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Agro Processing Sector Meat Industry National Science & Technology Innovation Road Map

(2016-2026)

1st Draft

June 2016

Addis Ababa

Executive Summery

A roadmap is a strategic plan that describes the steps a nation needs to take to achieve stated outcomes and goals. It clearly outlines links among tasks and priorities for action in the near, medium and long term. An effective roadmap also includes metrics and milestones to allow regular tracking of progress towards the roadmap's ultimate goals. Technology Road Mapping is a needs-driven technology planning process to help identify, select and develop technology alternatives to satisfy a setoff product needs. A technology Road Map is also a document that is generated by the technology road mapping process which is a learning process and is a consensus building process.

Globally, countries are facing many competitive challenges among the challenges technological computation is the main one. Technology road mapping, a form of technology planning, can help deal with this increasingly technological competitive environment. Experiences from different countries like the South Koreas experience show that technology road mapping is plays a crucial role in their rapid national economic growth which makes them become one of the world technologically advanced developed nation with in three decades. Investment decisions to leverage those technological investments needs sound information. Technology Road Map in its process provides a way to develop, organize, and present information about the critical system requirements and performance targets that must be satisfied by certain time frames. The main benefit of technology road mapping is that it provides information to make better technology investment decisions on organizational and national level. In line with it is an excellent tool to guide on Strategic Research & Development decisions.

Ethiopia is one of the countries with fast growing economy, with an average growth of around 10.9% for the past decade. There is a national aspiration to graduate to middle-income country status by 2033. If the industrialization goal and the vision of becoming a middle income country has to be realized such trend must be changed by introducing appropriate distortions or shocks in economy through the provision of extraordinary support to the industry sector. Nationally it is targeted that the industry sector will make up to 19 % of GDP by 2015 and 22.4 % by 2020, and finally expected to reach 27% of GDP by the year 2025 while the share of other sectors to the GDP for each milestone would proportionately decrease in favor of the industry sector (Source:-MOI, 2013). Industrial development is an important component of the national Growth and Transformational Plan (GTP). Hence, the technological road map for the successful implementation of GTP II (2016-2021 (2008-2012 EC) and GTP III 2022-2026 (2013-2017 EC) become vital with an emphasis of governmental policy which is directed towards shifting from agricultural based economy to industrialization that requires advanced technology.

The Government of Federal Democratic Republic of Ethiopia has launched National Science and Technology Innovation Roadmaps Development for 18 prioritized sectors. The Agro Processing Sector is one of the prioritized sectors. With this in mind, in line with national strategic plan priority the Meat Industry one of prioritized sub sector of the agro processing sector based on the key criteria of selection that are Export Oriented, Import Substitution, and Employment Creation. So that this document deals with the meat industry in its five parts that part one Introduction of the document covers (I) Background (II) Scope and boundary conditions of the road mapping effort (III) The current industry: its products, customers, suppliers and manufacturing processes (IV) Market trends and projections (V) Mission/vision, Project goals, objectives and end states. Part two TRM Deployment of the document focused on (I) Environmental Analysis: - Legal Frame Work, Key Stake Holders, Trend Analysis and SW0T Analysis, (II) Drivers and Future Prospect, (III) Strategic Products (IV) Key Technologies:- Technology Areas, Technology Alternative, Performance Dimensions & Targets, Prioritization & Selection, Stages of Performance Targets and Acquisitions of key technologies, (V) Macro National Science and Technology Road Map for Strategic Products and (VI) Micro National Science and Technology Road Map for Strategic Products. And it presents Recommendation and Action Plan in Part three with two Appendixes that Road Map Processing and The Participants of the Road Mapping Process in part four.

The document aligned with the strategic plan of the Ethiopian meat industry vision, goal, and objectives so as to make the meat industry capable of significantly improving the living standards of the Ethiopian people with respect to quality, quantity and sustainability of their food intake by providing the overall framework in terms of the current situations and the gaps of technology to be bridged for future prospects. Specifically, it addressed the product differentiation and strategic products identification, improve technology, skills and knowledge attainments, and then improve quality affecting parameters to solve the challenge of current processing by identifying, selecting, and developing technology alternatives of Meat Industry in in order to building an industrial sector with manufacturing capability which is diversified, globally competitive, environmentally-friendly.

The three identified strategic products are carcass, Value Added Processed Meat and Value Added Processed By-Products. Carcass [Beef and Shout Carcass] are mainly targeted for domestic market and for export market for Africa and Middle East countries. Value Added Processed Meat [Fresh Processed Meat, Cured Meat Pieces, Row Cooked Meat, Precooked – Cooked Meat, Raw (dry) Fermented Sausages, Dried Meat, and Precooked – Cooked Green Offal] are mainly targeted for international export market and also for urban areas of domestic market, and Valued Added Processed By-Products [Blood Meal and Bone Meal, Gelatin and Glue, Pet Food, Tallow, Processed Horn and Hoofs, Aloof Hide and Skin, Processed Red Offal, Animal Feed, Natural Compost and Biogas Energy] are targeted for both export and domestic market.

The selected key technologies for Carcass are Animal Receiving Pen [Receiving pen, Adjustable off loading Ramp, Digital washing system, Isolation pen] Lairage [Concrete Lairage, Pressurized water supply, Foot bath, Showering, Animal Driving devises, Electric stick, Incinerations [Refractory bricks Incinerator], Slaughter Laboratory [ISO Standard Laboratory , Food Scan Technologies, Microbial Testing facilities], Emergency Slaughter [Independent Emergency Complete slaughtering Lines], Complete Slaughter Lines [Gravity Complete Slaughter Lines, Fully Mechanized Lines, Conveyors, Leg & Horn cutter, Splitter, Sterilizers, Plat forms, Stunning, Rails, Hooks, Hanging], Slaughtering Amenities [ISO Safety Materials, Chemical Hand washing, Sensor Hand Washing, Aprons, Chain gloves, Sterilizer and Stainless Still knives], Cold Storage [Chillers, Freezers room, Ammonia system], Deboning [Deboning Cutting machineries, Electrical type saw blade], De-Hiding [Hydraulic De hiding systems, Electrical Motor rolling systems], Hide and skin Preservation [Solti Preservation, Brained Solution], Carcass Washing [Spray carcass washing , Stainless steel tunnel, Refrigerated Tracks.

The selected key technologies for Value Added Processed By-Products are Rendering Plant, [Semi-automatic controlled, Computerized parameter controlled batch rendering plant], Pet food Processing Plant [Bach System pet food processing plant, Continuous system pet food processing plant], Blood Processing [Continuous ring dryer blood processing], Gelatin and Glue Processing Plant [Gelatin extraction and processing plant, Milling, calibration Mixing of gelatin unit], Offal Processing Plant [Advanced sausage product, Intestine as raw material processed for surgical suture, Different pharmaceutical product], Waste Treatment Plant [Micro-screening to 50 micron ("Baleen" system), Coupled with a Sequential Batch Reactor], Biogas, Combined Heat and Power Generation Plant [Combined heat and power generation, Biogas facilities use developing a reliable mono digestion process using slaughterhouse waste as the sole substrate for anaerobic digestion then use biogas for generation power], Compost Processing Plant [Composting in remote area by transporting from each plant]. The selected key technologies for Value Added Processed Meat and packaging are Vale added Meat Processing Technology [Meat grinder (Mincer), Bowl cutter (bowl chopper), Piston stuffer, Clipping machine, Smokehouses, Tumbler or Massager, Vacuum packaging machine, Mixer / blender and Ice flaker, Frozen meat cutter], Vale Added Meat Packaging Technology [Food Graded, Biodegradable, Active Anti-Microbial Packaging, Vacuum and frozen packaging, Electrical type saw blade, Labeling & printing]. The key technologies of each respective strategic products will implement in three phases of time frame work of GTP2 and GTP3 from 2016-2026. The first stage performance target ranges from 2016 to 2018, the second stage performance target ranges from 2019 to 2021, and the third stage performance target ranges from 2021 to 2026. Behold, the document based on the above stage performance target indicates the possible options on how to acquire the key technologies.

To conclude this Meat Industry National Science and Technology Innovation Road Map identifies precise Vision that "to see Ethiopia Meat Industry's wholesome processed meat and by-products domestically self-sufficient and reach at pugnacious export volume thoroughfare applicable technology in 2025." And objective that "To provide a good information base regarding key technologies to enable making right decision and show direction of research and development of the future technology need of the meat industry." Therefore, it helps focus resources on the critical technologies that are needed to meet those visions and objectives. This focusing is also mainly important because it allows increasingly limited Research and Development investments to be used more effectively.

Acronym, Tables and Figures

CRGE	Climate Residence Green Economy Policy
CSA	Central Statistic s Agency of Ethiopia
EPE	Environmental Policy of Ethiopia
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
GTP	Growth Transformational Plan
HACCP	Hazards Analytical Critical Control Point
ISO	International Standard Organization
MFEC	Ministry of Finance and Economic Cooperation
MUDHC	Ministry of Urban Development Housing and Construction
SME	Small and Medium Enterprise
TQM	Total Quality Management
MOI	Ministry of Industry
AAAE	Addis Ababa Abattoirs Enterprise

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Part One – Introduction

General Background

A roadmap is a strategic plan that describes the steps a nation needs to take to achieve stated outcomes and goals. It clearly outlines links among tasks and priorities for action in the near, medium and long term. An effective roadmap also includes metrics and milestones to allow regular tracking of progress towards the roadmap's ultimate goals. Technology Road Mapping is a needs-driven technology planning process to help identify, select and develop technology alternatives to satisfy a setoff product needs. A technology Road Map is also a document that is generated by the technology road mapping process which is a learning process and is a consensus building process.

Technology road mapping is a needs-driven technology planning process to help identify, select, and develop technology alternatives to satisfy a set of product needs. It brings together a team of experts to develop a framework for organizing and presenting the critical technology-planning information to make the appropriate technology. Road mapping require different commitments in terms of time, cost, level of effort, and complexity. It also need, critical system requirements and targets, technology areas, technology drivers and targets, technology alternatives, recommended alternatives or paths, and a roadmap report. A single path may be selected and a plan developed. If there is high uncertainty or risk, then multiple paths may be selected and pursued concurrently.

Generally, TRM Planning can be Market-Driven Planning or Technology-Driving Planning. In Market-Driven Planning the process is that industry trends analysis, confirmation and revision of business strategy/planning → principally market oriented roadmap – Technology Roadmap (Product → Technology) development is focused. In Technology-Driving Planning the process is that market analysis focused on futuristic marketing from products/applications developed by technologies – Market Roadmap (Product ← Technology) development is focused.

Technology Road Mapping Require a certain Knowledge and Skills some of the participants or consultants must know the technology road mapping process. This includes how to identify needs and technology drivers, as well as how to identify, analyze, and select technology alternatives and paths.

Some participants must also have some content knowledge of the area being road mapped.
Different participants may have the content and the technology road mapping process skills. However, while these skills are important, they are not nearly enough. Equally important are the interpersonal and group process skills. Therefore, road mapping project, you need a road mapping consultant and/or facilitator who has both types of skills (road mapping and interpersonal) or a well-integrated team that includes both types of skills. The road mapping consultant does not need to be an expert, or even particularly knowledgeable, in the content of the area being road mapped. In fact, such expertise can be a detriment if the consultant/facilitator becomes too involved in the content of the roadmap. It is not the consultant's roadmap. It should be owned by the group of experts developing the roadmap, so their involvement and commitment is critical. But, in its implementation stage it requires a proper Techno-ware, Human – ware, Info-ware and Organ-ware.

Importance of Technology road mapping is a useful technology planning tool in an increasingly competitive environment. For a successful technology road mapping process, it is critical to identify why you are doing the road mapping and how it will be used. Technology road mapping is particularly useful for coordinating the development of multiple technologies, especially across multiple projects. This coordination is critical when dealing with technologies that are related to national core competencies. The information about and analysis of needs And technology alternatives is far more important than following a precise process and format. In summary, technology road mapping is a valuable process if done for the right reasons, but it should not be undertaken lightly or without good justification

Successful implementation of NSTI-RM requires Follow-up Activity that in the first step it is done by experts of different back ground and especially from the industry operators and then it must be critiqued, validated, and accepted by a much larger group that will be involved in any implementation. An implementation plan needs to be developed using the information generated by the technology road mapping process to make and implement the appropriate investment decisions. Finally, since both the needs and the technologies are evolving, the roadmap needs to be periodically reviewed and updated.

Boundary Conditions of the Road Mapping Effort

The Government of Ethiopia is aggressively working to encourage technology transfer activities at different stages in industries, enterprises, educational and training institutions; to contribute to the socioeconomic development of the country. Over the last twenty two years, the fast growing rate of Ethiopia has experienced agricultural lead economy policy with rapid industrialization and economic growth. Much of this change can be attributed to international technology transfer. But, the question remains, whether national technological accumulation capability is built and Ethiopian professionals are gaining best-practice knowledge and technologies, ultimately reducing their reliance on foreign capacities.

The need of industrialization is particularly strong in Ethiopia as it is an important means to accelerate the annual growth with better pace to achieve the Growth and Transformation Programs; and bring sustainable development in the country. As industrialization is regarded as one of the principal means to achieve and sustain a high level of economic growth, the universal desire among nations, irrespective of the system of planning and administration followed and level of development attained, is be more and more industrialized.

To effectively implement the mandate given by the government of the Federal Democratic Republic of Ethiopia the technology need in each sector should be assessed and the technology need of the country should be audited and identified. The growth of the country can be realized if appropriate technology need of the country based on its policy is assessed and identified at the national level, while in the meantime or in the long run individual industries/companies can fill their gap based on the assessed data for increasing productivity, improve quality and management practices.

Therefore, the Ministry of Science and Technology through the Technology Transfer and Development Directorate is planning to develop National Science Technology and Innovation Roadmap (NSTI-RM) in the 18 priority sectors areas. This is intended to implement the next two GTP 2 and GTP3 in collaboration governmental and private stockholders. Accordingly, two workshops have been conducted in Debrezeit Management Institute. The first workshop was aimed at mobilization of Expert's from Industries, Research Institute and Universities, besides the training on TRM Preparation was provided for the experts participated on the workshop by Korean Experts. The Second work shop also conducted on same place but at this stage the prototype mini TRM has been prepared by each sector experts shared with other sectors by PowerPoint presentation for the rest of all other sectors participants. And then, the Technical Committee for the preparation of the TRM for Agro Processing Sector established to produce this document.

Scope of Meat Industry Technology Road Map

- Ministry of Science and Technology is planning to develop National Science Technology and Innovation Roadmap (NSTI-RM) in the eighteen (18) priority sectors areas for GTP2 and GTP3. Despite the fact that this document is classified under this broader umbrella it is limited only:-

    - On Agro Processing Sector which is one of the 18 prioritized sectors.

    - And intended only for the implementation of the Growth and Transformation Plan (GTP) specifically GTP2 and GTP3.

- Under Agro processing sector there are five subsectors to be consider in the preparation of NSTI-RM which are (1) Cereal, Pulses, Roots, and Tubers, (2) Fruit, Vegetable, and Spices, (3) Edible Oil, Oil Seed Processing, (4) Meat, Diary, Honey and Feed Processing and, (5) Beverage Processing. Due to time and resource limitation the Technical Committee for Agro Processing Sector further prioritized these sub sectors based on the key criteria of selection in line with national strategic plan priority that are Export Oriented, Import Substitution, Employment Creation. So that this document under Meat, Diary, Honey and Feed Processing sub sector limited for:-

    - Meat Industry
    - Specifically limited to Cattle, Sheep and Goat Meat Products

- Above all the document limited to identify, select, and develop technology alternatives of Meat Industry.

- It is restricted on building an industrial sector with manufacturing capability which is diversified, globally competitive, environmentally-friendly, and capable of significantly improving the meat industry.

- Is constrained to achieve the visions, goals, objectives of the technology road map stated herein the document.

1. The Current Ethiopian Meat Industry and The Manufacturing Process

General Overview

The agro-processing industry in general plays a critical role for development, especially in developing countries. According to Wilkinson and Rocha (2009), the agro-processing sector on average contributes 52%, 36% and 32% of the total manufacturing value added for Low, Middle and Upper Middle income countries, respectively. Furthermore, the contribution could reach 66% for agriculture-based countries and 38% and 37% for the transforming and urbanized countries, respectively. (Source:-A World Development Report 2008 - Wilkinson and Rocha, 2009) noted that agribusiness can stimulate growth in the agricultural sector and reduce rural poverty. Similarly, the agro-processing industry has been identified by the New Growth Path as a key candidate. Generally the growing demand for food of animal origin in developing countries, stimulated by population growth, gains in real per capita income, and urbanization, represents a major opportunity for poverty reduction and economic growth.

For centuries, the Ethiopian economy is highly characterized as agricultural based with subsistence dominance level, low input-low output, rain -fed farming system. Currently, Ethiopia where aggregate economic growth of over 11 present per year over the period 2002–2007 EC has exceeded growth rates in many other world regions due to consolidated macroeconomic and political stability throughout the country. Robust economic growth in Ethiopia has been and is anticipated to translate into a growing demand for animal- source foods, the economy structure is dominated by service sector with the average GDP share of nearly 45% followed by Agriculture with the share of 44%. The industry sector contribution is the least of all with only 11% of the real GDP (Source:-MOFED, 2013).

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The Ethiopian meat production and distribution is characterized by beef, sheep and goats slaughterhouses found in different towns under direct supervision of municipals with a few export abattoirs found around Addis Ababa. Almost all the slaughter houses are in the level of the so called slabs. Currently, there was an attempt to establish modern abattoirs but almost all are not constructed with the art of modern slaughterhouse with an integrated byproduct and waste management plant. The drainage system, process lay out, slaughter equipment, facilities are not available in an adequate manner and also substandard. Above it the industry lacks technical and managerial capability. Therefore the slaughter house serves their limited substandard service to local municipal dwellers. Due to this reason Illegal and informal slaughter has enjoying a great market share.

1.1 The Ethiopian Meat Industry Products and Production

The Ethiopian meat products are characterized by beef, sheep and goats carcass without any further value addition. In terms of local meat product there is only carcass meat products produced from different municipal slabs distributed by the end users by butchers, hotels, restaurants and supermarkets, the Addis Ababa Abattoir Enterprise is the largest abattoir serving the local market. However, it is estimated that approximately 40% of the cattle and the 80% of the small remittent are slaughtered outside of the abattoirs in small butcheries by illegal slaughtering practices. (Source:-AAAE – 2005 Survey) Almost all exports are in the form of chilled bone-in carcasses which are air freighted from Addis Ababa. Therefore, there is no value addition practice of meat process and not take the advantage of the industry from local market as well from export market. Due to this reason some star hotels and caterings import considerable amount of meat from abroad.

The beef meat export sector appears to operate intermittently for example the volumes exported in 2012 approximately 60% were in bone as quarters and the remaining in deboned hindquarter and forequarter cuts. This situation is attributed to several reasons, chief among them insufficient demand for beef from slaughterhouses which are poorly maintained and which have a record of product rejections. But, currently there is no beef meat export. In the shoats, as well, there has been a gradual improvement in livestock turnover so that younger animals are being slaughtered which will also indirectly benefit the development of the meat industry as the end-user will get better quality carcass and cuts. The abattoirs processing sheep and goats seem to be operating relatively well and this sub-set is currently responsible for approximately 80% of exports by volume in 2013.

The meat quality is also influenced by lack of proper Pre slaughter handling of animals and poor post mortem handling. Furthermore, most factories don't have sufficient chilling; freezing facilities, Poor Storing, Packaging and labeling technologies that can assure effective preservation to keep for long time. Hence, comparatively, Ethiopian meat didn't have a brand in international market like other meat exporting countries like Namibia, South Africa, Brazil, etc. Some of the reasons for low demand of Ethiopian product abroad might be poor quality, internationally unrecognized, limited promotional campaign etc. Meat production per head of livestock in Ethiopia is low by standards of other significant livestock-producing African countries: just 8.5 kg per head of cattle per year, significantly lower than in Kenya and Senegal (21 and 16 kg respectively). Off-take in Ethiopia is low compared with that in other East African countries. The Figure 1 below shows livestock slaughter levels for Ethiopia in the period since 1993 as reported to FAO from official Ethiopian government statistics. It is clear from this chart that slaughter levels for sheep and goats have increased while those for cattle have stayed relatively unchanged.

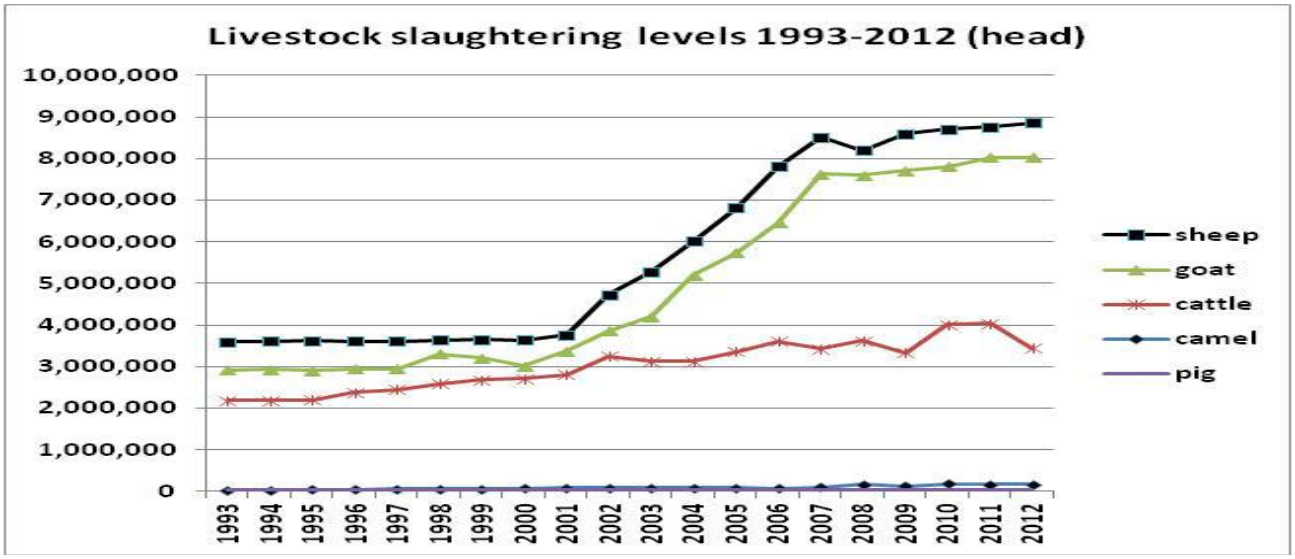


Figure 1:-Livestock slaughter levels for Ethiopia in the period since 1993 as reported to FAO from official Ethiopian government statistics – Source: Meateng Consortium – Feasibility Study for AAAE – 2014.

By contrast, cattle slaughtering rose only slightly in the 1993-2011 period, despite an almost 40% increase in cattle numbers. In 2011, cattle slaughter was estimated at around3.5 million head, giving a turnoff rate in the order of approximately 12 percent which is very low compared to commercial herds elsewhere in the world. The proportion of livestock slaughtering which are bush-killed in rural areas for local communities is not confirmed but presumably these are included in the official estimates discussed above. In addition, high animal mortality rates account for losses in overall production: these are estimated at approximately 10% for cattle and 15% for sheep and goats.

It can be observed in Figure 2 below that goat meat and sheep meat production have shown modest increases over the past decade in line with the higher slaughter levels. In regard to beef production, the chart shows the beef production spiked in the period 2010-2011 and the sector currently produces around 360,000 tons per annum (carcass weight), a 40%increase over levels observed at the beginning of the data series.

