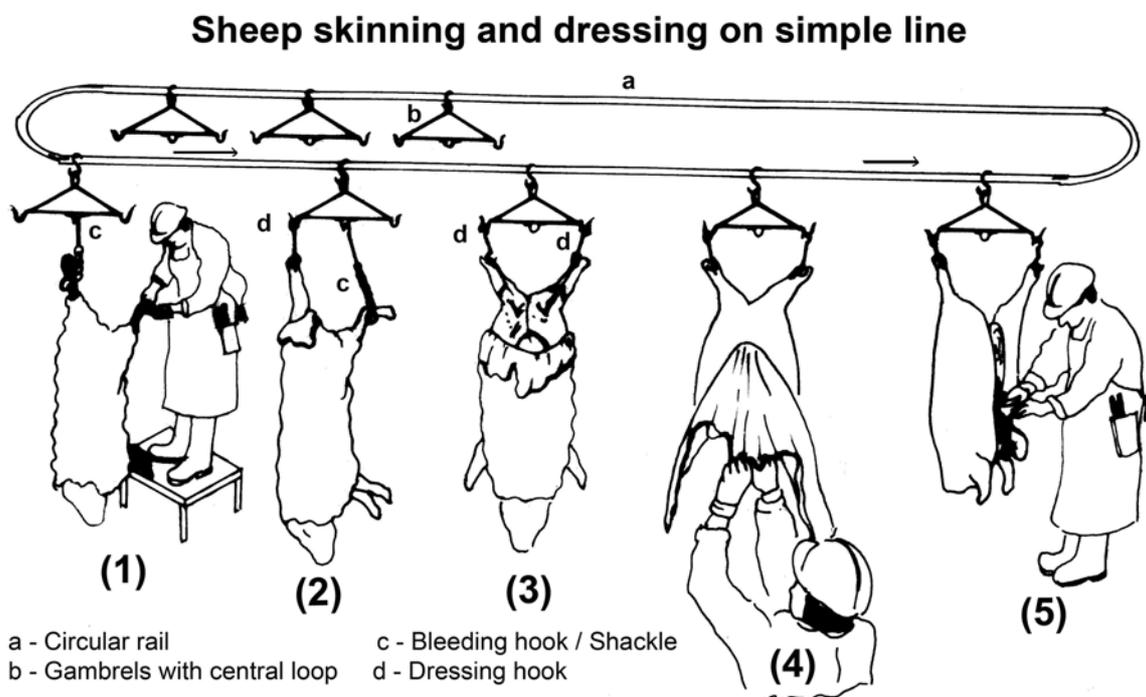


Fig. 16: Gambrel with dual function for small ruminant dressing: A shackle is inserted into one hind leg and then into the central loop of a gambrel for the skinning of the free (unsuspended) hind leg (1). Then the skinned legs are hooked into the gambrel (called "legging") (2, 3). All the skin is removed (4), followed by evisceration (5). This type of gambrel can be used for moving a carcass on a rail (as shown here) or left stationary (see Annex A5).

In many population centres of Asia's developing countries, in particular the Muslim countries where sheep and goat meat are in high demand, large-scale batch slaughter facilities can be found operating with a daily throughput of thousands of small ruminants. Unlike the batch slaughter of cattle, small ruminant batch operations fortunately can be carried out more hygienically because, after bleeding, the carcasses can be suspended vertically on hanging racks with hooks or suspension devices (Fig. 18). Batch slaughter of small ruminants in large-capacity municipal abattoirs probably will not be easy to replace because this system allows butchers to control and identify their own animals, which might be difficult to do in the line-slaughter system.



Fig.17: Farm slaughtering of small ruminants



Fig. 18: Batch-slaughtering system for small ruminants: This facility has a huge slaughtering floor with a multitude of hanging devices for vertical skinning and eviscerating.

Wherever possible in medium- or large-sized operations, line slaughter (Fig. 19) of small ruminants is the best option. In addition, a separate bleeding line should be available (Figs. 19 and 20), at the end of which the legging is carried out. This involves removing the skin around the hock, exposing the tendon dorsal of the hock (Achilles tendon) and cutting off the foot. The carcasses are transferred from the bleeding rail to the dressing rail by inserting spreading hooks or gambrels at the Achilles tendon. In this position, evisceration is easy and hygienic. In contrast to batch slaughter, meat inspection in line slaughter can be done without difficulty.

Conventional vertical line slaughter of sheep breeds with a large amount of wool can cause hygienic problems. A great deal of meat-surface contamination occurs during the manual skinning of the hind legs of such sheep because it is difficult to avoid contact between the hair and the meat surface. Also, butchers have difficulty keeping their hands and arms clean during the procedure.

For those woolly animals, a double-railing system that allows the suspending of the carcass by all four legs has proven very useful (Fig. 21). The legs and belly region are skinned in this position and then the forelegs are released. The remaining still-attached skin parts can be hygienically removed and the carcass can be eviscerated in this vertical position.

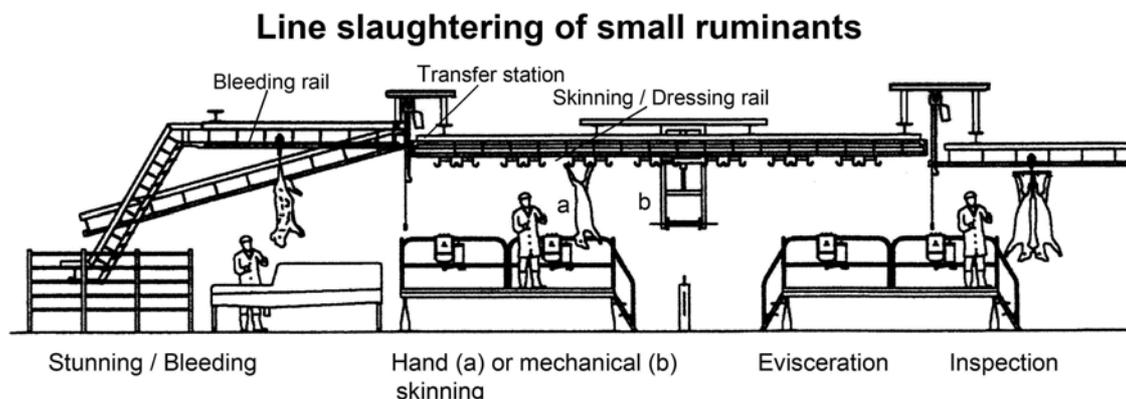


Fig. 19: Line slaughtering of small ruminants with bleeding rail (left) and dressing rail (right): Legging takes place at the transfer station. Bleeding hooks roll back by gravity on the sloped rail. Transport on rail moves either manually for a maximum of 30/h with manual skinning (a) or by an overhead conveyer for a maximum of 60/h, although a mechanical skinning device (b) is needed.



Fig. 20: Bleeding on rail: An animal is suspended on one leg by shackle or by plastic rope, as shown here.

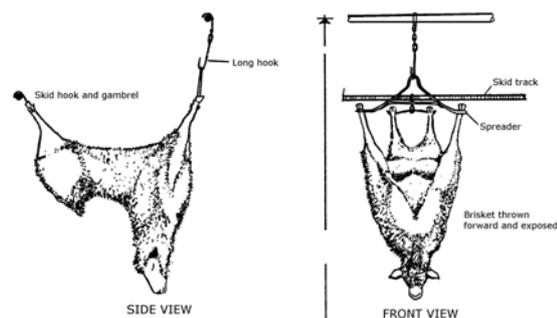


Fig. 21: Manual skinning of sheep with much wool: Suspension is from a double rail to avoid contamination during skinning.



Fig. 22: Hanging of dressed carcasses for dispatching or cooling

Slaughter systems for bovines

One of the principles of hygienic slaughtering is the lifting of carcasses off the floor at the earliest possible stage. Bovines, mainly cattle and buffaloes and in some areas also yaks, have to be lifted up mechanically. But many slaughter operators do not have the means for this or for proper carcass suspension. This results in a multitude of hygienic problems in bovine slaughtering.

Farm or field slaughtering of bovines is typically not very common, but it does take place, especially in an emergency situation due to drought or infectious disease. In the case of yaks, those that are kept in high altitudes are usually not near established slaughter facilities.

For slaughtering an animal in a farm or field situation, the so-called "tripod" (Fig. 23) has been developed. It allows for a carcass to be lifted up by means of a manual hoist, also called a "chain block", after the animal has been stunned, bled and flayed on the ground. The tripod is composed of extendable aluminium posts, which are lightweight for carrying. However, special precautions must be taken

when using this system to quarter the carcass: There may be a temptation to drop the quarters to the ground because there are no supporting rails. Also, if an entire herd of bovines has to be slaughtered, the tripod will create a bottleneck in terms of the time needed. This slowness may encourage the temptation to slaughter the animals simultaneously on the ground in order to speed up the process, but it will be at the expense of meat hygiene.

There were attempts in the past to construct mobile slaughter facilities, including the creation of a mobile container for slaughtering chickens. But the methods for slaughtering large animals either failed or were not very practical because the concept involved slaughter lines and equipment on trucks or in containers. If there is a need for a mobile slaughter facility in a field situation, the recommended approach calls for designing slaughter-line components, such as a rail system and hoists, in a way that they can be assembled and disassembled wherever livestock are to be butchered.

In some developing countries where programmes for upgrading slaughterhouses have been initiated, the introduction of the line-slaughter system has proven technically possible at a reasonable cost, even in small municipal communities, and acceptable to slaughter workers. However in some countries there was opposition to the method as pointed out in Table 1, for example in Indonesia and Pakistan. The opposition is among those workers and their employers, who are meat dealers or butcher shop owners, who are not prepared to change their traditional practices – much to the detriment of food safety and consumer protection.

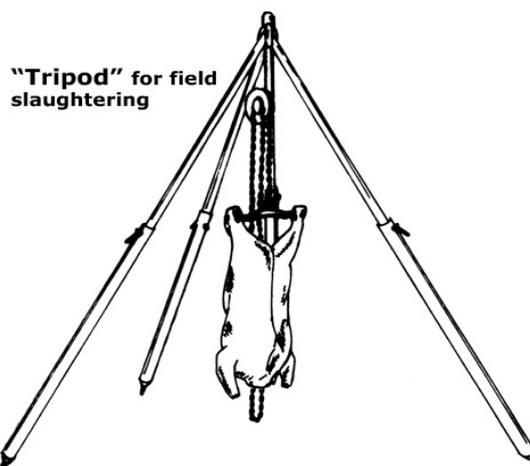


Fig. 23: Tripod composed of three extendable aluminum posts for field slaughtering

The differences between booth-slaughter and line-slaughter of bovines are schematically drawn in Fig. 24. In booth slaughtering (see diagram "A" in Fig. 24), all operations take place in one spot. Bleeding and the initial flaying is carried out on the floor; if a hoist is available, the rest of the operation (completion of flaying, eviscerating, carcass splitting and quartering) can be carried out with the carcass in a vertical position. For cutting the hind and forequarters, an overhead rail of approximately 2.2 m height is useful.

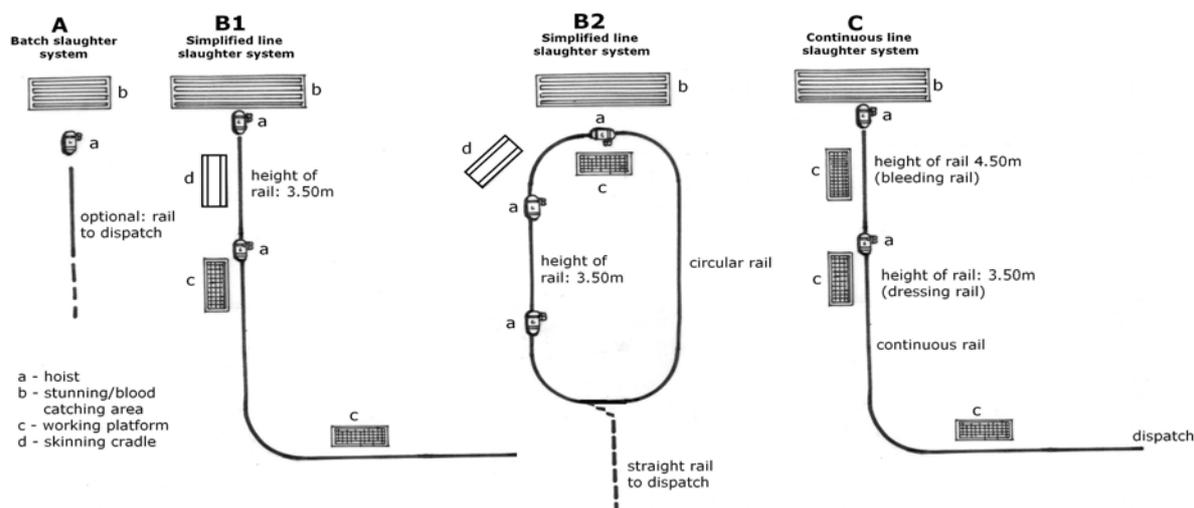


Fig. 24: Features of the bovine booth-slaughtering and line-slaughtering systems

The booth (and batch) system can be modified to include some elements from the line-slaughter system (Fig. 24-B2 and Fig. 27) and thus provide another acceptable alternative to the simple booth system (Fig 24-A). For instance, bleeding can be done in a separate location (Fig. 24-b). As shown in system B2 (Fig. 24), a circular rail (3 to 3.5 m high) with several mobile hoists can be used in one of the following ways:

Alternative 1: After bleeding the animal at the blood-catching area and initial flaying and hock cutting on the ground, the carcass can be hoisted up and moved along the rail to a free space where the rest of the flaying, eviscerating and splitting can be done with it in a vertical position. The circular rail allows for returning the mobile hoists to the stunning and blood-catching area to be used again for the next carcass. The disadvantage of this method is that flaying has to be started on the floor.

Alternative 2: The animal, after stunning, is lifted by means of a special hoist for bleeding in a vertical position. After the bleeding, the hoist then moves to a mobile skinning cradle and the carcass is placed on the cradle, where the initial flaying operation starts and the feet are cut. The cradle moves to any of the remaining hoists and the carcass is hoisted up and into a vertical position then moved along the line to where the flaying, eviscerating and splitting are done.

Fig. 25 depicts the sequence of the slaughtering and dressing operations in the booth system. Operations a1 to a5 are carried out in the same booth. The manual lifting shown is done with a wall-attached hoist, which in this case is preferable to a simple manual chain block. Instead of manual hoists, electric hoists can be used. If a skinning cradle is used (Figs. 26 and 28), the hoist of

the booth system is used two times: first for lifting up the carcass and to lower it onto the skinning cradle. Second, the hoist is needed to lift up the partly flayed carcass (Fig. 32) to a vertical position to complete the flaying as well as for eviscerating and splitting.

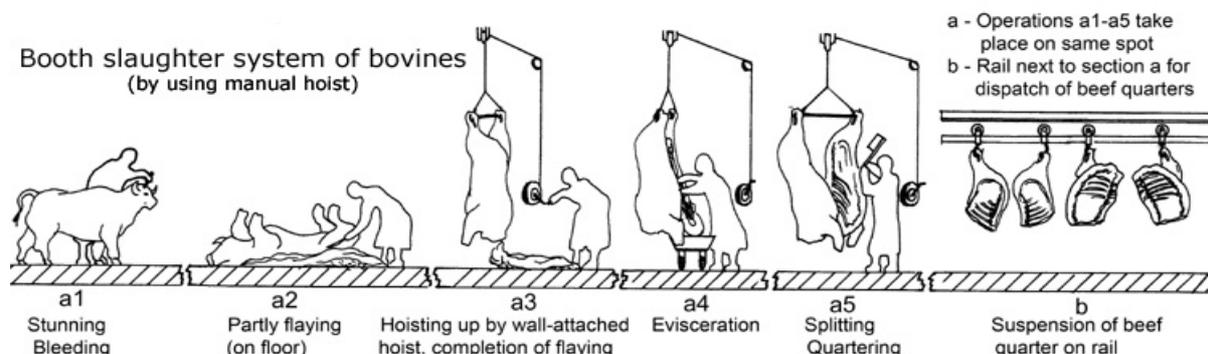


Fig. 25: Production flow (schematic) in booth slaughtering, with possibility of hoisting up the carcass: All operations depicted from a1 to a5 take place in the same spot, or "booth".



Fig. 26: A simple booth-slaughtering facility: Cables linked to the hoist support the carcass spreader on both ends. The skinning cradle here (foreground) is made of concrete, and there is a cattle restrainer for stunning (left). Booth slaughtering can be acceptable in small-scale conditions.



Fig. 27: Modified booth-slaughtering system: The circular rail holds several manual hoists.



Fig. 28: Skinning cradles for small ruminants (the smaller one) and bovines.

For a simple bovine booth-slaughter facility, efficient manual or electric hoists are indispensable for lifting carcasses off the ground – the most critical feature in bovine slaughtering. But slaughter workers often refuse to use the hoists because they are too difficult to operate. If the hoists do not keep a carcass in a relatively stable, suspended position, the various slaughtering steps (flaying, eviscerating and splitting) cannot be done accurately. In such cases, the butchers will lower the carcass in a way that makes it manageable but that places the neck or shoulder parts in contact with the floor (Fig. 8) and with all the negative consequences for meat hygiene. Or they may even give up trying to work with an impractical hoist and resort to floor slaughtering.

Therefore, technically appropriate equipment must be provided. Spreaders attached only from the middle section of the device to the overhead structures (Fig. 29) do not achieve sufficient stability. A wall-mounted hoist, which has two suspension chains or cables, each one attached to both ends of the spreader, is the most suitable piece of equipment (Fig. 26 and Fig. 30).



Fig. 29: Inadequate suspension of carcass: A carcass partly flayed on the floor is being hoisted up. Due to the spreader suspension from the middle of the device, the carcass is difficult to stabilize in a vertical position and thus allow for accurate work.

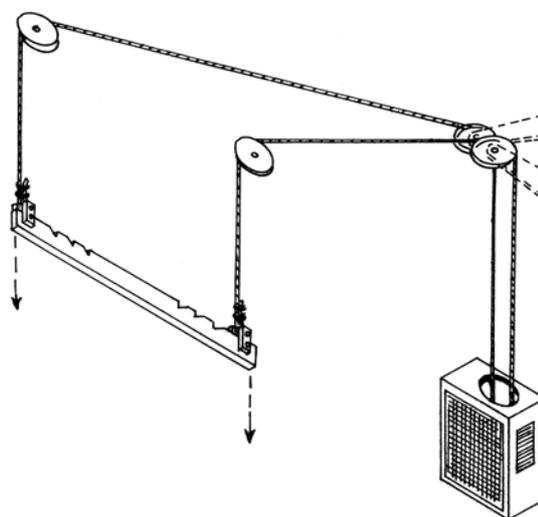


Fig. 30: Good carcass suspension: A spreader with connections on both ends, assisted by an electric wall hoist, maintains a stable position.

Although the middle-suspended spreader typically is not easy to work with, good carcass stability can be achieved if this type of device is used with an overhead rail. Using a specific landing device on the rail provides stability for accurately removing the hide as well as eviscerating and splitting the carcass (Fig. 31).

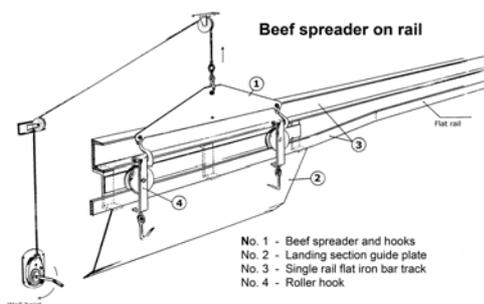


Fig. 31: Middle-suspended spreader placed on a rail: The placement on the rail provides stability.

Line-slaughter systems for bovines can be subdivided into 1) simplified line slaughter, or semi-line slaughter (Fig. 24-B1) and 2) continuous-line, or

full-line, slaughter (Fig. 24-C). The two differ in the position of the carcass: In the continuous-line slaughter, the carcass, once hoisted up, remains in a vertical position on the line throughout the entire process (Fig. 34), while semi-line slaughter uses vertical and horizontal positions (Fig. 33); the horizontal operations take place with the carcass on a skinning cradle. For this purpose, the carcass has to be lowered from its vertical position to the horizontal position on the cradle, where the initial flaying operation starts and feet are cut. Having done this, the carcass is gradually lifted up until it returns to the vertical position on the rail for complete flaying, eviscerating and splitting (Figs. 32 and 33).

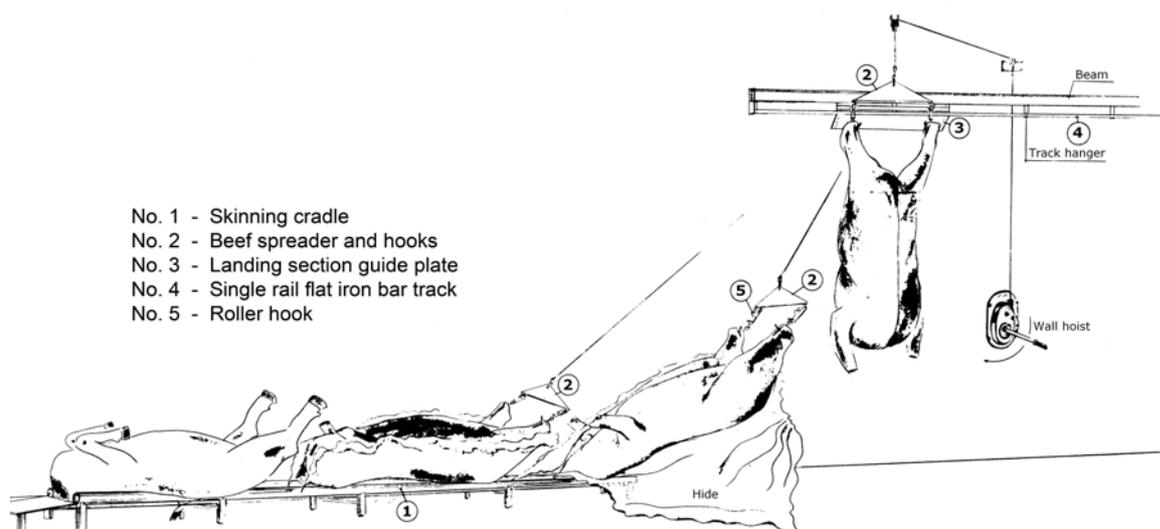


Fig. 32: Sequence of flaying operations on skinning cradle in which the carcass is gradually lifted for complete flaying

Semi-line slaughtering of bovines using skinning cradle

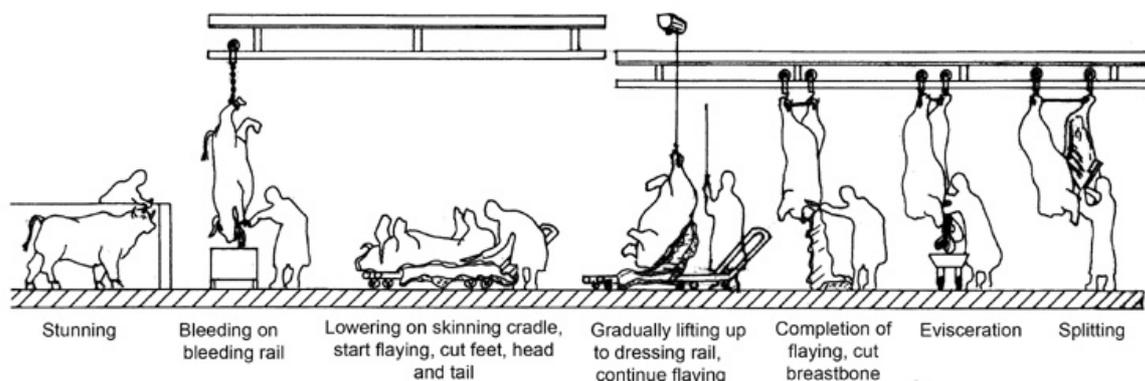


Fig. 33: Semi-line slaughtering: The carcass is temporarily taken from the line and placed on a skinning cradle. Using the cradle avoids contact with the ground.

In semi-line slaughter, the feet are cut off while the carcass is on the cradle. To hoist the carcass out of the cradle, the spreader is inserted into the Achilles tendons of the hind legs (Figs. 29 and Fig. 40).

In the continuous-line system (Fig. 34), the animal is hoisted up for bleeding and the carcass remains in this position during the entire flaying and dressing steps. For bleeding, the stunned animal is hoisted up by means of a bleeding hook, also called a shackle (Fig. 39 and Fig. 41). An alternative to this procedure is a method used for ritual slaughtering in which the bleeding is done with the carcass in a horizontal position on the ground and then hoisting it up.

In the continuous-line system, changing from the bleeding hooks to the dressing hooks (Fig. 41) has to be done while the carcass is vertical. To accommodate this process, two rails with different heights are required: the bleeding rail (4.5 m) and the dressing rail (3.5 m). The change of hooks takes place at the transfer station (Fig. 34) in an operation called “legging” (see also Figs. 35 and 36).

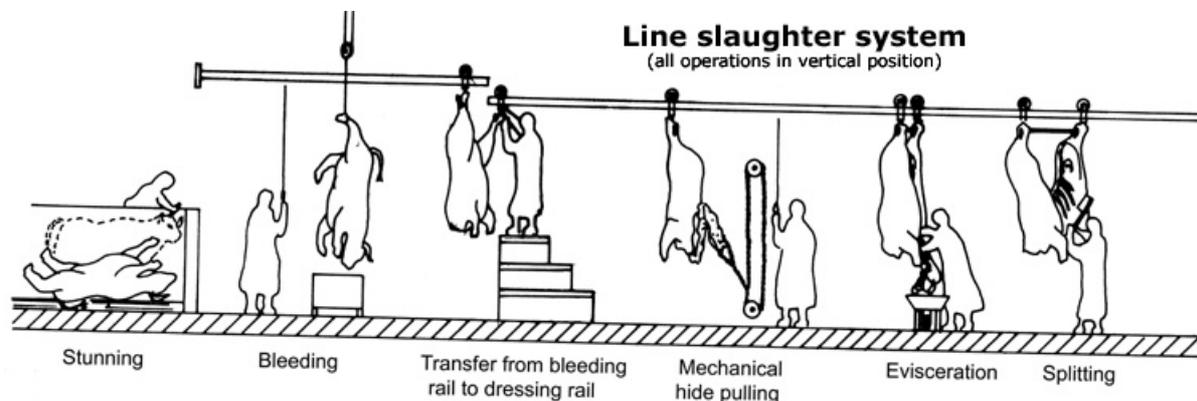


Fig. 34: Continuous line slaughtering: The carcass remains on the line from the point of hoisting up for bleeding. Instead of the depicted mechanical hide pulling, simple manual flaying can also be used. Different heights for the bleeding rail (left) and the dressing rail (right) are required.

Figs. 35 and 36 illustrate the steps in the legging process. In Fig. 35, the carcass is suspended on the bleeding hook, which is positioned on the higher (4.5 m) bleeding rail (right). The hide from the other (unhooked) hind leg is then removed. The foot is cut off (as shown in Fig. 35) by using pneumatic tongs, or a “hock cutter”, but it can also be done with a knife). The dressing hook is then inserted into the Achilles tendon and connected to the lower dressing rail (3.5 m).



Fig. 35: Carcass during legging

Fig. 36 shows the different positions of the carcass during legging. The carcass (far right) is suspended by means of a bleeding hook on the higher bleeding rail while the other leg remains free; hide removal begins here. The carcass in the middle is still suspended with one leg by the bleeding hook while the skin removal is completed on the other hind leg. After the foot is removed, the free leg is then hooked to the lower dressing rail. The carcass (far left) is suspended at the Achilles tendons of both hind legs on



Fig. 36: Positions during legging

the dressing rail; legging has been completed on this carcass and it is ready for flaying and eviscerating.

Comparison of two types of slaughter lines for bovines, with different capacities

As illustrated in Figs. 37 and 38, the following compares the technical details and differences in equipment and operation of two well-equipped bovine-slaughter lines for low throughput (line I, with 5–10 head per hour) and for medium throughput (line II, with 10–15 head per hour). Both types meet the requirements for line slaughter in small- to medium-sized abattoirs.

Space needed for the lines: The increase of the capacity, starting from a low level (I=5–10 head/h) to approximately twice this capacity (II=10–15 head/h) requires more space for line II (30 m versus 20 m) and more mechanization of the line equipment.

Stunning: The required size of the stunning box and equipment (preferably captive bolt pistol) is the same for both types.

Bleeding: The bleeding area should be larger for line II because it may be necessary to keep two to three bled carcasses there that are waiting for the next operation. Line I has a mobile bleeding hoist, while in line II the carcasses are suspended on shackles from the bleeding rail for bleeding.

Legging and transfer: In both types of lines, the legging is done at the transfer station. The two systems differ as follows: In line I the carcass is moved to the transfer station by a mobile bleeding hoist. Line II has a bleeding rail on which shackles (bleeding hooks, Fig. 41) hold the carcass and move it to the transfer station.

Flaying or hide pulling: In line I, flaying is done manually. Platforms at different heights allow workers to reach all areas of the suspended carcass. There are similar platforms in line II, but they accommodate only the loosening of the hide; removing the hide takes place at the mechanical hide-pulling station. For technical variations of the mechanical hide-pulling equipment, see Figs. 44 and 45).

Eviscerating: This is carried out in line I by one operator who uses a platform that is adjustable in height. Because line II accommodates greater capacity, two operators are needed, one for the green offal and another for the red one. Both operators stand on a fixed platform, but at different heights.

Carcass splitting: Typically, electrical splitting saws are used in both lines; but given the small throughput of line I, simple tools (axes) will work sufficiently.

Inspection: For veterinary carcass inspection as well as internal quality control, a station with platforms is useful for line II. In line I, both types of carcass inspection can be done from the floor. For the meat inspection of the internal organs and the heads, both types are not large enough to justify a mobile viscera table and head transport facilities that are synchronized with the movement of the carcasses, as shown in Fig. 79. In both types, viscera carts (Fig. 76 and Annex 11) and pluck and head-fixation facilities (Figs. 77–78)

are sufficient. However, carcasses and corresponding organs need to be easily identifiable.

Carcass washing: In line II, a stainless steel washing tunnel with spray nozzles is useful. For line I, the carcass washing can be done by using a simple water hose; but the area for the washing should be separated to keep the washing water from spreading across the floor.

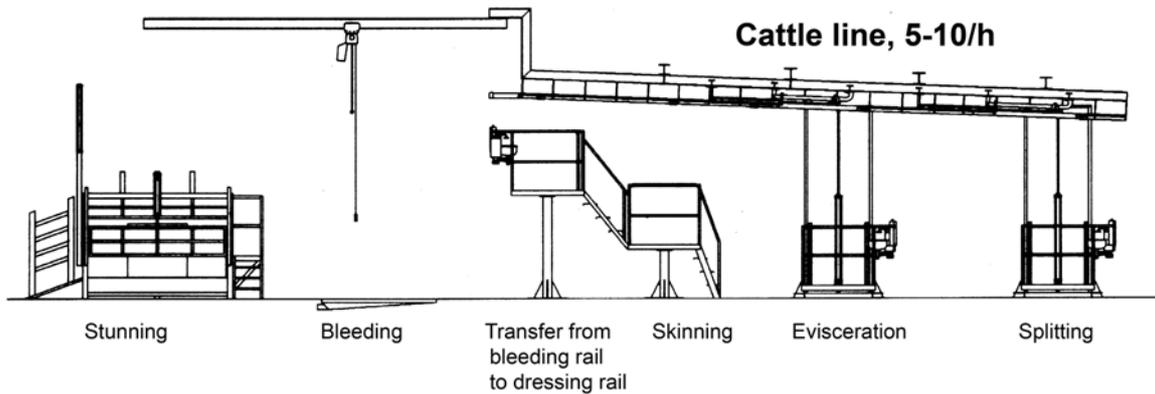


Fig. 37: Bovine slaughtering line (I) for low throughput (5–10 head/h) Minimum length: 20 m

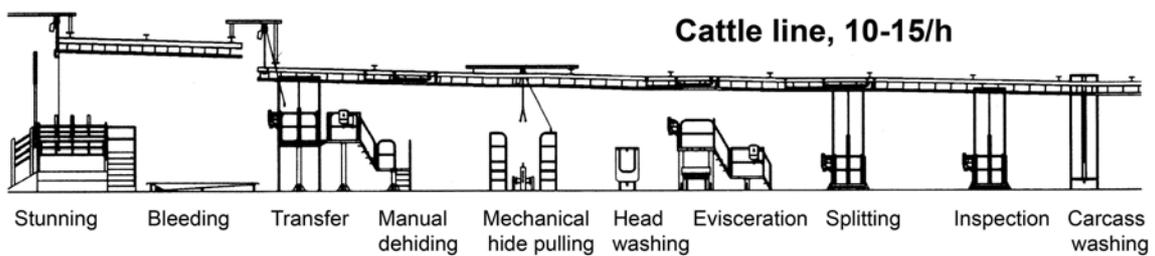


Fig. 38: Bovine slaughtering line (II) for medium throughput (10–15 head/h) Minimum length: 30 m

Figs. 39–45 illustrate some additional features for slaughter of bovines. See also Annex A1–4 and 9–11.

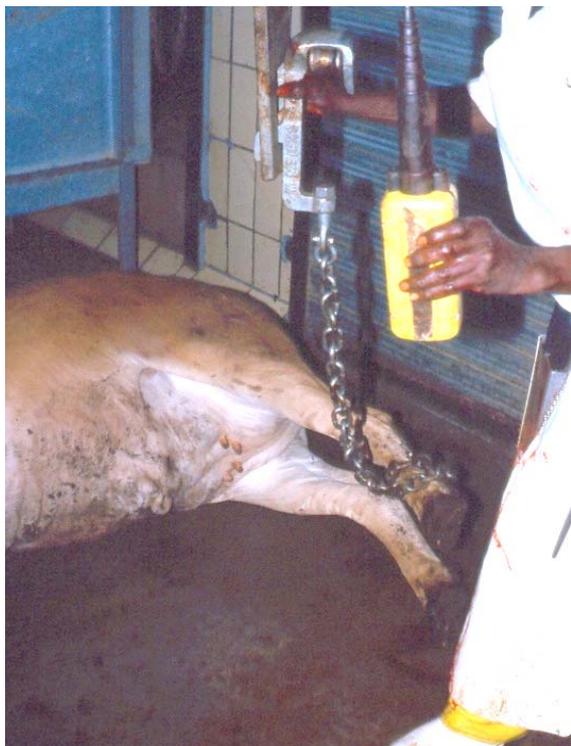


Fig. 39: Hoisting up with bleeding hook



Fig. 40: Beef carcass on dressing hooks on flat rail: The carcass is hung by a simple spreading bar.



Fig. 41: Bleeding hook, or shackle, (top) and dressing hook



Fig. 42: Manual flaying: Care is needed to ensure that no knife incisions occur and that no meat remains on the inside of the hide.



Fig. 43: Damage of tanned hide: Unskillful flaying results in many knife incisions that render the hide worthless. This happens particularly during traditional floor flaying. A mechanical hide puller is the best guarantee for good hide quality.

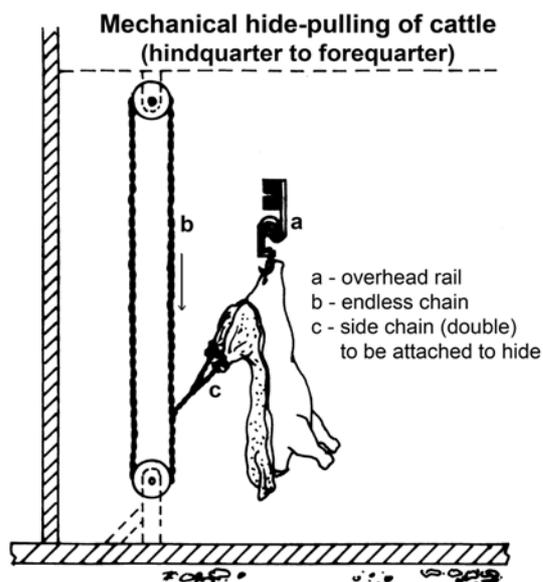


Fig. 44: Simple mechanical hide pulling by means of an electric hoist with an endless chain: The hide is stripped off from top to bottom. This device is well suited for both lines I and II.

Costing

Hygienic bovine slaughtering involves mechanized equipment. The cost of setting up cattle-slaughter facilities depends on the quantity and type of technical equipment used.

Hoists are indispensable; good-quality manual hoists cost US\$500–1 000 while electrical hoists are US\$2 000. Other electrical equipment that are considerably useful (but can be supplemented with manual tools in the small- to medium-sized facilities) are the electrical splitting saw (imported cost: US\$10 000), a breastbone saw (US\$5 000) and a hock cutter (US\$4 000). As well, captive bolt pistols (imported) cost US\$300–400 and the ammunition runs about US\$0.10 per cartridge.

The other items, such as stunning boxes, overhead rails, platforms, working tables, chutes, viscera tables and carts, hanging racks and, in most cases, the bleeding and dressing hooks, can be fabricated locally at much less expense than buying on the international market.

In an APHCA-member country, building a slaughter facility (building only) requires an estimated US\$300 per square meter. Thus, a physical structure housing a small- to medium-sized bovine slaughter line occupying 20x10 m would cost approximately US\$60 000. The most expensive part of a modern slaughter facility is the refrigeration units. Building and installing a normal-sized carcass “chiller” (refrigeration unit) would cost around US\$140 000. Carcass chillers are not used in traditional meat marketing practices. However, with the gradual shifting of consumer preference for chilled meat sold in quality shops and supermarkets, there will be an increasing need for carcass chillers.

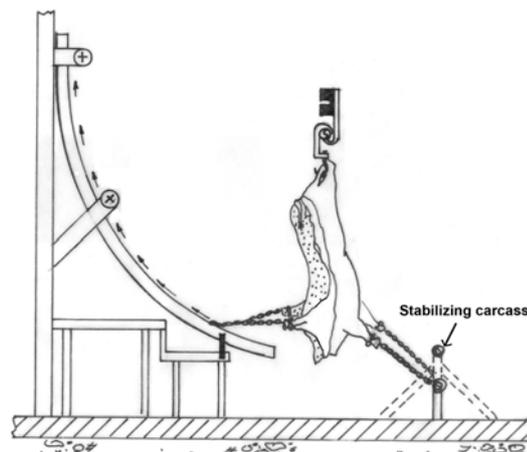


Fig. 45: Advanced mechanical hide pulling using a chain elevator: The hide is stripped off from top to bottom by fixing the carcass at the forelegs. This method is better suited for larger operations.

Approximate costs of equipment for booth slaughter of bovines (in US\$):

Manual hoist	1 000
Electric hoist	2 000
Skinning cradle	500
Platforms	1 000
Railing, hooks	1 000 (up to 3 000)

There are several options for equipping a bovine booth slaughter facility, from staying small and requiring only one hoist, no cradle and a short rail to the much larger system that involves a bleeding hoist, one or several cradles, one or several skinning hoists and an extensive rail system. The total expense generally will vary from US\$3 000 to 15 000.

Approximate costs for a low-throughput (10–15 head/h) bovine slaughter line (in US\$):

Stunning box	3 000
Captive bolt pistol	400
Rodding equipment	1 000
Hock cutter	4 000
Electrical hoists (3)	6 000
Platforms (galvanized, stationary)	6 000
Overhead rails (galvanized)	10 000
Breastbone saw	5 000
Splitting saw	10 000
Head-washing cabinet	5 000
Carcass-washing cabinet	6 000
Chutes, viscera carts, racks, tables	10 000
Hooks, small tools	5 000
Total	71 400

The above figure reflects the minimum cost for a low-capacity, partly mechanized installation that allows for the efficient line slaughter of bovines. For a slaughter line complete in all aspects, especially to comply with hygienic requirements, some additional equipment will be necessary: meat inspection tools and installations, hand-washing basins and thermostat-regulated hot water receptacles for sanitizing knives, saws and other tools. Expenses for such a good-quality slaughter line can run as high as US\$100 000.

Slaughter systems for pigs

Farm slaughter of pigs is very common and easier to do than with bovines because they weigh less (around 110 kg for a 4-month-old pig). Of course, sows and boars are much heavier and hence more difficult to handle without proper slaughtering facilities.

In contrast to other livestock, pig skin is commonly eaten. This requires the removal of the hair during slaughtering, which is done by scalding the pigs in hot water (60°–62°C) or by steaming the skin in more advanced operations. Both procedures serve to loosen the hair, which is then removed by a scraping

process. In small- to medium-sized operations, a knife is used for scraping, but in larger operations machines are used.

Once the hair is removed from a pig, there should be no further contact between the floor and the skin (which will become food for human consumption). There are ways to maintain this principle in a farm process: Scalding can be done by either pouring hot water onto the carcass or submerging it in a container filled with hot water. As shown in Fig. 46, the problem of loading and unloading the carcasses can be solved by using a wire mesh carrier. The carcass is then placed on a ladder-type device, in a horizontal position, for dehairing and then turned vertically up. In this position, eviscerating and carcass cutting can be hygienically carried out (Fig. 47).



Fig. 46: Using a stainless wire mesh device for loading and unloading of pig into a scalding vat

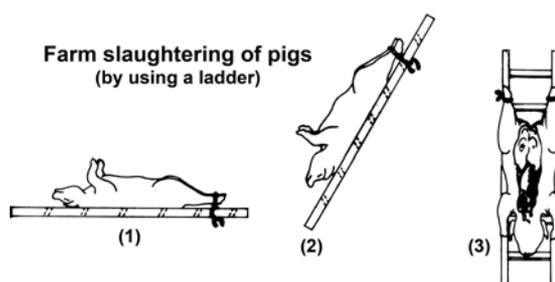


Fig. 47: After scalding and dehairing, place the carcass in horizontal position on an ordinary ladder (1) and then turn the ladder vertically (2) for eviscerating and cutting (3).

Commercial pig-slaughter operations in APHCA-member countries usually have a minimum daily throughput of 50 animals in a small facility and up to 400 or more in a larger place. Small-scale pig slaughter for commercial purposes is rare. There is evidence of this level of operation in Nepal, and the small-scale slaughter method just described (Figs 46 and 47) would be applicable. However, in those operations, there appears to be inadequate separation of live pigs from the carcass dressing and fresh meat selling (see the Nepal country report in Annex B).

In medium-sized and larger pig-slaughter operations, which are common in most Asian countries, hygienic slaughtering can easily be achieved by equipping the facility with a modern set-up (Fig. 54): railing systems with elevating devices, electrically heated scalding vats, lifting devices for moving carcasses into and out of the vat, dehairing machines with mechanical loading and unloading devices and electrical splitting saws.

However, in most of the pig-slaughter facilities in APHCA-member countries, modern systems are not in place and are not likely to be introduced any time soon. As long as the pork goes unchilled to the markets and consumers, such a system may not be necessary. What is critical is the elimination of the unhygienic batch slaughter of pigs (shown on pp. 14-15). This can be done by installing a semi-line system, which enables hygienic slaughtering and carcass dressing without electro-mechanical equipment. Such systems have been developed to good standards in the Philippines, for example.

In many pig-slaughter facilities in APHCA-member countries, there are no proper lifting devices and carcasses are dragged along the floor from the stunning and bleeding stages to the scalding and onto the scraping tables. For example, in the facility illustrated in Fig. 48, pigs are stunned behind the fencing at the left-hand side. Carcasses are then dragged across the floor and manually lifted into the scalding vats, which stand 1 m high. From there, carcasses are dragged onto the scraping tables where they are also eviscerated horizontally. They are only hung on rails for splitting.

A great deal of improvement can be achieved if the pig slaughtering and dressing are carried out on floor surfaces constructed at different levels (a "terraced" or multitiered system). In this approach, the killing of the pigs takes place at the highest level and carcasses are gradually lowered during the various procedures. This system utilizes gravity and facilitates moving the carcasses without complicated electro-mechanical elevating equipment.

In a small-scale facility, two different tiers, or levels, of the floor may be sufficient. However, evisceration must be done with the carcass in a horizontal position after completing the manual dehairing (Fig. 49), although horizontal evisceration is not the best hygienic solution. Also, if carcass splitting is carried out (which is not the case everywhere), it may be necessary to do so in a horizontal position on the table.



Fig. 48: An example of common pig-slaughtering premises: This type of facility has impractical working lines with hygienic deficiencies.

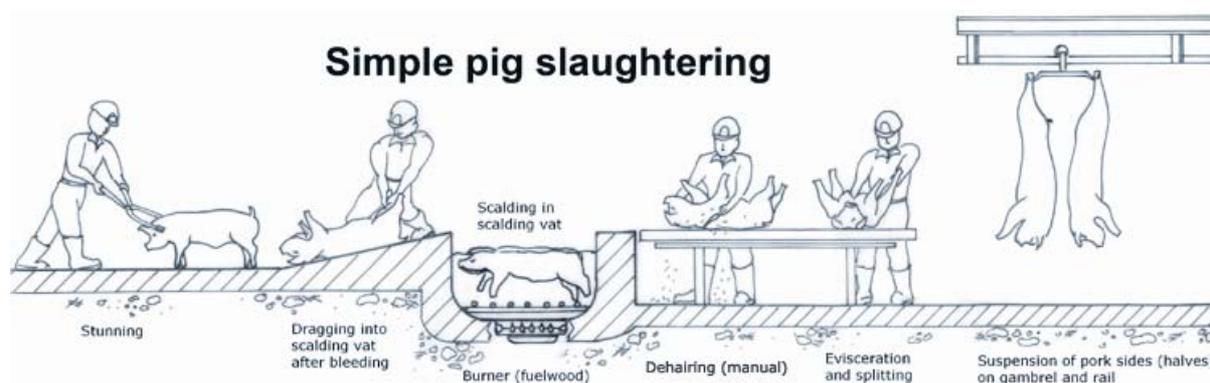


Fig. 49: Small-scale pig slaughtering on a two-tiered floor

Much better working and hygienic conditions can be achieved with three tiers, or levels, of floor surface (Fig. 50). The bleeding of the pigs after stunning and the collection of the blood have to be done carefully for hygienic reasons. Blood is usually collected in a receptacle that is held close to the bleeding wound. Care should also be taken that the scalding water is renewed or supplemented with fresh water from time to time and maintained at the correct temperature (60°–62°C).

In the two- and three-tiered systems, the overhead railing starts at the scraping and gambrelling area. From here, all procedures are organized in a straightforward and hygienic manner. Above the scraping table, the rail can be kept low for easier gambrel lifting of the carcass (with the hind legs of the pig hooked). The eviscerating and splitting procedures take place on another lower level of floor, which enables the operators to work more easily because the rail height at their level is approximately 2.6 m high. In this method, there is no risk of the carcass touching the floor.

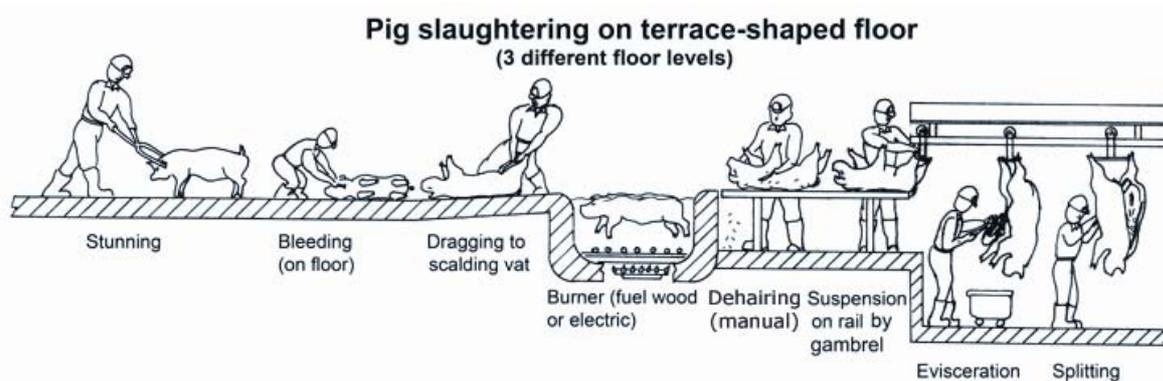


Fig. 50: Medium-scale pig slaughtering on a three-tiered floor

The great advantage of the terraced (multi-tiered) floor is the lack of need for electro-mechanical lifting or moving devices. An overhead railing system that starts at the gambrelling operation (at the scraping table) is sufficient and can be manually operated.

To further facilitate these manual operations, clever designers have created some simple devices that supplement the technically good and hygienic traditional slaughtering of pigs, such as in Indonesia and illustrated in Figs. 51 and 52. Moving the pig carcass from the scalding vat up to the scraping table requires physical strength. As shown, rollers installed on the outlet side of the scalding vat facilitate such work (Fig. 51). If mechanical lifting of pig carcasses is required at any stage in the slaughter line, the device shown in Fig. 52 can be useful.



Fig. 51: Scalding vat (stainless steel) with metal rollers: The rollers facilitate the transfer of pig carcasses from vat to scraping table.

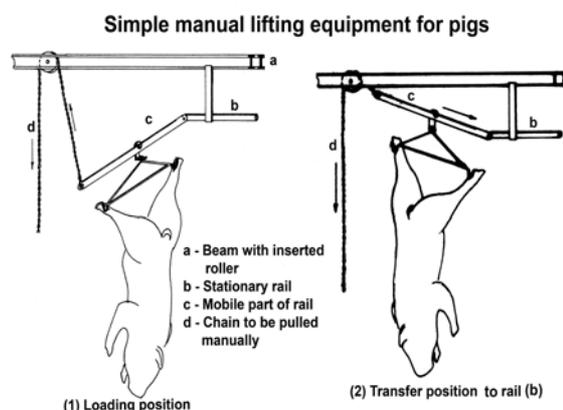


Fig. 52: Manual lifting device for pigs: This device is useful for transferring carcasses from the scraping table to an overhead rail.