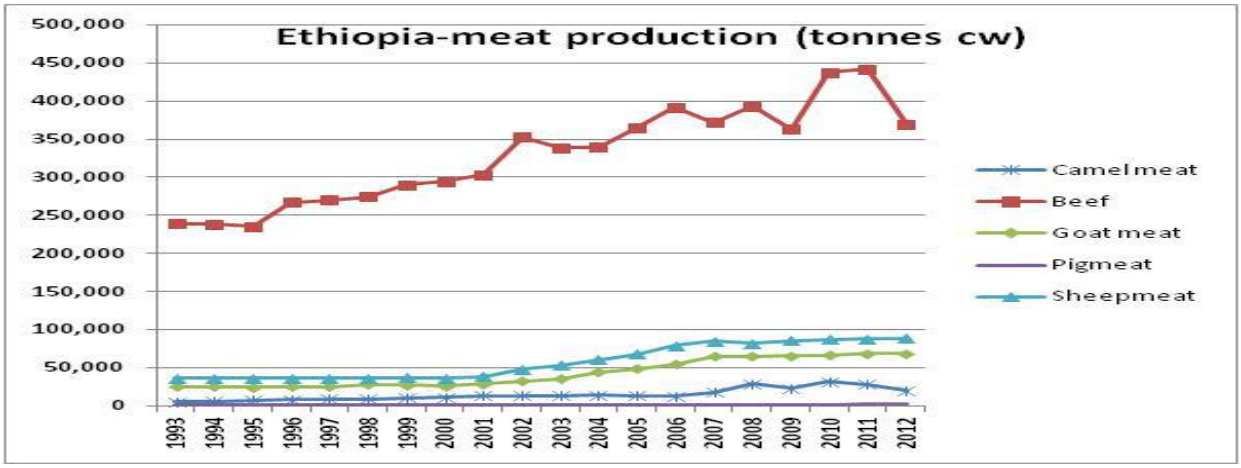


Figure 2:- Ethiopia meat production trends since 1993 - Source: Meateng Consortium – Feasibility Study for AAAE – 2014.

1.2 The Ethiopia Meat Industry Customers

One of the strategic subsectors given priority by the government for achieving the GTP 2 and GTP 3 is Meat Industry. Despite of the strategic priority given for the sub sector still there exist low consumption: Among the main reasons for low consumption in Ethiopia, low per capita income, high domestic meat prices, the fasting days by the Orthodox Christians (43% of the population) does not consume meat products for over 200 days per year can be mentioned. One of the most factors which potentially affect the level of meat consumption in the future is to be the population demography along with meat production and consumption; and the impact of illegal or informal livestock slaughter which occurs throughout the country. Despite this fact the population growth, the income improvement and the urbanization with modern life style promised that the domestic meet demand will dramatically increase for the coming ten years.

The latest population census for Ethiopia was undertaken in 2007, when the total population was estimated at 73.845 million. Central Statistics Agency of Ethiopia projected the country's population to increase at a rate of 2.7 percent per annum over the following five years from 2007 to reach an estimated 83.742 million inhabitants by 2012. A declining rate of growth was then applied to the following years beginning at 2.5 percent in 2013/14 and reducing to less than 1.6 percent in 2036/37, to arrive at a forecast of 136.7 million people by the year 2037. CSA also forecast significant change in the urban/rural composition of the population over the coming decades to the effect that by 2037 over 31 percent of the population will live in urban areas. Therefore, it is forecasted that in regard to Addis Ababa, CSA forecast its population to swell from 2.7 million people, indicated earlier, to be almost 10 million by 2037. It is noted that the FAO per capita estimates Household Income, Consumption and expenditure Survey which placed annual consumption at around 50.6 kg per household. The time series for Ethiopia indicated that a slight increase in per capita consumption levels has occurred over the past decade. The meat consumption will be predominantly beef and veal (67%), mutton and lamb (13%), goat (12%), poultry (5%) camel or other meats (3%). Pork consumption is effectively nil. This shows that there exist high meat demands in the domestic market. (Source:-Meateng Consortium – Feasibility Study for AAAE – 2014.)

Generally, Ethiopia has the tenth largest livestock inventory in the world. However, the country's current share in the global export market for meat is quite small. In 2011, the volume of global meat exports was estimated at USD 105 billion, and Ethiopia accounted for less than one percent of this total, of which most is chilled sheep and goat carcasses. This ranked Ethiopia as the 43rd largest meat exporter. Which shows that we have a chance to expand our share of margin in the international market. Above all, if the current technological problems solve out there exist a feasible an export market customer for the meat industry specifically targeted in Africa, and Middle East. (Source:-FAO)

1.3 The Ethiopia Meat Industry Supply

In the eye of the main target of this document, it is worthwhile to highlight some facts about livestock sector which is number one supportive and basis of the meat industry. Ethiopia has the largest livestock herd in sub-Saharan Africa, with an estimated cattle population of 56.7 million, sheep population of 29.33 million, and goat population of 29 million (Source:-CSA, 2014). According to FAO statistics, comprising both official data and its own estimates for missing years, Ethiopia has large numbers of cattle and shoats, with 2014 shown in Table 1. Camels and pig numbers are however much lower. According to the table, Ethiopia holds a prominent position with regards to ruminant numbers, however much less so for poultry (mainly chicken in Ethiopia) and is definitely not a pig farming country, only ranking 37th in Africa and 137th at world level.

M=million	Ethiopia Herd/flock Size (mio)	Africa comparison			
		Major herd/flock		Ethiopia in Africa	
		Country	Size	Rank	% of Africa
Cattle & buffaloes	56.7	Ethiopia		1st	18.05%
Sheep & goats	58.4	Nigeria	111.6 m	3rd	8.29%
Camels	1.2	Somalia	7.2 m	7th	4.94%
Pigs	0.03	Nigeria	6.9 m	37th	0.10%
Chicken	56.9	S. Africa	200.0 m	9th	3.05%

Table 1:- Ethiopian livestock numbers with Africa comparisons, FAO 2014 - (Source:-French Veterinary International – Feasibility Study for AAAE – 2016.)

Livestock holdings are intrinsically tied to the objective and purpose of the region's agricultural output. The national cattle herd structure reflects these functions with 40 percent males and 60 percent females, designed to maximize herd replacement. Oromiya Regional State has the greatest number of livestock of all the autonomous states of Ethiopia with about 40 percent of all cattle, 24 percent of sheep, 19 percent of goats and 41 percent of camels. Amhara Regional State has the next largest number and percentage of animals, with 24 percent of cattle, 26 percent of sheep, and 20 percent of goats but only a very small proportion of camels. The Southern Nations, Nationalities and Peoples Regional State has the third largest proportion of livestock with 19 percent of cattle, 16 percent of sheep, 14 percent of goats but few camels. The Somali Regional State has very few cattle in comparison with the three preceding states but has 25 percent of sheep (mostly the celebrated fat tailed blackhead Ogaden type that is much in demand for meat in the Middle East), 24 percent of goats and - its real wealth - 42 percent of the nation's camels. Afar Regional State has 14 percent of the nation's camels but also about 12 percent of goats and 5 percent of sheep with a lower proportion of cattle. In Tigray, no species exceeds 10 percent of the national total. The three states of Beneshangul Gumuz, Gambella and Harari are all small in geographical area and have minor proportions of livestock, as do the two City Administrations of Dire Dawa and Addis Ababa. (Source:-CSA, 2014).

Livestock production as supply for meat industry is highly fragmented and geographically dispersed, and limited large commercial operations**.** In Ethiopia, meat cattle productivity is much below potential (one of the lowest) and characterized by low birth weight, sub-optimal growth rate, average age at first calving (4.5 years), Boran cows under pastoral management (4 years), Boran cows at Abernosa ranch (22 months), long calving interval (2 years), delayed age to reach market or slaughter weight, low power output of draught animals, low carcass and milk production, average meat production/slaughtered animal (110 kg beef and 10 kg mutton) and low per capita consumption of animal products meat (8.5- 10 kg). This is merely due to very low off-take rates, large numbers of animals that by-pass abattoirs and are exported live, producers who are not commercially oriented and sell only in need of cash or when draught animals get too old, lack of certifications and acceptable international standards by meat processors. Through both formal and informal trade channels, Ethiopia is a major supplier of live animals to Somalia, Djibouti, Kenya, and Sudan as well as to Saudi Arabia.

Average carcass yields per animal slaughtered are estimated by the federal government's agriculture department to be 110 kg for cattle, 130 kg for camels, 10 kg for sheep and 8 kg for goat. Livestock production growth rates have been low until recently and lag behind population growth, which is increasing at a higher rate. This has effectively led to a decline in per capita consumption of livestock products, particularly beef consumption, which is estimated to be less than 8.5 kg per annum. This places Ethiopia among the lowest ranking countries in Africa in terms of meat consumption, an apparent irony given the size of the livestock inventory and the perceived importance of the sector to the national economy.

Assessing changes in meat production volumes is somewhat problematic because of the lack of authoritative data in this area. FAO uses calculated data based on slaughtering and assumes that only minimal growth in average carcass weights has occurred over two decades (see Figure 2 below). If indeed average carcass weights have not changed over two decades, it underscores the underdeveloped nature of the livestock sector in which traction, milk and fiber production are more important drivers than meat production. In the absence of other data the FAO estimates are included as part of the total supply assessment considered here.

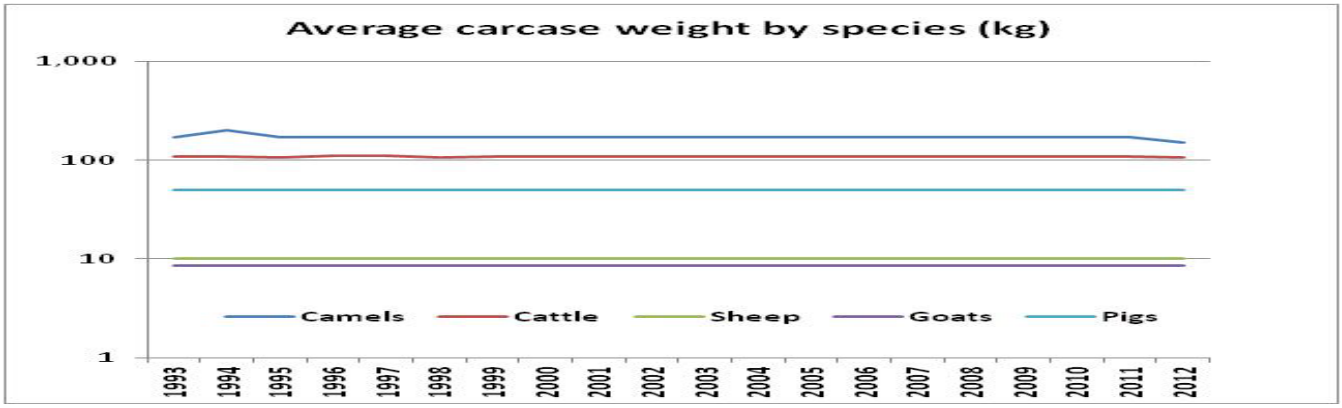


Figure 3:- Assumed average carcass weights by species - *Source: Meateng Consortium – Feasibility Study for AAAE – 2014.*

Despite its large livestock inventory, Ethiopia's cattle and sheep holdings are currently underdeveloped and not part of an integrated commercial chain with demand drivers determining the volumes and categories of livestock that come through the marketing system. At smallholder level, livestock are retained for as long as possible, they represent cash in the bank and are in overall terms probably kept beyond their prime meat production stage. This has a flow-on effect in terms of the age, condition and musculature of the animals that are turned off and it is a major inhibitor in the short term development of a commercially focused meat production industry as distinct from livestock production system.

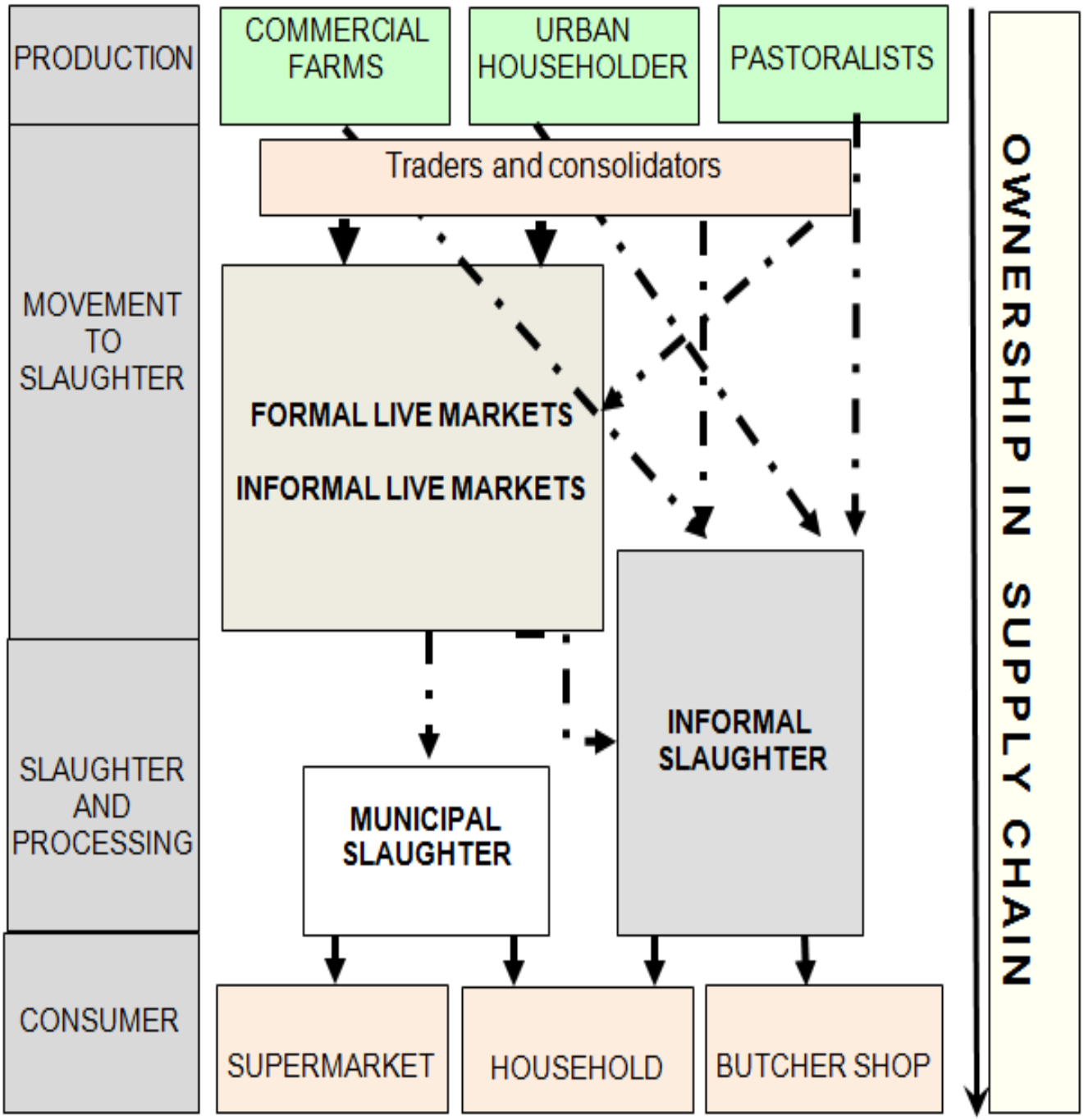


Figure 4:- Schematic of the livestock marketing chain - *Source: Meateng Consortium – Feasibility Study for AAAE – 2014.*

1.4 The Manufacturing Processes Detailed Description

The purpose of this Meat Industry Manufacturing Process description is to set out guidelines for the slaughter of cattle and small ruminants, namely sheep and goats, in developing countries like Ethiopia. Despite of the fact that the nowadays the, world technology is fully robotic Manufacturing Process. The whole part of this 1.4 is from FAO Corporate Document Responsibility - Manual for the slaughter of small ruminants in developing countries.

More than any other source of red meat, cattle, sheep and goats have the widest distribution in most areas of the developing tropics because of their prolific nature, hardiness in adverse conditions and, most important, their high rate of acceptability with the vast majority of people. Small ruminant stock occurs in all types of environment, from rain forests to deserts, and is numerically more common in foreign trade than any other species of livestock. In most countries of Africa and Asia cattle, sheep and goats serve the dual purpose of supplying dietary needs and as a source of sacrificial offerings, the latter often precluding their use as food. For instance, the Arabian Peninsula, which embodies a number of Islamic states, though traditionally a livestock-deficient region, imports large numbers of sheep, between 4–5 million annually, for the Haji (Id-el-Fitr) festival.

The popularity of cattle, sheep and goats is not always matched by suitable methods and procedures for their conversion into food. The great majority of these animals occur in rural areas which are also centres of tradition where ritual observances are strongest. Consequently, these are the places where they are mostly slaughtered, consumed and/or used in sacrificial offerings. Unofficial slaughter of cattle and small ruminants is much greater than officially recorded slaughter.

Again in in developing countries like Ethiopia, the methods of cattle, sheep and goat handling and slaughter for public consumption invariably follow traditional and ritualistic norms, some of which at times are at variance with acceptable practices resulting in cruelty to animals, quality losses in meat and a challenge to public health and aesthetic values.

The chief objective of this Meat Manufacturing Process description therefore is to outline a few procedures governing modern-day slaughtering, particularly those concerned with humane practices and the attainment of a good quality product which is safe and wholesome for human use. This will be done taking into consideration the key aspects of religious and traditional observances and the possible modifications that can be brought to bear on them for the attainment of the objectives.

Additionally, the important question of livestock and carcass handling, slaughterhouse hygiene and sanitation, waste disposal and byproduct utilization will be covered as will specifications required for the construction, equipping and rehabilitation of slaughter premises. It is also aimed that to compare it with developing countries like Ethiopia Meat Industry current Manufacturing Process.

Types of Slaughter Premises in developing countries like Ethiopia normally seen in developing countries are of three kinds: modern abattoirs, old slaughterhouses and slaughter slabs and makeshift premises.

Of the three, **modern abattoirs** represent the most progressive and the ideal in conventional abattoir design, equipping and services. Often built and controlled by central governments with foreign technical assistance and management, these abattoirs are operated on industrial lines with a wide range of services featuring cold storage, processing, by product utilization and waste recycling activities. Some of them have export objectives primarily in chilled and frozen meat although at times some of their manufactured products (and byproducts) are channeled into local sale in substitution for imports. Few modern abattoirs in developing countries slaughter directly for public consumption, being as they are commercial or profit-motivated establishments with little inclination for low revenue services.

The **old slaughterhouses and slaughters labs** handle the bulk of public slaughters. These premises merely make facilities available for use by licensed butchers and traders for the slaughter of livestock at stipulated fees, and in accordance with public health, inspection and marketing regulations. Slaughterhouses and slaughter slabs thus operate as service establishments under the management of municipal and local authorities, their field of activities often being limited to the larger towns and built-up areas.

The third category of slaughter premises, **the makeshift**, for want of a better term, include all kinds of places such as converted buildings or rooms, shade of trees as well as open bare grounds that a butcher or a community may find convenient for the operation. Mostly private-owned and under no formal authority or licensing these premises and their products are neither inspected, quantified nor subjected to trade and health regulations. Makeshift slaughter premises are characteristic of village and rural locations. Occasionally, however, they may occur in the suburbs or on the fringes of larger towns. In the latter, they are sometimes considered to have links with illegal livestock trading and the slaughter of sick and diseased animals. Because they defy obvious norms in slaughterhouse construction, equipment services and hygiene, their existence and operation is not advised. In unavoidable cases, these premises should be allowed to operate only if the animals and their products are to be inspected.

This Meat Manufacturing Process description will be concerned with slaughterhouses and slaughters labs of the kind found in larger towns and built-up areas as these constitute the core of official slaughter operations in the developing countries like Ethiopia. Indeed, many of the present premises are fairly old structures, having been built several years ago (some more than half a century old), and at a time municipal engineering and public health requirements were less stringent and different from those prevailing now. This Meat Manufacturing Process description first dealt with the general best process practice infrastructure [siting, layout and construction with facilities for slaughter, equipment and operating tools]. Selecting Animals for Slaughter Also taken into consideration are the key requirements for slaughterhouse rehabilitation and modernization.

Items of value produced during slaughter other than the carcass and edible offal are referred to as byproducts. Byproducts are thus inedible material less rejects and waste. Byproduct industries are many and specialized in industrialized countries particularly the USA and Europe. The range of products is also wide and diversified. This is made possible by volume and variety in raw material and, most important, in technology.

Less-developed countries conversely have limited yields of slaughterhouse byproducts due to the greater premium placed on non-carcass components as a source of food. Table 2 shows for instance that the average East and West African cattle yield a high proportion of their body weight as saleable meat relative to inedible, the ratio being about 70 percent : 30 percent. On the other hand, in North America the saleable yield profile of slaughtered steers compared to inedible material is in the region of 60 percent to 40 percent. This ratio is however reversed at the retail level as the carcass is deboned and trimmed of excess fat in response to consumer preferences.

Potentially available byproducts from cattle are thus higher in yield in North America (45 percent) than say West Africa (9 percent), the latter comprising only the hide. Similarly, sheep and goat skins constitute the only body components of value outside edible meat. The yield here accounts for about 15 percent of live weight in the East African goat. In the West African dwarf goat no byproducts are harnessed when the animal is dressed with the skin on, i.e. by singeing and scraping off the body hair. Consequently, maximal use is made of the animal body, about 75 percent as food, leaving the rest as rejects.

It is possible, nevertheless, to modify slaughter practices in the poorer countries and salvage usual rejects, blood, horns, hoofs, gut contents, and any condemned meat and manure for byproduct processing. Also in cultures where stomachs, intestines, lungs and reproductive organs are banned from diets, much raw material can be retrieved for further use.

It appears, however, that such utilization can be possible only where volume is available (as in large municipal abattoirs) and provided cattle products are included. In this way the opportunity is offered not only for more economic production but also as a means of removing nuisance from the slaughter premises, and assuring a hygienic and sanitary environment.

Apart from hides and skins (which are already being utilized) the following groups or items of byproducts can be considered for processing, taking into consideration their agro-industrial significance:

a. Soft organs - stomachs, intestines, lungs, carcass trimmings, reproductive structures etc. (where not utilized for food); floor sweepings, drainage trappings and condemned meat - together for rendering into meat/bone meal;
b. Hard organs - horn and hoof can similarly though separately be processed into horn/hoof meal and used as fertilizer;
c. Blood - can be dried into blood meal and used in animal feed.
d. Gut contents and manure (from lairages and kraals) for compost or fertilizer production; another possibility here is biogas production.

A. Infrastructures for Slaughterhouse Operation Process

(1) Best Suited Sitting of Slaughterhouse

Slaughterhouses are best suited on the outskirts of a town or village, at a distance from built-up areas. This is to prevent possible inconvenience to dwelling-places either by way of pollution from slaughter wastes or by way of nuisance from noise, stench or the presence of scavenging animals such as vultures, stray dogs, etc. Conversely, remote location secures the premises from contact and likely contamination from residential units close by. Nevertheless, some proximity to the city or town should be maintained to take advantage of vital services such as power and water supplies. Another feature of the area selected is that it must be open, treeless and with air currents to provide for natural lighting and ventilation as dark environments can cause lapses in hygiene while stagnant air can induce growth of spoilage organisms on meat and meat handling equipment. Trees also attract birds which are agents of contamination.

The siting of slaughter premises near waterlogged areas must be avoided. Evidently such sites can raise sanitation problems as in the breeding of mosquitoes and stagnation of wastes. Where possible, the location of the plant should be made at a higher elevation relative to the surroundings. Location near watercourses or inland bodies of water such as rivers, lakes and lagoons is also unadvisable. This is to avoid the temptation of discharging wastes into the waters with consequent pollution and cross-contamination of the premises. Liquid waste can, however, be discharged into these waters provided it is treated and rendered safe for aquatic life or for humans using the waters. Discharge of waste into the sea without prior treatment is recommended provided the effluent is delivered through pipes and deposited far out into the sea, at least 5 km from the coast. However, this should be done in line with local municipal and environmental regulations where these exist.