Properly done traditional pig slaughter on a three-tiered floor results in hygienically impeccable pork. The system is essentially semi-line slaughter because, starting from the gambrelling operation, all processes take place on the rail. Investment costs are low because only a few pieces of technical equipment are needed (beyond the physical building): electrical stunning tongs, a scalding vat (preferably electrically heated with thermostat for maintaining a constant temperature), a scraping table and overhead rails with gambrels.



Fig. 53: Core equipment for a “terraced”, or multitiered, slaughtering line: This entails the scalding vat (bottom), scraping table (middle) and the overhead rails.

Approximate costs of equipment for a terraced pig-slaughter line (in US\$) (one line with 20 head/h):

Electrical tongs (imported)	2 000
Scalding vat (stainless steel, locally made)	3 000
Scraping and gambrelling table (stainless steel, locally made)	1 500
Railing system (galvanized, locally made)	3 000
Hooks/gambrels (stainless/galvanized, locally made)	1 500
Total	11 000

In contrast to the traditional lines, modern pig-slaughter lines (Fig. 54) consist of the following technical devices for smooth production and adequate hygiene:

- electrical stunning equipment
- bleeding hoist and trough
- scalding vat with loading and ejection device
- dehairing (scraping machine) with ejection device
- scraping and gambrelling table
- gambrelling hoist
- platforms and overhead rails for eviscerating and dressing.

Electric breastbone and splitting saws are commonly used to replace the knife and axe. More sophisticated lines also use vacuum bleeding with a hollow knife, carcass singeing and polishing machines, and automated conveyer systems.

Fig. 54 and Annex A6-8 illustrate the basic equipment and production steps of a modern pig-slaughter line.

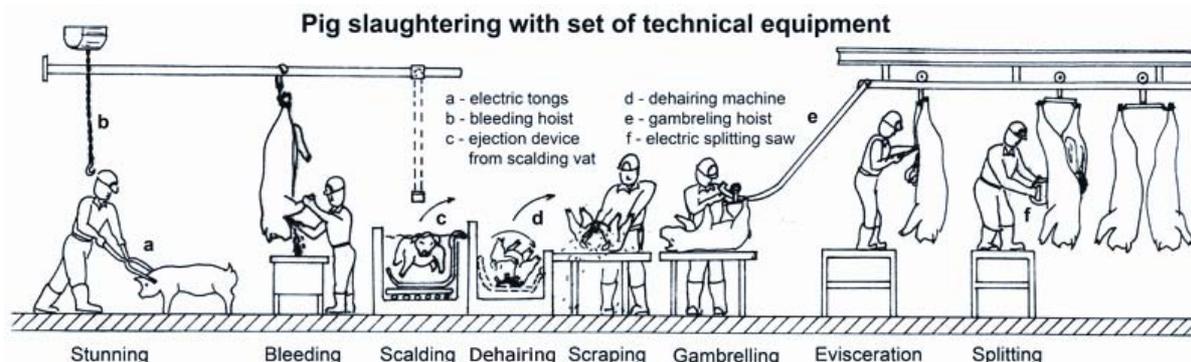


Fig. 54: Modern pig-slaughtering line with basic equipment (from 12/h):
The line length is 20 m.

Bottlenecks, or production jams, which determine the throughput per hour, tend to occur at the scalding vat stage. Minimum scalding time for one pig should be four minutes. If the scalding is done one by one, 12 pigs can be put through per hour – on the assumption of five minutes for one pig (scalding plus transfer time). To increase the frequency, machines that enable simultaneous scalding of several pigs have been developed (Fig. 55). Nowadays, these are widely used in medium- to larger-sized pig-slaughter facilities.

Also, larger operations have replaced the relatively slow manual or electrical hoists used in the bleeding and at gambrelling operations (as shown in Fig. 52 and Fig. 54) with continuous electrical elevators (Fig. 56). These are very practical because bleeding hooks and gambrels can be easily hooked on to lift up the carcasses.

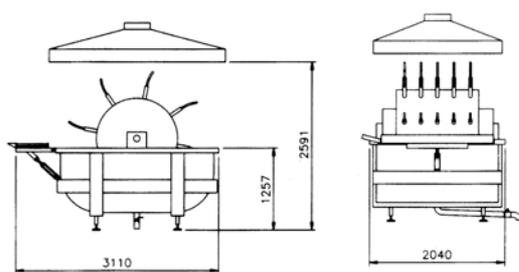


Fig. 55: Scalding machine for simultaneous scalding of several pigs: The slowly rotating drum moves pigs through the scalding bath in exactly the time necessary for efficient scalding. Left: side view; right: front view.

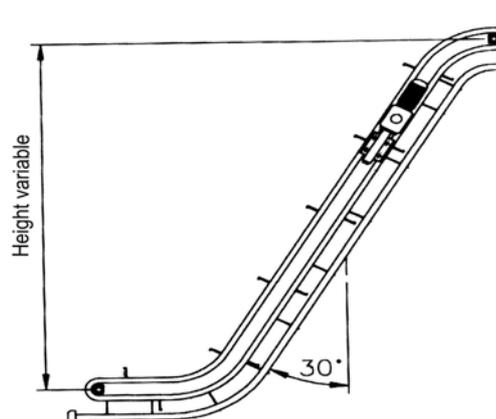


Fig. 56: Continuous electrical elevator

The gambrelling from the scraping table enables the suspending of the carcasses in a spread position (Fig. 57), which in a medium-sized operation allows for the final hair removal (by knife), singeing (manually by torch), eviscerating and splitting.

However, the spread position also can be achieved with ordinary dressing hooks in two ways: either by inserting a metal bar (“spreader”) between the hooks (Fig. 58) or by installing a double rail, with one hook attached to each rail (Fig. 59).



Fig. 57: Gambrels



Fig. 58: Spreader: Hooks on each hind leg are separated by the spreader.



Fig. 59: Double-rail system: The carcass is hoisted up on two converging rails; the horizontal rails are parallel (approximately 1 m apart).

Facilities in APHCA-member countries generally need to import (from outside the region) some of the core equipment necessary for a modern pig-slaughter line, such as the electrical stunning tongs, scalding machines with rotating drums and dehairing machines. However, manufacturers recently began producing electrical stunning equipment in the Philippines (Fig. 60) and electrical scraping and dehairing machines in Vietnam (Fig. 61) for use in commercial pig slaughtering. A little more time is needed to determine if this regional production is of equal quality with the equipment brought in from outside the region.



Fig. 60: Electrical stunning equipment manufactured in the Philippines



Fig. 61: Dehairing machine manufactured in Vietnam

Approximate costs of equipment for a low-capacity modern pig-slaughter line (in US\$) (similar to Fig. 54 and Annex A7, Fig. 99)

Electric stunning equipment (imported)	2 000
Electric hoist (for bleeding and loading vat)	1 500
Scalding vat 1.5x2.5 m (electrical heating and discharger)	3 000
Dehairing machine	30 000
Scraping/gambrelling table (stainless steel)	1 500
Gambrelling hoist	1 000
Railing system (galvanized)	6 000
Hooks, gambrels (galvanized/stainless steel)	3 000
Platforms (galvanized)	2 000
Electric splitting saw (imported)	5 000
Breastbone saw	2 000
Miscellaneous equipment	5 000
Total	62 000

The dehairing equipment used will considerably affect the total expense. If imported from a developed country, a basic dehairing machine will cost around US\$30 000 (or up to US\$60 000 for a simple but higher capacity one). The costs can be considerably higher if a more expensive imported dehairing machine is integrated into the line. However, by using locally fabricated items elsewhere in the line, if available, and using manual tools (axe and knife) for the splitting, the overall investment can be considerably lower. And if the regional production (Vietnam) of a dehairing machine proves successful, the expense for a basic machine can be cut by half.

Certainly highly mechanized slaughter lines greatly facilitate proper pig slaughtering; but they are also prone to technical defects that might not be easy to repair under the conditions of a developing country (lack of spare parts and technical expertise). Also, investment costs for the modern slaughter lines are much higher than for the traditional system. The trend in Asian countries, especially in private-sector enterprises operating ambitious high-quality meat production, is a shift to the mechanized slaughter lines. However, the many private and public slaughterhouses that rent out their facilities to meat dealers with their own butchering teams will certainly continue running traditional lines, which are technically less complicated, less subject to breakdowns and more durable in harsh day-to-day use. For these facilities, a shift to the terraced-floor method (at three levels, as shown in Fig. 50) that requires only a minimum of mechanical equipment is recommended.

Multispecies slaughter systems

Slaughter systems for multiple species do not seem to be in high demand in APHCA-member countries. In theory, multispecies refers to a combination of pig and small ruminants or bovine and small ruminants. Because small ruminant slaughtering is of importance mostly in Muslim countries (where it is also an option for meat export), the combination with pig slaughtering can be ruled out.

There are a number of combined bovine- and small ruminant-slaughter lines, especially in countries with large sheep and goat populations. Such slaughter lines are primarily designed for bovines. Small ruminant slaughtering on the same line uses the same railing system but with different hooks. For small

ruminant slaughtering and dressing, gambrel-type hooks with a long central straight metal bar are used; these keep the small carcasses low enough to allow skinning and dressing operations by workers positioned on the same platform, which typically are used for cattle slaughtering. In facilities that slaughter both small ruminants and bovine, the line requires modification to include a second lower line (rail) only for bleeding of the small ruminants (otherwise they are too high) that enters at a transfer station. (Such a system has similarities to the line shown in Fig. 19.) At the end of the dressing line, special hanging racks (Fig. 22) move the small ruminant carcasses along the relatively high bovine railing systems.

For very small operations in countries with beef and pork consumption, a facility for both bovine and pig slaughtering similar to those developed in Europe is recommended. This type enables the slaughtering of both species in a vertical manner.

As shown in Fig. 62, bovines are partly flayed on a cradle and hoisted up by the electric hoist (b) and beef spreader (a) for eviscerating and splitting. Pigs are first scalded and then hoisted up by the lifting device (c) for eviscerating and splitting on the twin rail (d). Of course, both operations do not take place simultaneously. For beef slaughtering, both lifting devices (a) and (c) are used, as follows: After splitting the beef carcass on device (a), the two forequarters are hooked into (c) and the hind and forequarters are separated. After moving the forequarters onto the rail (d), the hindquarters are transferred from (a) to (c) before landing on the twin rail (d).

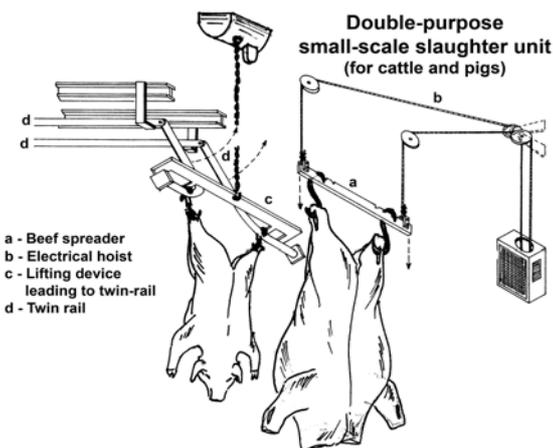


Fig. 62: Small-scale unit for slaughtering bovines and pigs (non-simultaneously)

Currently utilized stunning methods and recommended improvements

Internationally recommended methods for stunning livestock are rarely used in APHCA-member countries. Especially with the stunning of bovines, for which the practised method is to inflict a blow to the head with either a hammer (Fig. 64) or the back of an axe. For bovines, in particular buffaloes, another common practice is to stab a pointed knife, or "puntilla" (Fig. 63), into the foramen atlanto-occipitale and sever the spinal cord. The foramen is easily accessible in buffaloes, whose thick skull and skin render a hammer blow inefficient. There are abattoirs producing top-quality beef using stunning pistols with a mushroom head (acceptable to some Muslim communities, as shown in Fig. 72) or a penetrating captive bolt pistol (Fig. 67). Stunning pistols of the captive bolt type should always be used on animals that are restrained in stunning boxes (Figs. 68 and 69 and Annex A 12). See Fig. 70 for a depiction of electric stunning of cattle.

Electric stunning tongs are frequently used for slaughtering pigs, although they are mostly of the home-made type, such as the one shown in Fig. 60 (which has

a transformer) or the very primitive wooden tongs connected to the mains, as shown in Fig. 65. In both cases, the electrical parameter used most likely is not the most suitable for pig stunning because they may cause a great deal of pain and thus negatively influence the biochemical properties of the meat.



Fig. 63: Using the “puntilla” for stunning

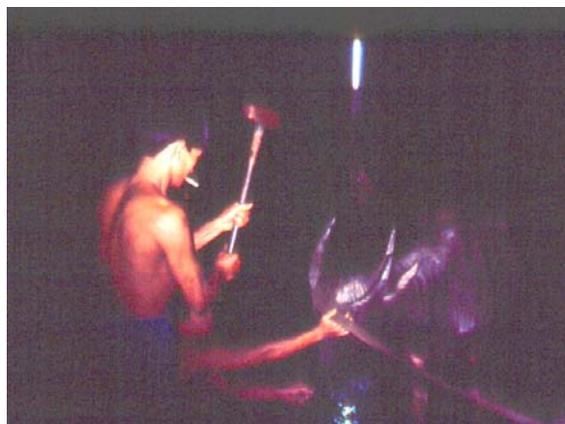


Fig. 64: Using a hammer for stunning

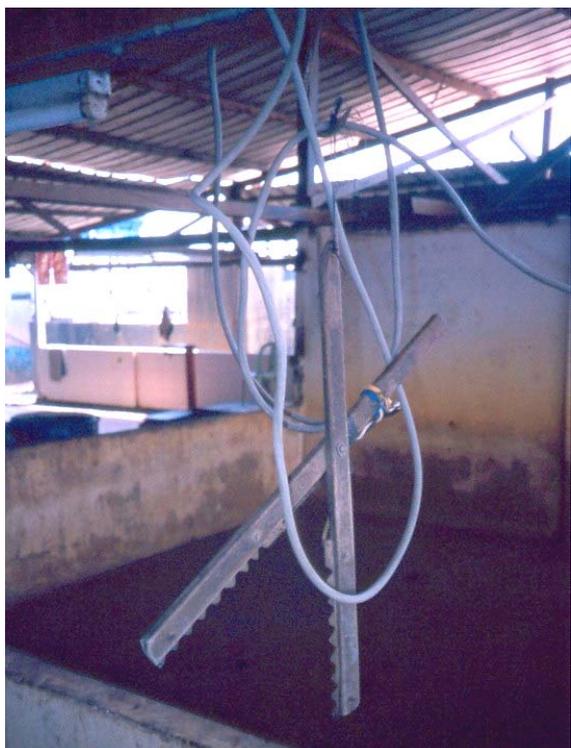


Fig. 65: Primitive home-made wooden tongs for stunning pigs, by directly connecting them to an electrical source, with no transformer



Fig. 66: Proper electrical stunning with suitable equipment

There is an urgent need for acquiring proper stunning equipment in facilities throughout the APHCA-member countries. This can be as simple as purchasing electrical tongs for stunning pigs (Fig. 66). If locally produced tongs are not satisfactory, imported ones that allow for the regulation of the voltage (120–300 V, according to the size of the pigs) and other parameters (amperage and

frequency) by a transformer should be used. These typically cost around US\$2 000. Electrical stunning tongs can be used wherever the power supply is available and they normally do not need a great deal of maintenance and supplies.

In the case of captive bolt pistols for bovines, penetrating types are relatively cheap to acquire (US\$300–400). However, typically there are problems maintaining a supply of cartridges. The different pistol manufacturers (all located in developed countries) also produce the cartridges, specifically made for each type of pistol. But importing a continuous supply of cartridges can be difficult for individual abattoirs in countries with air freight or firearm restrictions. In these cases, the government livestock department should facilitate the importation.

There was an attempt in the past in Thailand to produce cartridges for captive bolt pistols in military factories. But the enterprise failed due to a small demand for the ammunition; a pooling of needs from several APHCA-member countries could make such an attempt more economically profitable and thus successful.

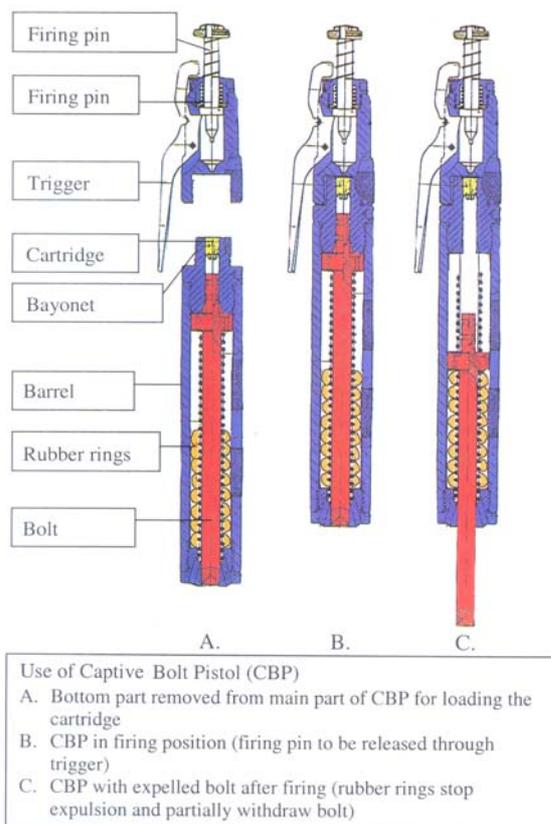


Fig. 67: How the captive bolt pistol operates

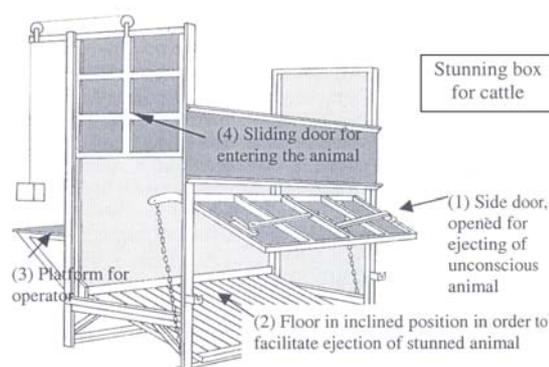


Fig. 68: Stunning box with revolving door for ejecting animals

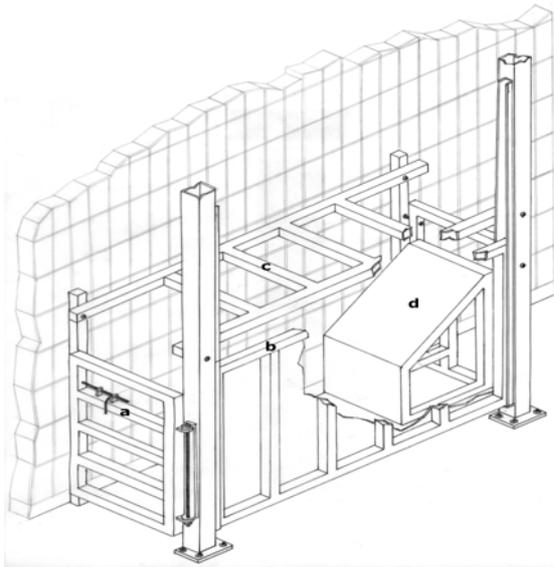


Fig. 69: Wall-attached stunning box for small-scale operations: The hinged door (a) allows animals to enter; the upward-sliding door (b) allows them to be released; protective grid (c); the steel plate (d) prevents animal from lowering its head.



Fig. 70: Electrical stunning of cattle: The photo shows an animal about to enter a neck restrainer; once the animal is restrained, electrodes from a stunning device are placed on the nose and heart. This is an accepted Halal method used in a Jakarta abattoir.

Restraining livestock for Halal slaughter

Restraining small ruminants for Halal slaughtering is easy – animals are manually laid on a bleeding table and their throat is then sliced (Fig. 71). Restraining bovines is much more difficult because they are less docile. Without supporting equipment, bovines are usually forced down by attaching ropes to the fore and hind feet of one side that are then firmly pulled from the other side.

Other livestock subject to Halal slaughter are camels, and they are even more difficult to restrain. Some butchers resort to such horrible methods as severing the hock tendons to make them collapse.



Fig. 71: Halal slaughtering of sheep



Fig. 72: Captive bolt pistol with mushroom head

Some Muslim authorities regard the electrical stunning of small ruminants and bovines (Fig. 70) as acceptable. Some also tolerate the use of non-penetrative captive bolt pistols, which have a mushroom-shaped top on the bolt (Fig. 72) and inflict a blow to an animal's head.

Currently, a meat scientist in Pakistan is working on behalf of Australian authorities on a comprehensive review of Halal slaughter, including potential methods to reduce animal suffering. The completed report would be worth future discussion.

Specialists within the Meat and Livestock Australia (MLA) organization have developed a cattle-restraining box (Fig. 73) for use in Asian countries. The box facilitates the laying down of cattle and the cutting of the throat. However, it still enables the animal to struggle a great deal. A cattle "restrainer" (Fig. 74) that rotates 90 degrees has been used in the Muslim south of the Philippines, though it is unclear if it is working satisfactorily.

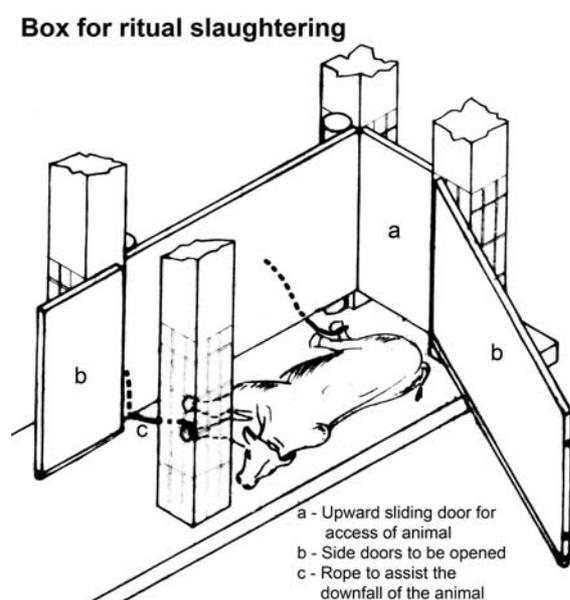


Fig. 73: Bovine restraining box: A rope is attached to the left fore and hind feet and pulled from the opposite side, under the wall of the box; the opposite wall (b) is closed during bringing down the animal.



Fig. 74: Rotating bovine-restraining box: The box with the restrained animal can be mechanically tilted 90 degrees to facilitate Halal slaughtering.

Meat inspection

Presumably, all APHCA-member countries have introduced some type of meat inspection law. A legislative framework is necessary to enforce the regulations or directives on meat inspection. The regulations need to provide technical specifics on ante-mortem and post-mortem inspection procedures and judgement of carcasses or carcass parts as well as definitions of technical terms and registration requirements for commercial abattoirs.

Detailed regulations on ante- and post-mortem inspection are not commonly used by meat inspectors or are even not available in some countries. This

explains why, in many cases, meat inspectors lack a systematic approach when conducting inspections in the slaughter line. Some have been observed subjectively choosing organs or lymph nodes for visual scrutiny, palpating or incising checks while ignoring other parts, such as a bovine head, that should always be included in routine post-mortem inspection. The on-the-line meat inspections that were witnessed during the research period for this report were only carried out in a few abattoirs that were producing either for export or for top-quality meat shops. Inspection by an official government meat inspector was observed in only one pig abattoir visited, which is producing for the local wet markets. In the majority of the abattoirs and slaughter slabs visited during the research period, no inspection was ever carried out for wet-market meat. There were veterinarians or meat inspectors present in some places, although they were seen tending to office work and not inspecting the meat.

Also noticed during the research were a number of exhausted or obviously sick livestock brought to be slaughtered. The resulting meat was included in routine deliveries to markets or shops. These practices, which are obviously very common, underscore the need for more professional approaches in meat inspection including ante-mortem inspection in the interest of food safety and consumer protection.

The situation is made more difficult because the meat inspection proclamations or laws, where they or supplementing regulations exist, are issued by the central government. They refer to government-controlled abattoirs, such as export abattoirs. State- or municipality-run abattoirs do not seem to acknowledge that legislation as binding law. In other cases, the Ministry of Agriculture is responsible for meat hygiene in general, but the Ministry of the Interior or Ministry of Public Health has responsibility for meat inspection. Such diffusion of roles can cause a great deal of confusion, which only enables officials to pass on responsibilities to others. Such a situation used to be the case in Thailand; the Government has since delegated and made clear all meat hygiene and inspection responsibilities to the Ministry of Agriculture.

The urgent need for professional approaches and consolidated responsibility applies also to abattoirs producing for the domestic supply. These facilities should be held accountable to the same hygienic requirements as export operations, including ante- and post-mortem inspection of meat, and which should be coordinated by only one ministry.