(2) Best Suited Lay-out of Slaughterhouse

The choice of a site for construction must be followed by considerations for layout. Here both the premises and the immediate environment need consideration. Premises meant to serve large communities and hence likely to have a heavier workload must be planned as full slaughterhouses and not as simple slaughters labs. This means that they must have physically identifiable operational zones such as killing, dressing, inspection and off-cleaning areas, each in turn provided with its given set of equipment and operating gear.

The premises must be fenced to keep out undesirable individuals and to prevent animals from entering the yard. Outside the fence, a kraal with roofing must be provided, but within the yard and close to the killing floor, a lairage would be necessary. Lairages are enclosed or roofed spaces for resting animals prior to slaughter, while kraals are essentially holding grounds for animals waiting longer for slaughter. Both must be provided with watering facilities. In addition, the kraals should have feeding troughs for cut herbage, or else the animals should have ready access to grazing in the neighborhood.

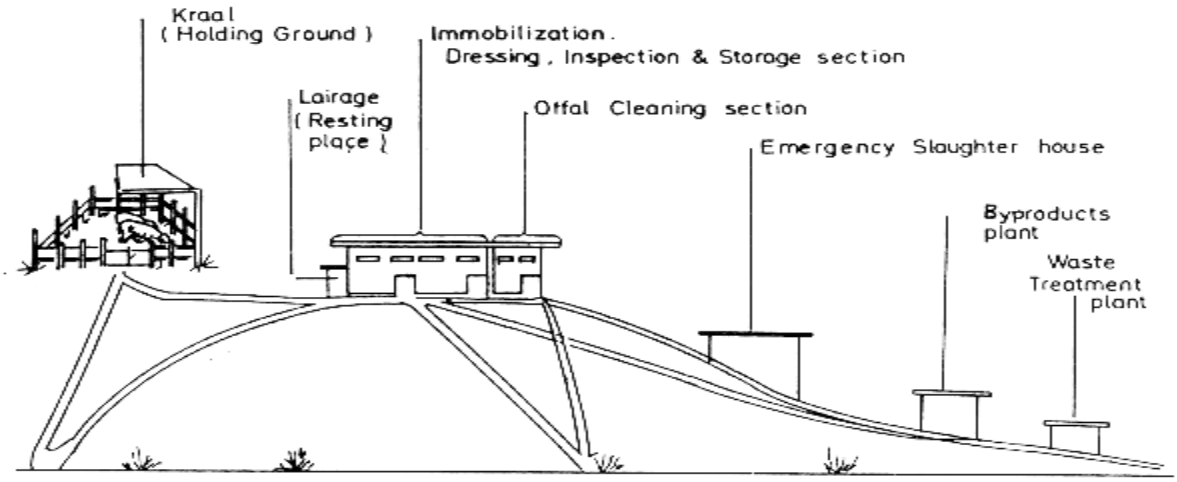


Figure 5:- location of slaughter premises and auxiliary units

Auxiliary services and functions such as livestock marketing, hide-drying and manure accumulation and collection must be located at some distance from the plant. In other words, no activities should take place in the immediate environs of the premises other than the resting of animals and, if unavoidable, kraaling. Slaughtering in the yard in rural slaughter slabs during peak seasons must similarly be discouraged, as all such activities predispose meat to contamination.

(3) Materials for Construction and Installation

The general principle regarding the choice of materials for constructing and equipping slaughter premises is that the materials must be durable and be able to resist deterioration or destruction from external influences such as the weather, air, steam, water and insects. This means that materials such as swish, wood, thatch and corrugated iron are undesirable. In their place brick, sand Crete, stone, reinforced concrete, asbestos, tile and slate should be used.

For the operating chambers, the materials used must not be pervious to water and blood or stained by fat; glazed tile or a hard smooth material should be used for the walls to facilitate cleaning and prevent absorption of moisture and fat. A similar principle should apply to the selection of equipment for the chambers: stainless steel, galvanized metal and aluminum are good choices for metal fittings or furnishings while plastics may suit containers and working surfaces. The general items of furnishings are discussed in the next chapter.

(4) Facilities, Equipment And Tools

1) Water and Drainage

All public slaughter premises must have a dependable source of clean water or what is normally referred to as potable water, preferably pipe-borne, to maintain hygienic and sanitary services in the plant. The water must be well distributed in terms of point-location inside the premises and must be hot, if possible, for hygienic washing of products and facilities.

In the absence of pipe-borne water, surface or underground water from rivers and wells can be used but must be pre-treated. It would be useful, however, to install a reservoir or tank on the premises as a security against shortages and breakdown of pumps.

Side by side with water is the question of drainage. All washings or wet cleaning must course over the slaughter floor into a collecting drainage and empty eventually outside the building. The floor should be designed to slope toward the main collecting drain, the latter in turn to slope toward exterior connecting pipes. While the walls must have a hard smooth surface to prevent staining with blood and fat and hence facilitate cleaning, the floor must be rough or grooved to forestall slipping.

2) Lighting and Ventilation

Lighting is another important requirement. In the cities and towns, connection with the main municipal electricity supply should be possible, but failing that a diesel generator can be installed. Transparent insets can also be made in the roofing at vantage points to provide natural lighting or sky-lighting. Wide lintel windows or bay openings, covered with gauze to exclude insects, also serve the same purpose, as well as provide ventilation.

3) Basic Equipment

The standard installation and equipment required in modern slaughter premises are those necessary to effect a rapid and hygienic conversion of livestock into meat in what might be called the dressing operations, and those required to prepare the offal for further use or disposal into waste, otherwise referred to loosely as cleaning and rendering operations. The facilities required for these services must be carefully selected and kept separate.

a. For dressing (including immobilization) the following are important:

i. **Stunning Pen**: A small or narrow enclosure into which the animal is led from the Lairage to be rendered unconscious (in conventional slaughter) after which it is bled; also referred to as the knocking pen;

ii. **The Hoise**: A device for lifting up the stunned animal for bleeding; it can be operated manually, mechanically or electrically. The hoisting system is often built into an overhead rail-system to facilitate movement of the animal for dressing and the carcass for inspection;

iii. **Kinning Cradle**: A metal or plastic rest with a trestle arrangement onto which the bled animal is placed for skinning and evisceration, often used where a hoist system is unavailable;

b. The offal gear comprises the following as major equipment:

i. **Collecting Troughs**: These are containers for receiving blood or collecting gut material and are also utilizable for disposal of non-carcass components such as shanks and hoofs;

ii. **Offal Cleaning Tables**: Often built into the offal chamber wall, they may be of concrete, galvanized metal or stainless steel and provided with high pressure water points for cleaning offal.

4) Orientation of Slaughter Floor Activities

As far as possible, the carcass dressing and offal cleaning operations should be kept separate. In large slaughterhouses, this is achieved by physical demarcation of the slaughter premises into distinct operational zones or by the disposition of the working gear as a whole.

Where this is not possible, as in a slaughter slab which may operate on a single "all-purpose" floor, the separation of dressing and cleaning operations can be effected by orientation of the activities in such a way that they follow in one direction only. Care must be exercised however, in dressing operations as skinning and evisceration have contaminating influences. Blood collection and the initial handling of condemned meat must also be done carefully and away from the carcass. The practice of slaughtering animals in any available space within the premises is negative to this concept and should be discouraged.

5) Slaughtering Tools

Relatively fewer tools are required for the slaughter of small ruminants, and some can be made by local metal workshops or blacksmiths. They include the following

i. **Sticking Knife**: A knife with a six-inch blade (15.2 cm) and a v-shaped end used in severing the blood vessels of the neck to bleed the animal;
ii. **kinning Knife:** As the name implies, this knife is used for the removal of the animal's skin. Also with a six-inch blade and characteristically curved backwards to allow for ease of operation, it can be used to scrape off burned hair from carcasses being dressed with the skin-on;
iii. **Meat Saw**: A replaceable blade handsaw which is used in sawing through bone;
iv. **Meat Chop**: Also called the cleaver, the mea chop is a heavy axe used for separating heavy structures, e.g. the head from the neck or the shanks from the leg;
v. **Spreader**: A metal device for suspending the animal body and spreading out the legs for dressing and inspection;
vi. **Grinding and Honing Stones**: Grinding stones are coarse grained and used for the initial sharpening of knives into thin edges, then finished with the homer which is of fine-grain to provide extra thinness. Either oil or water may be used in sharpening knives to prevent the stone from heating the knives;
vii. **Steel**: A long, tapering rounded and smooth metal rod on which knives are smoothened from time to time to improve keenness;
viii. **eat Tree/Hooks**: Metal devices with bent to curved ends for holding or displaying parts of the slaughtered meat and offal for washing and inspection.

B. Selecting Animals for Slaughter Operation Process

(1) Influence of Traditional Preferences

Old animals of all species are normally slaughtered for food in most parts of the developing tropics. This choice is dictated by the fact that animals take a long time to mature. Tradition also plays a role in selection, as younger animals are often tabooed or barred from diets. In addition, meat from older animals such as cattle fits in well with food preparation practices and eating habits because of its tough muscle fibres, a property which makes for prolonged cooking and produces chewable rather than tenderized meat, which is greatly desired in these cultures.

(2) Criteria for Selection

A few guidelines are however worth observing in selecting livestock for slaughter. These deal with the health condition and the physical quality characteristics of the animal, two important factors in the production of wholesome, good quality meat.

1) The Health Aspect

The obvious mark of a healthy animal is a quick, smart appearance underlying which are keen, well-disposed body reflexes. When such animals move, they do so steadily with ease, not jerkily or with difficulty. Animals that are not fat or bulky, yet unable to move or walk with ease, must be suspect of unsound condition.

When resting, the animals must not be entirely motionless. Some movement or reaction must take place when disturbed. Extremely weak, old and highly emaciated animals often have poor reflexes due to a weak muscle condition which does not produce desirable meat upon slaughter. Also, animals in an advanced state of pregnancy must be spared from slaughtering, the reason being that their blood has large accumulations of harmful waste materials associated with the developing foetus which should not form part of food intended for human consumption.

Ordinary signs of ill-health should not escape the attention of the individuals making selection. Abnormal conditions like a high breathing rate, high temperature and fever, a foamy or frothy mouth, diarrhea and discharges of various sorts from the body are all evidence of a state of ill-health. Such animals must be separated from the rest of the stock and treated before being brought for slaughter.

A usual practice in the villages of poorer countries is the slaughter of sick, diseased and dying animals in an attempt to salvage their meat value. This is contrary to accepted conventions and must be prohibited as such meat can be a source of infection or food poisoning. It must be emphasized, however, that these are mere guidelines for the layman and should not substitute for the services of a professional veterinarian or a trained animal health inspector. Where possible such people should be brought in to assist.

2) The Quality Aspect

Maturity as a criterion for selection of livestock for slaughter in developing countries does not necessarily mean very old animals. A mature animal simply means a fully developed animal. Thus in sheep the following forms of maturity exist: Lambs (sheep under 1 year); yearlings (sheep about one year old), and mutton (sheep over 1 to 2 years old). According to this scale, the prime choice in developed countries such as the USA or UK might be a lamb, whereas in developing countries, it may be a 2-year old or over, although this is not always the case. Of importance is that some other selection criteria should engage the butcher's attention such as the weight of the animal (if this can be determined at the market) and its build and shape or what is referred to as conformation. These two criteria help in assessing the amount of meat on the animal and the quality of the carcass.

Meatiness:

The heavier an animal is, the more likely it is that it may dress higher, i.e. produce a carcass of heavier weight. This is true of well-fattened animals. Nevertheless other factors sometimes have an effect on carcass yield. For instance, an animal that has a thick skin, pelt or a heavy cover of hair over the body will most likely yield a lower dressing weight. Similarly, if the amount of “fill” of the gut of ruminants is high, carcass yields tend to be lower. In other words, as the offal or non-carcass components of the animal body increase in weight there is a corresponding drop in the yield of the dressed meat. The butcher should thus acquaint himself with the key criteria of animal selection to make a better choice in the stock he purchases.

Conformation:

Another yardstick of a meaty, good quality animal is the conformation or build of the animal which is seen in its stocky, rounded full-bodied nature. Such animals must also be short-necked, short-legged, and so on. The converse is true of the thin and leggy animals. Often thin animals are also poor-fleshed with bones jutting out. Bulk and wide-framed configurations as occur in some Zebu cattle, though not so much in sheep and goats, often reflect both poor conformation and low meatiness. Well-conformed animals are usually also well-fattened younger stock with fine-textured, palatable meat. Unless an animal has reached an advanced age or is weak and diseased, an effort should be made to condition it prior to slaughter. This can be achieved by feeding concentrates (grain byproducts) and cut herbage for about 2 months. Again, no rule will be established here as some animals have a limited genetic capability to put on the desired weight or to improve their conformation by feeding. Individual norms must therefore be established for the different breeds of stock.

C. Transport, Handling and Care of Animals Operation

(1) Reasons and Guidelines for Trucking Animals

Vehicular transport of animals to slaughter is slowly gaining ground in the poorer countries in place of the on-the-hoof method. This is quite evident with sheep, goats and pigs because of difficulties of herding numerous small stock on-the-trotters to slaughter, a practice which also subjects the animals to stress, exhaustion, weight losses and lower quality carcasses.

Road transport featuring special trucks is probably the cheaper, commoner and more convenient means of conveying animals because it affords more direct links with production and marketing centres than does rail or air. A few precautions are worth nothing in road transporting small ruminants to slaughter:

a. the trucks must be specially designed or conveniently modified to convey the stock;
b. they should allow ample ventilation and lighting;
c. if open trucks are used, the top should be covered with a tarpaulin or canvas material to protect the animals from rain and sunshine;
d. they should have easy loading and off-loading mechanisms to prevent injuries, and above all
e. they must provide for maximum comfort of the animals

In loading the trucks, the animals should be kept from a state of excitement. Rushing them in with force or with violent beatings must be avoided: heavy whips often cause bruises which ruin the quality of the meat. A moderate-size flock must be transported at a time. Overloading and overcrowding should not take place: animals get bruised, suffocate or become exhausted when this happens, and over long distances they may lose weight.

Cattle, Sheep and goats may be trucked together, but should not be mixed with cattle especially the bulky, long-horned types which are apt to squeeze and trample upon them or cause them injuries. When trucking is routine (i.e. regularly between fixed points) and over long distances clearly defined routes must be followed, these being provided with resting stops for feeding and watering.

On arrival at the slaughter holding ground, they must be discharged, with patience, avoiding all cruelty. Immediately upon off-loading, the animals should be stored out: the sick and fatigued to be placed in special pens and the normal animals in the kraal. Needless to say, the sick animals should regain fitness before being slaughtered. Should it be necessary to lift and carry the sheep or goat, one hand must be placed under the jaw with the other at the hock. They should not be lifted by grasping the skin or hair as this causes surface bruising. To catch them, a leg must be grabbed first.

The trucks in which the animals are conveyed should be washed and disinfected after the discharge, but if this is not possible, they should be swept thoroughly and sprinkled with sawdust.

(2) Animal Holding and Care

Physically fit animals that are to be slaughtered within 24 hours must be conveyed direct to the lairage for rest. Those waiting their turn are to be held in a kraal or pen. During the resting period any excitement must be avoided. Feed must be kept away from the animals at least during the last eight hours before slaughter. However, fresh clean water may be provided throughout the resting time. Ante-mortem inspection should be made during this period or about twelve hours before the animals are delivered to the killing floor.

Rest is important because when animals are overworked or fatigued carcasses of lower quality result from slaughter. The meat is similarly affected if the animals get a heavy "fill" from feeding prior to slaughter. Time must therefore be allowed for the gut to empty itself of bulk at which time fewer nutrients as possible will be present in the blood stream and the cells of the body. With this, spoilage bacteria act less on the carcass, thus reducing the incidence of off-taste and souring. It should be noted further that when a great deal of food is present in the gut, it makes evisceration difficult. Conversely an empty gut reduces viscera size and makes its removal easier: it also lessens the possibility of spilling the contents of the gut on to the carcass, thus facilitating its cleaning, while eliminating contamination.

D. Slaughtering Operation Practices And Techniques

(1) Forms of Slaughter

Slaughter methods prevailing throughout the world are governed either by tradition, ritual or legislation depending upon the people and the country. In essence, the methods relate to the manner in which the animal is killed and bled and to some extent dressing and handling prior to use as food. Ritualistic or religious slaughter often requires the animal to be in a state of consciousness at the time it is bled. This is characteristic of Jewish (Kosher), Sikh (Jhatka) and orthodox Islamic (or Halal) slaughters. Some cultures in Africa and Asia also slaughter animals in the conscious state although these do not necessarily carry ritualistic connotations.

Where a complete state of unconsciousness is rendered prior to bleeding the process is known as humane slaughtering. Under such practice, the state of unconsciousness and accompanying painlessness is effected either by mechanical, electrical or chemical means in a process called stunning. Stunning also renders the animals' motionless thus eliminating excitement and possible cruelty.

(2)The Humane Method & Conventional Techniques of Slaughter

Unless disallowed by rituals and established traditions, the humane method and associated techniques of slaughter are recommended for use as they allow for safer, more economic and hygienic operations and a desirable quality product. The following steps are crucial in the application of the method;

1) Stunning

The modern mechanical method of stunning is by shooting, consisting of two forms:

i. Use of a captive bolt pistol which delivers a force (concussion) into the head of the animal to make it unconscious;
ii. Use of a penetrating free-bullet gun or firearm. Compression stunners with or without penetrating heads, using air (not cartridges) are also employed in immobilizing livestock.

An older method in which a knocking or striking hammer is wielded on the head of the animal is now disallowed in humane practices in some countries, but in extreme and needy cases the hammer can be used to stun small ruminants by a quick blow at the back of the neck.

Stunning by electricity is used widely on small animals especially pigs. The simplest mechanism consists of electrodes or probes built in the form of tongs with insulated handles and applied between the ear and eye of the animal for 1–4 seconds. About 5–7 seconds must elapse before the animal is bled. The level of voltage used for sheep and goats is between 60 and 70 volts/AC 50–60 cycles.

Chemical stunning is a term applied to the use of carbon dioxide in making animals immobile before bleeding. Like the electrical form, Co_2 stunning, though a costly method, is nevertheless used quite commonly on small livestock including sheep and goats. The animals are led individually or in pairs into a pit, tunnel or a compartment where CO_2 of 65–75 percent (optimum 70 percent) concentration is released for 60 seconds. The animals quickly pass into an unconscious state, but are not suffocated. They are then removed and bled immediately. It is re-emphasized that stunning only deadens consciousness. So life is still manifest including the pumping action of the heart by which blood is forced out of the body facilitating bleeding.

2) Bleeding

Stunned animals must be positioned first for bleeding. A vertical or hanging position is achieved by shackling below the hock of one hind leg and hoisting the animal (head down) to a convenient height. Alternatively, the animal can be placed horizontally on a concrete slab or a sturdy plastic pallet for bleeding.

The actual bleeding operation is made by sticking or inserting the sticking knife through the neck behind the jaw bone and below the first neck bone. The object is to sever the blood vessels of the neck and let out blood. If the sticking is made at a lower position than indicated the oesophagus might be cut and the viscera contaminated. The bleeding should be as complete as possible, the usual time for sheep and goats being about 2 minutes. Insufficient bleeding and slow death could mean that the severance of the neck vessels is incomplete, or specifically that the arteries leading to the head have been missed, having only cut the veins during sticking. Practice and experience, however, perfect the technique.
Hoist bleeding is more hygienic and is recommended. It also facilitates collection of blood for further use.

3) Skinning

In removing the skin of sheep and goats initial cutting of the skin is done around the leg to expose and loosen the tendon of the hock for use as a means of hanging the carcass. This process is called legging.

A second step called pelting (after the term pelt normally applied to the skins of lambs and other wool or fur-bearing animals) involves the removal of the entire skin and preparation of the animal body for evisceration.

Tropical sheep and goats have hair not wool on their bodies, thus the term skinning is more appropriate for them. Skinning, like stunning, can be done either in the horizontal or hanging position, the former being more suited to small slaughterhouses and the latter for larger premises with bigger orders and with facilities or equipment for railing the individual carcasses one after another.

i. Hoist Skinning

With the animal body in the hoist position, and the skinning knife in hand, legging is commenced at the back of the free (unsuspended) leg by removing the skin around the hock and working toward the toes. This exposes the tendon on the back leg and the smooth joint just above the toe. The foot is cut off at this joint and the tendon loosened and hung on a hook to suspend the leg. The process is repeated for the other leg while the cuts are continued on the inside of both legs towards the naval region. The body skin is next removed. First an opening is made in the front legs, cutting toward the jaw and continuing over the brisket to the naval. Using the knife, the brisket is skinned, but from this stage on, the knife is normally not used further. This is to protect the "fell", a fine membrane occurring between the skin and the carcass which helps to improve the appearance of the carcass and reduce surface shrinkage. In place of the knife, therefore, skinning is accomplished by fisting or by use of the human fist, forced between the skin and the fell to remove the skin. Fisting also protects the skin from cuts and bruises which otherwise lower its value as a byproduct. The process of fisting begins from the brisket to the navel, then over the sides of the carcass, the rear legs and around the shoulders ending at the forelegs. The latter is skinned in the same manner as the hind leg with the foot being cut off at the break joint. To drop the skin off, a cut is made around the tail and bung and below the jaw with a knife. After this the tongue is removed, washed and placed on a hook and the head sectioned at the neck joint.

ii. Horizontal Skinning

The animal is placed on its back on a flat raised surface, such as a sturdy plastic pallet or a concrete slab. Cutting and fisting then begin at the forelegs, working toward the belly and sides of the animal, ending at the hind legs. The tendon between the hock and the toes is exposed and loosened and the feet, bung and head cut at the designated points.

4) Eviscerating

With the external structures, skin, feet and head, removed the next step is to cut open the animal body to dislodge the contents and produce the carcass. To avoid contamination of the carcass through accidental cuts or punctures of the stomach and intestines, simple but well-directed steps are followed. For this, it is important that the carcass remains or is placed in the hanging position.

The first step in evisceration is to cut around the tied bung or rectum and free it completely from all attachments and drop it in the pelvic cavity. Using the saw or cleaver the breastbone is cut or chopped along the midline up to its tip. Another cut is made from the cod or udder using the skinning knife down the midline into the breast cut. By practice, the pelvis (or lower part of the abdomen) is left uncut. The body cavity is entered into to sever the ureter connections to the kidneys while the intestines are loosened up further, then the stomach and intestinal mass (also known as the paunch) are pushed slightly out of the midline opening. (In industrialized countries, the kidneys and spleen are often left in the sheep carcass.)
At this stage, the liver is held out and severed of its connecting tissues then pulled out together with the freed contents of the abdominal cavity and dropped into a paunch truck. The gall-bladder is cut from the liver, taking care not to spill its bitter contents onto the carcass and spoil the taste of the meat. The final stage in evisceration is the removal of the contents of the chest cavity. By cutting the thin muscle sheet or diaphragm separating this cavity from the belly, the pluck (i.e. heart, lungs, trachea and oesophagus) can be pulled out as a unit. The fore shanks (i.e. the upper and lower arms) are fastened together using a tendon or a thick rubber band to plump the shoulders. The carcass is then washed and railed to the inspection bay.