Responding to this need begins first with the necessary updating of existing laws and/or developing meat-inspection regulations. The new Code of Hygienic Practice for Meat (CAC/RCP 58-2005, which was revised in 2005) of the Joint FAO/WHO Codex Alimentarius Commission can be an appropriate guideline. The Codex Alimentarius code consists of internationally accepted standards and recommendations for food hygiene and food technology/composition.

The second step is the training of meat inspectors. In 2001-2002, FAO conducted meat inspection training for the Asian region, and this type of initiative needs to be resumed. The APHCA would be an appropriate forum to initiate a training programme. However, in the interest of food safety and consumer protection, individual governments should also be more proactive in organizing national meat inspection training typically practised in many other areas of the world (Fig. 75).



Fig. 75: Practical training in meat inspection: Veterinary authorities in an African country organized national training courses in 2007.

Meat inspection and sanitary control in many abattoirs and slaughter slabs in APHCA-member countries currently are unsatisfactory. What is really needed in many countries is a major overhaul of improper operations; inspectors should take commonly accepted rules of meat hygiene and condemn any abattoir that does not meet those standards, on the basis of violating hygienic principles and creating hazards to food safety. If a local meat inspector is in too weak of a position to do this, government veterinary delegations should take on this task. Targeting the unsafe practices would help clean up many rough-shod productions and force entrepreneurs to upgrade their premises.

If there are unacceptable hygienic conditions at abattoirs or slaughter slabs or insufficient or no meat inspection being carried out, the inspectors should be targeted for some type of accountability. But there also needs to be improvements to the technical facilities for conducting proper meat inspection, which currently are very poor in most abattoirs. For instance, cattle heads are not inspected partly because of inspector negligence but also because they are not properly prepared – they have not been skinned and there are no racks to hold them. There is also a lack of viscera tables and viscera racks to be used for inspection purposes. Carcass inspection is frequently impeded by the cramped hanging of carcasses. Often there is not enough space or light for meat-inspection procedures. The worst situation is with the booth and batch slaughter, for which inspectors literally have to rush from one place to another to track carcass parts before they disappear into store rooms or transport vehicles. These types of operations have none of the equipment necessary for proper inspection; identifying organs to the corresponding carcasses is impossible in many places.

Although there is considerable technical reorganization needed to improve meat-inspection standards, this report offers only a few simple technical suggestions (Figs. 76–79).



Fig. 76: Viscera cart for green bovine offal: In small operations, green offal can be inspected in the cart after the evisceration process.



Fig. 77: Simple but efficient suspension on chain hooks of cattle heads and plucks for meat inspection



Fig. 78: Meat inspection in a small abattoir: Cattle heads and plucks are suspended on a rack for proper inspection.

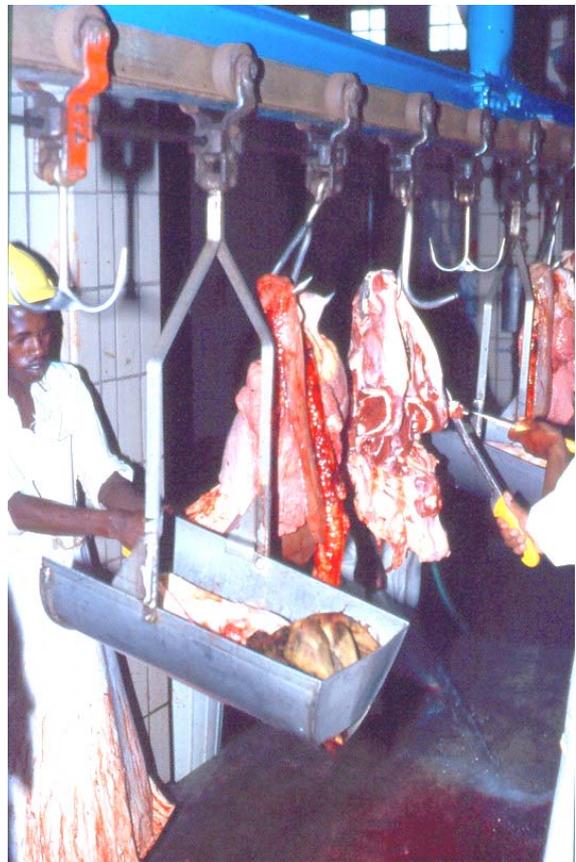


Fig. 79: Synchronized meat inspection for larger abattoirs: Simultaneously with the beef carcasses, carcass parts (head, plucks and feet) move on an overhead conveyor to pass through the meat-inspection station.

Sanitation and effluent treatment in abattoirs

Sanitation

The term “sanitation” refers to the cleaning and disinfecting of abattoirs as well as the controlling of insects and rodents through the use of chemical substances.

Necessary conditions for efficient cleaning and sanitation:

- Premises and equipment must be “cleaning-friendly”, which means they must have
 - easy and practical access to all contaminated areas and
 - smooth surfaces and adequate materials for building structures and equipment to be cleaned.
- Proven methods for meat plant cleaning and sanitation must be available.
- Personnel must be regularly instructed and trained in cleaning and sanitation methods.

During the research for this report, these conditions were rarely observed and then only in a few abattoirs producing for either the export or top-quality domestic market. Most abattoirs in APHCA-member countries are not “cleaning-friendly” (Fig. 80); they lack smooth, washable and impermeable surfaces. Instead, livestock slaughtering takes place on cracked concrete, paved slabs or even bare ground. Where cleaning and disinfecting are impossible, there will be a very high level of permanent contamination of the facility.



Fig. 80: Slaughterhouse floor and sidewalls impossible to properly clean and disinfect

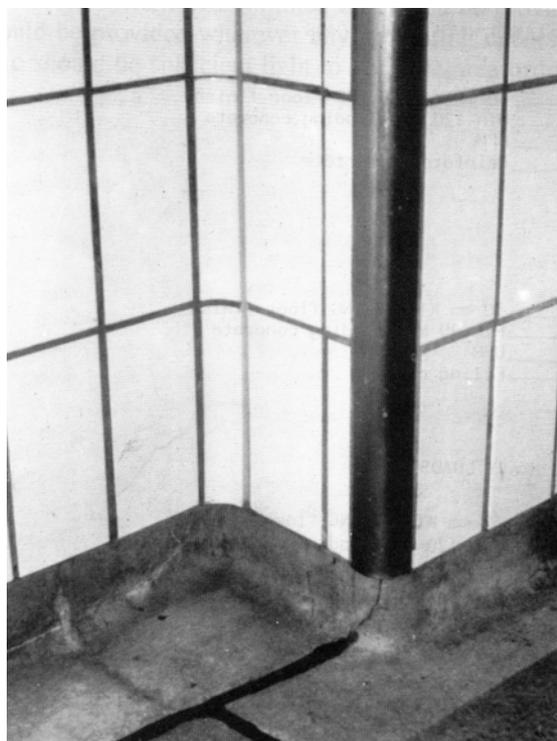


Fig. 81: “Cleaning-friendly” floor and walls with smooth and impermeable surfaces

To improve the cleaning and sanitation situation in abattoirs, physical structures need to be upgraded to make them “cleaning-friendly” (Fig. 81). “Cleaning”

refers to the removal of dirt and organic substances, such as fat and protein particles, from surfaces, walls, floors, tools and equipment.

For proper cleaning, the following techniques are required:

- dry cleaning (physically remove scrap, such as coarse solid particles, with a dry brush or broom);
- wet cleaning (using brushes and water hoses);
- high-pressure cleaning (pressurized water is applied with high-pressure units and special spraying lances);
- use of chemical cleaning solutions (detergents).

“Disinfection” is the complete removal of micro-organisms from surfaces, floors and tools. Disinfection is achieved either by using hot water (or steam, preferably) or chemical disinfectants (Fig. 82). Chemical disinfectants are the preferred compound for use in the meat industries.

Common chemical disinfectants that are recommended for use:

- chlorine-containing compounds
- aldehydes
- quaternary ammonium compounds
- oxygen-releasing substances (peroxide compounds).

During the research for this report, workers in a traditional pig slaughterhouse were seen using chlorine compounds for disinfecting; most probably it was the commercially available household bleach (sodium hypochlorite). This substance is suitable and efficient for disinfecting such traditional facilities – as long as the right concentration is used – because they barely use mechanical metallic equipment or machines. Chlorine compounds, otherwise, react very aggressively (corrosion) on the metal. However, the chlorine compounds do not affect floor and wall tiles or stainless steel equipment, such as scraping tables. Highly mechanized abattoirs should use quaternary-ammonium compounds or oxygen-releasing substances when disinfecting.

Best disinfection results are achieved when intensive dry/wet cleaning precedes chemical disinfection.

Pest control of insects (Fig. 7) and rodents appears to be a very rudimentary effort in abattoirs in APHCA-member countries, if at all.



Fig. 82: Disinfection of walls using portable spray equipment: For workers' protection, the wearing of gloves and face masks are recommended.

Effluent treatment

Slaughterhouses in APHCA-member countries typically have insufficient or, in many cases, no effluent treatment facilities. Thus, they create a great deal of pollution to water flows and the surrounding environment. While medium-sized and larger abattoirs have septic tanks, they tend to be poorly built, in a poor state of repair and/or not properly maintained – not emptied at specific time intervals.

Liquids resulting from such treatments and allowed to drain into the environment are highly polluting, as the following two examples illustrate (Figs. 83 and 84):



Fig. 83: Effluents dumped untreated beyond the walls of a rural abattoir



Fig. 84: Lagoon system combined with initial solid screening: This system is not ideal but is used for effluent treatment by an abattoir producing meat for top-quality markets.

Effluent treatment in small- to medium-sized abattoirs is a difficult issue and yet a major cause of poor hygiene. Highly efficient, combined mechanical and biological treatment plants are beyond the reach of such abattoirs because they are too costly in initial investment and day-to-day running. But simple treatment facilities such as soak-away pits or septic tanks do not produce the necessary results and are not capable of significantly reducing the pollution.

One solution out of this dilemma is the introduction of biogas digesters for abattoir effluent treatment. Biogas digesters are relatively inexpensive; construction costs for a 30 cubic meter digester is approximately US\$10 000. They require little maintenance and generate energy (gas to be used for energy requirements at the abattoir) and the solid residues can be used as fertilizer.

FAO has promoted this technology and initiated the construction of some prototype biogas digesters in connection with abattoirs, the most advanced installed at the Animal Products Development Center, a national meat training centre in Manila, Philippines.

Biogas digestion is the breakdown of organic substances that make up almost 100 percent of the pollutant load of farm or abattoir effluents, primarily to methane gas but also to CO₂ (to a minor extent) and traces of other gases

through the activity of anaerobic bacteria. Anaerobic conditions are created through the construction of air-tight chambers usually submerged in the ground. The construction materials used are hollow blocks, cement, sand, gravel, rebars and pipes. The capacity of the digester chamber depends on the volume of effluent to be treated and the retention time; but generally for small- to medium-sized abattoirs it holds 30 cubic meters. When biogas digestion is completed, most organic matter is broken down to methane, CO₂ and water. Remaining solid materials are primarily sludge.

Observations made during the research for this report indicates that the biogas digesters used for farm purposes need to be modified for abattoirs because the effluents from these facilities contain higher amounts of fat residues. Such fat residues have a tendency to generate a fatty layer or scam at the surface of the liquid in the chamber, which creates problems for the proper anaerobic digestion of the effluents. To tackle this situation, a double-chamber “digester” for abattoir waste treatment was developed, as illustrated in Fig. 85. Periodic release of the gas produced creates a mixing of the liquid contained in both chambers of the fixed-dome digester and prevents the formation of the fatty scam, as the following explains:

A = Starting point of biogas production.

B = Advanced phase of biogas production; strong gas pressure under the “dome” pushes fluid inside the digester into the second fermentation chamber.

C = Release of the biogas (through a pipe on top of the dome) causes the collapse of the gas pressure and the flowing back of the fluid into the first fermentation chamber; this produces the mixing effect desirable for abattoir effluents.

D = Renewed build up of gas pressure and repetition of the mixing effect once the gas is released.

The pollutant load of effluents is measured as “biological oxygen demand” (BOD). The BOD of abattoir effluents after treatment in a biogas digester is around 80 mg/L. Some countries have established standards for treated effluents for release into water flows. This standard is, for example in the Philippines, 50mg/L BOD. This means that after the anaerobic biogas digestion (in the “fixed dome digester” shown in Figs. 84 and 85), additional treatment is recommended to comply with stringent environmental-protection laws. This could be a

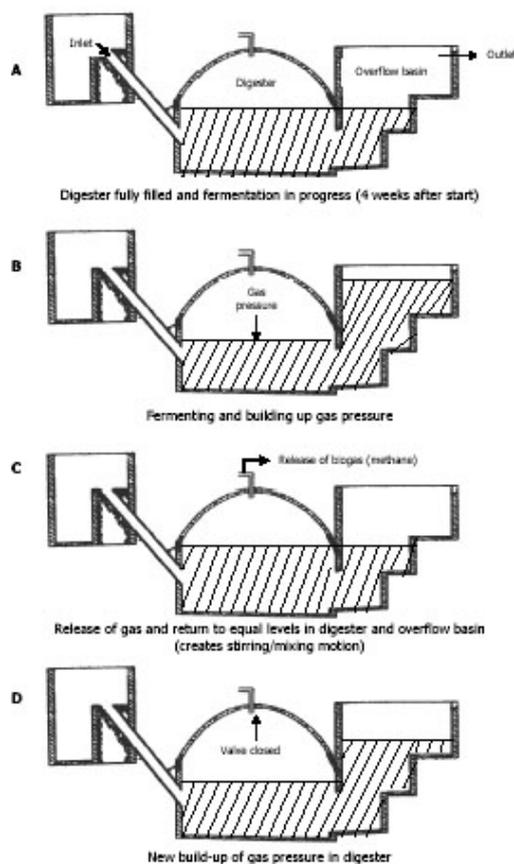


Fig. 85: Different phases of gas pressure and mixing effect produced in a digester

combination of aerobic and anaerobic treatments, such as a series of sedimentation and fermentation chambers (an "anaerobic baffle and filter reactor", as shown in Fig. 86). For less stringent environmental-protection requirements, the anaerobic effluent treatment in the dome digester is sufficient. The retention time in the digester depends on the volume of wastewater and the pollution load and may vary from one to four weeks.

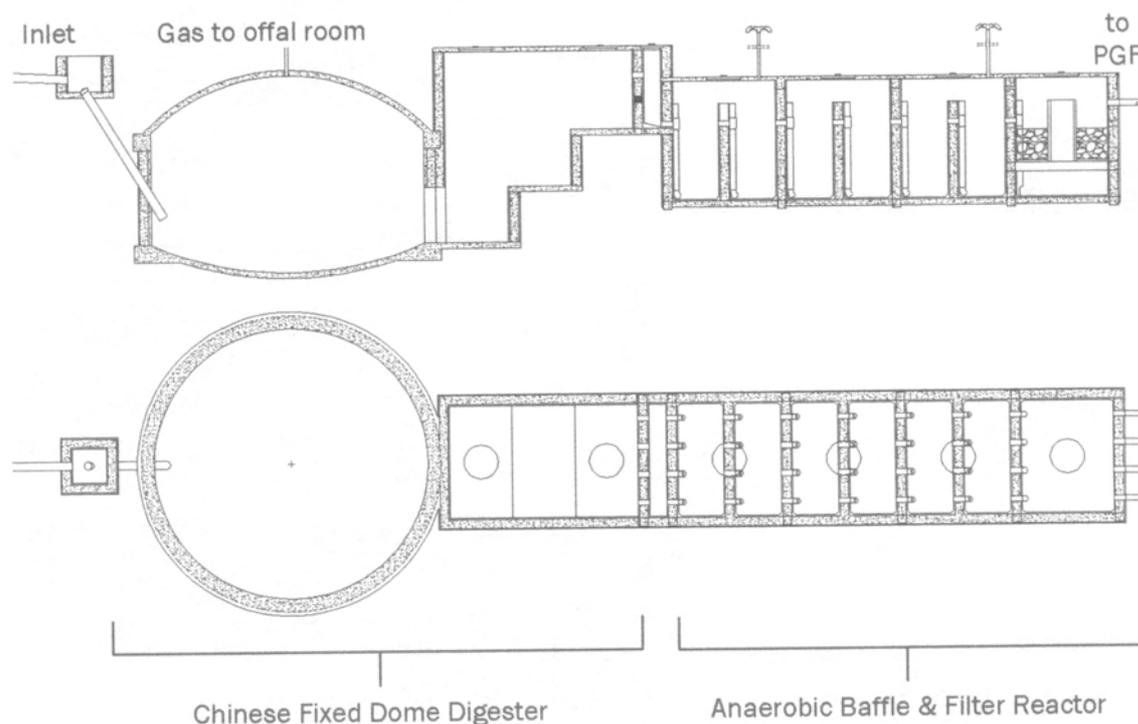


Fig. 86: Biogas digester of the fixed dome type: Side view (top), ground view (bottom). The "fixed dome digester" units (see also Fig. 87), where the main part of the biogas digestion takes place, are combined with additional treatment units ("anaerobic baffle and filter reactor" built according to the septic tank principle) (see also Fig. 88) for further purification, if needed, of the treated wastewater.



Fig. 87: Construction of a biogas digester of the fixed dome type: Ceiling of the dome completed (middle), second fermentation chamber still open (bottom).



Fig. 88: Construction of a biogas digester: An anaerobic baffle reactor under construction.

The treatment capability and capacity of biogas digesters is typically not sufficient for effluents from larger abattoirs. For proper treatment of such wastewaters, aerobic biological treatment plants with mechanized and pumping elements (Figs. 89 and 90) are needed. There are some high-quality abattoirs in APHCA-member countries where this type of treatment plant is operating. With increasing environmental problems, other large abattoirs will have to consider this type of treatment approach as well.

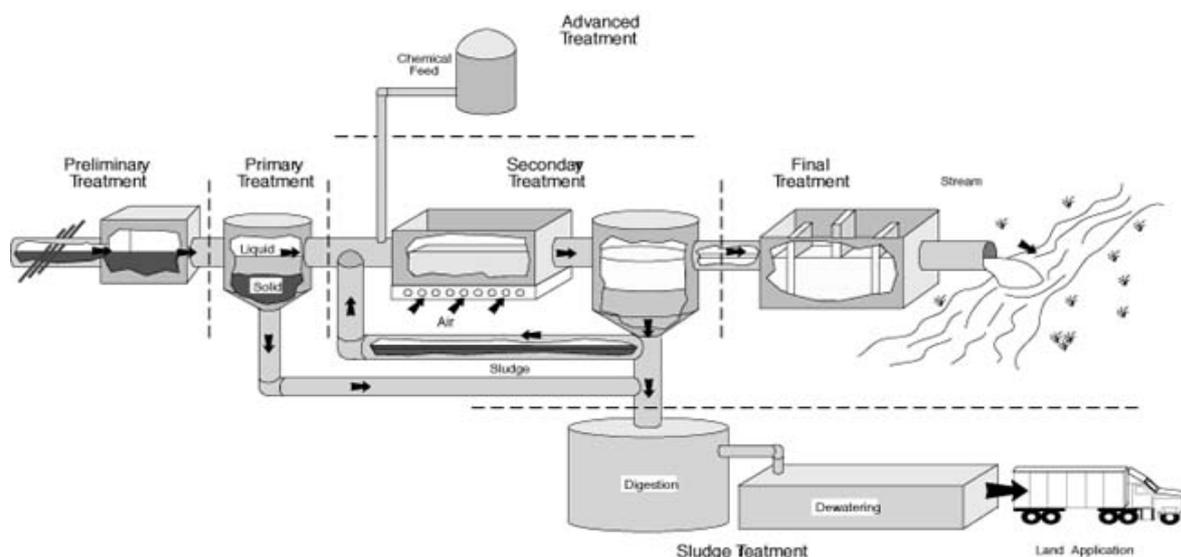


Fig. 89: Schematic view of aerobic biological effluent treatment plant

The principle of effluent treatment in such plants is illustrated in Fig. 89 and entails the following procedures:

Preliminary/primary treatment: Screening of large solid parts from the wastewater as well as inclusion of fat traps and sand traps.

Secondary treatment: This is the core function of the plant, where air is injected into the aeration tank to boost the activity of aerobic bacteria for breaking down organic wastes. The resulting sludge is composed of the bacteria and organic materials. To keep the level of bacteria at a high concentration in the aeration tank, part of the sludge is recycled; the other part goes to the sludge treatment.

Sludge treatment: This can either be drying of the sludge, such as for fertilizer, or the sludge can be subjected to anaerobic digestion that produces biogas (shown in the lower part of the scheme in Fig. 89). In this treatment system, the aerobic reactions are responsible for the effluent clearance – the anaerobic reactions are supplementary treatments only.

Investments into aerobic biological treatment plants are much higher than in biogas plants. Aerobic biological treatment plants can either be assembled at the abattoir or, for smaller operations, prefabricated units are available from specialized manufacturers. Investment costs vary according to the size of the facilities and the need for additional processing units. Investment costs can range from US\$50 000 to 200 000. Larger abattoirs in the Asian region must consider aerobic effluent treatment plants in their future development programmes.



Fig. 90: Compact aerobic biological effluent treatment plant: Shown here is an aeration tank (right) and sedimentation tank (left), with a pipe system for recycling sludge.

4. Conclusions

While there are some encouraging signs of improvements in the abattoir sector in APHCA-member countries, such as new buildings, they cover only a tiny segment. There are still far too few new and technically efficient abattoirs available, compared with the hundreds of slaughterhouses and slaughter slabs in each country, most of which are not in the hygienic condition needed for the supply of clean and wholesome meat.

When compared with other developing regions, conditions in the majority of traditional Asian slaughterhouses and slaughter slabs are extremely poor. Many of them do not fulfil minimum hygienic requirements to produce safe and wholesome meat. Improvements are needed urgently.

In this region, slaughterhouses typically are located in urban slum areas. This implies that there is something unclean being produced, and slaughter workers act accordingly, feeling unobliged to work hygienically. The situation is aggravated by the poor condition of facilities. There is a need for profound rethinking in Asian developing countries on this issue; the ideal is to regard slaughterhouses in the same light as other institutions that serve the public, such as hospitals or schools. After all, meat produced in slaughterhouses is economically and nutritionally the most valuable but hygienically the most sensitive food in human nutrition.

Improvements are needed in slaughterhouse structure and installations, in waste and effluent treatment and in the way slaughterhouse workers do their job. Sanitary control measures must be efficiently enforced, and sanitary control personnel empowered to shut down operations or exclude facilities from the food chain if minimum requirements are not met.

In some countries there is obviously still a long way to go to achieve these targets, in particular in the small-scale sector and in rural slaughterhouses. But the time has come to reform this most neglected sector in livestock development. Abattoirs that do not comply with the minimum requirements should be rigorously closed down by authorities. These aims must be achieved through joint efforts by the government sector responsible for enforcing sanitary laws and regulations and the municipal and private sectors that operate the slaughterhouses.

Cleaning up the abattoir sector will require huge investments just to get facilities in APHCA-member countries up to basic standards. Highly hygienic meat marketing found in Western countries cannot yet be considered. Instead, the regional benchmark should be that facilities supply the traditional "wet" meat markets with clean, hygienic, unrefrigerated meat.

A cost calculation for the necessary investments will depend on which animals are predominantly being slaughtered. The following outlines a model scenario for improvements – using a typical Asian country with large pork and moderate beef consumption and 500 registered slaughterhouses for pork and 50 facilities for beef:

First step: Consolidate the many very small facilities into units with higher capacity. Inefficient and highly unhygienic facilities that do not meet minimum requirements are closed down. In the pork sector, the concentration ratio of remaining facilities would be 4 to 1, and in the beef sector it would be 2 to 1. This means where there were previously 500 pork slaughterhouses, the number would shrink to 125, and where there were 50 beef abattoirs before, the remaining amount would be 25.

Slaughter lines for these improved abattoirs would still be simple. For pork, the model shown in Fig. 50 and for beef, the model shown in Figs. 37, 38 and Annex A1/A2 would be adopted. The minimum cost for the pig-slaughter line would be around US\$12 000, and for the bovine slaughter line it would be US\$70 500–100 000. Pork abattoirs with increased capacity would need a minimum of two or three slaughter lines, as depicted in Fig. 50. The investment in pork abattoirs (assuming three lines in each facility at US\$12 000 each for 125 abattoirs) would be US\$4.5 million. For beef abattoirs (assuming half of the 25 premises at US\$70 000 each and half at US\$100 000 each), the overall investment costs would be slightly more than US\$2 million. These figures do not include the construction costs for the buildings, holding pens and effluent treatment facilities. In a very conservative estimation, these costs may average around US\$80 000 for each cattle facility (total US\$2 million) and US\$60 000 for each pig facility (total US\$7.5 million). Thus, the minimum investment to clean up the abattoir sector in this scenario would require around US\$16 million. If contingencies and additional materials and supplies are added, the minimum investment may run closer to US\$25 million.

The construction of facilities would all be very basic but functional and hygienic. They would serve to supply the traditional wet markets and thus no refrigeration costs have been included in these calculations.

Also, the clean-up would not be thorough if other sources of heavy contamination of meat were not targeted, such as the transport facilities and the market stalls. Additional investments will be needed to address the contamination that takes place in these areas. This ultimately will involve a shift to marketing a certain share of the meat produced in refrigerated form, which is an expected future development. But it will require greater investments for the refrigeration units, which currently cost around US\$140 000 for one.

Slaughter lines could be more cost efficient if most or all individual parts needed could be fabricated locally or within the region. Importing slaughterhouse equipment from developed countries causes costs to surge. It would be desirable if more technical companies in the subregion would include abattoir equipment in their manufacturing programmes. So far, there are only a few companies capable of producing good-quality simple equipment, such as hooks, overhead rails, platforms and working tables. Such firms were identified during the research mission for this report in Indonesia, Pakistan, Philippines and

Vietnam. Some of these companies have endeavoured to go into more sophisticated equipment manufacturing (such as what is shown in Fig. 60 and Fig. 61). However, it remains to be seen if such equipment can compete in the international market or if further improvements are needed. There were also a few companies in the countries visited that manufacture good-quality prefabricated panels (metal sheets with interior solidified polyurethane foam) that can create cold rooms but also can be used as wall material for new slaughter facilities. But the research mission also identified many inexperienced firms involved in slaughterhouse construction. In some cases, the output quality is good while in others there are significant quality deficiencies, such as substandard welding and non-durable galvanization. Clearly, more development work is needed in this sector.

5. Recommendations

A. Government policy and legislation

Rapidly growing livestock production in response to increasing meat demand, particularly in developing countries, is associated with environmental pressures and problems. Some of these can be mitigated through appropriate measures, but many of them are unavoidable and difficult to address. Similar to livestock production, the conversion of livestock into meat at the abattoir stage can be linked to various health and environmental hazards. Fortunately, these hazards can be contained if abattoirs function properly and produce meat according to stringent hygiene and environmental rules and regulations.

In this context, one key responsibility of governments is to develop and provide for abattoirs and for the meat sector as a whole the necessary hygiene and environmental legislative frameworks. These need to be supplemented by regulatory systems ("directives") to be issued by governments and designed to implement and strictly enforce the laws.

The abattoir sector in many countries in Asia has been neglected compared to other sectors of national and regional livestock development. Consequently governments should, on the basis of effective hygiene laws and regulations, encourage and facilitate the construction of good standard abattoirs by the private or public sector, e.g. through the removal of bureaucratic obstacles, the provision of sound technical advice, and the identification of possible state financial incentives or subsidies.

B. Government's role in ensuring public health standards and consumer protection

One principle of modern meat hygiene is the sharing of responsibilities for consumer protection between the meat business operator and the government official health and hygiene control entities. Meat business operators must be prepared to accept the primary responsibility for the hygienic quality and safety of meat and meat products. They are supervised in this task by the official government control authorities.

In order to enhance the viability and safety of current consumer protection systems in the region, a significant increase of investment by abattoir/meat business operators in suitable equipment for hygienic slaughtering and proper meat inspection as well as in waste treatment facilities is an urgent requirement. In addition, governments must participate in complementary investments focused on capacity building in Good Hygiene Practices and sanitary control of meat as detailed in topic 5 below.

Cooperation between the meat business operators and the supervising Government personnel, usually official veterinarians, must be improved to ensure that those officials have unrestricted access to the meat plants and are provided with all necessary documentation regarding food chain information and internal hygiene process control. Effective process control in abattoir operations on the basis of Good Hygiene Practices (GHP) and Hazard Analysis and Critical Control Point Schemes must be the ultimate target to be achieved in APHCA-member countries in the necessary closer cooperation between meat business operators and veterinary authorities.

Ensuring efficient and comprehensive consumer protection requires that GHP measures do not focus exclusively on sanitary abattoir operations, but also on the handling of live animals at the pre-abattoir and of the meat produced at the post-abattoir stage. Government initiated public health measures in this respect comprise efficient ante-mortem inspection by official veterinarians, assessment of the risk of residues in meat caused by illegal or inadequate feeding practices as well as hygiene control during the handling of meat post-abattoir, including transport/distribution through the meat supply chain. It is clear that the benefits achieved by hygienic abattoir operations/management will be negated by severe meat contamination occurring during the various meat retail operations.

C. Improved meat inspection practices

Consumer protection can only be assured by the implementation of internationally accepted meat inspection practices required to prevent the spread of zoonotic and/or food-borne diseases. Current practices are very deficient and in some APHCA countries the situation has even deteriorated. This necessitates urgent and immediate improvements, both in terms of available personnel and efficient meat inspection practices. It is the role and responsibility of governments to provide sufficient inspection personnel. To facilitate this process in the context of scaled down resources, the closing down of a number of inefficient and unhygienic small slaughterhouses and concentrating resources (both financial and human) on fewer but good standard abattoirs would be a rational move towards ensuring existing plants with more effective official inspection services. Governments must also invest in human capacity by laying more emphasis on improving the proficiency of meat inspection personnel (see topic F.).

Supporting the meat inspection services includes ensuring the availability of laboratory facilities in each country for diagnosing parasitic or infectious diseases. Concurrently the hygienic status of meat and meat products produced for the markets as well as the hygiene of equipment and premises used in the meat chain should be tested in such laboratories.

D. Promote local abattoir engineering companies/equipment manufacturers

The poor functioning and hygiene of many abattoirs in developing countries is linked to the fact that efficient and good quality slaughter equipment is practically only available from developed countries, at costs not readily affordable by local meat business operators. The majority of most locally produced abattoir equipment are typically deficient in terms of material quality and functionality. This results in difficulties in operating such equipment properly, breakdowns, corrosion and short productive life. Local companies engaged in the manufacture of abattoir equipment should be promoted by technical assistance programmes. Their access to internationally developed technologies should be facilitated; this could include the import of locally not available machinery and materials. Regional technical cooperation in this sector should also be promoted, thus enabling specialized manufacturers to benefit from the economies of scale generated by larger distribution networks throughout the region. It fosters the availability of more profitable and possibly cheaper manufacturing through higher output numbers of individual equipment.

E. Set up a representative range of pilot equipment for abattoir operations

The establishment of pilot and demonstration facilities, featuring recommended equipment for small to medium-scale abattoirs for replication in the individual countries, would be one initial step in technically and hygienically upgrading abattoirs in APHCA-member countries. Donor and APHCA funding could be combined for this purpose. Preferably the demonstration units should be built in connection with an existing meat training institution where also routine slaughtering at a daily basis is carried out to support practical demonstrations/training. The demonstration equipment should not only be limited to genuine slaughter facilities but also include equipment for humane killing of slaughter animals as well as treatment plants for solid abattoir wastes and abattoir effluents in order to address the much needed improvement of the environmental impact of abattoirs.

F. Abattoir sector training

Training in the abattoir sector is urgently needed for personnel at abattoirs carrying out sanitary, meat hygiene and technical operations:

a) Training in Meat Inspection

Insufficient skills and knowledge in meat inspection routine practices are a key constrain to ensuring food safety of animal products. This includes deficiencies in judgment from the food safety aspect of suspicious or diseased animals or meat. National Veterinary Authorities should make all efforts possible and practicable to start training programmes in meat inspection. However, it has to be realized that not all APHCA-member countries may be currently in a position to provide such training that meets international standards.

Therefore efforts should be undertaken, possibly in technical cooperation with FAO and inputs from donor countries/organizations, to set up regional training in

meat inspection. The best solution would be the establishment of a long-running meat inspection training programme at a suitable facility in Asia, where meat inspection personnel from APHCA-member countries would receive profound theoretical and practical training in meat inspection. The skills acquired would enable these trained experts to act as trainers in their home countries providing outreach training at a national basis for local meat inspection staff. Previous similar FAO conducted regional projects in Africa and Asia have proved extremely useful and had a decisive impact on the standard of meat inspection in many participating countries.

b) Training in Abattoir Technology and Hygiene

While APHCA-supported meat inspection training as described in (a) should preferably be organized on a regional basis, training in abattoir technology and hygiene should primarily be conducted at the national level, with the assistance of national and possibly international experts. In this case the principle of "training of trainers" could be applied, but also the slaughter personnel in individual abattoirs directly be targeted. The training should not only refer to correct slaughter techniques but should always be linked with practices indispensable for efficient slaughter hygiene. In addition, training on these subjects on a regional level could materialize if the demonstration center (mentioned above in topic E.) for abattoir equipment could be made available.

ANNEX A1

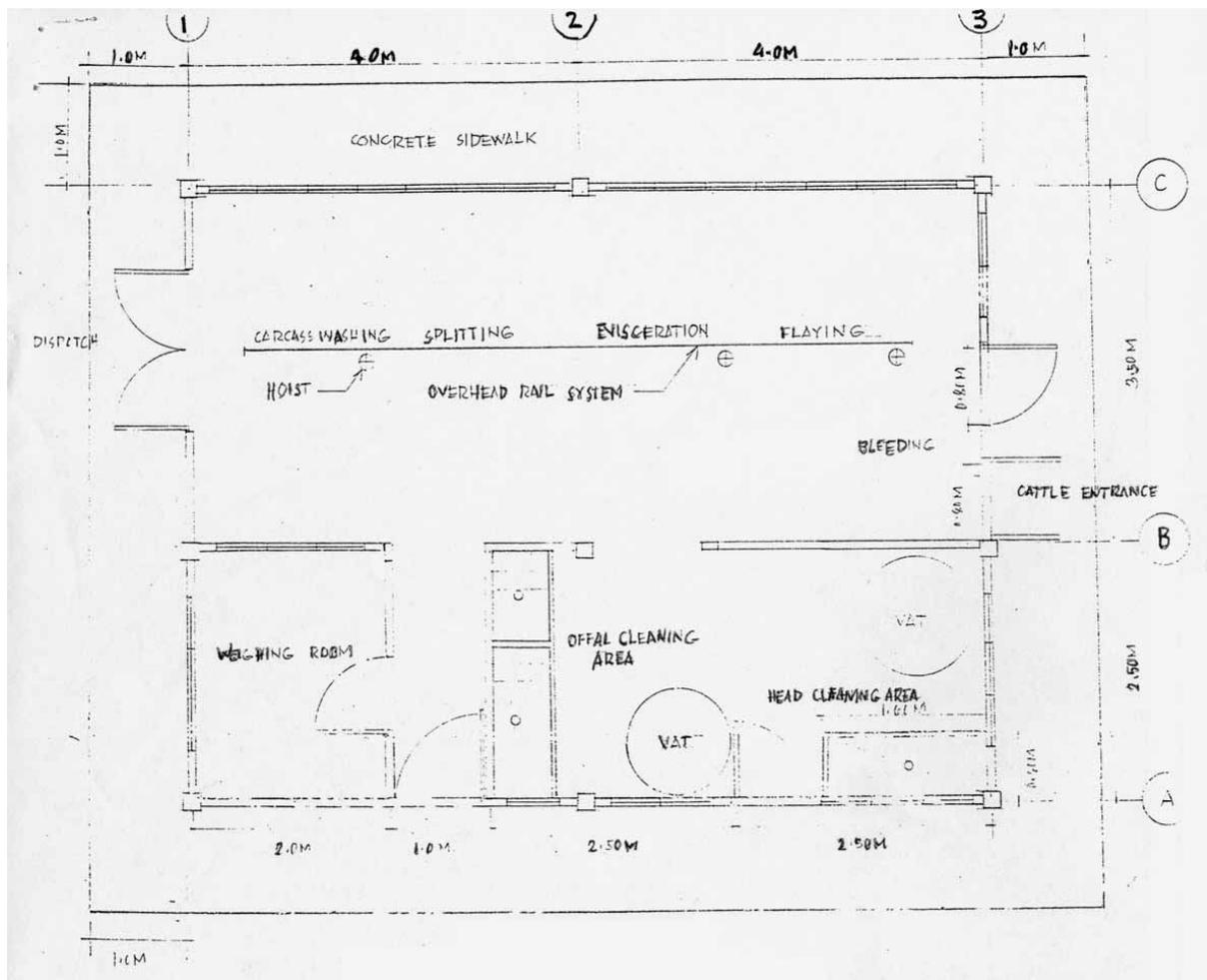


Fig. 91: Mini slaughterhouse for cattle: Line-slaughtering system. Slaughter floor and by-product area measure 8 x 6 m

Height of bleeding rail = 4.5 m
 Length of bleeding shackle = 1.4 m
 Height of dressing rail = 3.60 m
 Length of flaying/dressing rail = 7 m
 Length of dressing hook = 0.6 m
 Height of platform = 1.3 m
 Length of spreaders = 0.9 m
 Quarter rail height = 2.6 m
 Dispatch rail height = 2.3 m

ANNEX A2

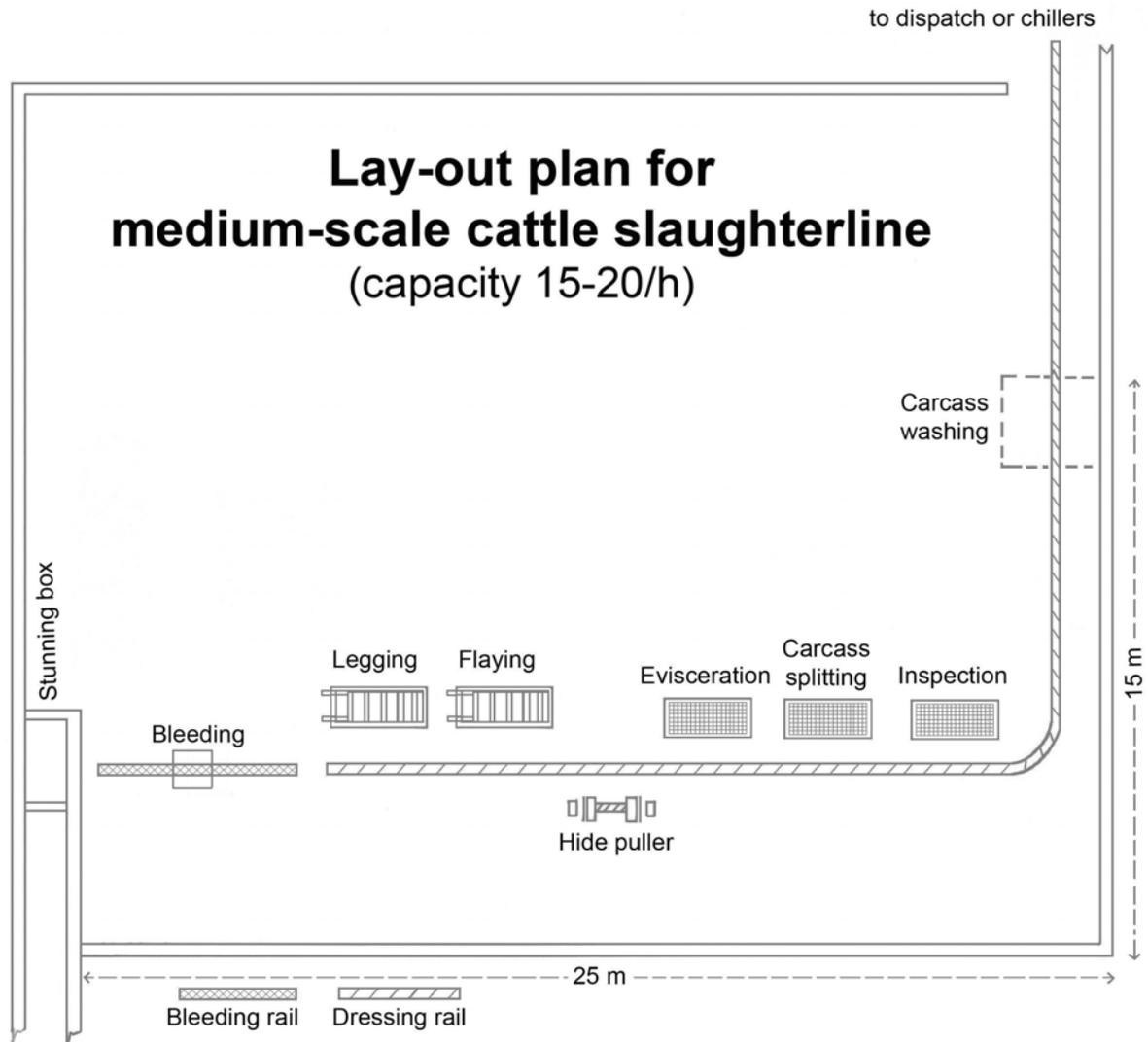
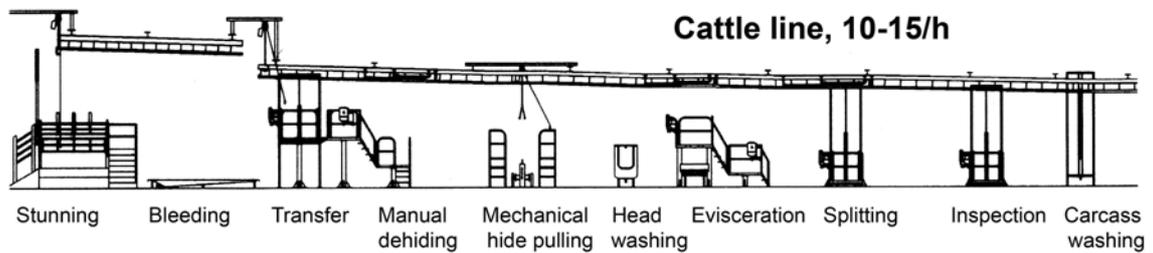
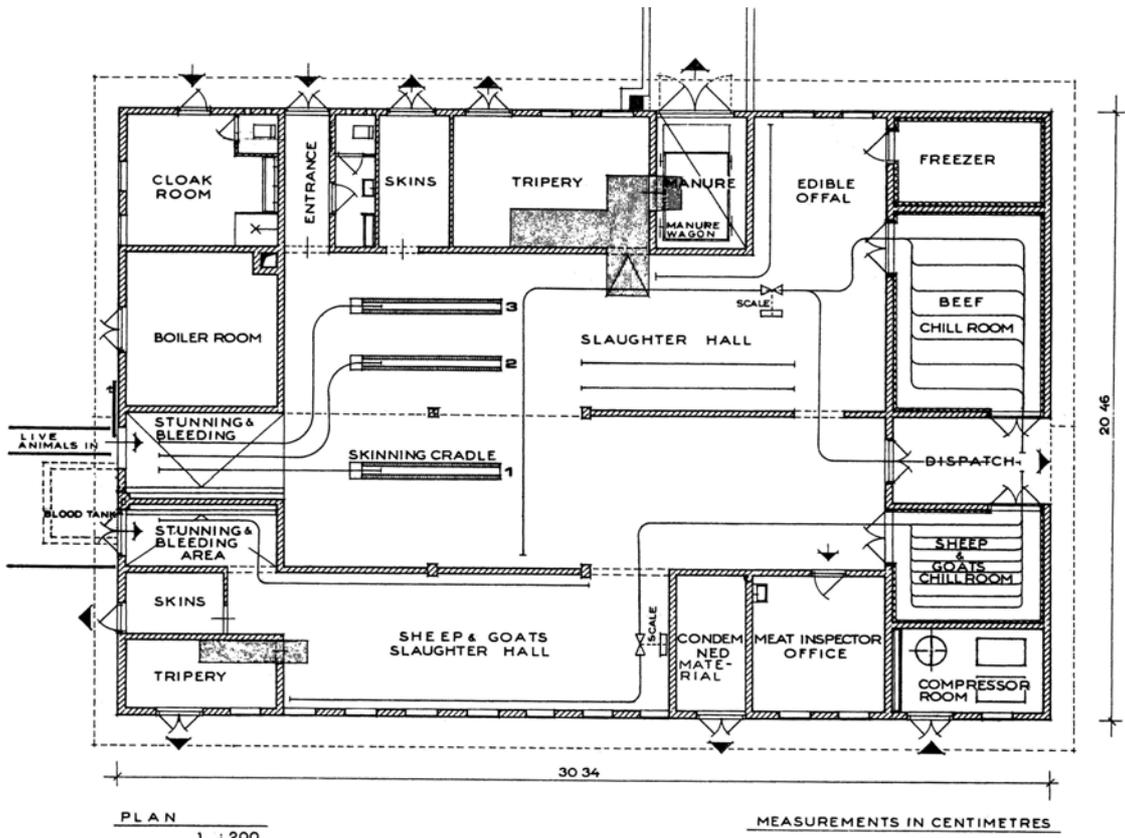


Fig. 92



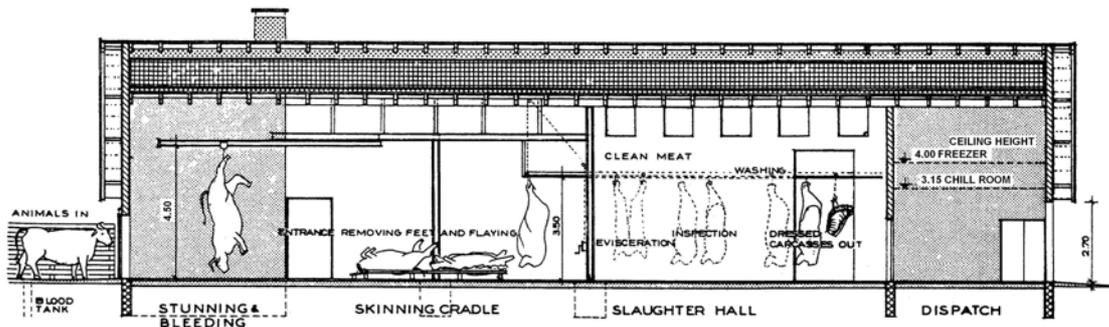
Side view corresponding to above floor plan

ANNEX A3



**Medium-size cattle abattoir incl. refrigeration section
(ground view drawing)**

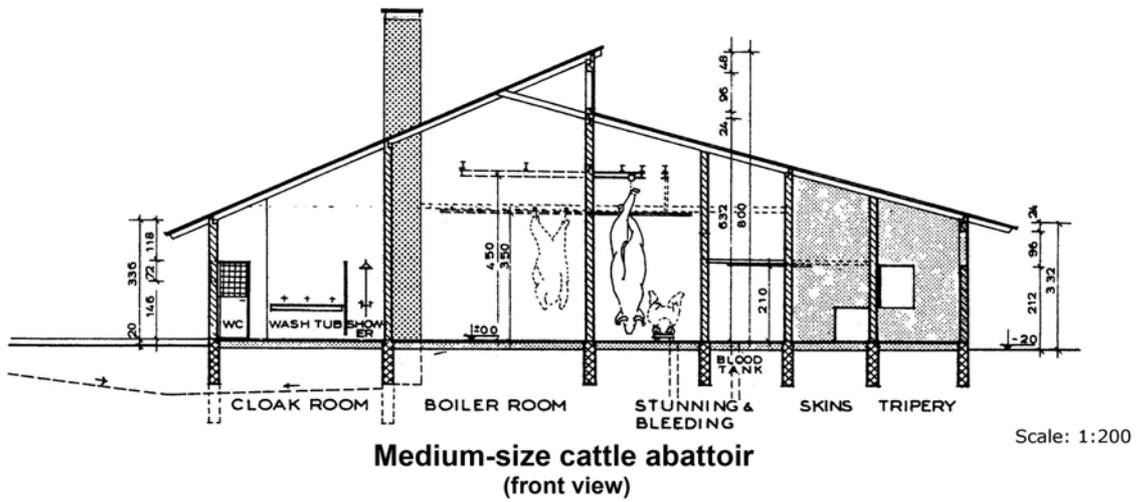
Fig. 93



**Medium-size cattle abattoir incl. refrigeration units
(side view) (scale 1: 200)**

Side view of the above floor plan

ANNEX A4



Front view to floor plan Fig. 93

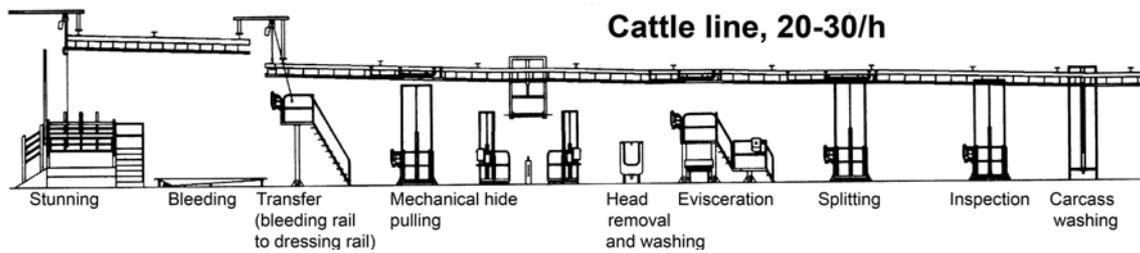


Fig. 94

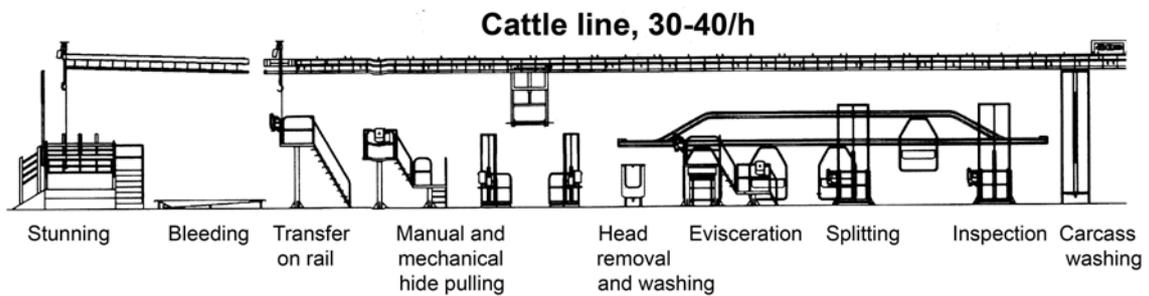
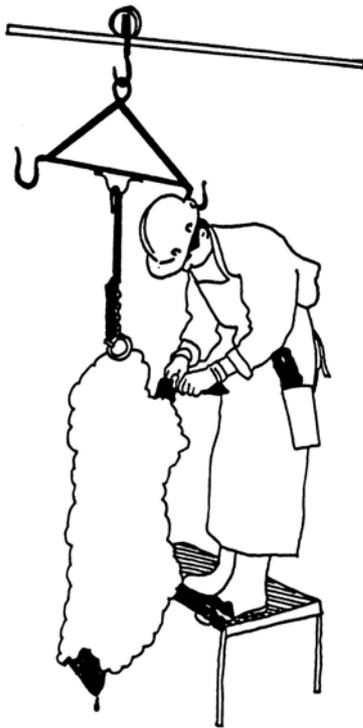


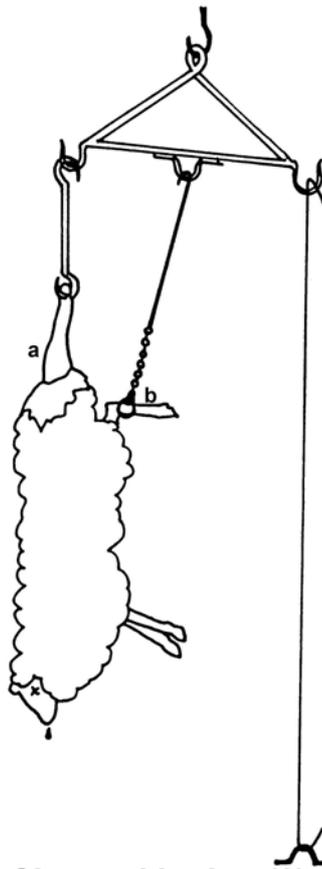
Fig. 95

ANNEX A5



Sheep skinning (1)

One hind leg on bleeding hook attached to middle part of gambrel. Skinning of the opposite hind leg.
Fig. 96



Sheep skinning (2)

Skinned hind leg hooked into gambrel (a), removal of bleeding hook and skinning of this hind leg (b).