5) Postmortem Inspection

Aside from the carcass, parts of the animal body which are assembled for inspection are the tongue, head, pluck, liver and paunch. The carcass is held still in the suspended position. However, the visceral organs including the head and tongue are placed on hooks in a separate bay while the stomach and intestines remain in the truck. Each carcass is identified with its set of organs for inspection. Inspection is normally carried out by professional veterinarians but in some parts of the world trained public health inspectors are employed. Their duty is to examine the slaughter products for evidence of disease and abnormality and eliminate them from the public meat supply. There is no substitute for a trained individual, but if it becomes necessary a plant manager with public health training should be acquainted with critical cases of abnormality and deal with them expeditiously. Congestion is indicated by accumulation of blood in a part of the organ while inflammation may be signified by heavily swollen areas. The bulletin however notes that "…bruises, minor injuries, parasites in the organs and enclosed abscesses and single tumors are frequently local conditions that can be easily removed", in which case the remaining material can be used as food. Nevertheless, expert advice must always be sought in doubtful cases.

6) Special Measures

Carcasses and edible offal that are considered fit for human use are stamped as "INSPECTED" and/or "PASSED" prior to consignment to markets. Unfit materials or those found unwholesome are marked as "CONDEMNED" and destroyed. In some countries, partially unfit materials are held as "RETAINED" for further examination when they are condemned if the condition is generalized, but when localized they are trimmed off and passed. Similarly during ante-mortem inspection animals whose health condition is doubtful are removed from the regular lot as "SUSPECT", re-examined and either passed for slaughter or condemned as the case may be. Less serious cases are however slaughtered separately to enable useful parts of the animal to be salvaged. It is a recommended practice to have separate facilities for holding condemned and retained meat as well as suspect animals. "EMERGENCY" slaughter facilities should be made available for handling suspect stock. In large industrial plants, condemned meat is destroyed by incineration, although in the smaller slaughterhouses of some developing countries, the burial method serves as a cheaper alternative. Burial pits must be deep, and all material placed in them must be defaced or rendered inedible by use of charcoal dust or lime to prevent possible human (and incidentally dog or hyena) salvaging.

E. Traditional and Ritualistic Slaughter Operation

These methods of slaughter differ from the humane practice and its associated techniques in the sense that by interpretation of the basic tenets governing them, the animals must be in a state of consciousness at the time they are bled. The bleeding must also be complete. This is mandatory in the best-known of ritualistic slaughters, the Halal (Islamic), the Kosher (Jewish) and the Jhakta (Sikh) methods. In most traditional slaughters, however, there are no fast rules, at least in Africa; hence some of the practices can be modified in the light of accepted conventions. It is quite probable that traditional slaughters represent the fundamental or orthodox practices which have prevailed in human societies throughout the ages and from which all others including the ritualistic and the humane of the present day have been derived.

(1) African Traditional Slaughter

The salient feature of African traditional slaughter is that the Cattle, sheep or goat is first securely held on its back on the ground by two or three men while the mouth is grabbed tight and drawn backwards to stretch the neck. The slaughterer then cuts the throat transversely with a series of strokes half-way deep into the neck. Blood is allowed to drain off until the animal (still tightly held) is motionless or dies. The head is then severed off completely. The next processes are skinning and evisceration which are not dissimilar to conventional methods, except that they are conducted on the ground with some randomness, especially where the workmen have no experience. Skinning begins with severance of the feet, and together with the head, they are saved for further cleaning and use as food. In evisceration, the organs of the belly, intestines, stomach etc. are removed first, followed by the contents of the chest cavity.

Some societies do not skin their animals. Instead the animal body (together with the head and feet) is singed and scraped of the hair, then scrubbed with a sponge and water to remove residual char and hair. After this they are close-shaved, rewashed and eviscerated.

Singeing and scraping the skin in tropical sheep, for instance, is made easier by the fact that these animals have hair not wool. The process naturally increases carcass yield, and evokes flavors highly acceptable to the cultures that use this practice. Traditional slaughtering is fairly common in the rural areas and villages of the developing world. Considering that large numbers of sheep and goats are slaughtered in these places, and that the practice is basically non-ritualistic, one would expect that traditional slaughters would, in time, provide a convenient basis for the modernization of slaughtering procedures in these countries.

(2) Islamic Slaughter (Halal)

Of all the ritualistic slaughters the Islamic or Halal method is the most widespread. Derived from the Koran, the law governing Halal slaughter stipulates that the name of Allah (or God) should be mentioned at the initiation of the operation, and that in the exercise of it, blood must flow out completely from the animal.

Islamic practices thus permit animals that are alive only and fully conscious to be slaughtered, as through this complete bleeding can be assured. Among some sects, orientation of the operation toward Mecca, the Holy City of Islam, is demanded in symbolic reinforcement of the reference to Allah.

In strict Halal practice, stunning is ruled out since technically it puts the animal in a state of unconsciousness before bleeding. Nevertheless some Islamic communities accept electrical stunning as cattle, for instance, are known to recover from this application and lead normal lives - an indication that they still remain alive after stunning. Other Islamic groups in parts of Africa and Asia employ the hammer method of stunning.

Slaughters are quickly done - the animal being cast down by shackling maneuvers, laid on its back while the neck vessels and passages (oesophagus and trachea) are severed by a single slash of a sharp knife. Bleeding proceeds to completion, as blood is abhorred in diets. (Among domestic stock only cattle, sheep and goats are utilized by Islam as food. Pigs are completely banned and operations involving them are not permitted near those of the accepted species.)

These then constitute the main requirements of Halal slaughter. Generally, Islamic slaughters are acceptable to the adherents of other faiths including Christians and some Hindus. However, the reverse is not true for Islamic adherents: that is to say, they do not accept slaughters from members of other religions. Therefore, in some countries in Asia and Africa, a convenient arrangement is to delegate public slaughters to Islamic butchers. For this reason, the range of commercial ruminant operations from procurement of stock (at farm gate) to butchering and marketing is by convention done by members of the Islamic faith.

(3) Jewish Slaughter (Kosher)

"Kosher" is the term applied to the procedures and techniques of slaughter as well as the products derived there from under the Jewish faith, if done according to the laws of the religion. In the Hebrew language, Kosher means fit to be used as food. The laws of Kosher date back to Moses and affect the species of animals used as food. Like the Islamic religion, these include cattle, sheep and goats among domestic livestock with the exclusion of pigs. The basis of the selection of these species is enunciated in the Talmud, as well as relevant passages of the Bible (Deuteronomy 14: 4–5 and Leviticus 11: 1–8).

Other regulations governing kosher slaughter are derived from Hebrew traditions referred to as Shehitah. Under these the animals are to be fully conscious, killed and blend thoroughly by one clean stroke of the knife. Animals are however hoisted and shackled first. A 16-inch (40.6 cm) razor-sharp steel knife called the chalaf is stuck into the throat by a trained slaughterer, the shohet, in an operation in which the animal is killed and bled at the same time.

Skinning is made from the chest down to the level of the belly, and the chest is cut open first for inspection and later evisceration. Specified organs of the viscera, lungs, stomach and blood vessels are examined by an inspector called the bodeck for abnormalities, ruptures and foreign matter. Carcasses that are fit (ritualistically speaking) are passed by the bodeck with a mark on the chest.

Condemned ones receive the symbol (+). In some industrialized countries kosher carcasses meant for public use are re-inspected in the conventional manner by the government authority and passed or rejected depending upon their condition. By Jewish tradition, only the forequarters or fore saddles of ruminants are utilized as food as these have relatively larger blood vessels which can be seen with ease and removed. The meat is ready for food thereafter. If however storage is desired, the period allowed is 72 hours. Beyond this the carcass becomes trefah or unfit for use as food. The ritual of begissing or washing after the stipulated 72 hours eliminates trefah, and extension of washing after further 72 hour periods is allowed.

For carcasses being held under prolonged storage such as export consignments from say South America to Israel, the trefah rule is modified to allow washing before storage and re-washing thereafter regardless of the holding or consignment time. Kosher slaughters are predominant in Israel and in cities with large Jewish populations such as New York, London and Paris. Although there may be pockets of Kosher practices elsewhere, these slaughters do not occur to a significant extent in developing countries because of the relative absence of Judaism in these places.

(4) Sikh Slaughter (Jhakta)

Although it is the least applied globally of the major religious slaughters, Jhakta is of interest as it represents an extreme departure from known practices. The method is practiced mainly under Sikhism, a religious creed which is an offshoot of Hinduism centered in the Punjab, India. Some other Hindu communities also practice it. In all, Jhakta adherents throughout the world do not exceed 10 million.

The main feature of the method is that it is an instant decapitation process limited only to sheep and goats. (Cattle are regarded as sacred by Sikhs and Hindus and are therefore not eaten.) In the exercise of Jhakta, the head of the animal is held securely or fastened to a rigid pole or object, and with the hindlegs stretched by hand on the other side, the head is chopped off with a heavy sharp cutlass in a single stroke. After this, the animal body is dressed for use.

F. Storage And Consignment Of Meat Operation Process

Slaughter operations are not considered as complete until the carcass or meat leaves the premises for consignment to markets. Traditionally in many developing areas, meat is preferred warm, in the freshly slaughtered state; hence it is delivered to markets soon after inspection. By choice, therefore, slaughter premises have no need for cold storage and are thus not provided for in the design. Butchers hence tailor their supplies to the daily needs of the community and surpluses hardly occur.

(1) Cooling (Short-Term)

Despite the fact that meat is sold fresh in these countries, cooling of carcasses is necessary before conveyance to markets. Freshly slaughtered carcasses, it must be remembered, are warm systems with temperatures close to ordinary body temperatures of 37°C (or 98.6°F) and subject to bacterial attack. They should be cooled rapidly under natural ventilation on the hoist in a well-spaced position until the surface is dry. Where refrigeration is available the cooling should reach a temperature of about 10°C (or 50°F). If it goes below this point, the carcass might "sweat" on the surface when conveyed outside, and this could cause bacterial growth. In the absence of refrigeration on the premises, commercial facilities can be used.

(2) Prolonged Cooling and Freezing

Refrigerated storage is absolutely necessary if shipment is to be delayed for a day or so. Sheep and goat carcasses are cooled to a temperature between -2° and +2°C (or approx. 28 to 35°F) for a period of 18 to 24 hours. Moving cold air causes rapid action, not only against surface spoilage but also deterioration in deep tissues. After cooling the carcasses must be consigned promptly in refrigerated vans.

Holding of meat for rationing purposes or against a lean season which is fast becoming a practice in some large urban centers in meat deficient countries calls for extended storage or freezing Again rapid action is needed. The carcasses can be frozen whole or cut transversely along the last rib into two and packed in a way to allow free air movement around them. It should be noted that slow freezing in contrast to the rapid form causes formation of large ice crystals within spaces in the fibers. Upon thawing, the fibers sometimes rupture resulting in low quality meat.

(3) Edible Offal

The below figure present a schematic breakdown of slaughter products. Apart from the carcass, other edible meat includes red offals (liver, kidney and heart), grey offals (stomach, intestine, lungs and spleen) and dark offals (head and feet). The red offals can be given the same cooling treatment as the carcass, but the others should be sold quickly. If storage is desired the grey and dark offals should be held in a separate chamber and spread out to allow for more effective cold action.

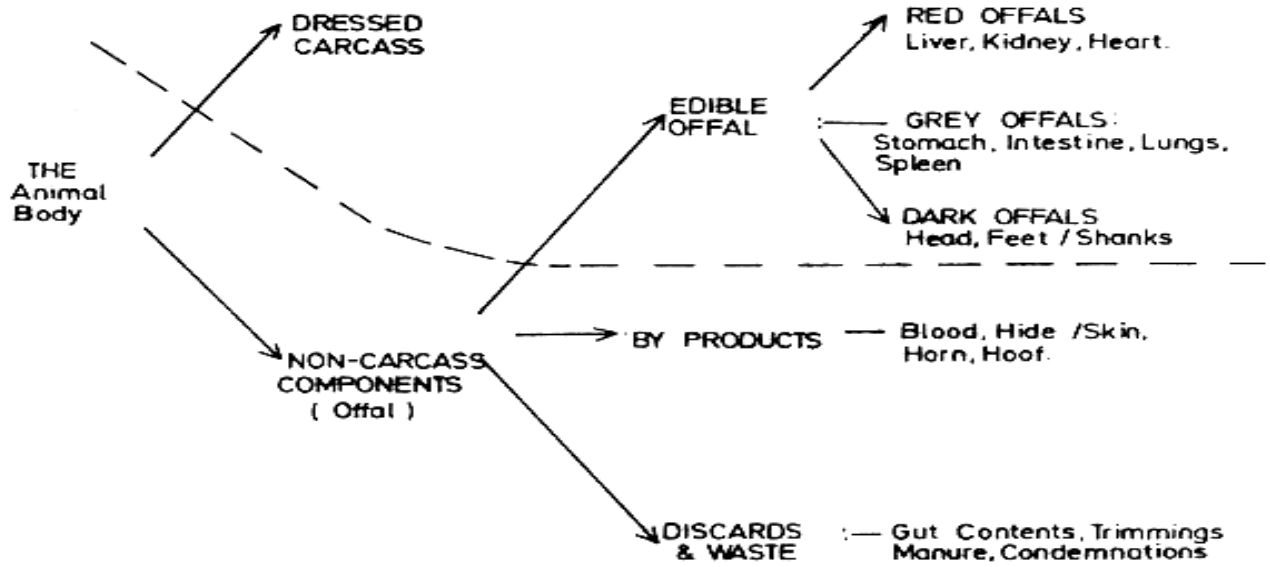


Figure 6: Schematic breakdown of ruminant slaughter products

NOTE:

Items above the broken line constitute saleable meat. The scheme as a whole is highly generalized and may not represent the state of affairs in all areas. Some communities utilize red offals only for food apart from the carcass. In others, as much meat as possible is salvaged from the animal including scrapings from hides and skins. The latter are sometimes shaved, cut up and brought to prolong boiling to soften for use. Blood in most places is flushed into effluents and under normal conditions of slaughter does not constitute a byproduct, but waste.

(4) Other Considerations

The development of cold-storage in large municipalities should be made a matter of deliberate policy. This becomes necessary as the population increases and the demand for meat goes up. Refrigeration also improves meat marketing especially at the cold store level where consumer selection for quality offers additional cash advantages to the butcher.

Traditions do change; thus the concept that meat storage can always be provided for indirectly by the animal in the live form may not always be valid. Disease and drought for instance are known to cause reductions in populations of livestock where fit and healthy animals could be slaughtered and stored for future use.

G. Slaughter Hygiene Operation Process

(1) Basis and Criteria

The subject of hygiene has been covered, though diffusely, in almost every chapter of this operation. Because of possible gaps and omissions, this part is presented to consolidate the subject and broaden its scope. There are three basic criteria upon which hygienic measures in slaughterhouse organization and operations rest. These are the need to:

a. eliminate the risk of bacterial infection and food poisoning with meat as the vehicle of transmission;

b. prevent spoilage or putrefaction and thereby enhance the keeping quality and safety of meat;

c. secure meat of good eating quality, appearance and aesthetic value through proper handling

(2) Sources of Bacterial Contamination and Ways to Avoid Them

Unless otherwise infected, the meat of freshly slaughtered animals is basically sterile. The presence of microorganisms on post slaughter carcasses is thus blamed on contamination occurring immediately before, during and after slaughter.

The major sources of contamination are the animal itself, tools and equipment used in slaughter, the workmen and the condition of the slaughterhouse environment. Dirt, soil, body discharges and excreta from animals in holding pens or lairages are the primary sources of contamination of carcasses in the later stages of the operation. This happens irrespective of whether or not the animals are fit and have passed ante mortem inspection. In some establishments, the animals are washed just before stunning and bleeding. This step has the added effect of cooling or calming down the animals which factor is of importance in securing good quality carcasses.

For similar reasons, it is advisable to avoid operations on the floor. Hoisting during sticking, skinning, evisceration, washing and inspection is recommended in even modest premises, including makeshift ones. This, in effect, necessitates the provision of adequate floor space with suitable assembly of equipment to handle the animal bodies.

In this respect it is advisable to have only a few workmen on the floor specialized or experienced in the various steps to handle the operations separately with quick and rapid dispatch. Where this is not possible or where floor space does not allow, the principle of separating dressing operations from offal cleaning ones must be strongly adhered to.

The precautions that must be taken in slaughtering involve the following:

a. Sticking: the knife should be cleaned after each animal is disposed of and rinsed in hot water. It is said that a contaminated knife can transmit bacteria into the animal tissues during the early stages of bleeding when the pumping action of the heart is strongest. If this should happen, deterioration in deep tissues can also result.

b. Skinning: uncontrolled knife skinning or even fisting can similarly introduce spoilage organisms on the surface of the carcass. By the same token, singeing and scraping of the animal body as is practiced under traditional African slaughters must be done to avoid splits in the skin by fire action; and after sponging and washing the carcass, clean hot water should be used in rinsing before evisceration.

c. Evisceration: care should be exercised not to puncture the intestines. The workmen should follow the procedure of tying the bung (rectal end of the intestine) and the cut end of the oesophagus, then removing the paunch (intestine and stomach) first, followed by the pluck, (trachea, heart, lungs, etc.), both en masse and disposing of them separately. The pluck should be hung on a hook while the paunch should be dropped in a paunch container. Obviously the stomachs and intestines should not be opened while carcass dressing is in operation as such a move can easily cause contamination of the meat.

d. Washing: carcasses should be washed with clean potable water under pressure if possible. If water is a problem as happens in some rural areas, dry slaughter by trained men should be resorted to as it is safer for carcasses to be dry clean than to contaminate them with water from polluted sources.

e. Offal handling: the various classes of edible offal, red, grey and dark should be cleaned separately. The red offals can be washed on a separate line in the slaughter room after inspection, but grey offals (stomach and intestines) must be moved to a chamber provided for them. Initially they should be emptied of their contents dry, and then flushed with water. The dark variety (head, feet) should be singed, scraped and washed outside the premises. Some dark and grey offal are utilized as byproducts by some communities, and should be disposed of as such rapidly.

f. Byproducts: delicate items such as glands and organs, if required, must be collected and conveyed from the plant by special methods as well as blood to be used for food or pharmaceutical purposes. Blood coagulates soon after it leaves the animal. Handling of this item as well as glands thus poses a problem hence unless the plant is a large one and previous arrangements have been made for their removal, collection should be avoided, more so in small rural premises.

g. Discards and waste: these are variable. Usually in developing countries they include the contents of the gut, blood and trimmings that cannot be used for food and therefore flushed into effluents. However, coagulated blood and other solids must be strained out before disposal.

h. Personnel: next to the animal, equipment and methods of operation, the personal hygiene of the workmen is the most singularly important factor in slaughter operations, the reason being that contamination of food and disease transmission thereby depends equally on the human element as well as on the tools and methods of operation. Individuals assigned to slaughter services must be of sound health and of good personal habits. People who are sick or with boils and sores must be barred from the premises. All must be routinely examined for their health condition. Furthermore persons who habitually exhibit unhygienic habits like spitting, nose-blowing and coughing must not be employed. It is important to allow only approved and scheduled workmen into the premises at the time of operation and these individuals must be identified by proper attire, e.g. a clean white T-shirt and trousers with long waterproof aprons over them. Boots must be worn with the trousers neatly tucked inside. Above all, the workers must be exposed to a formal code of hygiene.

H. Sanitation and Waste Disposal

(1) Objectives and Scope of Sanitation

Whereas hygienic measures deal with the operational aspects of slaughter or the creation of conditions under which animals, activities and personnel can be secured from contaminating the product, sanitation is focused on the establishment and maintenance of healthy environmental and appropriate physical conditions congenial to the attainment of a wholesome product. In essence, the two concepts are identical, culminating in the same end-result, but differing in targets. In this connection, the scope of sanitation may be identified broadly with structures and facilities, i.e. the premises, installation and equipment, that is their disposition and maintenance. Additionally, sanitation covers specific slaughter operations that are likely to cause contamination, e.g. offal cleaning, waste disposal and infestation by pests, etc. This chapter, like the previous one, will collate aspects of the subject already touched upon as well as add new information.

(2) Location and Lay Out

The influence of siting, design and construction of slaughter premises on sanitation has been dealt with at length in Chapter 2. In summary, the following guidelines are offered. The ideal site for a slaughterhouse should be fairly airy, outside built up areas and possibly close to the coast, if such a location is available. Established townships if close to the premises could easily be the source of air-borne contaminants from households or industries. The area must be open, preferably on high ground, to keep drainage from stagnating in the surroundings.

Alternatively, the area must be dry and not waterlogged or puddled as these could cause mosquito breeding. River, lake and lagoon sites must be avoided partly for the above reason, but chiefly to prevent livestock from drinking from them if polluted as well as to eliminate the temptation of discharging slaughter wastes into the waters, which could be drinking sources for humans.

Finally, the site must be large enough to accommodate auxiliary slaughter functions or structures such as holding pens (kraals), an emergency slaughters lab and a byproducts plant. The immediate vicinity should be cleared of all bush, and roadways leading to and from the premises must be well laid out and paved.

(3) Construction and Facilities

Materials used in constructing and equipping the plant (Chapter 3) must be durable. Specifically they must be impervious to water, easy to clean and to sanitize, non-corroding and not attractive to insects or termites.
Demarcation must be made of the slaughter/dressing zone from the offal/waste handling areas, and these areas from personnel places of convenience such as bathrooms and toilets. The interior of all rooms and chambers should have ample lighting and ventilation: lighting to facilitate the work and ventilation to flush out stagnant air and enhance the keeping of the product.
Of operational facilities needed, water is most important. Standards in industrialized countries stipulate the use of ample potable water from the public or municipal supply system. The water must be colorless, odorless and free from organic matter. It must also be well conditioned to eliminate, for instance, 'hardness' and be properly distributed in the plant such as at strategic points with hosing where necessary. Hot as well as cold water is necessary.
In the developing countries, these conditions may be difficult to attain especially in rural areas. Some municipalities can only clarify water, but not treat, sterilize or condition it; consequently in some towns pipe-borne water is boiled prior to drinking. Many rural slaughter outlets draw their water supplies from the same source, river or lake, which may serve also for washing, bathing and even drinking, not to mention occasional waste disposal. Even where dug-outs and wells are available, the quality of water can still not be guaranteed unless a treatment plant is available to assure safety for use in slaughter operations.

(4) Cleaning Operations

Large quantities of clean water are required in the cleaning of floors, walls, equipment and tools. The operation should begin with removal of solid waste such as meat and fat trimmings, bone chips, blood clots and so on by brushing them off the floor. High pressure hosing is then applied, starting from the walls and other rigid facilities and ending with the floors. Hot hosing under pressure is more ideal as it melts down fat and removes sticky waste from corners and drains. For scrubbing of tables, working surfaces and tools, hard fibre brushes and detergents are recommended. Liquid detergents are more useful than ordinary soaps, because they dissolve more easily in water by reducing the hardness while absorbing dirt or attaching themselves to it for removal by flushing with water. If liquid detergents are not available, powdered soap may be dissolved in water and used. After rinsing the washed items should be disinfected. Knives must be sharpened and sterilized or boiled in water.

(5) Waste Disposal

(a) Large Slaughterhouse

The wastes from a large slaughterhouse are a heavy polluter of any recipient. The waste water from a meat plant should be allowed into a municipal drainage system without previous thorough treatment in a waste water treatment plant. The details of such treatment are outside the scope of this manual. An outline is however given in order to show the size of the problem.

In the slaughter premises, the general principle regarding waste disposal is that initially, the solids and sweepings from operational waste (of the dressing chamber and offal floors) must be removed from the liquid. Secondly, the operational Liquid must be separated from the conventional drainage, namely that of toilets and bathrooms. The two lines should be kept apart within the premises well to the outside before being joined together.
The purpose of this is to prevent contamination of the premises in the event of a back-up of conventional sewage in the early stages of discharge. A catch-basin must be provided to collect residual solids, especially fat to prevent clogging of the system. Clogging can also result from discharge and coagulation of blood in the drainage and create further back-up problems. Thus by collecting blood in special containers, much inconvenience is avoided and valuable raw material provided for byproduct processing.