Fig. 97



Sheep skinning (3)

Both skinned hind legs (a,b) hooked into gambrel, pulling off the rest of the skin (c)

Fig. 98

ANNEX A6

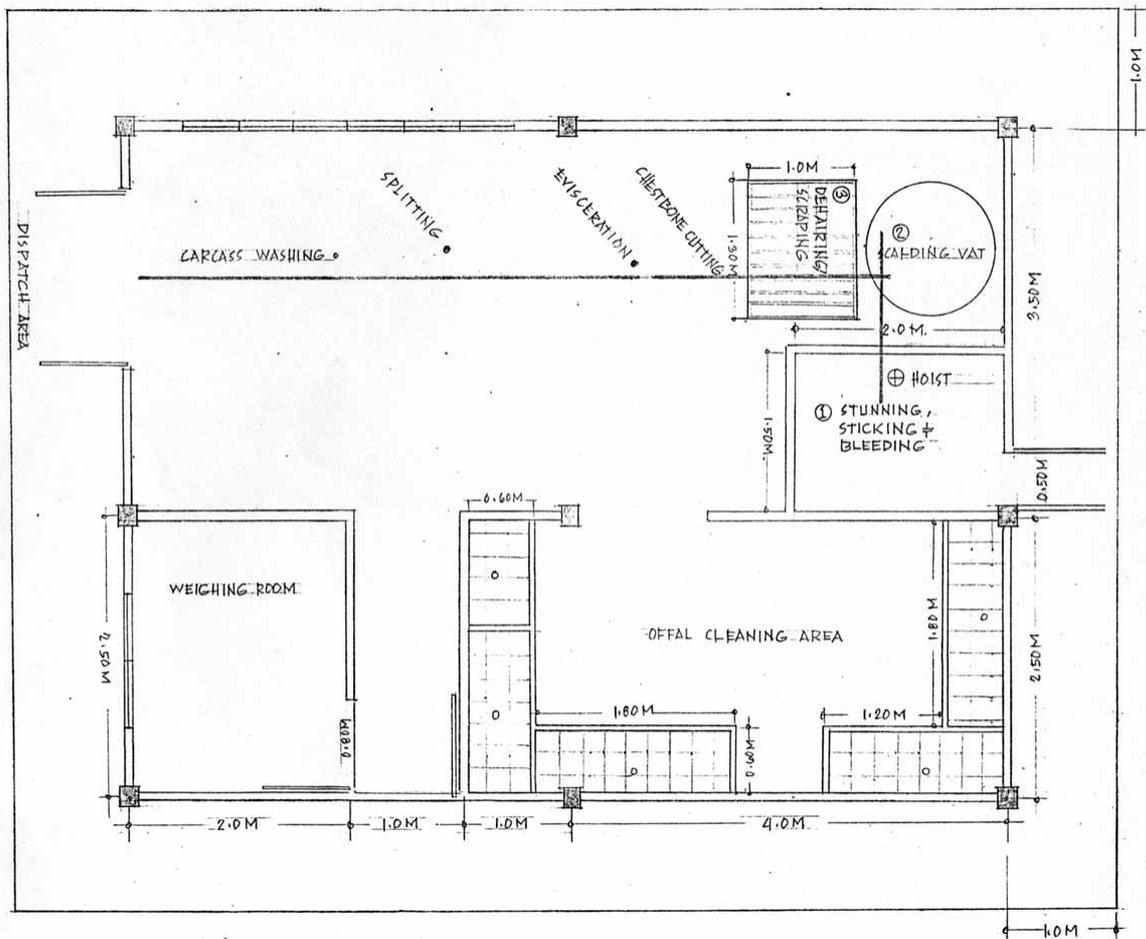


Fig. 99: Mini slaughterhouse for pigs: Line-slaughter system. Slaughter floor and by-product area measure 8 x 6.5 m

- Height of bleeding rail = 3.3 m
- Length of bleeding shackle = 0.84 m
- Length of gambrel = 0.63 m
- Height of dressing rail = 2.7 m
- Height of platform = 0.6 m

ANNEX A7

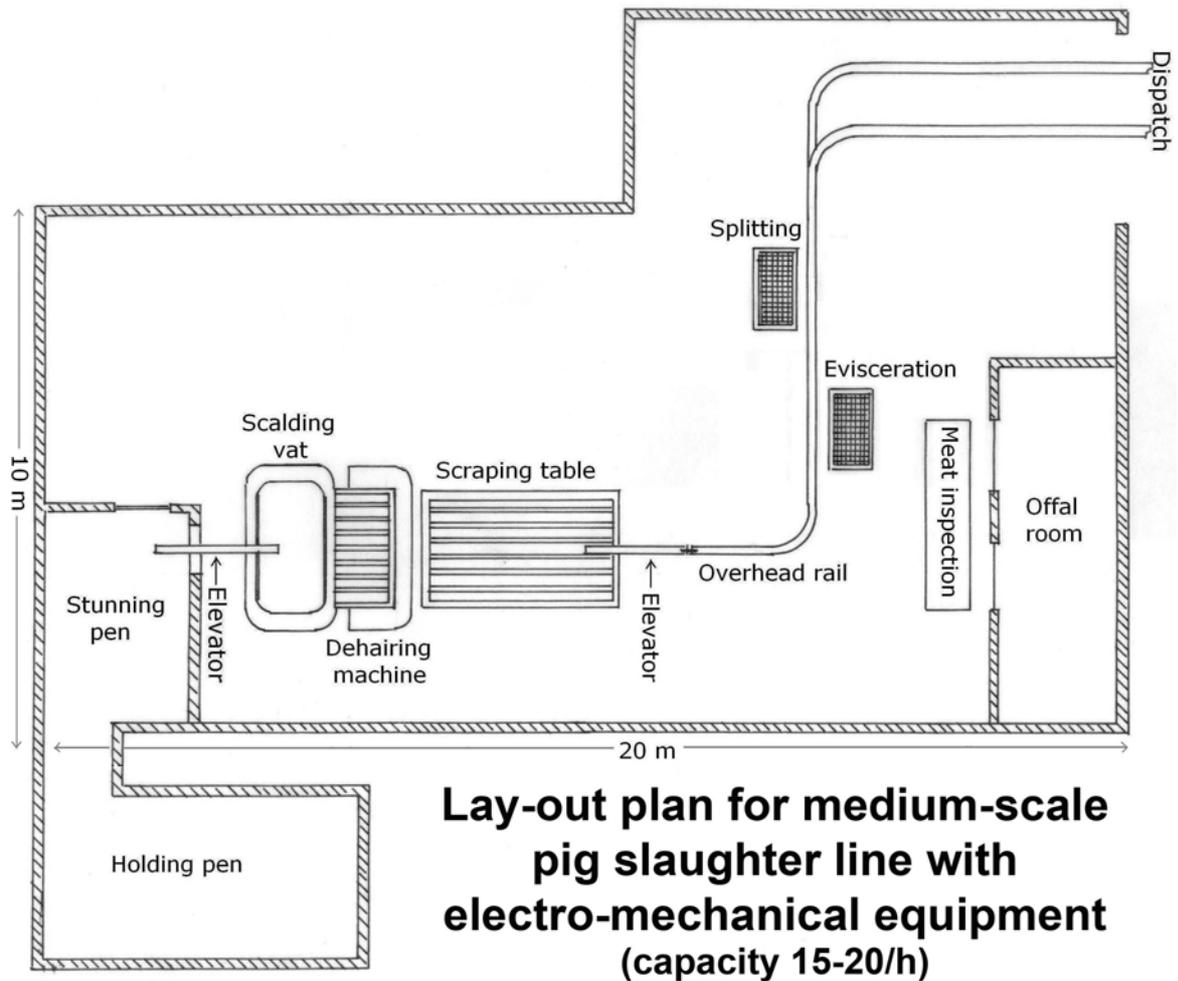
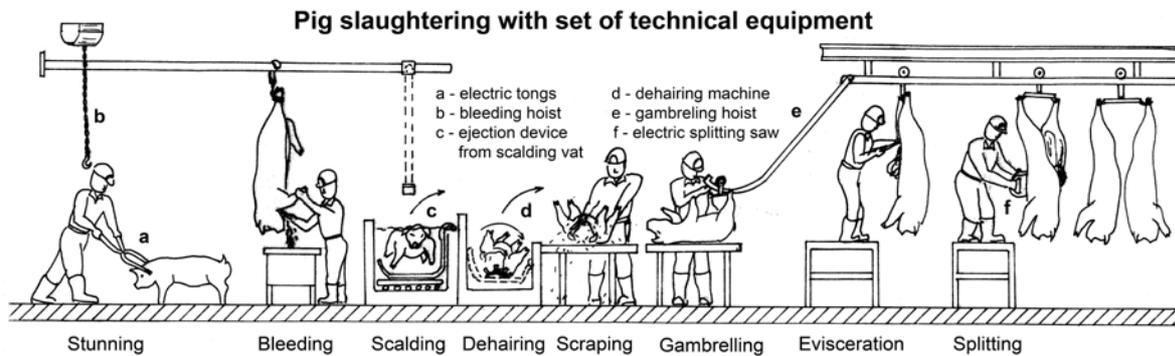


Fig. 100



Side view to above floor plan (Fig. 100)

ANNEX A8

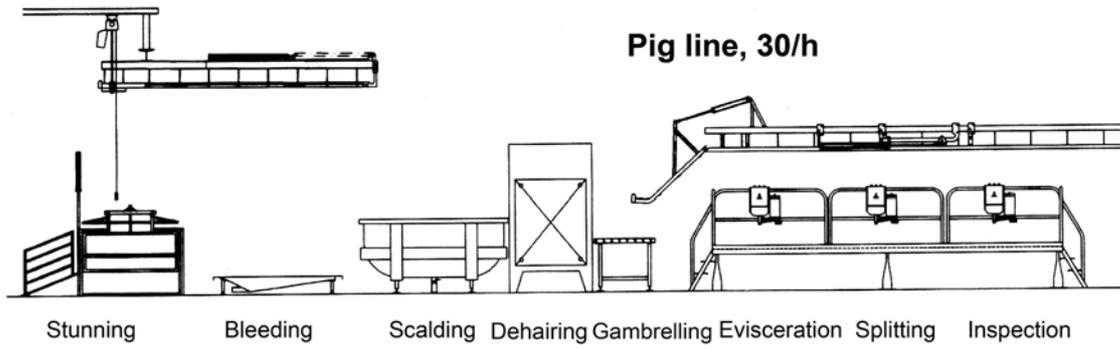


Fig. 101

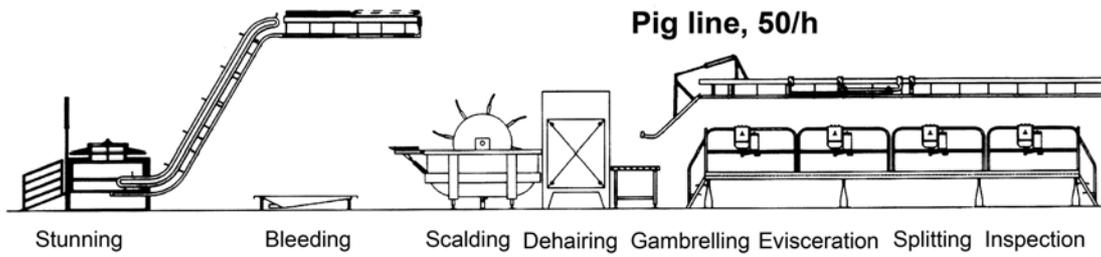


Fig. 102

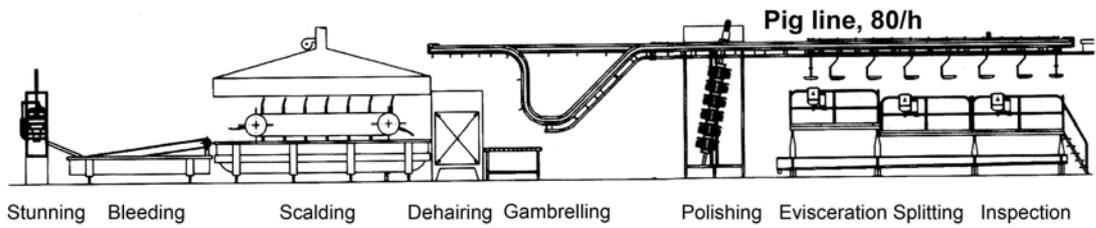


Fig. 103

ANNEX A9

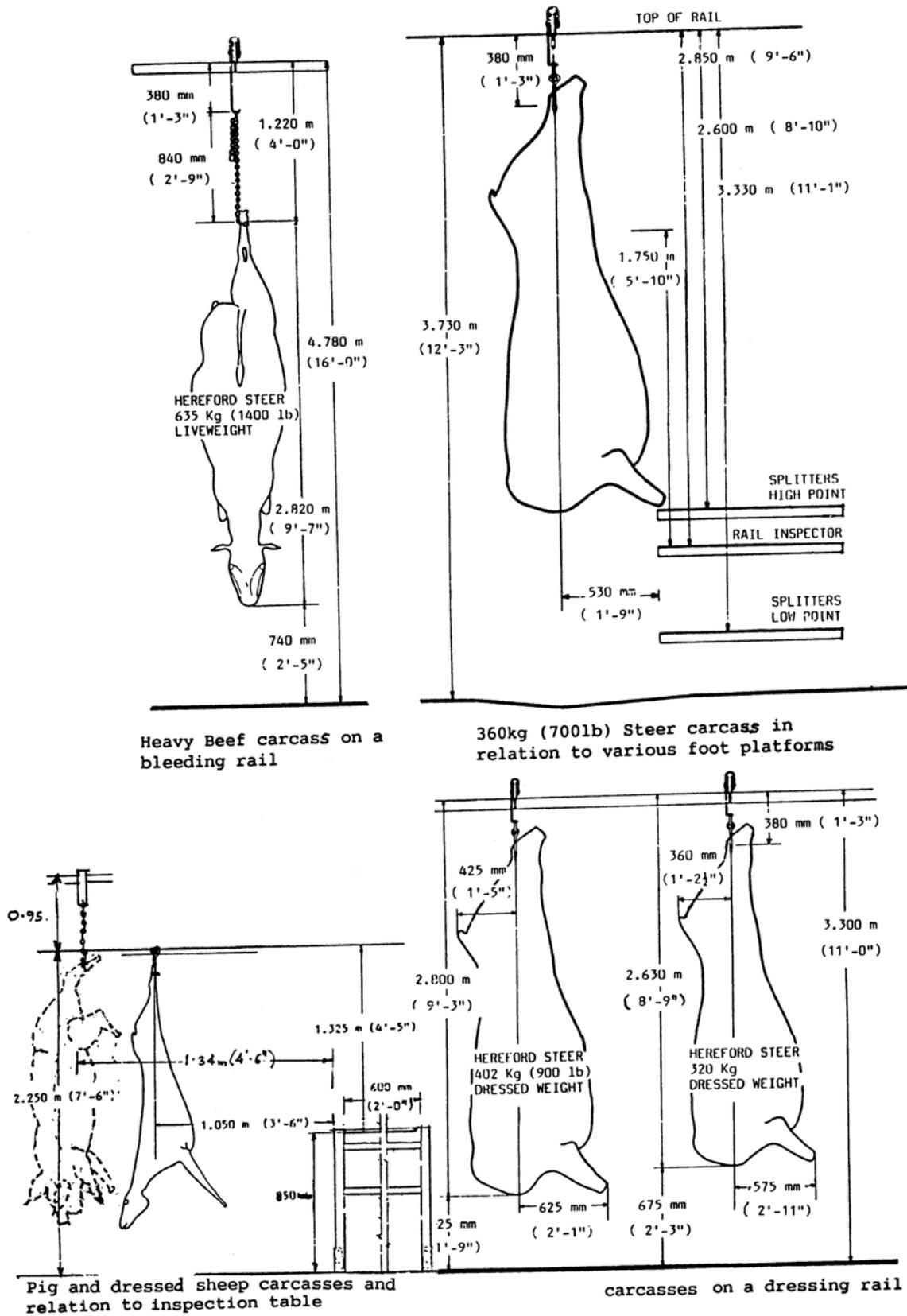


Fig. 104: Height of rails for line slaughter of bovines, small ruminants and pigs

ANNEX A10

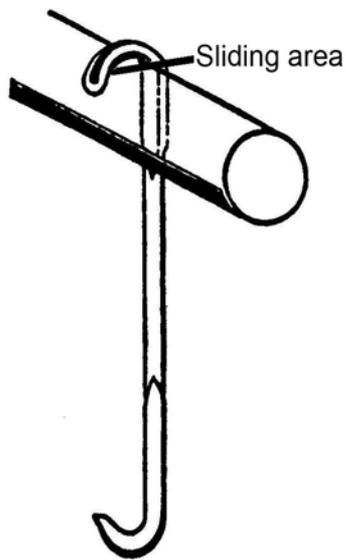


Fig. 105: Dressing hook
(sliding hook, one piece)



Fig. 106: Dressing hook
(sliding hook, two pieces)

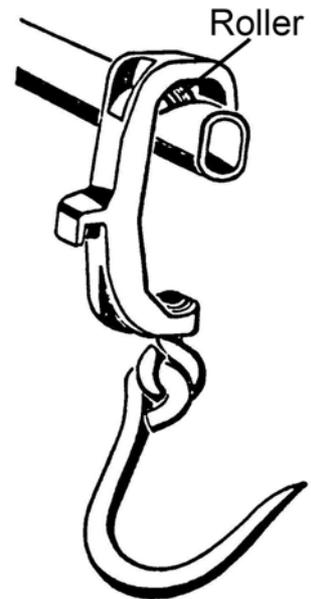


Fig. 107: Dressing hook
(roller hook, two pieces, roller part can be galvanized, hook part must be stainless steel)

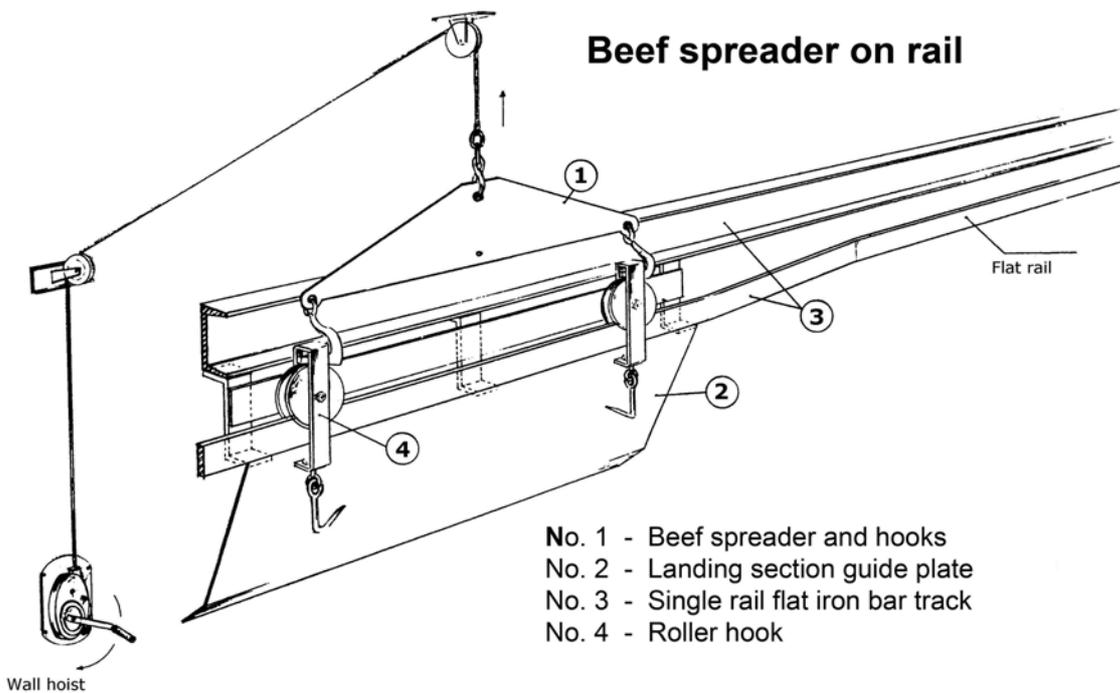


Fig. 108

- No. 1 - Beef spreader and hooks
- No. 2 - Landing section guide plate
- No. 3 - Single rail flat iron bar track
- No. 4 - Roller hook

ANNEX A11

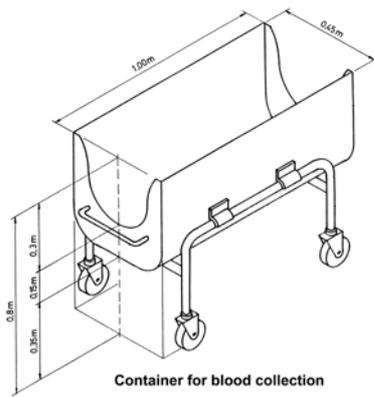


Fig. 109

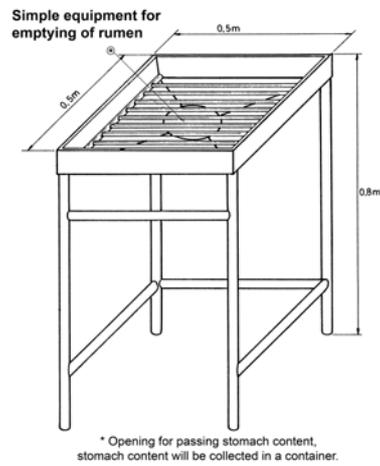


Fig. 110

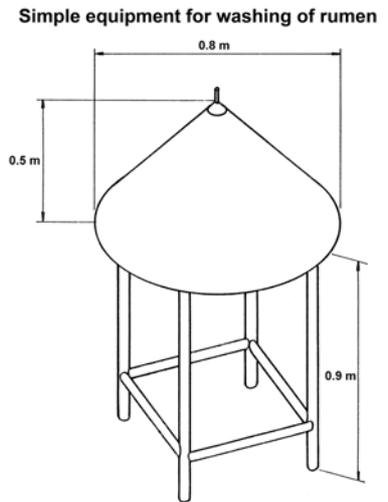


Fig. 111

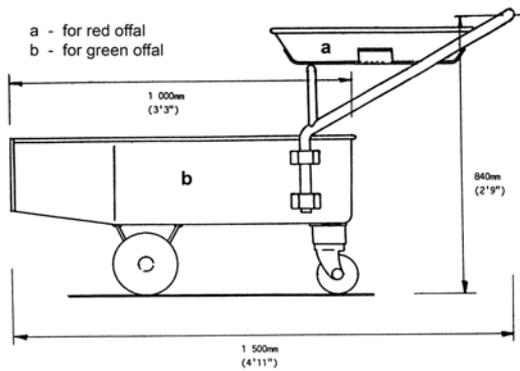


Fig. 112: Viscera cart

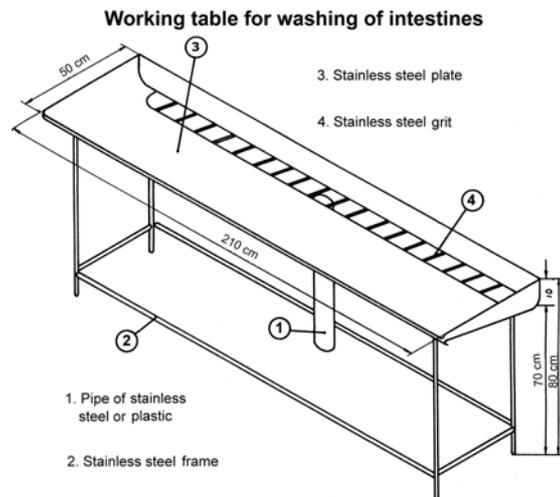


Fig. 113

ANNEX A7

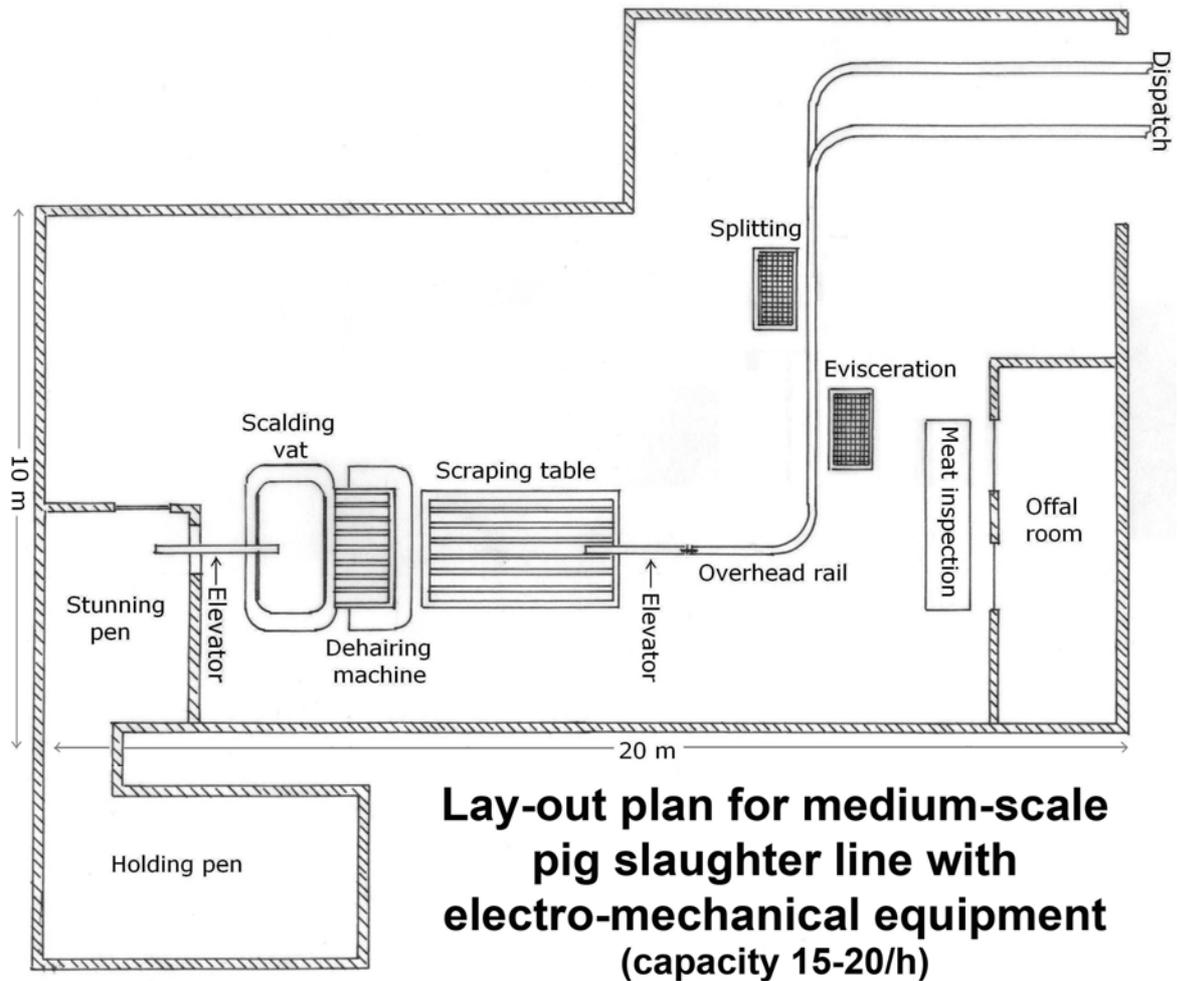
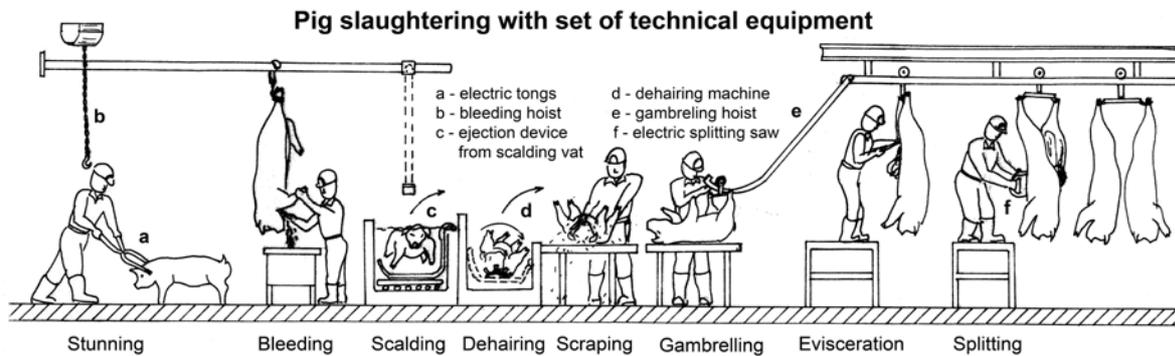


Fig. 100



Side view to above floor plan (Fig. 100)

ANNEX A12

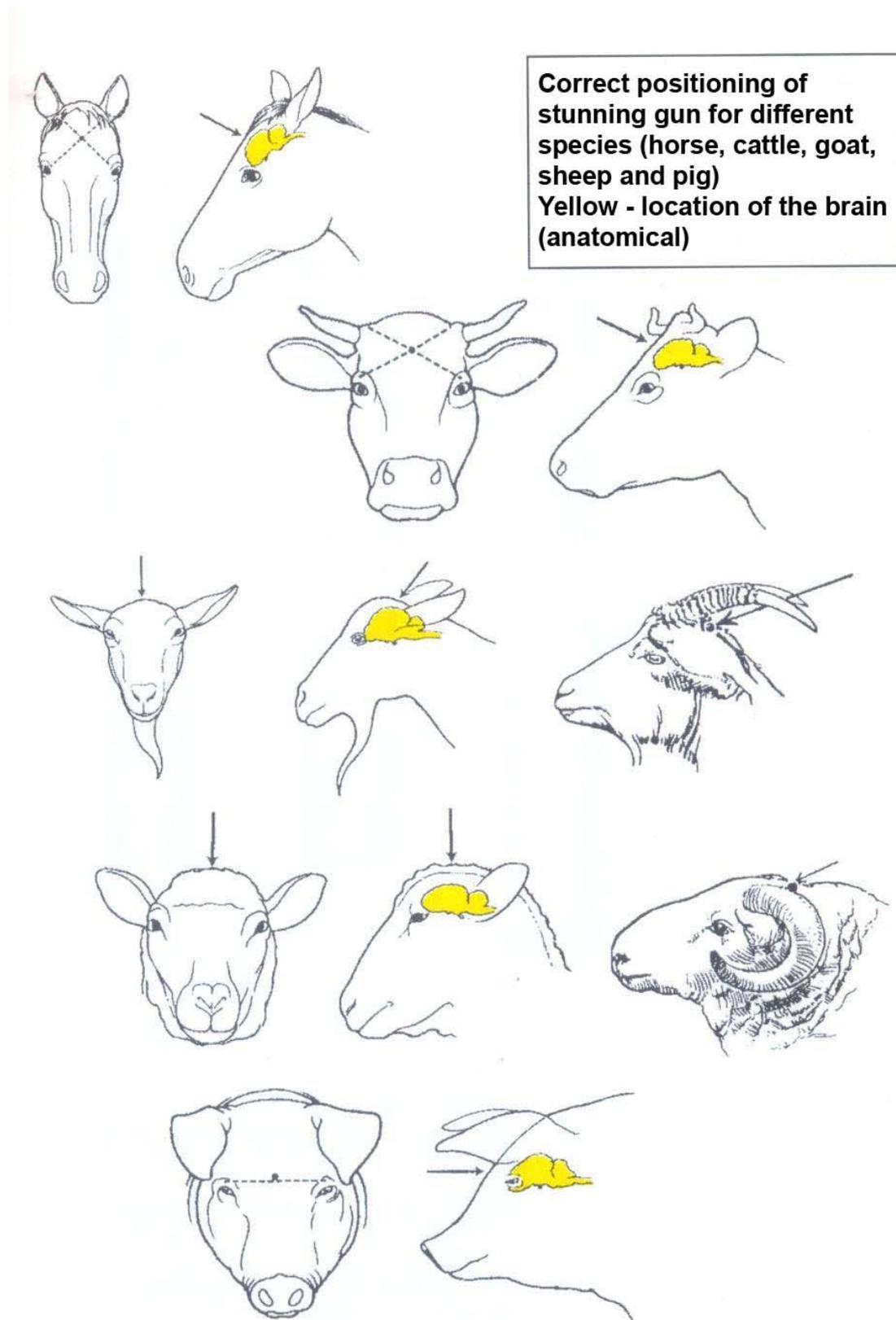


Fig. 114

Indonesia

Overview

In the red-meat sector, cattle are the dominant livestock species to be slaughtered in Indonesia. Buffalo meat is in demand only in some regions. Other red-meat sources are pigs, which are used only by certain religious groups. Slaughtering of pigs is common in Java, Bali and some other regions but with much lower meat output than what is derived from the slaughtering of bovines.

Indonesia is one of the Southeast Asian countries where investments in the abattoir sector are by both private- and public-sector enterprises. In the private sector, there appears to be two groups of enterprises: 1) a small number of efficiently run medium-sized cattle slaughterhouses with relatively modern line slaughter systems that produce chilled premium beef cuts from cattle imported from Northern Australia and fattened and finished in Indonesia; and 2) a large number of small-scale privately owned slaughter facilities (appearing once market liberalization and decentralized administrative structures took hold a decade ago), with only basic facilities and that primarily supply the traditional meat markets.

The mushrooming of such small technically, unhygienic and even obsolete slaughter places came at the expense of some large-scale slaughterhouses, such as the central abattoir of Jakarta. This used to be a very efficient operation, slaughtering in two lines up to 2 000 cattle per night using semi-automatic electrical stunning and modern line slaughter and dressing lines that enabled good hygiene and meat inspection. Apparently butchers and meat dealers nowadays prefer using the small abattoirs scattered around the country to supply the traditional meat markets because the slaughter fees and transport costs for livestock and meat are lower. The change in slaughter systems has resulted in high levels of meat contamination and deficiencies in sanitary inspection. This development is certainly regrettable and efforts should be made to reverse it.

According to the Directorate of Veterinary Public Health of the Ministry of Agriculture, there are 838 slaughter facilities registered throughout the country, which are categorized in two types:

Type I: Meets minimum hygiene requirements – 154 units (19 percent)

Type II: Does not meet minimum hygiene requirements – 684 units (81 percent)

Many of the numerous type II facilities are obsolete and should be shut down if they are not prepared to comply with minimum hygienic standards. There is a further issue in Indonesia with the quite sizeable amount of livestock that is slaughtered illegally without any sanitary supervision.

Assessment of slaughter facilities

This evaluation is based on seven slaughterhouses for cattle and two for pigs that meet the type I criteria of “minimum hygienic standards”. This standard can be clearly observed in the case of two well-mechanized cattle abattoirs, one slaughtering 60 and the other 160 head of cattle a day. In both abattoirs, animals are stunned following Halal requirements with a concussion stunner and bleeding on a bleeding grit; the carcasses are then hoisted up and all subsequent processes (hide pulling, eviscerating, splitting) are carried out with the carcass in a vertical position and thus avoiding floor contact.

In those two facilities, only quality beef cattle (deriving from Northern Australia and fattened locally) are slaughtered. The carcasses are kept cooled with the aim of producing vacuum-packed prime beef cuts and manufactured beef. The prime beef cuts are marketed to restaurants, hotels and supermarkets or sold in company-owned quality fresh meat shops in many locations of the country. These production and marketing systems are good for serving quality-conscious consumers but constitute only a tiny fraction of the beef market.

Elsewhere, beef is overwhelmingly slaughtered in much less suitable premises. Although many of the facilities have been officially rated as complying with the minimum requirements, in reality they do not meet the standards because the workers take little care of hygienic slaughtering. As in many other Asian countries, the system of renting out public or private slaughter facilities to meat dealers, who bring their team of slaughter men, is detrimental to meat hygiene. Those teams of slaughter workers have no understanding of hygiene and are difficult to train.

Indonesian authorities have implemented a series of measures to upgrade slaughterhouse conditions and to improve food safety. In the cities of Bogor and Yogyakarta, new municipal slaughterhouses were recently built with hygienic line-slaughter systems and included proper effluent treatment facilities. In Bogor, there is a battle between the authorities and the butchers because the latter so far refuse to use the new facilities. In Yogyakarta with its two separate abattoirs for cattle and pigs, a similar dispute seems to be ongoing, aggravated by the fact that nearby residents are opposed to pig slaughtering and the treated wastewater from the pig facility running through their area.

Reportedly, the municipality of Yogyakarta spent some US\$350 000–400 000 to build and equip the cattle and pig units as well as the effluent treatment facility. Indonesian authorities should not be discouraged by the negative response from the meat dealers and traditional butchers and should continue building medium-sized abattoirs. This type of abattoir is an appropriate approach to current and future demands in meat supply and food safety. Such abattoirs allow a certain degree of mechanization and much better hygienic slaughtering than in traditional small-scale facilities. The availability of such medium-sized abattoirs will in the long run enable authorities to phase out all unhygienic small-scale facilities that do not comply with the requirements of meat hygiene, effluent treatment and sanitary control.

Practically, all the equipment of Yogyakarta's new abattoirs were locally fabricated (cattle stunning box, overhead rails, platforms, hooks). The quality of

equipment seems satisfactory, although some of it should have better protection against corrosion, such as with galvanization. More complicated equipment, such as moving platforms, also has been locally fabricated. It remains to be seen if they function well under the expected harsh working conditions in public abattoirs.

Any future public abattoir projects in the country should make better use of the technical expertise available either at the national or international level. A number of details in the newly erected abattoirs could have been executed in a better manner without much additional cost, such as corrosion protection, wall tiles up to a certain height (in slaughter halls, up to 3 m) and better lay-out of slaughtering and dressing rooms.

Of the veterinarians employed in food and meat inspection, approximately 20 are national food plant auditors, 55 are subnational meat inspectors and 150 are veterinary public health inspectors (the latter probably not overwhelmingly involved in slaughterhouses). Considering the existing 850 abattoirs and slaughter slabs in the country, there is certainly a need to increase the number of sanitary control personnel.

Nepal

Overview

There have been significant developments in the Nepalese livestock sector over the past 15 years, with four multidonor-funded national projects. However, the improvements have focused on the live-animal sector, specifically in reference to animal health and breeding programmes, and the dairy sector.

The meat sector, particularly red meat production, has remained largely neglected. In Nepal, red meat derives from buffalos, small ruminants, goats and pigs; there is a significant slaughtering of pigs in the east of the country. The evaluation of the existing slaughter facilities underlines the stagnant situation, with no functioning improvements having been made for many years. There are as yet neither properly functioning slaughterhouses nor adequate meat-cutting facilities available, despite the demand for red meat for 20 million Nepalese citizens and millions of tourists each year.

There have been attempts at improving the abattoir situation: One slaughterhouse built with bilateral aid more than 20 years ago was technically too sophisticated and could not be run under the conditions of the country and had to close down. More recently, two private-sector, medium-sized buffalo slaughterhouses were built with technically inappropriate installations and one does not operate as planned and the other, still being built, is likely to have the same result.

Evaluation of small- to medium-sized cattle and buffalo abattoirs

The recent construction of the two buffalo abattoirs (in the Kathmandu area) is laudable. Unfortunately, the firms involved did not fully consider the technical, hygienic and environmental principles that should guide new slaughterhouse projects.

One of those slaughterhouses is located in a residential area and was built with unsuitable conditions, such as windows not far enough from the floor, extremely slippery floor tiles and no rounding ("coves") at the junction of walls and the floor. Moreover, the overhead rails and mechanical or electro-mechanical elevators were improperly designed and finished. They are not sufficiently protected against corrosion and were built with sloped gravity lines that are difficult for the manual support of carcass movement. These factors have made the installations difficult to operate, and the workers have resorted to their traditional methods: The entire slaughter process takes place on the floor.

The other slaughterhouse is still under construction, but because it is being equipped with the same inappropriate installations as the first newly built one, most likely the workers will reject the equipment and return to unhygienic practices. Major corrections to the set-up could improve the situation. However, the location of this slaughterhouse is not ideal. It is approximately 2 000 m up in the mountains with a difficult access road, in particular the last stretch leading to the premises.

Because there are no good functioning facilities for buffaloes and other red meat animals available, slaughtering of such livestock takes place on the bare ground or contaminated concrete slabs or floors with unhygienic slaughtering and dressing methods. It is an absolutely unsatisfactory situation. As in centuries ago, only knives and axes are used; no equipment is available for suspending carcasses or carcass parts, and some of the heavy meat parts are dragged along the dirty floor to transport vehicles. And worse, carcasses are deboned in the same unhygienic spot where the slaughtering took place, which is contaminated with dirty water taken from rivers, with intestinal content and with animal dung. These conditions cause heavy contamination of practically all domestically produced red meat across the country and render the meat unfit for human consumption. Due to the large meat demand, increasing numbers of animals are put through such facilities daily, causing increased levels of congestion and contamination.

Slaughtered buffaloes, which provide the bulk of meat in Nepal, suffer the worst contamination due to their weight and body volume, which makes such carcasses difficult to handle in the absence of any mechanical slaughter equipment. Also, their treatment before and at the point of slaughter is highly questionable from an animal-protection point of view.

Because the slaughtering takes place on the ground and because there is no proper meat inspection, the zoonotic diseases, in particular human cases of parasite infestation such as tape worm (cysticercosis and hydatitosis), are on the rise in consumers, according to the Veterinary Department. Presumably, the number of bacterial food poisoning cases through meat is also high.

As processed meat products are becoming increasingly popular in Nepal, meat processors are desperately looking for sources of suitable meat, which should have low bacterial loads. One meat processor is currently building a small abattoir for buffalo meat production. However, the construction does not look very promising for major improvement in slaughter hygiene, although there is room within the system for keeping the carcass in a vertical position off the floor. But the building is very narrow and located in a residential area; contamination and environmental pollution problems are expected. And the addition of yet another facility apart from the many others scattered around the country will only exacerbate the difficulties in efficient hygiene control and proper waste treatment. Centralized slaughtering of buffaloes in one or a few good-quality, medium-sized abattoirs would be a better option for Kathmandu.

Two very small pig-slaughter and meat sales facility projects were recently initiated in Kathmandu with the ambition to comply with minimum hygienic standards but appear to be instead creating hygienic concerns. The scalding vat and scraping table are in poor condition. And worse, there are wide open spaces between the meat shops, the place where the slaughter takes place and where live pigs are kept waiting. Contamination of the displayed meat with food poisoning agents such as *E. coli* or *Salmonella* that originate from the slaughter area and the live pigs kept in close proximity are certainly inevitable.

Government plans and projects

The Government is fully aware that the situation in the meat sector must change and has planned a two-fold strategy to tackle the problems. Private investment in slaughter facilities is encouraged and the Government is also preparing to establish public abattoirs on land by the river to be built by the municipality in Kathmandu.

Because the Government recognizes that part of the malpractices in the meat sector are due to negligence and ignorance of slaughtering and meat handling personnel, there are also plans to establish a training centre for slaughter technology, hygiene and meat inspection. The proposed location is near Biratnagar, at the site of an existing training centre for employees from the livestock sector. For the practical training instruction, the plans entail building a small slaughter facility in which commercial butchers from three nearby cities (including Biratnagar) will be invited to slaughter their livestock. This would then provide hands-on training experience. Other courses would target by-product technology such as hide and skin treatment and the processing of casings for sausage production as well as tanning technology that can be made available in the existing two tanneries.

For both programmes – building of public abattoirs and establishing a national training centre – donor co-funding is needed. The prevailing situation is both a hazard to consumers' health and a major source of economic losses through poor quality or spoiled meat and meat products. Investment for substantial improvements in the livestock slaughter sector can be easily justified and should be initiated soonest.

Pakistan

Overview

This evaluation entailed visiting only a small number of abattoirs in Punjab province, which is the most important livestock-producing province, and its capital city Lahore.

In Pakistan's abattoir sector, there are a few private companies dealing exclusively with the export of sheep and goat meat to Middle East countries. Slaughterhouses of these companies are medium-sized with capacities of up to 800 small ruminants per day and are relatively new. These facilities have line slaughter and carcass cooling units, are relatively well equipped, and slaughtering is carried out in a satisfactorily hygienic way. There is also, at a very limited scale, beef exporting to the Middle East. A cattle slaughterhouse producing beef for export that was visited for this evaluation had very basic installations with a number of manual hoists to be used for simultaneous batch slaughter of up to eight bovines. This is certainly not the kind of set-up expected in a beef-for-export abattoir.

Good hygienic standards can possibly be achieved in one privately owned cattle abattoir near Lahore, which reportedly is using line-slaughter installations for improved hygiene. This company, whose permission to visit their slaughterhouse could not be obtained, produces chilled beef carcasses and beef cuts for fresh meat sales in its quality-meat shops in Lahore. The shops have refrigerated display units for the marketing of prepacked meat and prime beef cuts. This marketing strategy of offering chilled quality beef as an alternative to wet market beef sales has obviously proved successful; in addition to the existing three meat shops in Lahore, three more are planned to open soon.

Apart from this new approach (which perhaps has been replicated in other major cities in Pakistan but unsubstantiated during the evaluation), the majority of the existing slaughter facilities produce for the traditional wet markets, where meat is sold "hot" (unrefrigerated). There are large traditional slaughterhouses in the major cities as well as a multitude of medium-sized to small facilities in the big cities and smaller ones located in villages. Altogether, according to a government listing, there are 309 slaughter facilities countrywide, mostly managed by the "city district governments"; these slaughterhouses can be categorized as "municipal abattoirs". There is also a considerable number of illegal slaughtering going on. In particular, small ruminants are slaughtered in fields and backyards.

A network of meat markets or numerous meat stalls outside the markets can be found in large and medium-sized cities as well as smaller population centres. Meat is a popular and much sought-after food in Pakistan, but annual consumption figures are still low due to the relatively high prices. Estimated consumption figures per capita and per year are 7.3 kg of beef/buffalo meat, 4.8 kg of mutton/goat meat and 3 kg of poultry meat. Goat and sheep meat are much favoured, and the prices are twice as high as for beef and buffalo meat.

New slaughterhouses recently were built to produce meat for export or to supply top-quality meat shops. Nearly all of the existing slaughterhouses producing for the domestic meat supply are more than 25 years old and do not meet hygienic minimum requirements. Due to the expansion of urban centres, they are now mostly located in densely populated areas and present severe environmental problems because of the untreated effluents and accumulated solid wastes. The abattoirs that produce for the local markets that were visited for this evaluation all need substantial improvements; for many of them, relocation should be considered.