The principle of handling liquid waste from the common outside drainage system is first to screen out, collecting and cart off solid matter. The rest is then let into a basin in which the finer and lighter particles settle while fat is skimmed off, including suspended organic matter which is sediment from the water phase. (Sludge is formed which can be collected and added to manure and processed together. In the second phase of the treatment, bacterial breakdown of dissolved substances in the water phase takes place. This process requires oxygen to convert organic matter into simple inorganic substances. The latter are removed by physical treatment or by chemical means. At this stage the water is considered treated, though not recommended for human use. It can be used for agricultural purposes or discharged into water bodies.

(b) Rural Slaughter Premises

These premises pose a problem as investment in waste treatment plants is too high in comparison with the low work load. Far easier and safer is to bury all solid and semi-solid waste along with manure in pits to make compost. Blood should, however, be collected separately and dried into blood meal. The liquid effluents can be spread out on the ground at some distance from the plant for quick drying as they empty on a slope from deep concrete drains away from the plant. Straw bedding should be placed on the ground initially to absorb the liquid and re-layered at each time of disposal. The site should be constantly maintained to ward off vermin.

(6) Vermin and their Control

The term "vermin" is applied to creatures which by nature like living close to man, scavenging on food and filth. In slaughter premises, the commonest vermin are rats, mice, flies and cockroaches. All multiply in great numbers within a short time. The dangers posed by these creatures is that they live in hidden places such as splits, holes and crevices in floors and walls gathering dirt on their skin, appendages, mouth or mouthparts with which they contaminate food, sometimes destroying the food outright. Furthermore, by their contamination of food, they are capable of transmitting disease mechanically to man. In the case of rats, they can cause food poisoning, rabies, typhus fever and bubonic plague among other diseases. Cleanliness and general environmental sanitation basically keeps them away, as accumulation of waste, refuse, manure etc. soon attracts them to slaughter premises. Doors and windows should be secured against all possible openings to ward off vermin. The insect group are usually kept off by flyproof and fly trap devices as well as gauze screenings, while rodents are at best exterminated by chemical poisons. However, caution should be exercised in the use of chemical exterminators as some of them often have harmful effects on man.

I. Hides and Skin Curing

Hides and skins have the highest yield and value of all products of livestock other than the carcass, and in some livestock-rich developing countries such as Somalia and the Sudan, they account for substantial portions of export revenue. The approximate yield of green (or fresh) hides and skins in pastoral tropical livestock is as follows:

	Percentage of Live weight...	**Aver. wt. kg**
Cattle	6–8	18
Large Sheep & Goats	14–16	6
Dwarf Sheep & Goats	10–12	4

Table 2: Hide and Skin Yield per animals in KG

Hides and skins are processed into leather by tanneries; hence it is necessary to preserve them for storage and shipment after removal from the animal. The method of preservation is curing, either in free air or by use of salt or both. In each of these methods the preservative principle is the same, namely, removal of moisture from the product to enhance keeping quality. Thus air acts by facilitating evaporation of moisture from the skin, and salt by osmotic withdrawal of water, thus making the moisture unavailable for growth of microorganisms. Salt has an additional protective effect as it penetrates the tissues and with its presence inhibits the growth of deteriorating organisms.

(1) Air-Curing

Hides and skins must be cured immediately after removal from the animal body. Initially, they are prepared for this process by cleaning off residual meat, fat and manure from the surface in a process called fleshing. They are then washed, drained and trimmed to remove the ears and lips. To air-cure the hide or skin, the ideal method is to stretch it with strings from all sides and angles over a wooden frame or wire loop, and suspend it in the open to allow air to circulate freely around it and dry uniformly.

This method is preferred to ground drying which yields a poor quality product with cracks, wrinkles and folds, as well as subjecting the hide or skin to moulding and putrefaction. Hot, dry environments such as prevail in some tropical savannahs are best suited to air drying, but not the humid or the wet-forest type. The main disadvantage about air drying is that shrinkage is high, about 40–50 percent of green weight; hence the finished weights are low, although they incur correspondingly lower shipping costs.

(2) Salting

Salt-curing processes are of two kinds: dry and wet. In the former process, the simplest method, called green salting, is to rub the flesh surface with dry salt and stack the salted pieces in a pile in a cool place under some weight for 30 days. At the end of the process the hides and skins are removed, shaken of the salt and folded for consignment.
They can, however, be air-dried over a wire or wooden frame after salting). The rate of application of salt is 25 percent of green weight, but fine salt is used for skins and coarse salt for hides. Shrinkage is less when hides and skins are green salted, but increases with additional air-drying.

Hides and skins are said to have been wet-salted when cured in brine which is a strong solution of salt prepared at 15–20 percent concentration. The term brine curing is also used for the process. For skins fine salt without impurities is used, while rock salt suffices for hides. The immersed products are held in cellars often in the slaughter premises at a temperature of 10° to 16°C (or 50 – 60°F) for 3 to 4 weeks. Shrinkage is fairly low, between 15 and 25 percent. Thus yields are higher, up to 70 percent which in effect makes wet salting the most desirable process in sales returns. The wet-salted hides and skins are also of best quality barring deterioration which can be more pronounced in wet hides compared to the dried varieties.

Cured hides and skins are graded and purchased according to weight, quality and condition. The weight criterion as explained previously is based on curing yield. Quality basically refers to the class of hide or the breed or type of animal from which it is extracted, while condition relates to physical characteristics such as the extent of damage to the animal, due for instance to disease, branding and flaying methods.

INTRODUCTION, DEFINITIONS AND CLASSIFICATION

- Basically the term by-products and offals are used to denote the part or particles, which is not included in the dressed carcasses.
- So, by-products may be defined as**, "***everything from the abattoir or butcher's shop that is not sold directly as food".*
- Some of the by-products are organs, such as kidney, brain, liver, heart, lungs and intestinal tract, gullets and sweet bread, stomach, blood, bones, hooves, horns, hair and bristles, hide and skin, etc.
- Animals, which die at abattoir prior to slaughter, or those animals or parts of animals, which have failed to pass meat inspection as, fit for human consumption, are also included in the by-products.
- Ears, lips, snouts, teeth, foetus, gall bladder, trimmings, fleshing and dew claws are also listed under by-products.
- Organs such as kidney, brain, liver, heart and tongue are classified as edible by-products while the others are classified as inedible by-products.
- The basic factors making the deviation between edible and inedible products are determined by the purchasing power of the consumer, his food habits, religious taboos and customs.
- On the border line between these two extremes is a small group of organs which depending upon the food customs and purchasing power of the consumer may be considered either edible or inedible.
- Among these are organs such as uterus, spleen, testicle, lungs, intestines, stomach and blood may be considered fit for human consumption provided, they are derived from sound animals and were not contaminated during the process of slaughter and dressing.
- These by-products can be further sub-divided into (i) Principle by-products including hide and skin, blood, hooves and horn and (ii) Secondary class of by-products which includes a wide range of items manufactured from the principle by-products for example, blood meal, fibrin, haemoglobin, blood albumin, serum, plasma and so on from blood, Fat yields glycerin and soap; bones yield gelatin and nitroglycerine, Hides yield leather shoes, bags, belts, clothing, etc.
- Collection and utilization of by-products will be very difficult in small and widely scattered slaughterhouses with smaller throughputs.

IMPORTANCE AND BENEFITS

Importance of utilization of by-products

- The need for efficient treatment of the by-products is based on
- The necessity for their rapid, hygienic disposal thus avoiding decomposition and formation of obnoxious odours.
- If abattoir by-products are not removed and treated properly, then these will become a serious source of contamination to fresh meat.
- The efficient process of abattoir by-products, which secure some economic return on material, which would otherwise be wasted.

- Therefore, the efficient processing of by-products is agreed on both by the meat trade and by public health authorities.
- So, it becomes the obligation of the local authority to see the unsound meat is hygienically disposed off.

Benefits derived from the by-products

- Improvement of the environmental sanitation
    - Blood, trimmings, fleshiness, condemned organs and all unused offals attract flies, rats, dogs, vermin causing public health nuisance and even danger of spreading diseases.
    - Sanitary disposal of such offals often present great difficulties, as offals tend to clot drains, decomposed rapidly and produce objective odours.
    - Meat slaughtered and kept in unsanitary surroundings created by undisposed offals results in products not only of inferior keeping quality but also serving as a potential vehicle for disease transmission.
- Healthier and more productive livestock
    - Use of bones as bone meal, as mineral supplement for stock feed improves the health of the Livestock.
    - Meat, bone and carcass meals contribute as valuable sources of sterile protein food supplement.
- Secondary rural industry
    - The manufacture of by-products of animal origin leads to the establishment of secondary rural industries.
    - Examples are tanneries, tallow, soap, glue and bone meal manufacture, etc.
- Price structure
    - By-products influence the price of meat and the price paid to the producer for livestock.
- Creation of new employment
    - The conversion of offals in to by-products creates new employment and skills not only at the primary industry level but also at the secondary industry level.
- Better crops
    - The offals converted into fertilizers will help in increasing the yield of crops.

PLAN AND LAYOUT OF BYPRODUCTS UTILIZATION PLANT

- Due to our vast livestock population, it is very important to harvest animal byproducts for their economic value as well as to provide employment to marginally educated masses. In our country, livestock density demands the setting up of at least one animal byproducts processing plant at each 50 km range.
- Establishment of animal byproducts processing plant within or in the vicinity of each abattoir will also alleviate the pollution problem.
- The biogas production unit for the mutual benefit could utilize the resultant waste from both.
- Important considerations during the establishment of a byproducts utilization plant are: In tropical and subtropical countries, a byproduct plant

should be established adjacent to the slaughterhouse or it may be a part of the same building connected through chutes or gravity pipes. In earlier case, the passage between slaughterhouse and by product plant must be constructed with concrete, stones or bricks and the slope should be towards byproduct plant. The establishment should preferably be away from inhabited area.

- As far as possible, there should be provision of overhead rails from slaughterhouse to the byproduct plant. A byproduct plant should have its own-screened drainage with a gully fitted with individual grease traps. The byproduct plant should have clear clean and unclean sections. Charging platform or raw materials inlets form a part of unclean sections whereas processed and sterilized byproducts are prepared, stored and disposed of from clean section having separate exit point.
- The floor, walls and ceiling should be made up of smooth and concrete material so that these can be easily and frequently washed. A floor slope of ½" per ft. is generally recommended.
- A byproduct plant should invariably have a hide/skin salting room, renderers, tripery, boiler, manure bunker, store besides common amenities.
- The plant building should be open and ventilated to prevent humidity build up leading to corrosion of equipment and building. It will also check the growth of moulds and bacteria in the building. The roofing material may preferably be corrugated asbestos sheeting. There should be provision of exhaust fans from each partition.
- The equipment to be installed should cope up with the byproduct or offal accumulation expected each day. Renderer, fat settling tank, fat expeller, blood press, grind mill etc., are essentially required. A boiler of suitable capacity is inevitable for processing as well as cleaning operations. It should have a steam pressure of > 80 psi.
- At the initial stage, processing of one or two byproducts can be taken up. The operations can be further extended in stages.
    - A byproduct plant should have the following main sections:
    - Hides and skins section with salt store.
    - Tripery/Gut processing section with cleaning tables, water taps etc.,
    - Carcass utilisation plant with renderer, bone digester, fat settling tank, fat expeller and adjoining milling room and store.
    - Besides boiler, worker lockers, amenities and adjacent manure pit are other important requirements.
    - The boiler should be of suitable capacity keeping in view the availability of raw material; and consumption of renderer.
    - The requirement of steam has been worked out to be 1.25 lb per lb of raw material to be processed.

J. Meat/Bone Meal Production

The raw materials for quality production of meat/bone meal are all parts of the animal, less the skin or hide, hair, horn, hoof, blood and gut contents. This means that they may include skinned heads and feet, bones, viscera and carcass trimmings which are not utilized for food. Condemned material and relevant parts of freshly dead animals can be included, but not putrefactive material or that in a

high state of decomposition. This material should be incinerated or buried in deep pits.

A steam-rendering tank is used for meat/bone meal production. This is an oblong-shaped or vertical cylinder with a cone-shaped base built of heavy steel and fitted with a steam-charging mechanism to provide high temperatures for cooking.
Water is first introduced into the tank, up to about one-third capacity; hence the term wet-rendering which is commonly applied to the operation. (Dry-rendering excludes the addition of water and in fact expels moisture from the system. It is used mainly to extract fat from tissues. Tanks used in dry-rendering are of the horizontal type, the heat being applied at lower temperatures)

When water has been placed in the wet-rendering tank the relatively heavier materials like bones, feet and heads are put in next in reduced sizes at the bottom of the tank. Softer organs such as those of the viscera and carcass trimmings are layered next. Finally, fat is placed on top, allowing a headspace for the boiling action. In practice, the fill does not exceed three-quarters of the cylinder's volume.
With the tank closed, steam is charged through the bottom directly into the tank. This is done under pressure which should keep rising to about 18 kg (or 40 lb) and held there for about 5 hours. It should be noted that the boiling point of water is elevated as pressure increases.
Thus at ordinary atmospheric pressure water boils at 100°C (212°F), but with an extra pressure of say 4.5 kg (10 lb) the boiling point is raised to 115°C (240°F) and at 6.8 kg (or 15 lb) to 121°C (or 250°F) and so on. Heat is necessary to break up, soften the tissues and release fat, and importantly destroy harmful microorganisms.

At the end of the heating time, the pressure is lowered gradually and the tank is allowed to cool for 40 – 45 min. During this time, the heavier material gravitates to the bottom. Water collects above this while fat settles on top. The fat is removed first (as a byproduct, tallow) followed by the water. Finally the cooked meat and bone material is discharged. After removing residual moisture, the meat/bone material is dried, milled and bagged. (The cooking water contains some dissolved protein and fat: both are removed separately, the protein being added to the meat/bone meal before drying, and the fat to tallow stock).

Meat/bone meals, sometimes called feeding tankage, are used in animal rations. Each batch should, however, be analyzed to determine the nutrient composition as the phosphorus and protein content are important criteria for grading and marketing. Horn and hoof are prepared similarly to meat/bone meal, but this is done separately. Often the horn/hoof meals are used as fertilizers.

K. Production of Blood Meal

- The processing of blood can yield both inedible products and products suitable for animal feeding.
- Blood can also used as human food as it is very valuable source of protein.
- It is used in the preparation of black puddings and sausage making.
- Occasionally, slaughter does not lend itself to economical treatment of blood, as the quantities are small.

- Only plants, whose daily kill is large, can make use of the blood fully by installation of a suitable plant by which the liquid can be dried.
- The desirable feature in the construction of the abattoir is that the animals should be bled at a central point by which arrangement a greater degree of hygiene and facilities can be achieved.
- An animal body contains nearly 5-7% blood of its live weight.
- However, during slaughter blood is not fully recovered, where spilling, or faulty management always loses some of it.
- Fresh blood must be processed at the earliest moment as otherwise it decomposes rapidly with an appreciable loss in the nitrogen content.

Table 3: average yield of blood/animal

Species	Yield
Buffalo/cattle	10-12 kg
Goat/ sheep	1-1.5 kg
Pigs	2-3 kg
Poultry	30-50 g
Calves	1.5 kg

Time of bleeding of different food animals

Cattle	6 minutes
Sheep	5 minutes
Calves	5 minutes
Pigs	6 minutes

- The amount of blood yielded
    - The yield of blood meal is about 1/5th of the initial weight of blood.
    - It is an excellent source of essential amino acids, lysine being 6-8%.

USES

- Animal blood is used in several ways and its collection method also depends on the specific end use.
- Some of the uses are listed below.
- As human food
    - Only a small quantity of available blood is used as human food, such as for preparation of *black puddings* and *sausages*.
    - Blood used for human food must be of fresh and derived from animals, which have been inspected and passed.
    - It is very difficulty to collect clear blood from animals slaughtered according to Jewish or Mohammedan rituals as such blood is often contaminated with regurgitated food.
    - The collection should be done in clear receptacles in such a manner as to prevent contamination.
    - Blood containers should be identified with the carcass, so that, if the carcass is condemned, the blood may be destroyed.
    - The blood after leaving the body clots quickly due to formation of *fibrin*, which enmeshes most of the blood cells squeezing out the serum.
    - Liquid blood is required for certain manufacturing purposes both for food and industry.

    - This can be achieved by defibrination and is done by stirring the blood, with a wooden ladle or by whipping it with a wire whip.
    - The fibrin will gradually settle on the blade or whip, which will be dark–red in colour.
    - It is a valuable food for man and poultry or can be used for the manufacture of *peptone or lecithin*.
    - The fibrin can be washed nearly white in water and dried and preserved until required.
    - *Plasma* is used as protein boosters in foods and used as binder or stabilizer in meat products.
- For industrial use
    - Preservation of blood by chemicals is necessary when the blood is used in *tanneries and other commercial use*.
    - But, however, because of the addition of chemicals, there is some loss of quality.
    - Chemical preservation may add some undesirable properties to the blood.
    - The addition of chemicals should be done only after consultation with the buyer.
    - For industrial use when liquid blood is needed, anti-coagulants such as oxalate or citrate is added.
    - The blood is then centrifuged to separate the red and white corpuscles from the serum.
    - Plasma is used as *waterproof adhesive in plywood industry*.
    - Used in *lithographic coloured solution*, this contains albumen and ammonium dichromate.
    - Used in *textile dyeing*, and as *stabilizer* for feed mixtures and pet foods.
    - Used as foam compounds in *fire extinguishers*; as *substitute for egg albumen* (blood albumen); in *ceramics* and is *cosmetic base formations*.
- As stock feed
    - Only fraction of the blood available can usually be used for human food or industrial use.
    - All the remainder should be utilized for *stock feed production* as *blood meal, mixed blood meal and lysine supplement.*
- As fertilizer
    - Used as *compound fertilizer* containing nitrogen and phosphates, *seed coating* and *soil pH stabilizer*.
- As biochemical and pharmaceutical
    - Amino acids – lysine, leucine, histidine and phenylalanine are used as biochemical.
    - Thrombin and prothrombin are used as blood clotting agents. Immununoglobulins, serotonin, peptone and plasma extenders are used as pharmaceuticals.
- As laboratory and biological media
    - Blood agar, tissue culture media, albumin and globulin, sphingomyelin and catalase are used as laboratory and biological media.

PROCESSING AND PREPARATION OF BLOOD MEAL

- Blood may be processed by heat treatment or without heat treatment.
- Processing of blood without heating will cause problems while feeding the meal to livestock.
- Raw, unsterilized blood meal is not recommended for feeding purposes.
- But in small abattoirs provision of blood processing plant is a costly affair.

Heat-treated blood

- Although dried raw blood has not been sterilized during manufacture, it is possible to sterilize the meal itself by heating it in a stove.
- Blood can be cooked together with offal and condemned carcasses.
- If blood only is available, this can be processed in the following manner.
- The blood is heated with constant stirring until it coagulates, care being taken to avoid burning or charring.
- An equal amount of boiling water is then added to the blood and the mass boiled together 4 to 5 lbs raw blood are equivalent to 1lbs of dried blood meal or 8 lbs of the mass prepared by adding water.
- Bran, pollard or other finely ground vegetable mater can be; mixed with the blood to add consistency.
- The feed prepared in this method has no keeping qualities whatever and efficient arrangement must be made for daily collection and feeding to livestock.
- Apart from blood collection, a speedy collection and feeding to livestock, a speedy collection without the addition of water and rapid elimination of moisture prior to drying are essential in order to obtain a good product.
- This is achieved by coagulation and pressing.

PRINCIPLES IN MANUFACTURE OF BLOOD MEAL

The simple principle in the manufacture of blood meal is as follows:

- Blood collection
    - Blood should be collected in such a way as to avoid floor washings, detergents, insecticides or any other extraneous material.
- Storage and transport
    - Whole blood may be properly mixed with equal amount of rice bran, which will absorb it.
    - Such a mass can be transported in gunny bags in rainy or low sun season, whereas it can be dried in summer or hot sun on a concrete platform to nearly 10-12 % moisture.
    - To whole blood, 1% quick lime is added by weight, which will give it a black rubber like consistency.
    - This mass will not adhere to the transport containers, keep well for 24 hours and it will not attract flies.
    - Addition of lime also increases the calcium of the end product.
    - Alternatively, common salt can be added @ 20% of the blood by weight to increase its storage life and enable safe transport to the plant.

- Coagulation by heating
    - The blood should not be charred.
    - The blood will turn black. It should be boiled for 15 to 20 minutes to destroy pathogenic organisms.
    - Injecting live steam may coagulate the blood.
- Pressing
    - Blood mass is collected in Hessian bags or any other porous bags, hung and 40 to 45% of moisture from blood can be squeezed out simply by pressing.
    - This reduces the time and expense of drying.
- Drying
    - Blood can be dried in the sun on concrete floors.
    - Many methods of mechanical driers can be also employed.
    - Up to this process it should be done quickly to avoid nutrient or quality loss. Drying is done in two methods
    - *Sun drying*
        - In hot and dry climate, pressed blood mass can be dried by spreading in shallow trays.
    - *Cabinet drying*
        - In pilot plant, a cabinet drier with steam coils at the bottom and exhaust fan at the top can accommodate many trays at a time and remove the moisture efficiently.
- Cooling
    - Sun dried blood can be milled immediately. But blood dried by other methods should be allowed to cool.
- Milling
    - For preparing stock feed, the blood is milled. Any hammer mill can be used.
    - If preservation is done, 3% salt is to be added. Rapid chilling is required.
- Fumigation
    - Blood meal can be disinfected with methyl bromide, ethylene oxide, etc., for long-term storage.
- Packaging
    - Blood meal is packed in polyethylene bags or airtight containers.
    - It is advised to avoid undue exposure to high temperature and moisture during storage.
    - Lime treated blood meal has a storage life of several months.

LARGE SCALE PROCESSING

- Blood can be spray dried or batch dried.
- Wet blood should be dried daily.
- Well-dried blood can be milled whenever convenient.
- Spray drying
    - This is similar to (that of) milk powder manufacture and yields a very fine water-soluble powder of light colour.
    - The defibrinated blood is blown through a fine nozzle into a heated chamber and falls down in the form of powder.
    - Installation is very costly and this is designed for larger production.
- Batch drying

- This is a blood drier, which is a matter similar to that of dry rendering of meat offal, but with a very smooth inner shell.
- In this method, overcooking leads to over agitation and loss of fine particles in the wastewater whereas, under cooking has the same effect, as some uncoagulated blood will be lost.
- Blood after coagulation, should have moisture content of slightly over 70%.

DIFFERENT METHODS OF PROCESSING

Where equipment is available, blood can be processed in several ways, as follows:

- Dried without previous treatment
  - Here blood is dried under steam pressure and by constant agitation. A blood drier is a standard horizontal dry -rendering matter.
- With other offal
  - Blood can be wet or dry–rendered together with inedible or condemned matter and used for enriching the protein content of the whole material.
- Dried after coagulation and pressing
  - The coagulated blood may be transferred either to draining tanks, with a perforated bottom, which allows the liquid to drain off by gravity, or it can be put into a press with a top fitted with handles for screwing down.
  - The coagulated blood, which now contains only some 40% moisture, is fed in to a dry-rendering matter, either alone or mixed with other offal.
- Speed
  - Wet blood rapidly deteriorates and hence daily processing is essential.
  - The thoroughly dried blood can be milled whenever abattoir supplies have been accumulated.
- Test
  - Moisture and ammonia content are the two factors determining the quality of blood meal.
  - Keeping quality is good only when the moisture is approximately 10 to 12%.
  - The protein content of blood meal should be 75 to 85%.
  - Low protein content indicates the presence of extraneous matter.
  - It has a characteristic iron odour.

PLASMA AND SERUM

- Blood consists of plasma in which erythrocytes, leucocytes and thrombocytes (platelets) are suspended.
- Plasma, in turn consists of serum and fibrinogen.
- Action of thrombin on fibrinogen separates out fibrin.
- Serum is rich in albumin and globulin.
- Thus, plasma is recovered from unclotted blood by centrifugation, whereas serum is obtained from clotted blood.
- It may be noted that normal blood clotting time of most domestic animals is 3 to 6 minutes.