A modern large abattoir with a line-slaughter system was built in Karachi 25 years ago. To this day, the local butchers refuse to use the modern installations in that facility because they do not want to abandon their traditional methods and fear the mechanical equipment will be more time consuming. That these modern systems are hygienically better for the production of clean meat seems to be of no interest to them. In Islamabad, there is a semi-mechanical large abattoir built not too long ago; but the equipment is said to be not operational for technical reasons, and the butchers engage in traditional practices of slaughtering and dressing on the floor.

The Lahore central abattoir has not received any major upgrades in the past ten years, but slaughtered output has grown considerably (up to 800 cattle and 1 500 sheep and goats per day) – beyond what the facilities were designed for. For the slaughtering of bovines, the outdated batch system is still used, with an estimated 30 animals slaughtered simultaneously on the floor. This congested and unhygienic slaughtering causes much meat contamination, with live animals, killed animals and flayed and eviscerated carcasses in close vicinity on the floor, exacerbated by millions of flies settling down on the meat surfaces as soon as they are cut open. The subsequent hoisting of the bovine carcass sides with primitive manual ropes does not change the situation because the meat contamination has already occurred.

The slaughtering of small ruminants in the Lahore abattoir is organized according to the batch-slaughter system; however, the animals are held in a vertical position on simple hooks for skinning and eviscerating. This may lessen the contamination likelihood to some extent – but only if the slaughter is done carefully.

Particularly unhygienic slaughtering of sheep takes place during the annual Eid el Fitr religious holiday when 3 million sheep are slaughtered outside proper facilities in one day. These sheep are typically heavier (at 20 kg) than the ones preferred for export meat to Middle East countries (at 8 kg). Members of the meat and by-product sectors have asked the Government to establish provisional slaughter facilities, including mobile services, at least in the major population centres for this annual religious-day slaughtering.

In addition to ensuring better meat hygiene and waste disposal, such temporary measures would make use of the sheep intestines for the processing of sausage casings, which are needed for export purposes. Specially selected sheep weighting 20 kg deliver the best casing quality for export but because of the unorganized slaughtering on Eid el Fitr, most intestines cannot be collected with the freshness needed for good quality casing production, and it is thus wasted through spoilage.

Sheep-slaughter facilities with a throughput of 100 or more animals per day make the intestine collection economically and technically feasible. Intestine value is calculated at 1 percent of the carcass value (4 000 *rupees* compared with 40 *rupees*). The value of the skin is 10 percent and is also an important export item. Sheep casings are predominantly exported to European Union countries, the Far East (Japan) and North America. Casings are animal by-products that are not subject to stringent trade restrictions for animal health reasons because they are heavily salted for preservation (up to 10 percent); however, the European Union issues export licenses to processing firms because of the need for required hygiene standards at the production facilities.

The traditional slaughtering of bovines and small ruminants at smaller slaughterhouses in the suburbs of the large cities or in small townships takes place in the same way as just described. But there is a problem in these facilities with the waste disposal. Although the solid waste from the large abattoirs is removed to dumping sites, the effluents are drained untreated into the regular water flows. In small abattoirs, effluents are simply drained outside the premises where they form accumulations of dirty contaminated water.

The abattoir situation described in Punjab Province can be considered representative of what happens elsewhere in the country. Punjab is even at the forefront of some new initiatives in the livestock and abattoir sectors. The government of Punjab has decided to establish the Punjab Meat Development Company, which will be a programme for the integrated production of meat animals; for example, male buffalo calves are to be raised to slaughter weights of 250–300 kg instead of killing them at the age of 1–2 weeks. For such fattening and also for the better organizing of slaughtering buffalo cows, the unhygienic facilities are to be replaced with modern abattoirs, which will produce primarily for the local demand but also for the export market. All this is planned to be done in close cooperation with and substantial investment from the private sector. One modern bovine abattoir (with a throughput of approximately 15 head/h) to be built near Lahore is already in the planning phase; a similar project is under consideration for Islamabad.

Similar to other Asian countries, large international wholesale and retail supermarket chains are opening branches in major cities in Pakistan. One of the most difficult problems such enterprises are facing is to find suppliers of good-quality clean meat. Such enterprises cannot continue with practices they have adopted, which is accepting meat that has been slaughtered at abattoirs that are not up to standard and that has been transported unrefrigerated to the supermarket's cooling unit where it is then cut. Hygienic slaughtering and cooling of carcasses must in these cases be the obligation of the abattoir.

To establish new facilities with slaughter lines for bovines, expert inputs from renowned equipment suppliers or even turn-key operators will be needed. This includes the necessary waste and effluent treatment facilities. Such efforts can be efficiently supported by local technical firms.

A visit to one manufacturer of cooling systems for the food industries, including the fabrication of polyurethane-isolated panels for cold rooms that would be suitable for slaughtering and meat-processing facilities, was included in the research mission for this report. This manufacturer is also capable of producing

galvanized and stainless-steel overhead rails, meat hooks and working tables of seemingly good quality.

As in many Asian countries, training in abattoir technology and hygiene is also urgently needed in Pakistan. It is certainly hard to change traditional methods of slaughtering livestock as practised at the Lahore municipal abattoir or at similar operations. But with the emergence of modern abattoirs, new generations of slaughter workers need to be trained, and thus suitable institutions for this purpose are needed.

The Department of Animal Products Technology at the University of Veterinary and Animal Sciences in Lahore has taken the lead in this respect and is in the process of establishing training facilities for livestock products. These projects will all be located at the compound of a university experimental farm some 30 km outside Lahore. A training centre for the dairy industries is already under construction. For the meat sector, a training centre for abattoir and meat-processing technology and hygiene is planned for construction in the same compound. Such a move is very timely to service needed reforms for Pakistan's abattoir sector. Donor inputs for such a project will certainly be very important. The training facility should have a medium-sized line for slaughtering bovines and a simple line for small ruminants along with installations for refrigeration and for meat cutting and some equipment suitable for meat processing. The plans for the training centre entail renting out the slaughter lines for use by the butchering community in the nearby city of Pattoki, which would at the same time secure the continuous availability of livestock at the premises for training purposes.

The training centre would also be helpful for providing training in meat inspection. Pakistan has a Slaughter Control Act dating back to 1963 that needs to be updated. In practical terms, veterinarians, mostly private practitioners, are entrusted to carry out meat inspection on a part-time basis. Meat inspectors are reportedly present during the slaughtering of animals for export meat production. For domestic slaughtering, the presence of meat inspectors is not common. Increased centralization of slaughtering in larger, modern abattoirs will facilitate proper meat inspection and bring about much-needed reforms in sanitary control and improved consumer protection.

Philippines

Overview

The Philippine National Meat Inspection Service (NMIS), an entity under the Department of Agriculture, has established a nationwide list of accredited slaughterhouses that are categorized into A, AA and AAA; the AAA is the technically and hygienically most advanced. Currently, there are about 100 facilities on this list.

In addition to the accredited slaughterhouses, there is a large number of licensed slaughterhouses that amount to about four times that of the accredited facilities. These slaughterhouses are licensed for commercial slaughtering mostly by provincial or municipal authorities. Responsibility for sanitary control in these facilities rests with the provincial or municipal authorities, while the accredited ones are supervised by veterinarians belonging to the NMIS and representing the federal Government.

Combined, the accredited and licensed slaughterhouses add up to an estimated 500 facilities. Most of them slaughter pigs only; others operate separate pig and cattle slaughter lines in the same premises. Facilities with only cattle- or buffalo- (called "carabao" in the Philippines) slaughter are rare. Most slaughterhouses are privately owned; a small number is run by municipalities or owned by municipalities and rented out to private entrepreneurs. The common practice is to provide slaughter facilities to several meat dealers, who bring in their own teams of workers. These meat dealers deliver unrefrigerated meat mostly to the wet markets.

There is a top quality cattle- and pig-slaughter facility near Manila, where beef and pork carcasses are refrigerated immediately. The operating company also has about 400 meat shops across the country, where the chilled meat is sold to consumers. The facility near Manila supplies only part of the meat shops; other shops in Luzon or distant islands are supplied by slaughterhouses not owned by this particular company but that follow its policy for carcass chilling. One of those providers is a United Nations Development Programme/FAO-established model slaughterhouse at the national training centre, known as the Animal Products Development Center, in Metro Manila.

Another top quality cattle- and pig-slaughter facility reportedly exists in the southern island of Mindanao, which is considered a disease-free area; the meat produced is for export.

Evaluation of pig abattoirs or pig-slaughter lines

Most traditional pig abattoirs in the Philippines are designed for simple but efficient carcass movement off the floor. This unique feature is found across the country and should be replicated in other Asian countries. The design principle is a tiered, or terraced, slaughter floor. Holding pens, the stunning area and scalding vats are located on one level; scraping tables are placed on another lower level. The difference in height is such that the top of the scraping table

reaches the level of the scalding vat, but operators are positioned lower. The start of the railing system is on another lower floor, with operators there standing at the lowest position of the floor (see Fig. 47). This multitiered floor design allows the easy loading and discharge from the scalding vat without mechanical elevating equipment. On the scraping table, pig carcasses can easily be manually moved to the start of the railing system, which is in a convenient height to hook the hind legs manually and without the use of elevating equipment from the scraping table position. Eviscerating and splitting is done on the rail, with operators standing on the lowest floor level, which again provides them the most convenient position without the need for platforms for these operations.

The tiered-system works very well and prevents any floor contact of carcasses, beginning at the scalding stage. Some slaughter teams try to cut corners by dehairing as well as eviscerating and splitting on the scraping table. Although there is no floor contact, this operation should be discouraged because scraping, eviscerating and splitting on the same working surface leads inevitably to cross contamination. These pig abattoirs should be equipped with sufficient overhead rails that enable eviscerating and splitting on each carcass in a vertical position.

A recently built but not yet operating medium-sized pig slaughterhouse, as well as the industrial slaughterhouse and the APDC pig line previously mentioned, use only a one-level floor design for their operations. However, the slaughter lines have elevating equipment for placing the pigs into the scalding tank and for hoisting them up on the gambrelling line for eviscerating and splitting.

For simple, small- to medium-sized pig-slaughter operations, the multitiered floor design is highly recommended because it allows pig slaughter off the floor with a suitable railing system without needing any other costly and technically complicated equipment that is prone to mechanical breakdowns.

Evaluation of cattle/carabao-slaughter lines and facilities

The previously mentioned industrial bovine-slaughter facilities use line systems with and without skinning cradles. These operations are flawless and provide hygienically impeccable beef to the consumer.

In most other bovine-slaughter facilities, batch slaughter is practised. Actually, some of the newer or recently restructured facilities are designed for line slaughter. But the slaughter personnel are not using it because either the systems do not function well or the operators were not instructed in the proper use. In such cases, several manual chain blocks have been provisionally attached to the overhead rail, and each chain block serves as the elevating equipment on that specific spot for batch slaughter.

Genuine batch slaughter systems are available in most other bovine-slaughter facilities. In these places, simple manual chain blocks are mounted to overhead beams. Partial flaying of the carcasses is done on the floor; the carcasses are then manually hoisted up for completion of the flaying and eviscerating and splitting.

The use of cradles is difficult in such batch-slaughter systems because the animals are knocked down (in the Philippines by the use of a hammer) and

collapse on the floor, where the bleeding is carried out. The heavy carcass is difficult to place manually onto the cradle. Using the skinning cradle would involve hoisting up the carcasses two times; first for placing it on the cradle and second for elevating the partly flayed carcass for complete flaying and eviscerating.

In facilities visited for this evaluation, the slaughter personnel appeared to have accepted the use of chain blocks for elevating the carcasses in order to avoid eviscerating and splitting on the ground. Ordinary chain blocks, with the beef spreader suspended from its middle to the chain, pose an operational problem because the suspended carcass can swing horizontally in all directions. This situation is counterproductive for exact splitting along the spinal column and prompts butchers sometimes to abandon the vertical position and do the splitting on the floor. Others lower the carcass to a point where the forequarter gets firmly attached to the floor, a measure that stabilizes the position of the carcass and facilitates splitting but causes enormous contamination of the meat at the forequarter. This practice, observed in several places, must be prohibited.

Apart from the malpractice that leaves the forequarter contaminated, beef slaughtering in the facilities visited for this evaluation is carried out in a reasonably clean method. It appears that the NMIS has forced a number of cattle-slaughter facilities to introduce the chain-block system. Some facilities apparently were downgraded from AA to A because they did not comply with the NMIS requirements. Downgrading does not stop meat from being distributed, but it does narrow the distribution area of a slaughter facility; for example, the supply may no longer be possible within the province but it is still allowed within the surrounding township.

Malpractices particularly in beef slaughtering originate largely from the way slaughter teams are organized. It is common practice that a meat dealer entrusts one skilled worker to slaughter the animals. That person ("head butcher") will recruit a few people as helpers who typically are unskilled workers, and worse, have no idea about slaughter hygiene. They do not receive a salary but collect a few trimmings from each carcass that they sell for money. And the helpers are interested in pleasing the head butcher in order to continue being employed. During the research mission for this evaluation, one such helper was seen splashing water from buckets indiscriminately on the dirty floors and on carcasses, both those with the hide on and those already flayed and eviscerated, and thus generating permanent meat contamination. Because of the constant turnover of helpers in these teams, teaching slaughter hygiene can be a losing battle. It is obvious that such a system is absolutely counterproductive to the introduction of adequate slaughter hygiene.

From visiting a few examples of slaughter facilities and from previous experience, it is obvious there has been a great deal of progress in conditions in the Philippines, which is largely credited to the NMIS professionals. And judging by the transport of meat to markets that is organized by the municipalities with trucks modified to hang carcass parts or in butcher-owned transport vehicles, it seems that the majority of the clean-meat production makes it safely to the markets.

Meat inspection by veterinarians, carcass by carcass, was only observed in the industrial slaughter facilities that produce for the high-end meat shops.

Vietnam

Overview

The abattoir sector in and around Ho Chi Minh City (HCMC) represents the largest meat consumption area in Vietnam. In this area, large-scale, medium-sized and small-scale abattoirs are operating, slaughtering predominantly pigs (29 abattoirs officially registered in HCMC metropolitan area) and a few specializing in cattle slaughtering (two officially registered). In terms of size and slaughter capacity, some of the HCMC abattoirs exceed the size of abattoirs in other parts of the country. However, the medium- and small-scale facilities in HCMC are considered representative of facilities in the rest of the country, and thus the evaluation of them can speak for the standards countrywide.

In the pig meat sector, there are continuous-line abattoirs, semi-line abattoirs and also slaughter facilities that have no installations to assist the movement of carcasses. There is one large-scale pig abattoir in Hai Phong (not included in the research mission for this report) that was designed in the 1980s for export purposes and uses a continuous-line system. The second abattoir with continuous-line pig slaughtering in three separate lines is the VISSAN abattoir in HCMC, built in 1974. The semi-line systems use traditional ways to move the carcasses from stunning and bleeding to scalding and scraping, frequently dragging them along the floor; but for eviscerating and splitting, the carcasses are suspended on rails. In systems without any installations, all operations, from bleeding to splitting and further carcass cutting, take place on the floor.

In the cattle-slaughtering sector, the VISSAN abattoir is the only line facility (with two cattle lines) in the country. In this system, carcasses are hoisted up after the stunning, and all procedures, from bleeding to splitting, take place in the vertical position. This cattle line, imported more than 30 years ago, is still in reasonable condition and allows excellent hygienic slaughtering. It is surprising that the VISSAN cattle line was, for 30 years, the only line installation in the country for this livestock species, although this system has been preferred for many years for medium- to large-scale cattle operations.

All other cattle facilities use the batch-slaughter system, in which the animal is killed, dehided, eviscerated and split (the latter not always done) and, against all rules of meat hygiene, the carcass is deboned on the same spot. Batch slaughtering remains an option for small-scale cattle operations, although the dehiding, eviscerating and splitting should be done with the carcass hoisted up in a vertical position. In the cattle-slaughtering facilities visited during the research mission, no hoisting equipment was available, forcing the workers to carry out all procedures on the floor and thus inevitably causing heavy meat contamination that is severely aggravated further by the deboning of the carcasses on the same spot.

Evaluation of small- to medium-sized cattle and buffalo abattoirs

Apart from the VISSAN abattoir (currently slaughtering on average 30 cattle despite its 20-fold capacity), the situation in cattle abattoirs is disastrous from a

hygienic perspective. The practice of batch slaughter without any equipment to elevate the carcass from the floor contaminates the spot for slaughtering due to the faeces and urine of the live animals, the dirty hides of the animals collapsed on the floor, boots or bare feet of the workers and the water splashed around to wash the floor, hides and meat. Drained blood and intestinal content adds to the contamination. When stripped from its hide, the bare carcass surface becomes exposed to this contamination. Worse, it is common practice to completely debone out of the carcass on the same spot, thus creating a multitude of fresh meat surfaces that get contaminated. Then the boneless meat cuts are dragged along the floor to transport vehicles where they are again deposited on the floor.

During the research mission, two cattle abattoirs were visited in the night time. The one under HCMC jurisdiction (with a throughput of 70 cattle and buffaloes per night) has to comply at least with some basic hygienic requirements, such as slaughter places slightly elevated from the rest of the concrete floor and use of stainless hooks and stainless tables – although these factors did not help much because contamination had already occurred or there was renewed contact with the dirty floor in between using the stainless hooks and tables. The abattoir outside of the HCMC boundary (with a throughput of 30–40 cattle and buffaloes per night) had none of these basic hygienic standards, and this may be the case in the rest of the country.

It seems that some major meat producers realize the grave hygienic deficiencies in the cattle abattoirs with batch slaughter because they are currently constructing three new abattoirs with line systems and imported equipment (more details further on). Similarly, one private cattle-slaughtering entrepreneur plans to change the inadequate batch system currently in use to a line system. Technical assistance should be given to avoid construction and installation failures, especially with the fabrication of equipment, which is to be done locally by manufacturers who most probably lack sufficient experience in the abattoir sector.

Evaluation of small- to medium-sized pig abattoirs

For this evaluation, four pig abattoirs were visited. One (with throughput of 200 pigs per night) that is located outside the HCMC boundary had no technical equipment. Even the scalding was done by pouring hot water on the skin of the carcasses. Slaughtering, splitting and carcass cutting was carried out on the floor with the same disastrous consequences as witnessed in the cattle operations. Two other pig abattoirs (one with a throughput of 1 000 pigs, the other with 120 pigs per night) had semi-line systems suspending the pigs after scalding and scraping – which brings about considerable hygienic improvements.

The fourth and smaller abattoir (30 pigs per night) is a model facility for continuous-line slaughter. It was developed with technical inputs through an FAO co-sponsored project. In this facility, the pigs are mechanically elevated into the scalding tank and scraping machine and onto the dressing rail, without any floor contact. Interestingly, the electrically heated scalding vat, electrically driven scraping machine and also the electrical stunning tongs were designed by the faculty of the Food Science and Technology of Nong Lam University (formerly the University of Agriculture and Forestry HCMC) through the FAO project and locally built by using high-quality stainless steel. The model scraping machine has

already been replicated, and this model is in use in the smaller of the semi-line facilities mentioned previously.

These are very good developments and hopefully will be followed with further upgrading of the pig-slaughter sector. In general, there are some hygienically satisfactory facilities currently operating for the slaughtering of pigs, which is technically less demanding than cattle slaughtering. But further improvements are needed. One critical area for improvement is the scalding procedure, which currently is done with vats too small for the number of pigs put through and renewal of the water used needs to be changed more frequently. As well, there needs to be better control of the scalding water temperature at 60°–62°C; the current practice is to keep it too hot, even up to boiling point, which damages the skin by coagulating the proteins, leaving it too soft and negatively impacting meat quality. Another area needing improvement is the stunning procedure, which currently relies on the use of home-made wooden stunning tongs. No transformer is used and the electrical current comes directly from the mains; this can be torturous for the pigs and also negatively impacts on meat quality. Some of the smaller issues that should be corrected include inserting the hooks into the Achilles tendon instead of into the cut tendons of the hind foot and the incomplete removal of hair through mechanical or manual scraping.

Past and future development of the Vietnamese meat sector

In Vietnam's centrally planned economic system, there were different structural developments in the slaughterhouse sector in the past. In the early stages after the country's post-war economic development, slaughtering was, as much as possible, centralized using the modern large central abattoir VISSAN in Ho Chi Minh City, which was built in 1974 (with two cattle- and three pig-slaughter lines of high capacity) and a few traditional medium-sized abattoirs in Hanoi and other big cities. The VISSAN abattoir was built through an extraordinary project that was funded with German aid with the aim of securing the meat supply in the then-beleaguered city of Saigon (which surrendered only one year after completion of the abattoir to invading North Vietnamese troops). VISSAN was then successfully run by the Communist Government as HCMC's central and practically only slaughterhouse.

The partial opening up to a market economy in the 1980s and 1990s created unfavourable developments in the slaughterhouse sector similar to experiences in other Southeast Asian countries: primarily the mushrooming of many small privately run slaughter facilities with obsolete technical and hygienic equipment, if any at all. These small slaughterhouses running without much expense for maintenance, hygiene measures and energy operated more cheaply than the large abattoirs could and thus attracted large numbers of animals away from the established facilities. The consequence was that butchers slaughtered cheaper but hygiene in general declined, and sanitary control was difficult or could not be implemented at all.

Due to the still-strong government presence in the economy, the veterinary authorities have been in a stronger position than in many other Asian countries to reverse the negative developments. According to the Department of Animal Health of HCMC, there are currently 31 abattoirs operating in the city, 2 for cattle and 29 for pigs. There are plans to build three modern abattoirs to cope with 70–80 percent of the meat demand in HCMC. One of the three new

abattoirs is reportedly already under construction some 20 km from HCMC and is to be ready for operation in September 2008 by a private cooperative.

In addition, there are plans to relocate and restructure the VISSAN. Ten years ago there were plans to shut down the facility but there was no new facility available at that time; closure would have increased the number of filthy unhygienic small slaughter operations and thus FAO lobbied the HCMC People's Committee to keep the VISSAN operating. The current plans involve the construction of a new VISSAN slaughter and meat-processing plant some 40 km outside HCMC in 2008 and, upon completion, the closure of the old VISSAN facility. This development will considerably upgrade the abattoir sector in southern Vietnam.

These two new abattoirs will have a combined pig-slaughter capacity of 8 000 pigs a day. However, to supply the demand in HCMC, 10 000 pigs per day are needed.

The veterinary authorities are intending to allow slaughtering only from abattoirs with a defined capacity or daily throughput, such as 300 pigs or 50 cattle; if these stringent plans materialize, this may create some logistical problems for the traditional unrefrigerated pork-supply system in HCMC. Currently this supply system works very well by sending the pig carcasses/pig sides from the various abattoirs unchilled to two main wholesale markets. From there, the pork is taken on the same morning to the retail markets. Consumers purchase from the retail markets the unchilled pig meat, which was slaughtered only a few hours previously.

The existing large pig abattoirs currently can only produce a total of approximately 1 000 pig carcasses per hour, which requires slaughter cycles of more than ten hours per night to supply HCMC adequately. Apart from delays in supplying the retail markets, the proposed veterinary authorities' measures would be prohibitive in terms of meat shelf life: meat stored for ten hours or more is prone to spoilage when kept in ambient temperatures, as is the current practice. Taking this issue into account, the veterinary authorities are planning to add another ten smaller abattoirs (along with the three large-scale facilities) to supply the city's suburbs.

The only way to solve the supply problem created by limited slaughtering to selected abattoirs will be the introduction of refrigeration for just-produced meat. With the addition of refrigeration, abattoirs could produce in ten-hour or longer shifts continuously to supply the retail markets. However, the pork sides would have to be kept for 24 hours in the refrigeration units before they are transported to the wholesale and retail markets.

This is how the meat-marketing system is practised in developed countries. However, Vietnam, like most other Asian countries, is not yet ready for such a change, first, because the infrastructure with uninterrupted cold chain is not in place and, second, because many consumers are not yet prepared to accept chilled meat. Also and specific to Vietnam, there is considerable processing of meat into loaves, balls and sausages, which is very popular. The amount of fresh meat currently marketed as chilled through supermarkets or quality meat shops is estimated at 5–15 percent. This proportion is steadily increasing, and the Animal Health Department is encouraging the introduction of chilled meat sales

in up-market butcher outlets or supermarkets. Realistically, a sudden change to chilled meat for all market outlets is certainly difficult to implement in the short term.

Reportedly in China, a country with similar government involvement in the economy as in Vietnam, practically all major abattoirs are required to refrigerate slaughtered meat with subsequent delivery of chilled meat to market outlets. This is certainly the meat-marketing system of the future and has strong implications on the structure of abattoirs. Abattoirs will need to have refrigeration units, which are not economically viable for very small operations and hence will contribute to the phasing out of such operations. Vietnam will most likely be one of the first countries in Asia, after China, to undergo such structural changes.

In terms of slaughter equipment manufacturing, there is reportedly only one producer of poultry-slaughter lines. Equipment for pig and cattle slaughtering, even hooks and overhead rails, is still being imported from abroad, previously mostly from Europe (France, Germany) but now increasingly from China.