- Only from those abattoirs where slaughter is carried out on bleeding rails blood can be collected for human use.
- Trocar knife (with hollow handle) and canula are used for hygienic recovery of blood, which is collected in clean and sterile stainless containers.
- An ideal vessel should have a diameter of 45 cm and a depth of 15 cm.
- It can be washed with hypochlorite or steam sterilized.
- To prepare plasma
    - blood collection is done quickly in an anticoagulant (trisodium citrate 4%, 1 ml for each 10 ml of blood, otherwise oxalate, EDTA or heparin is used).
    - Blood is then centrifuged, which will separate plasma from cell mass.
    - Plasma is stored in bottles or polyethylene bags in frozen conditions.
- To prepare serum
    - blood is collected carefully and allowed to clot and subjected to further processing in a cold room.
    - Chilled clotted blood is cut into smaller lumps to bring about quick contraction of clots.
    - Serum collected in first 12 hours is generally clear except for some suspended RBCs.
    - It is centrifuged in a bucket centrifuge at 100 rpm and filtered through Seitz filter.
    - The yield of serum is about 10-12% of the weight of whole blood.
    - It keeps well at 4-5^{o}C for one month and at –20^{o}C for six months.
    - Dried blood serum is referred as blood albumen and is used as the cheapest substitute for dried egg albumen powder in the industry.
        - To prepare it, to clear yellow serum is added 0.05% phenol on weight basis.
        - It is sprayed or vacuum dried to soluble fine powder.
        - The yield of albumen is 10-20% of the weight of the serum.
        - It is stable in airtight containers in cool places for several months.

FIBRIN AND ITS PRODUC

Fibrinogen

- Blood collected with anticoagulant is centrifuged to obtain plasma.
- This plasma is buffered with sodium citrate acetic acid buffer with simultaneous addition of aqueous ethanol until pH of the solution becomes 7.2 and ethanol concentrates reaches 8%.
- Now fibrinogen is precipitated and removed by centrifugation.
- It is filtered, sterilized, freeze-dried and stored.

Fibrin foam

- Plasma is suitably treated with citrate buffer of pH 6.
- The solution is clarified by centrifugation and diluted to contain less than 2% fibrinogen and pH is adjusted to 6.25.
- The solution is vigorously beaten to obtain fibrinogen foam.
- This is converted to fibrin by the addition of thrombin.
- The fibrin foam is frozen, cut into cubes and then freeze-dried.

- Fibrin foam is white to cream coloured spongy material.
- It can soak up liquid upto 30 times its weight and is very useful in nerve as well as arterial surgery and prostate operations.
- It does not inhibit the action of antibiotics and eventually digested in the body system.

Fibrin powder

- It is used to arrest bleeding where coagulation is delayed in skin injuries.

Fibrin bioplasts

- These are moulded materials resembling plastic, which are prepared from fibrin powder.
- They can be moulded even as bone joints and need not be removed from the body.

FOAM COMPOUNDS

- From blood protein foam compounds are derived which are the cheapest foam type fire extinguishers.
- These are quite effective in dealing with fire involving petrol, fat, naphtha, etc., although generally unsuitable for spirit or alcohol related fires.

Blood is fairly rich in nutrients, especially protein, but being liquid it readily collects dirt once it leaves the animal body. Dirt starts putrefaction which lowers the blood's usefulness, and if drained outside on the slaughterhouse grounds sanitation problems arise by virtue of its clotting property. Other nuisances created by clotted blood are stench, filth, attraction of rodents and the breeding of flies. It is of utmost importance that blood when collected should be handled in a hygienic manner and processed with minimum delay.

(1) Collection and Yield

It can be collected directly in metal or plastic drums if the animals are hoisted for bleeding, but if killed on the floor small enamel or plastic bowls can be placed immediately beneath the let-out to receive the blood and empty it into the drum. The estimated yield of blood and blood meal in average tropical livestock is as follows: **Table 4: Fresh Blood and Dried Blood or Blood Meal yield per KG**

	Fresh Blood		**Dried Blood or Blood Meal, kg**
	As % of livewt.	**Weight, kg**	
Cattle	2.5	6.30	1.26
Sheep and Goats	0.6	0.25	0.05

(2) Small Scale Processing

Where only a few animals are slaughtered in a day, small-scale low-technology processing can be undertaken rather than to spill the blood to waste and create problems of sanitation. Thus from say 10 cows and 3 sheep, approximately 64 kg of fresh blood can be obtained which can yield at least 12 kg of dried blood. To process this blood is cooked in a tank to coagulate it, and is drained of liquids which collect on top after cooling. The coagulum is then broken up and spread on

a tarpaulin or plastic sheeting for drying. Alternatively, the coagulated mass can be placed in a simple solar dryer for drying.

(3) Wet Rendering

In plants that have steam-rendering tanks, the fresh blood can be mixed with selected non-carcass components of the description given in Chapter 10, paragraph 2, and wet-rendered. In this instance, the blood should substitute for water in the tank. An advantage here is that the protein content of the offal meal will be raised quantitatively with the addition of blood, although some amino acids may be damaged by the strong action of the heat while others may leach into the cooking water.

(4) Commercial Drying

A more productive approach is to process the blood under relatively reduced temperature conditions using a commercial blood drier. In principle, the blood-drier is a dry-rendering tank disposed horizontally and invested with a steam-jacket. Special devices are provided within the tank to prevent blood from coating on the interior walls and reducing drying efficiency.

Blood is introduced into the tank as a coagulated mass, previously obtained by steam action. As much liquid as possible should be squeezed from the coagulum. Heating is initiated at 82°C (180°F) and progressively raised to 94°C (200°F) for about three hours, then elevated to 100°C (212°F) for 7 hours. Drying is complete when the final moisture level in the dried product is about 12 percent. During drying, moisture is constantly and rapidly removed from the tank by means of condensers to which the tank is connected. Complete moisture removal is not desirable otherwise the final product would darken or char, while above the 12 percent level the residual moisture can cause deterioration and loss of nutrients. The protein content of the finished product is about 80 percent.

L. Manure, Compost and Biogas

Digestive and excretory wastes of ruminants, collectively referred to as manure are a mixture of dung and urine and occur in two forms: as sweepings from lairages which are built into heaps outside the slaughter building and collected from time to time in small quantities by small-scale farmers to enrich soil fertility, and as kraal manure which may remain permanent on the holding ground. Kraal manure is less-preferred because it is often sogged with water (from rains) or mixed with earth from treading by the animals as well as straw from bedding, thus creating problems in collection and spreading on farms.

(1) Use of Manure

In either form, the quality and usefulness of manure becomes reduced as exposure to the open without protection or sheds or roofing causes loss of valuable nutrients, e.g. nitrogen by evaporation, and soluble substances (potassium and phosphorus) by leaching during rains. Otherwise cattle dung is a good source of

phosphorus while the urine yields liberal amounts of nitrogen and potassium. Furthermore, the organic matter component of the manure remains longer in the earth when applied to soils to provide crops with a steady source of nutrients.

Fresh, straw-free manure with its urine mixture can be collected and held in special sheds or enclosures to decay a little before being put on the soil. If placed on the soil surface without prior decay or improper mixing with the soil, the manure loses considerable nitrogen, apart from physically smothering plant growth. Ruminants are known to avoid grazing close to pastures with dung on them.

(2) Composting

The process of breaking down organic matter in dead plant material, crop residue and leaves by decay before returning them to the soil can also be applied to old manure. The process is called composting. Farm composts are normally heaped above the ground, alternate layers of plant residue being sprinkled with ammonium sulphate, lime and water to facilitate decay. The pile is protected from rain and strong winds by being covered with heavy logs or a mud wall, then left to rot.

For environmental and sanitation reasons, the composting of manure should be done in pits or bunkers instead of stacks and heapings. A pit is an ordinary hollowing of the earth, while a bunker is a chambered structure constructed with cement blocks or bricks above the ground. Both structures must be roofed or provided with sheds for security against rain. By the same token, water-logged areas must be avoided when locating the structures. The pits and bunkers are filled with alternate layers of kraal and lairage manure which should be wetted slightly with some liquid waste water from the slaughterhouse. They are then topped with leaves and covered with heavy boards or roofing sheets. Breakdown of the material proceeds slowly. After 2–3 weeks the contents should be turned and mixed, repeating the process after 4–5 weeks. In about 8 weeks or less the compost should be ready. Well-rotted manure must be fine textured without much straw in it.

ORGANIC FERTILIZER

- Split and soiled blood is collected in drums and transported in closed vehicles in 4-6 hrs for processing as fertilizers.
- This blood is preserved by treating with 2% formalin or 2% Lysol solution and dried in sun.
- Dried blood contains about 12% nitrogen with traces of phosphorus, iron and copper.
- It is generally used as compound fertilizer after supplementing with super-phosphates.
- Thus, animal blood can be subjected to multiple uses and the list is so varied.

(3) Biogas Production

Compost of even higher fertilizing characteristics is obtained as a byproduct in the breakdown of manure in special devices called digesters for the production of biogas. (Biogas is so called because it is a mixture of gases produced as a result of anaerobic breakdown of organic matter by bacteria. The gases in the mixture are methane, 60 percent which is the main component and a source of fuel; carbon dioxide, 36 percent, and hydrogen, oxygen, nitrogen and hydrogen sulphide making up the rest.)

As a rule, biogas production is not economic, the yield being very low. In animal wastes, for instance, the yield of biogas is lowest for cattle; pigs are intermediary with poultry being highest on the scale. In addition, operational problems exist affecting the charging of the system and continuous flow of gas, not to mention the explosion hazard. Proven commercial plants must be procured if biogas production from animal wastes is contemplated. In this case the digester gas utilization must be based on a practical necessity such as requirement for heating water (by direct burning) to maintain sanitary services in the slaughterhouse.

Because of its low yield, another consideration can be the advantages offered by biogas production in the treatment of organic wastes including the removal of offensive and insanitary influences from the environment. Whichever the application, compost is always produced from the operation, which with treated liquid waste, can be used in vegetable cultivation to yield revenue to offset costs.

M. BONES Processing

Yield

- Bone account for an average of 15% of the weight of a dressed carcass.
- This amount varies with breed, age, state of nutrition, etc.
- It may be as low as 12% in beasts of top condition, and as high as 30% in emaciated cattle.
- The bones of sheep and goats average from 20 to 30% and of pigs from 12 to 30%.

Composition

- Bones contain 50% water, 15% red and yellow marrow, 12% organic matter and 23% inorganic matter.
- Bone marrow (red and yellow) consists 96% fat.
- The defatted and dried bone contained organic matter and inorganic salts material in a ration of 1: 2.
- Bone collagen is called *ossein*, which is the main constituent of the organic matter and accounts to approximately 33 to 36% when boiled.
- This organic matter yields gelatine.
- The inorganic matter consists of approximately 32.6% calcium, 15.2% phosphorus, small amount of sodium, potassium, magnesium, traces of copper, cobalt, zinc, iron, manganese, sulphur, etc.

Uses of bones

- In the past, bones have had many uses, for example, in the manufacture of dice, buttons and knife handles.
- Today plastic has replaced bones for these purposes and; this use for bone will not be described here.
- Because of the complex nature of bones, different processes have been designed to recover different components like fat, protein and inorganic material. Owing to its high calcium and phosphorus content, bone meal is used as a constituent of poultry feeds and as a fertilizer.
- Calcined bone, obtained by roasting in air, is used in the manufacture of high-class pottery and china, in the refining of silver and in copper smelting.

VARIOUS METHODS OF TREATING BONES

- The various methods of treating bones while recovering the fat can be summarized as follows:
    - Processing under pressure
        - In this method the bones with all adhering meat and tendons together with other offals are processed under pressure to obtain bone and other meat meal.
    - Boiling bones in open kettle
        - In this method all adhering material is freed by dissolving a small part of the ossein.
        - The bones are then lifted from the boiling liquid and milled to produce raw bone meal.
    - Boiling bones under pressure
        - In this method the ossein gets free and this protein is used in meat meal production and milling the bones for steamed bone meal.
    - Conserving the ossein for gelatine manufacture
        - By subjecting the bones to prolonged cooking in open vats avoid boiling by not exceeding 87.8°C (190°F).
        - This results in the loss of the fat while preserving the ossein.
        - Such weathered bones may be used for the manufacture of gelatin, raw or steamed bone meal.

SOURCES OF BONES

- In the United State, Australia and Argentina, bones are left over as a by-product of large establishments producing boneless meat and sausages or in canning factories.
- Fresh bones from whole carcasses are rarely available in developing countries.
- The skull and feet are the bones, which usually considered, as abattoir offal.
- In poor countries, even these are sold as food.
- In such abattoirs negligible amounts of bone are recovered from the whole carcass.
- Sometimes only the jawbone is recovered from a whole carcass.
- The main source of bones is those remaining after they have been boiled for soups or from animals, which have died in the field.

BY-PRODUCTS OF BONES

- Bones contain 33 to 36% of organic substance, bone collagen or ossein, which is the mother substance for gelatine and glue.
- Gelatine
    - Gelatine can be obtained by boiling ossein or by boiling degraded bones in water acidified with Hydrochloric acid, which separates the gelatinous substances.
    - It is a derived protein of albuminoidal class, which has both – edible and inedible (technical) uses.
    - Edible gelatine is manufactured from fresh bones obtained from slaughtered and inspected animals under strict hygienic conditions.
    - Pure gelatine is an amorphous and transparent substance devoid of any colour, taste and smell.
    - It is brittle when dry, softens on heating and then decomposes with burnt hair smell.
    - It swells in cold water absorbing 5 to 10 times its weight and dissolves on warming upto 30oC.
- Glue
    - Glue is the inferior gelatine and is obtained in the same manner as gelatine.
    - It is low-grade gelatine with comparatively dark colour and has only inedible uses.
    - Chemically there is no difference between gelatine and glue.
    - Glue is used as an important adhesive in plywood, furniture, sand paper, gummed tape, etc.
- Ossein
    - Ossein is obtained by breaking the bones in weak acids, which dissolves the mineral components leaving the organic matter.
- Bones may by collected from
    - Abattoirs where large quantities of bones are available.
    - In the field where bones may be collected from eating houses, refuse dumps or from carcasses.
    - Skull and jawbones are non-gelatine-yielding bones.
    - Gelatine manufacturers grade the bones in five different groups as Grade I, II, III, IV and V.
    - Only long bones are selected not the flat bones.

PREPARATION OF BONES FROM ABATTOIRS

- The aim in preparation of bones is
    - To select only those bones which contain gelatine
    - To deprive the bones of all the adhering fat, tendons, meat, sinews and blood.
    - To dry the bones.
- During all the above operations, care should be taken that gelatine-yielding material is not lost through over heating.

SELECTION OF BONES

- This process involves selection of mainly six long bones-femur, tibia, metatarsus, humerus, radius and ulna, metacarpus, etc.
- Cutting
    - Only thighbones (tibia), buttock bones (femur), flat (meta-tarsus), and round (meta-carpus) skin bones, blade (Radius and ulna) and cannon (humerus) bones should be used.
    - The first is to saw of the knuckles and kneecaps with a power driven circular saw.
    - The cutting is done through the line of the nerve hole, the aim being to expose the marrow to the direct action of hot water.
- Heating
    - A tank provided with perforated steam coils, which allows the injection of live steam, can be used.
    - When steam is unavailable cooking can be done in open tank. The tank is filled with cold water and then charged with bones.
    - Then the water is heated gradually.
    - The temperature should not exceed 87.8°C (190°F) for about 6 hours, which is sufficient to melt the fat and loosen all the adhering meat.
    - The bones should not be boiled nor did the bones put into boiling water.
- Cooking
    - Cooking may be taken for about 10 hours.
    - After cooking the tank is allowed to cool.
    - The fat will rise to the top and can be skimmed off.
    - The bones are washed and then dried.
    - Then the dried bones are crushed.
    - These crushed bones are dispatched for preparation of gelatine.
    - Gelatine is extracted under carefully controlled pressure.
    - A strong solution is run off from the digester.
- Washing
    - After removal of fat, the bones are washed with warm water.
- Drying
    - These bones are dried in sun on wire netting.
    - In wet weather, drying is done in hot room.
- Crushing
    - The bones are crushed by a simple stone crusher to a size ranging from 1-2 cm cubes.
    - Crushed bone pieces, which pass through 0.2 cm mesh, are considered bone meal.

MANUFACTURE OF GELATINE AND GLUE

- Principle
  - Gelatine is produced by the action of hot or boiling water on collagen or ossein by the process of hydrolysis
- Procedure
  - *Washing*
    - Defatted and uniformly crushed bones to a size of 1-2 cm are washed with water.
    - Similarly, the glue stock is washed and soaked with water.
    - It is decreased by prolonged exposure to sun or brined or limed (saturated $Ca(OH)_2$ solution, 10% by weight) for several weeks to remove the non\collagenous material and fat.
  - *Demineralization*
    - Then it is washed and is demineralized by soaking in 4-10% HCl for 1-2 days.
    - It is washed with water to yield a clean, soft stock or ossein.
  - *Extraction or cooking*
    - 60°C (140°F) highest quality glue
    - It is done by controlled hydrolysis to recover different grades of gelatine.
    - Extraction is done in steam-jacketed pans and it takes place in several runs of 3-5 hours at successively higher temperatures.
    - No direct flame is used.
    - The heat treatment yields glue as follows
      - At At 65.5°C (150°F) medium quality glue
      - At 80°C (176°F) low quality glue
      - At boiling point the quality is the lowest.
    - Residue is pressed and dried for use as livestock feed or fertilizer.
  - *Filtration*
    - The liquor or soup is drawn off from each cooking by pressure filtered to increase clarity.
  - *Concentration*
    - The liquid extracts are vacuum evaporated to yield gelatine of 30-40% concentration.
  - *Drying*
    - The concentrated gelatine is spread on a thin sheet of a large drum, which is heated by steam *(spray drying)*.
    - Then the gelatine cut and removed in few minutes with the help of a knife.

GENERAL INFORMATION AND USES OF GELATINE

- It is difficult to make gelatine or even glue of good quality under rural conditions and therefore rural abattoirs are advised to collect the glue stock and sell the stock to glue or gelatine manufacturers.
- So the fresh glue stocks have to be preserved before delivery.
- These can be dried in air or wet or dry salted.
- The gelatine may be sold in sheets, broken to flakes or powdered as per the requirement of the user industry

- The rejected hides and skins, hide trimmings such as marks, snouts, ears, shanks, skin from (slunk) unborn animals, tendons, sinews, horn pith, casings and loose connective tissues are materials which can be used to produce glue or gelatine.
- These are known as *glue stock*.
- Zinc sulphate is used as preservative to extend its keeping quality.

Uses of gelatine

- Gelatine is used in food industry for making brown pies, ice cream, jellies and soft chocolates making as foaming agent.
- As capsules in medicine
- As binder in tablets
- As plasma extender in blood transfusion
- As a sizing agent in textile and leather industry
- In photography
- As culture medium for bacteria
- Used in the manufacture of smokeless gunpowder.
- Now Gelatine is also manufactured from pig's skin in Germany.
- 100 parts of beef bones yields 6 parts of gelatine.
- 100 parts of veal bones yields 50 parts of gelatine.

BONE MEAL

- Bone pieces of les than 2 mm size constitute bone meal.
- Sterilized bone meal a good source of phosphate supplement in livestock feed.
- Animals deprived of adequate phosphorus in feed and fodders suffer from osteophagia, osteoporosis, rickets, etc.
- Collection of desert bones and their conversion to bone meal is an economically viable proposition.
- It is also important from sanitary point of view.
- It can provide employment to very poor and illiterate people with meager means at their disposal.
- It will invariably bring about improvement in the livestock.
- It should be noted that sterilization of such bones is a must.
- The yield of bone meal is one third of that of raw bones (1:3).
- Quality of bone meal is determined by the presence of phosphorus and calcium that should ideally be present in the ratio of 1:2.
- *The average composition of bone meal is*
    - Calcium : 30.5%, Phosphorus : 15.5%, Protein : 7.0% and Fat : 1.0%
- The bones are cooked under pressure to remove the remaining blood, fat, meat and dirt.
- Then the bones are drained.
- The bones will be dry little and sterile.
- The bones are then milled in a disintegrator.

Uses of bone meal

Used as mineral supplement in stock feeding or as phosphate fertilizer.

2. Meat Industry Overall Market Trend & Projections

The meat market trend in Ethiopia including the type and number of facilities, what is known about their operations including export market involvement and other points which might affect the meat supply situation. Much of the literature associated with the livestock sector in Ethiopia emphasizes the fact that there is a strong "disconnect" between livestock production and market requirements about meat quality, eating consistency, color, fat coverage and types of descriptors used in other meat industries, particularly for beef. This "disconnect" is attributable in part to the agrarian i.e. noncommercial livestock production system still found in Ethiopia.

A second factor is the elaborate marketing system stretching from the production area to the tertiary and terminal markets. The complex nature of the marketing chain effectively means that producers do not receive clear market signals about end-users' product requirements, nor do they receive feedback on ideal livestock weight, fat score, dentition/age or other parameters that affect meat quality. It is significant too that the Ethiopian industry has no national handling or transport code of practice because these also affect eventual meat eating quality. There are numerous small, basic slaughterhouses throughout Ethiopia which supply the local populace with their meat requirements. In the major cities outside Addis Ababa there are small municipal works and in addition an unknown proportion of total slaughtering will be bush-killed for on-farm or rural communities. These locations are not included in the analysis as it is considered unlikely that products or carcasses from these sites enter the market in Addis Ababa.

From market reports it appears there are ongoing issues with some beef slaughterhouses in terms of access to livestock, quality of livestock, hygiene standards of meat processing, affordability of road and shipping services and documentation meeting requirements in the importing country. As a result, the beef export sector appears to operate intermittently. Of the volumes exported in2012 approximately 60% were in bone-in form as quarters and the balance in deboned hindquarter and forequarter cuts. This situation is attributed to several reasons, including poor demand for beef from slaughterhouses which are badly maintained and have a record of product rejections.

On the following tables and graphs the meat industry projection is clearly stated for the next GTP II and GTP III period which this technology road map document deals with regarding its implementation period for the coming ten years ranges from 2016-2026.

Table 5:- Meat Production Projection in thousands tons 2015-2025

	Total meat	Beef	Goat meat	Sheep meat	Poultry	Camel meat
Base Year 2015	1300	980	97	115	46	74
2020	2103	1467	196	171	99	170
2025	3400	2400	207	237	209	120

Source:- Ethiopian Meat and Dairy Industry Development Institute

Figure 6:- Meat Production Projection in thousands tons 2015-2025

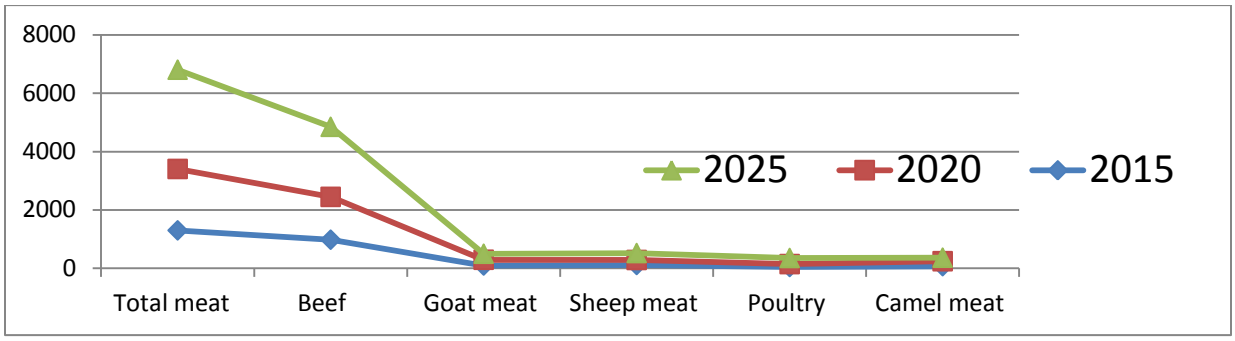


Table: 7- Consumption Projection in thousands tons 2015 – 2025

Category	Total meat	Beef	Goat meat	Sheep meat	Poultry	Camel meat
Base Year 2015	1100	824	69	76	42	54
2020	1670	1323	105	105	75	62
2025	2700	2100	169	169	100	121

Source:- Ethiopian Meat and Dairy Industry Development Institute

Figure 7:- Consumption Projection in thousands tons 2015 – 2025

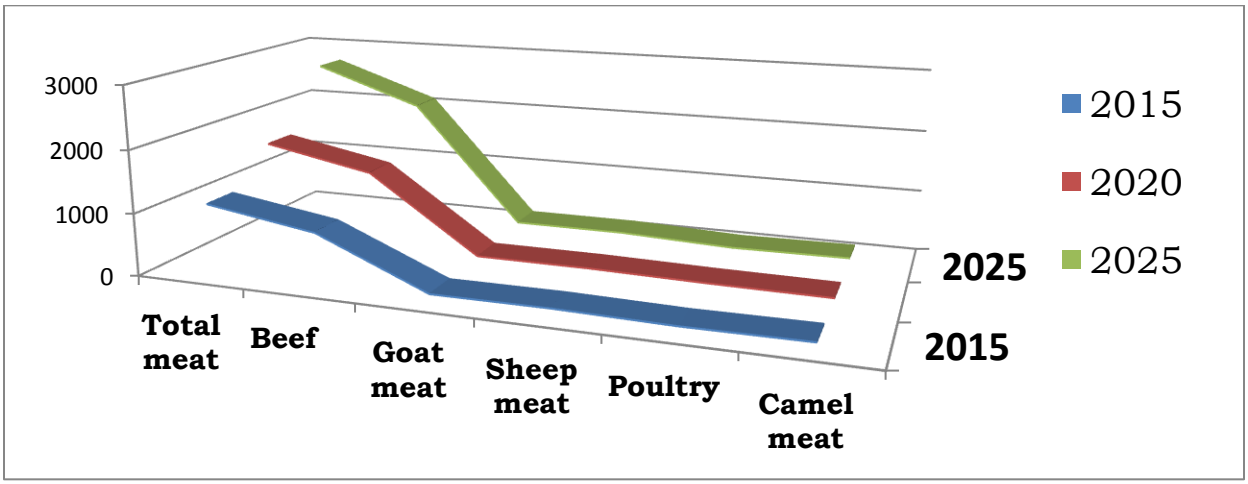


Table 8:- Meat Export Target Volume Projection in ton and in USD 2015-2025

Category	Meat Export volume in ton	Meat Export value in 1000 USD
Base Year 2015	17854.72	112169.2
2020	37501.01	796493.4
2025	78764.94	5655757

Source:- Ethiopian Meat and Dairy Industry Development Institute

Figure 8:- Consumption Projection in thousands tons 2015 - 2025

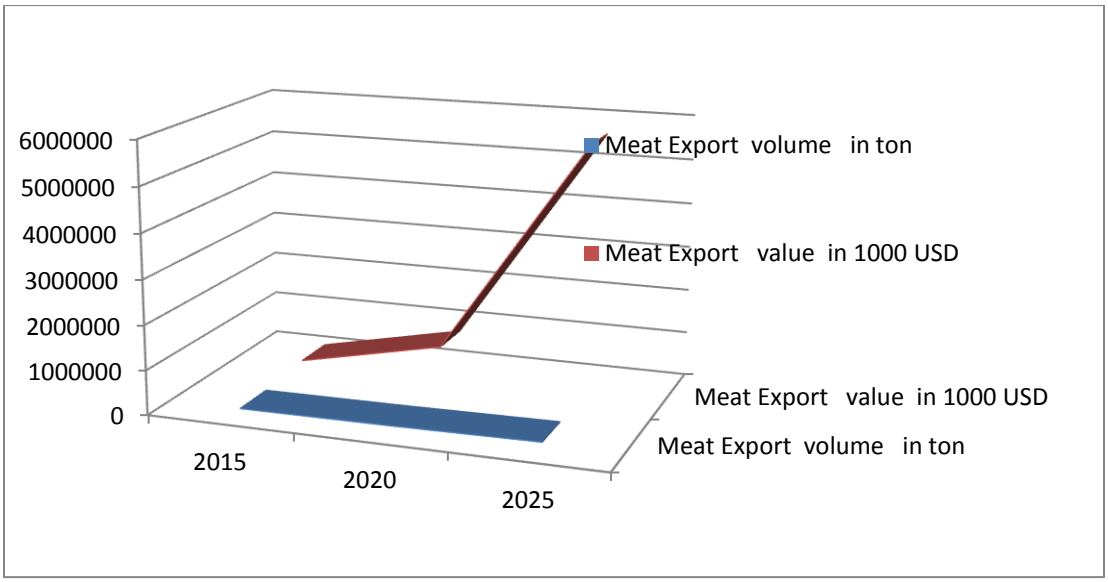
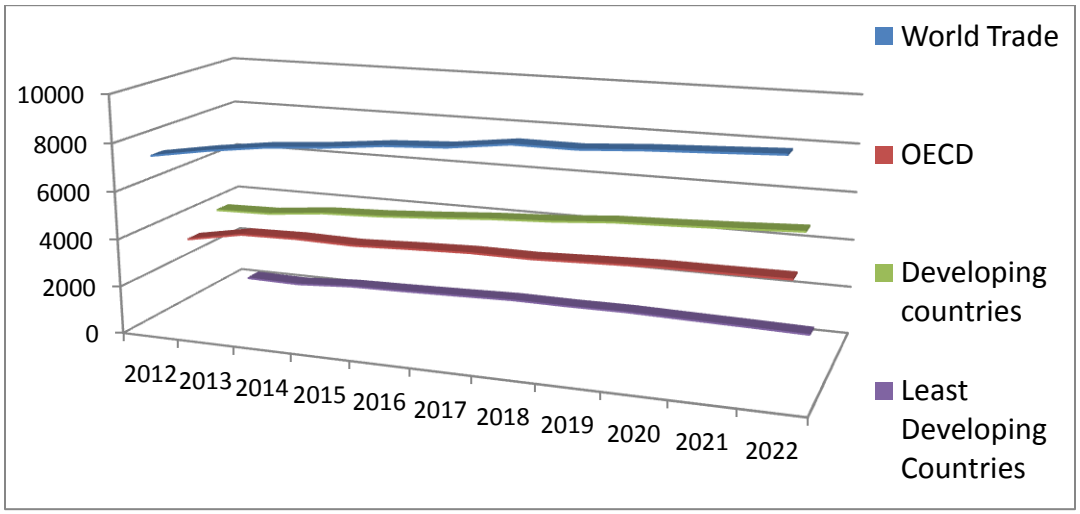


Table 9:- International Beef meat project 2010 - 2022

Category	Projection										
	2010-2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
World Trade	7 429	7 819	8 121	8 130	8 310	8 559	8 680	8 968	9 123	9 225	9 333
OECD	3 292	3 726	3 773	3 724	3 819	3 896	3 887	3 976	4 054	4 062	4 081
Developing countries	3 977	4 029	4 265	4 355	4 507	4 677	4 798	4 990	5 073	5 174	5 291
Least Developed Countries	167	130	290	332	389	455	439	456	411	373	325

Source:- Ethiopian Meat and Dairy Industry Development Institute

Figure 9:- International Beef Meat Projection 2010 - 2022



3. Technology RM Vision, Mission, Goals and Objective

Vision

To see Ethiopia Meat Industry wholesome meat and by-products to meet international standard to reach at domestic market coverage with pugnacious export volume thoroughfare applicable technology in 2025.

Mission

To have the right technology through adaptation, improvement and innovation by identifying technology gaps and selecting critical ones to meet the future needs of the meat industry and ensure the competitiveness of the industry.

Goals

- Enabled meat export volume in tone of 17854.72 from 2015 to tone of 78764.94 by 2025.
- Enablement export from USD 112169.2 (2015) to USD 5655757 by 2025.
- Enabled Meat Production in thousands tons of beef 980 from 2015 to 2400 in 2025, of Goat 97 from 2015 to 207 in 2025, of Sheep 115 from 2015 to 237 in 2025.
- Enabled Meat Consumption in thousands tons of beef from 824 2015 to 2100 in 2025, of Goat 76 169, Sheep from 79 2015 to 169 in 2025.
- To reach 100% hygienic and healthy slaughtering service of cattle, sheep and goats wholesome meat to the public and export market with competitive price in a speedy and trustfulness.
- Introduce 2 value added meat products of processed meat & by-products.
- Assured 100% hides and skins production quality
- Double employment opportunity through transform and adapt applicable meat processing technology.

Objective

To develop, organize, and present information about the critical system requirements and performance targets that must be satisfied from 2015-2016 time frames so as to sound information base regarding key technologies to enable making right technology decision and show direction of research and development of the future technology need of the meat industry.

Part 2 – Technology Road Mapping Deployment Process

Outline

The road mapping development process generally deals with the technology identification and selection for meat industry to achieve the objectives and goals of the industry. It comprises of six chapters including Chapter 1 – Vision and Future Prospect of Meat Industry, Chapter 2 - Environmental Analysis, Chapter 3 – Trends and SWOT Analysis, Chapter 4 – Identification of Drivers, Chapter 5 - Strategic Products and Chapter 6 – Linking of Key Technology with future Market Opportunity.

Vision Building deals with Setting out the future prospect with Vision, Goal and Objective development of the Ethiopian Meat Industry based on the assessment of the industry in part one of the introduction. **Environmental Analysis** deals with three basic points first the legal frame work of the Meat Industry, the secondly deals with Meat Processing Stake holders Analysis. Environmental analyses also assess the current industry in line with technological usage, the shortcomings of the current technology in the industry to indicate the gaps of the industry from the view of technologically advancement. Besides it assessed the drawback of the technology shortcoming up on the quality, quantity, efficiency and market demand implication.

Trends and SWOT Analysis deals with Trends assessment of the Ethiopian Meat Industry in Large Scale and Small Scale with the lists and histories of the Ethiopian Meat Processors. Identification of Drivers deals with the Social, Technological, Economical, Environmental and Political drivers of the technology needs and indicates STEEP analysis. The Drivers details includes (i) Social: Population growth & urban development, income improvement driven demand, Traceability, Public Health, Job creation by value chain, (ii) Technological: Animal Welfare, Capacity utilization, Standard Slathering Facility, Long shelf life regiment, R&D, (iii) Economical: Export Oriented Market Demand, Regional Economic Integration, Import substitution, (iv) Environmental: Climate change, Environmental regulation, Abattoir waste management, (v) Political: Political stability, Government Commitment express by the major policies, strategies and plans of the country and detailed SWOT Analysis. Based on the above road mapping process Strategic Products are identified and the appropriate key technologies selected from alternative technologies and finally Linking of Key Technology with future Market Opportunity is presented as (i) Macro National Science and Technology Innovation Road Map and (ii) Micro National Science and Technology Innovation Road Map.

4. Vision and Future Prospect of Meat Industry

The Vision and Future Prospect of the Ethiopian Meat industry Chapter covers (i) The Ethiopian Meat Industry Vision, (ii) Overall Targets of the Meat Industry, (iii) Strategic Objectives, (iv) Implementation strategies for Development of the Meat Industry (v) Meat Industry Development Programs and Implementation Plan [The Federal Democratic Republic of Ethiopia – Ministry of Industry, Ethiopian Agro-Industry Strategy – meat Industry Sub-Sector Strategic Plan (2015-2025).

4.1 The Ethiopian Meat Industry Vision

Building meat industrial subsector sector with the light processing capability in Africa which is diversified, competitive, environmentally-friendly, improving export performance and there by contribute to the improvement of foreign exchange earnings and the living standards of the Ethiopian people by the year 2025

4.2 Overall Target of Meat Industry

The overall goal of the meat industry subsector strategic plan is to bring about structural change in the livestock sector and meat industry through livestock and meat industry development to achieve same the clear picture of the Ethiopian Meat Industry Structure is necessary to strengthen the linkage among the stakeholders.

4.3 Strategic Objectives

To meet the stated vision and goal of the meat industry subsector, the following strategic objectives are formulated to solve the aforementioned strategic issues and make the subsector sustainably competent:

***Strategic objective 1*:** To increase qualified livestock production and supply;
***Strategic objective 2*:** To scale up quality and safety of meat and it's by product;
***Strategic objective 3*:** To enhance processing capacity level and utilization;
***Strategic objective 4*:** To increase value added and diversified product meat product and its by-product ;
***Strategic objective 5*:** To strengthen stakeholders and value chain actors' cooperation and linkage for common shared vision and goals;
Strategic objective 6: To increase financial access flow across the value chain***;***
Strategic objective 7: To enhance human skill, knowhow and managerial skill across the value chain;
***Strategic objective 8*:** To develop and expand market diversification, access and marketing system.

4.4 Implementation Strategies

The successful implementation of the strategic plan of the Meat Industry depends on the implementation of the programs, projects, and major activities that are pivoted tightly with the strategic objectives of the meat industry plan. The implementing strategies are also designed based on these strategic objectives. Based on the overall strategic directions indicated major implementation strategies for livestock, processing and marketing are formulated. The major strategies are:-

(i) Livestock sector (for all livestock type)

- Improve animal feed production and supply in livestock production system
- Enhance animal health system in all livestock production system
- Improve meat animal genetic productivity in all production system
- Promote smallholder herd productivity through commercial orientation in high-potential areas in all livestock type
- Expand feedlot sector to sustain livestock supply in high-potential areas in all livestock type
- Transform traditional poultry to modern production system
- Enhance effective livestock oriented agricultural extension services
- Improving the policy and regulation environment across the value chain
- Integrate interventions across the value chain
- Improve Finance accessing across the value chain actors in livestock sector
- Encourage linkage and cooperation among farmers and other actors through developing strong supportive institution and associations
- Strengthen Conducting Research and development on livestock production system(breed , feed and animal health)
- Capacity building and technology development on animal livestock production system(rearing practices, fattening feeding system , breeding and animal health controlling) that improve herd efficiency on animal husbandry, animal nutrition and feed formulation
- Encourage private sector and NGOs participation in animal feeding system, breed multiplication and dissemination and animal health service provision improvement.

(ii) Processing

- Upgrade capacity level and utilization of abattoirs
- Improve efficiency and use of other existing local abattoirs
- Enhance industry consolidation through strengthening the existing and establishment new of supportive institutions that encourage stakeholder to for work for common vision and goals
- Assist and commission the studies in the area of value added meat product
- Enhance Capacity building on value addition, upgrade the knowledge and skill of available human resource and produce new competent and appropriate professionals and technicians in the meat industry
- Encourage value addition through adopting new technology and new products from model countries
- Ensure quality and food safety
- Upgrade the technology level of all abattoirs and service providers
- Create awareness for the society on quality and safety of meat products
- Improving the policy and regulation environment across the value chain

(iii) Marketing

- Develop and implement marketing strategy
- Maintain and develop market for both live animal , meat product and its by products
- Reliable supply of live animal and meat product both for domestic and export market
- Strengthen international , regional trade and economic zones cooperation
- Develop efficient marketing system for both live animal and meat product trading.
- Strengthen and develop standard and internationally accepted marketing infrastructure and roads across the value chain
- Enabling access to finance for value chain actors in the market
- Enhance capacity building through education and training on market skills , knowhow and communication
- Strengthen conducting Marketing Research and development
- Improving the marketing policy and regulation environment across the value chain

4.5 Development Programs and Implementation Plan

The aforementioned strategic objectives and strategies guide to develop various programs and thus categorized as top priority/urgent and other/indicative programs as indicated below:

(i) Top priority Programs

✓ **Meat Animal feed production and supply improvement program**

Strategies

- Design resource management system (like: optimal foraging model, zero-grazing system or cut & carry system, ERP) and improve infrastructures.
- Encourage private sector and NGOs participation in animal feeding system, breed multiplication and dissemination and animal health service provision improvement
- Improve feed production and supply
- Enabling service providers access to finance
- Improving the policy and regulation environment across the value chain

✓ **Meat Animal genetic productivity improvement program**

Strategies

- Enhance breed improvement and dissemination centers for all types of meat animals under consideration (bovines, Ovine, Camels & chickens) at national level and breed improvement units;
- Develop; expand and making use of state-of-the art breeding techniques include embryo transfer technology (ETT), estrus synchronization and AI service and establishment of semen producing stations and chicken breeds improvement centers for efficient and effective breeding system
- Encourage private sector and NGOs participation in breed selection and identification provision improvement
- Improve Finance accessing across the value chain actors in livestock sector
- Enhance effective livestock oriented agricultural extension services
- Strengthen Conducting Research and development on livestock production system(breed , feed and animal health)
- Improving the policy and regulation environment across the value chain

- ✓ **Meat animal health input supply and surveillance enhancement program**

Strategies

- Enhance animal disease management and eradication strategies
- Introduce traceability system (at pilot level)
- Implement biosecurity measures to maintain favorable animal health status
- Improve and Enabling institutional support and linkage of the Sector on animal health system
- Encourage private sector and NGOs participation in animal health system improvement introduce livestock insurance services
- Encourage private sector and NGOs participation in animal feeding system, breed multiplication and dissemination and animal health service provision improvement
- Improve Finance accessing across the value chain actors in livestock sector
- Enhance effective livestock oriented agricultural extension services
- Strengthen Conducting Research and development on livestock production system(breed , feed and animal health)

- ✓ **Meat Animal production system development and supply reliability program**

Strategies

- Promote smallholder herd productivity through commercial orientation in high-potential areas in all livestock type
- Expand feedlot sector to sustain livestock supply in high-potential areas in all livestock type
- Transform traditional poultry to modern production system
- Enhance effective livestock oriented agricultural extension services
- Improving the policy and regulation environment across the value chain
- Integrate interventions across the value chain
- Improve Finance accessing across the value chain actors in livestock sector
- Capacity building and technology development on animal livestock production system(rearing practices, fattening feeding system , breeding and animal health controlling) that improve herd efficiency on animal husbandry, animal nutrition and feed formulation

- Improve Finance accessing across the value chain actors in livestock sector
- Strengthen Conducting Research and development on livestock production system (breed , feed and animal health)

✓ **Financial access flow improvement across the value chain *program***

Strategies

- Strengthen the finance sector and improve the availability of loanable funds to the sector
- Improve access to loan for communal farmers and small enterprises engaged in livestock sector
- Introduce new financing programs focusing on special and dedicated financial provision to value chain actors like Agribank's farmer support project (specialized loan provision for smallholder farmers) and other loan provision mechanism for feedlot operator
- Revise collateral requirement :introduce land ownership access to loan and institutional collateral
- Introduce livestock insurance
- Improving the policy and regulation environment across the value chain

✓ **Meat and its byproduct supply reliability and upgrading program**

Strategies

- Strengthen capacity level and utilization of processors
- Improve efficiency and use of other existing local abattoirs
- Assess the abattoirs' of providing incentives package strategy
- Encourage and support the existing abattoirs and meat processing industries in improving their technology levels
- Promote and support the expansion, establishment and capacity improvement of the existing and new by-product processing industries
- Promote and assist product diversification of by product processing companies through adoption, copying and dissemination of new technologies
- Upgrade the knowledge and skill of available human resource and produce new competent and appropriate professionals and technicians in the meat industry

- ✓ **Market access expansion and development program**

Strategies

- Develop and implement marketing strategy
- Maintain and develop market for both live animal , meat product and its by products
- Reliable supply of live animal and meat product both domestically and export market
- Strengthen international , regional trade and economic zones cooperation
- Develop efficient marketing system for both live animal and meat product trading.
- Develop standard and internationally accepted marketing infrastructure across the value chain
- Enabling access to finance for value chain actors in the market
- Capacity building on marketing through education and training
- Strengthen conducting Marketing Research and development

(ii) Other Programs

- ✓ **Strengthening capacity building across the value chain program**

Strategies

- Enhance Capacity building on value addition, upgrade the knowledge and skill of available human resource and produce new competent and appropriate professionals and technicians in the meat industry
- Strengthen Capacity building and technology development on animal livestock production system(rearing practices, fattening feeding system , breeding and animal health controlling) that improve herd efficiency on animal husbandry, animal nutrition and feed formulation
- Enhance capacity building on marketing through education and training

- ✓ **Value addition of meat and its byproducts development and widening program**

Strategies

- Assess the abattoirs' of providing incentives package strategy
- Assist and commission the studies in the area of value added meat product
- Encourage and support the existing abattoirs and meat processing industries in improving their technology levels
- Adopt products from model countries and encourage new product development
- Encourage and support slaughter houses/abattoirs handling and classifying of byproducts in type
- Enhance Capacity building on value addition, upgrade the knowledge and skill of available human resource and produce new competent and appropriate professionals and technicians in the meat industry
- Encourage value addition through adopting new technology and new products from model countries

- ✓ **Quality and safety improvement program**

Strategies

- Support and advise abattoirs to use standard procedures for better slaughtering and meat handling practices
- Encourage and establish research and product development incubation centers with full laboratory facilities.
- Assist and apply international meat quality and safety standards
- Encourage and Enforce implement of international standard waste treatment plant and waste disposal system

- ✓ **Stakeholders/ value chain actors cooperation and linkage enhancing program**

Strategies

- Establish strong supply linkage method between by-product processers and slaughter houses (local and export)
- Strengthen the existing and establishment of new supportive institutions and associations that encourage stakeholder to work for common vision and goals
- Improving the policy and regulation environment across the value chain

✓ **Meat and its by product service provision enhancement program**

Strategies

- Establish and Mandate a regulatory body under MoT to undertaking registration of all meat service providers across the country
- Implement standard quality and safety program
- Upgrade the technology level of all service providers
- Create awareness for the society on quality and safety of meat product

✓ **Efficient marketing system development and expansion program**

Strategies

- Develop efficient marketing system for both live animal and meat product trading.
- Develop standard and internationally accepted marketing infrastructure across the value chain

✓ ***Develop and implement effective and flexible regulations, decrees and other supportive governing rules.***

Figure 10: Meat Industry Subsector Strategic Plan Framework

✓

5. Environmental Analysis

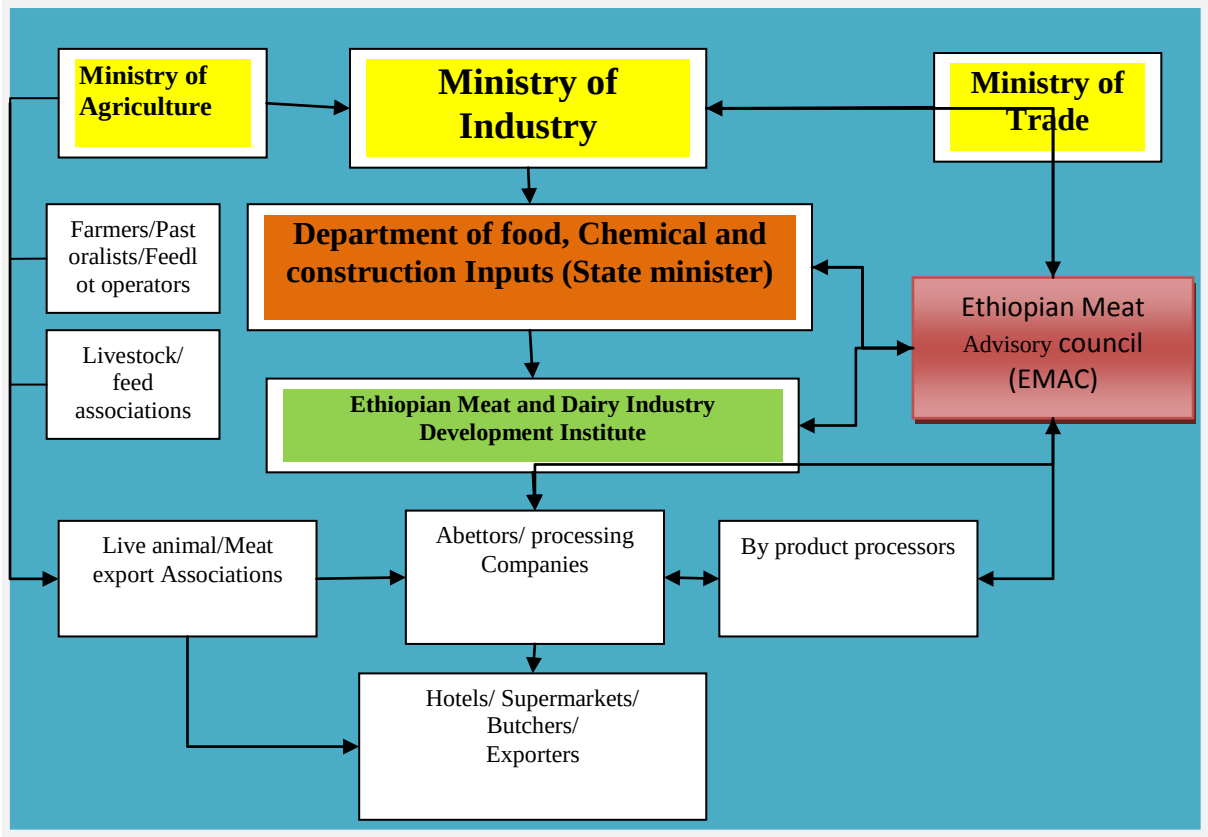
The Ethiopian meat Industry is at its infancy level and characterized by low competitiveness with almost all of the abattoirs and meat processing companies currently working under capacity. Local meat consumption habit is weak and amount of meat supplied to the international market is also small with limited number of regional and international country destinations irrespective of the large livestock resources the country endowed. Together with this, so far, the meat industry structure is feeble with limited role definition among the various bodies playing in the sector.

5.1 Major Stakeholders of the Meat Industry

The major stakeholders in the industry structure include: Ministry of Agriculture, Ministry of Industry, Ministry of Trade, abattoirs and processing companies, hotels and exporters. These stakeholders are linked to one another and expected to work together for the competitiveness of the sector. There are a number of industry-wide institutional actors and legal and regulatory factors that contribute politically, in governance, advocacy and marketing related activities without which the successfulness of the industry may not be possible. These include:

- Ministry of Agriculture and Natural Resources Development (MoANRD): is responsible for the developing of policies and strategies and supervising the performance in to the development of the Meat Industry.
- Ministry of Finance and Economic Cooperation (MoFEC): for the settlement of foreign loan and interest.
- Ministry of Industry (MoI): develops policies and strategies for the expansion of the Meat Industry.
- Ministry of Trade (MoT): responsible for the fair distribution of sugar
- Environment Protection Agency (EPA): responsible for the sustainability and Health Environment
- Food Medicine Health Care Administration and Control Authority (FMHACA): responsible for products control
- Regional Administrations: Closely works with both the Meat Industry by way of not only providing the necessary areas but also by way of creating awareness and mobilization the necessary resources for the operators.
- Cooperatives and Unions: these institutions are significantly important for the close and actively engagement of operators on the Meat production process
- Research Institutions: Introduction and adaptation of improved varieties.

Figure 11:- Ethiopian Meat Industry Structure and Major Stakeholders



5.2 Regulatory Frameworks and the Major Policies, Strategies and Plans of the Country

✓ **The Constitution of the Federal Democratic Republic of Ethiopia**

The 1995 Federal Democratic Republic of Ethiopia constitution sets out the principles and guidelines for environmental protection and management. The Constitution specifically states that everyone has the right to live in a clean and healthy environment and the government will make every effort to provide such an environment (Art.44).

✓ **General Regulatory Framework**

Policies, legal and regulatory frameworks shape the role of the actors in the value chain. A broad range of policies can facilitate or hinder the productivity of a given value chain. In Ethiopia, a number of policies and legal and regulatory issues were issued. Among others, the legal and regulatory documents relevant to the value chain include:

- The Growth and Transformation Plan,
- Climate Resilience Green Economy strategy,
- Cooperative Proclamations,
- Investment Proclamations,
- Animal Diseases Prevention and Control Proclamation (No.267/2002)
- Animal Trade Control Regulation Proclamation (No. 819/2006)
- Legal Notice No. 428 of 1972. Meat Inspection Regulations
- Directive in relation to meat distributions by Food Medicine Health Care Administration and Control Authority (FMHACA)
- The Slaughtering, Meat Processing and Rendering Environmental Standard
- Animals and Animal Products Import And Export Regulations
- Ethiopian labor law

✓ **Domestic Standard Regulations**

Domestic regulations focused on adaptation of international standards which have been practiced by every firm in the sector. The Ethiopian Standard prepared under the direction of Agricultural and Food Technology Technical Committee and published by the Quality and Standards Authority of Ethiopia (QSAE). The different standards and their respective requirements for meat industries are ES 1109:2005: Mutton and Goat meat curried and canned – Specification, ES 1110:2005:- Chilled and frozen mutton and goat meat-specification, ES 1111:2005:- Chilled and Frozen Beef-Specification, ES 1118:2005:- Abattoirs-Basic requirements Meat inspection proclamation No. 274/1970, clearly provides that the main reason for the issuance of the proclamation was to ensure the production and market of meat and meat products, which are sound, wholesome and otherwise of a quality totally fit for human consumption, and thus to protect foreign and domestic consumers.

Under the Public Health Proclamation No. 200/2000, the preparation, distribution, or making available to consumers any food which is unhygienic, contaminated, non-wholesome or mislabeled, and which does not meet the standards of food quality, is prohibited. Any food provided for human being for consumption must fulfill hygienic requirement of the food, and it must be free from health risks and shall satisfy the standards of food quality.

As it is stated under article 9 of proclamation No. 200/2000, any person who is engaged in any activity of selling, producing for sale, storing, preparing or preserving of any food, which is intended for human consumption, is required to meet the standards set by ministry of health.

Thus, legal notice No. 25/1943 and legal notice No.145/147/1950, which deal with the production, distribution and sale of food and food products produced domestically, are applied

The Livestock Marketing Authority (LMA) was set up in 1998 with the objective of promoting domestic and export markets by initiating policies, laws and regulations, issuing quality control directives on exportable and importable materials, encouraging and establishing staging points and quarantine stations for domestic and export trade, promoting the organization of livestock markets, abattoirs, skins and hides shed, encourage the condition of research on the marketing of animal and animal by-products.

- ✓ **The Environmental Policy of Ethiopia**

The goal of the EPE is to improve and enhance the health and quality of life of all Ethiopians, and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole, so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

Now days, addressing environmental issues become a must for survival of industries. To sustain with in the sector companies must implement ISO 14000 series environmental strategy. Meat industries focused, as their ISO 14001 environmental strategy, on three key areas, Water Consumption, Energy Consumption and Product Packaging. ISO 14001 environmental certification provides a framework for environmental management best practice to help organizations: Therefore, ISO 14001 Environmental Management Certification guarantee companies sustainability in the global dynamic market through a series of technology and work practices changes.

- ✓ **Government Concern for the Livestock Sector**

The policy entitled "Livestock Development Policy" which issued in 2014 addresses a legal framework and development strategies and has an action plan for farmers using livestock as supplementary source of income. The Policy aims at the development of small and medium enterprises and large businesses in the livestock sector. The policy aims to bring about a radical change in the current livestock production system and will help in exploitation of potentials of the livestock sector. Import of dairy and livestock machinery/equipment not manufactured locally, is allowed duty free. To provide access to credit to small holders, micro credit schemes have been initiated through commercial banks. Establishment of slaughterhouses and temporary quarantine stations is encouraged in private sector.

6. Trend Analysis of Meat Industry in Ethiopia

The trend analysis of all enterprises involved in meat processing has been broadly categorized in two. The first category comprises of all export standard abattoirs (may be large or medium scale) and offal processing factories. Offal processing companies get their row materials from export abattoirs and municipalities. The second category focuses on all city and municipality abattoirs which considered as small scale processers that serve the slaughtering process for only local consumption. The trend of the industry analyzed described hereunder in detail.

6.1 Large-and Medium-Scale Meat Processors

Those abattoirs are automated and semi-automated in their killing, dehiding, dressing and sanitation operations are considered as large and medium scale process. The abattoirs in this category are found in three different statuses. Some abattoirs are operational others are non-operational although their construction phase is completed and the rest are under construction. Here under are the major operators of the meat industry that can use for the trend analysis of the meat industry:-

Organic Export Abattoir: - Organic Export Abattoir was established in 2006 by an Ethiopian national in the form of a PLC. The firm is located in Modjo, a town about 73 km from Addis Ababa. It covers 2.5 hectare land area. It has annual capacity of 4500 ton shoat meat and 7200 beef. The abattoir is HACCP and ISO certified. The firm faces transportation problems (in transporting live animals) and a shortage of skilled labor. The abattoir has hygiene and sanitation problems. African countries including South Africa, Angola and Congo are potential export destinations, but transportation to these countries is not economic. The firm is in the process of acquiring land to establish its own animal fattening project and cattle slaughtering line. (EMDIDI, 2014)

Luna Export Slaughter House:- Luna Export Slaughter House was established on 2.5 hectare land as a PLC in 2003, with its headquarter in Addis Ababa and slaughterhouse in Modjo,73 km from Addis Ababa. It has designed slaughtering

capacity of 5230 ton/day. The firm is currently engaged only in exporting lamb and mutton.

It is not currently producing at its full capacity, in part because of lack of adequate supply of live animals that meet the required standard. The abattoir has requested land for ranch development, but still did not get satisfactory response from the concerned bodies. Trade fairs, e-marketing and embassies business diplomacy in target countries are the main means of getting customers. All the products of the company are produced for the export market, mainly for countries in the Middle East. (EMDIDI, 2014)

Modjo Modern Export Abattoir PLC: - Modjo Modern Export Abattoir was established in 2008 on 2.7 hectare land area in Modjo town about 83 km from the capital. It has annual production capacity of 5230 ton of shoat meat. It exports lowland sheep and goat meat to the United Arab Emirates and Saudi Arabia. It is HACCP and ISO certified. Modjo modern abattoir sells its products to a group of long established clients and does not look for additional customers since the firm is not confident about the supply of live animals, its processing capacity and the unpredictable air cargo service. In addition to this there is no air plane flight to North Africa, where there is potential market for Ethiopian meat product. The abattoir is poor in its slaughter house design; there is no separation line between killed and live animals which is not in line with the animal's welfare. It has also direct implication in determining the meat quality. More over the ground of the slaughter house is not hygienically constructed. (EMDIDI, 2014)

Helmex Export Abattoir: - The abattoir was established in Debrezeit, on land area of 5.6 hectares. It has annual production capacity of 6000 ton shoat meat and 7200 ton cattle meat. It is HACCP and ISO 22000 certified. It is under expansion to export cattle and camel meat. main weakness of the abattoir that make it perform less in the 2005 E.C are poor management, unpredictable cattle supply, maintaining malfunctioning units like chilling units and sterilizers. Since the factory is not using latest meat technologies, the product sometimes has dark color, which is quality defect. The factory is also poor in its hygienic practice, with cracked floor (EMDIDI, 2014).

Abergelle Export Abattoir: - Abergelle export abattoir was established by EFFORT in 2010. It has 5 hectare land area. The abattoir has annual production capacity of 2850 ton shoat meat and 9072 ton beef. It was engaged in exporting frozen beef until 2012. But after engaged in operation, it stops due to loss instead of profit that the factory faces, since local meat price becomes expensive compared to export market price. The abattoir also lacks air cargo service from MeKelle airport and there are no customers who pay better price for the product. Poor internal management system is another weakness of the Abergelle export abattoir that hinders the overall performance of the abattoir. (EMDIDI, 2014).

Aschraf Export Abattoir:- Aschraf export abattoir was established by Sudanese investor in 2010 in Bahirdar with land area of 5.5 hectares. The abattoir is highly modern compared to all other abattoirs in Ethiopia. It has annual meat production capacity of 5378 ton shoat meat 13219 ton beef. It also has well equipped facilities for deboning and meat by product processing (rendering plant). The abattoir was exporting chilled beef, but stop immediately due to high cattle price as it is reported by the factory manager. EMDIDI has tried to make it operational by making market study of shoat meat export. But generally the measures taken by federal investment agency, the Amhara regional state administration and Ethiopian meat and dairy technology development institute are not as such significant to make the abattoir operational. It needs serious attention, follow up and support to make the abattoir functional. (EMDIDI, 2014)

Abyssinia Export Abattoir: - The former Sami export abattoir and later Abyssinia export abattoir was previously owned by Egyptian investor. The abattoir is located in Debrezeit with 1.5 hectare land area coverage. Due to financial problem, the owner sold the abattoir to Ethiopian investor to work together in the form of Share Company. The abattoir faces serious problems of credit services, land provisions services, basic infrastructures, for extended time. The abattoir is currently trying to facilitate market destination in Dubai, Saud Arabia and Egypt (EMDIDI, 2014).

Jima Abattoir: - This abattoir under construction is being built 6 km east of Jima town in a place called Seka. It is owned by an Italian company known as Gvo River Organic Agro-Industry P.L.C. The total land area secured by the company is 196 hectare of which 156 hectare, few distance from the abattoir, is to be used as holding ground. Essential equipment and machinery are to be imported from Italy. There is a plan to buy a refrigerated track of 8 ton capacity to transport meat from the abattoir to Jima airport. However, no thought is given to buy a dedicated truck to transport animals from purchasing centers to the abattoir. There is no immediate plan by the company to prepare deboned carcass and to use vacuum packing technology. The throughput of the abattoir would be 25 cattle/hour or 200 cattle per 8 hours and 75 shoat/hour or 600 shoat per 8 hours. There would be two physically separate lines for cattle and shoat which allow the slaughter of the two species simultaneously. The company plans to use private planes to transport the meat to markets in the Middle East (MoARD, 2006).

Aksker Ethiopia Casing PLC: - Aksker Ethiopia casing PLC which is located in Modjo was initially involved in offal processing and exporting. The factory has got 2.5 hectare land provision to perform offal processing and exporting in better way and construct export abattoir. The new export abattoir which is under construction has annual production capacity of 6,000 ton cattle meat, 6,000 ton shoat meat and 3710 ton offal products. Turkey is the key market destination for its offal product. The abattoir is still requesting electric power, land and credit services for its progress and good performance. Ethiopian meat and dairy technology development institute is working with the concerned bodies to facilitate these services.

Yongtai Offal Processing PLC: - Yongtai Offal Processing PLC was involved in offal processing using rent house in Bishoftu town. It has annual production capacity of 380 ton offal products. China is the market destination for its products. Since the communities in the area are disturbed by the factory it is transferred to modjo and provided with 1 hectare land. Currently yongtai offal processing factory is under

construction, but its land shortage is still serious problem for the enterprise (EMDIDI, 2006).

NFA Abusiness PLC: - NFA Abusiness PLC is located in Modjo. It is currently processing offal products using rent house. It has 78 ton annual offal production capacities. The factory exports its products to china. The factory is not provided with land. It has also problems of market destination for its products (EMDIDI, 2006).

ELFORA Agro Industries PLC: - ELFORA Agro Industries PLC owns three export abattoirs located in Bishoftu, Melge Wondo, Metehara, and other two meat factories at Gondar and Kombolcha. Each of these abattoirs is discussed separately.

- **Debrezeit ELFORA: -** Debrezeit ELFORA export slaughterhouse, is one of the MEDROC sister companies, it was established in 1973. It is located in Debrezeit with land area of 5 hectares. The firm has 4608 ton shoat meat annual production capacity. It used to export meat of around 100 cattle on a weekly basis. Beef was exported to Congo and Ivory Coast. But currently it is limited to local supply in its cattle meat production. The condition of the abattoir is very poor with unhygienic equipment, walls, floors and ceilings. The sinks in the kill floor do not have hot water and soap for general hygienic purposes. The plant does not have appropriate sterilizers and sinks (MoARD, 2007). The performance of the abattoir is decreasing from time to time, due to shortage of cattle supply. In connection with the abattoir is limited by the government to purchase livestock only from VAT registered suppliers which multiplies its cattle shortage. (EMDIDI, 2014).

- **Methara ELFORA: -** Methara export abattoir was initially established in Methara town by Saud Arabian investor and later owned by MEDROC sister company, ELFORA. It has land area of 5 hectares. The abattoir has got maintenance service by 17 million birr budget support form Ethiopian meat and dairy technology institute before two years but still did not start operation. The reason behind this is small

number of VAT registered livestock traders that are not even sufficient to supply the behind this is small number of vat registered livestock traders that are not even sufficient to supply the Debrezeit ELFORA. The export has strong resistance not to operate unless it is permitted to purchase animals from non VAT registered suppliers/traders (EMDIDI, 2014).

- **Melge-Wondo Meat Factory: -** Melge-Wondo Meat Factory was one of the ELFORA agro industries which were engaged in chilled beef production. It is located SNNP in specific location Wondogenet. The abattoir used to export quartered carcass to Egypt but not operating currently. (EMDIDI, 2014).

- **Gondar ELFORA: -** Gondar ELFORA is located in north Gondar The factory, after privatized by MEDROC sister company, ELFORA, is not involved in production. Instead it was providing slaughtering service for Gondar town. Now another abattoir is established by small and micro enterprises just to serve the slaughtering service in Gondar. It was very difficult to get more information about the current status and future plan of the abattoir. Currently it is engaged in poultry egg production. (EMDIDI, 2014).

- **Kombolcha ELFORA: -** Kombolcha ELFORA and food processing factory, was initially established by Italian government, produces canned meat sauce for military ration. Now it is also serving as abattoir for Wollo University and large hotels in Dessie. The factory is currently facing cattle supply shortage. Expensive cattle price is also another challenge for the factory. (EMDIDI, 2014).

6.2 Small Scale Processors

All municipality abattoirs that serve the slaughtering process for only local consumption in the country use totally manual operation and hence are considered as small scale process for the purpose of this document. The municipality abattoirs are often old, of poor construction and design, have basic

facilities that are usually in want of repair or renewal and may or may not have regular electricity and water supplies.

Many of them have no boundary fence, no lairage and very poor access for motor vehicles. Even if they are fully operational, they have insufficient capacity for today's demand especially at the major festivals which encourages backyard or home slaughter of animals. This might be due of the fact that they constructed perhaps more than 30 years ago .There are an unknown number of much simpler slaughter facilities in each wereda. These mostly comprise a simple concrete slab with perhaps a hoist to raise carcasses off the ground and have a usually rudimentary drainage system. Some municipality abattoirs like Bahirdar municipality abattoir are non-operational due to their poor performance. Customers are obliged to slaughter their livestock at their own backyard. Some other abattoirs like Gondar and Debrebirhan are outsourced to small and micro enterprises and are serving relatively better services, but still poor in facility.

The operational abattoirs are serving to butchers, hotels, restaurants, universities and individuals consumers. All the abattoirs don't use modern technologies even they lack basic traditional facilities like shoe, knife, axe, uniform, vehicle, road, etc. some abattoirs like Bahirdar doesn't have simple knife. They use the worker's knife that he brought from his home. They don't have also variety of services beyond slaughtering. Almost all abattoirs don't have supply linkage system to processors operation in the country. There are an unknown number of much simpler slaughter facilities in most weredas, although their organization is very poor which hinder the attraction of customers towards the service. As a result it is possible to find a lot of wereda, zone, and regional cities without municipality or other organized institute to serve slaughtering service. In general, most local abattoirs are offering poor service quality. As a result of this and culture, the society uses backyard slaughter system. This is basic hindering factor to development of the subsector.

Butchers: -There are many butchers across the country. Accordingly to the study team survey result, most of them are characterized by sanitation problem, no quality control measure, poor meat handling, and no packaging system. They are

also working under small scale due to many reported reasons like lack of places, working capital shortage, live animal shortage, etc…

Hotels/Restaurants: - Across the sample regions covered by the survey in 2014, it was observed that most hotels/restaurants are under the status of poor information delivery (poor data recording system or unwillingness to provide factual information) on actual annual slaughtering capacity and profit margin. In terms of Quality control practice, it was observed that no meat standard quality control practices are applied but there are some sanitary inspection mostly internal by using feedback from customers-sensory evaluation and abattoir stamp (external).Veterinary inspection of animals before slaughter is rarely practiced.

Supermarkets: - During the survey except one supermarket in Hawasa, there is no supermarket that sells meat products across the sample regions .However, in Addis Ababa; there are many supermarkets which involve in meat products trading. Most meat consumer in Ethiopia has no habit of buying packed meat or in the form from supermarket. Hence, peat products purchasing from supermarket by the society is highly underdeveloped.

6.3 Recent Development in Meat Processing Business

The numbers of meat processing factories in Ethiopia are growing, although there are serious challenges to operate sustainably. With the presence of non-operational export standard abattoirs, there are still new constructions of large scale export abattoirs. Among the well-known recent developments in meat industry sector, we can find Allana sons Ltd, Jigjiga livestock export abattoir, Halal food industry meat export abattoir, zayen export abattoir, petram export abattoir, Diredawa & Harar, abattoirs, Hawassa Abattoir and Addis Ababa Abattoirs Enterprise.

Allana Sons Ltd:- Allana Sons, one of the largest Indian meat processing companies, has invested $20 million to establish its first meat processing and exporting plant in Africa. The company has made its base in Ethiopia's Ziway town in Oromiya state of Ethiopia, 159 km from capital Addis Abeba (Walta Information Center). The Company secured 75 hectares of land, from the Oromia Regional

government to erect the plant around the Adami Tulu area in Ziway town, 163 kms from Addis Abeba. Upon completion, the plant will become Allana's first experience of investment on the African continent. Allana is one of the leading meat processing industries worldwide, exporting meats to more than 70 countries. Allana's commencement of operations is expected to exceed the supply of all the exporters that have been operating in Ethiopia in 2012, because it is going to produce 27, 375 tons of meat annually in its first phase. Allana also submitted proposals to the Ministry of industry to be given land to erect two meat processing plants in other areas. One of these is Yabelo, in the Borena Zone of the Oromia Regional State, located 567 kms east of Addis Abeba and known for its livestock abundance. Another one is in the Somali Regional State (EMDIDI, 2014).

Jigjiga Livestock Export Abattoir: - Jigjiga livestock export abattoir is one of large export abattoirs under construction in Jigjiga on 5 hectare land area. It has annual production capacity of 6,000 ton beef and 6000 ton shoat meat. The abattoir is allowed to import its machinery tax free (EMDIDI, 2014).

Halal Food Industry Meat Export Abattoir: - Halal export abattoir is another abattoir with annual production capacity of 16, 200 ton beef and 4500 ton shoat meat is located in Modjo town on land area of 4 hectare. Its construction phase is nearly completed, but did not start operation due high electric power fluctuation and lack of efficient transformer supply (EMDIDI, 2014).

Zayen Export Abattoir:- The abattoir is located in Arsi dera and covers land area of 6 hectares. It has annual production capacity of 5000 ton shoat meat and 15,000 ton beef. Zayen export abattoir was under construction by foreign partners. Unfortunately the partners reach to disagreement on certain issues. Currently there is trail to continue the construction by local investors (EMDIDI, 2014).

Petram Export Abattoir:- The abattoir is located in Debrezeit and covers land area of 5 hectares. It has annual production capacity of 5760 ton shoat meat and 18,000 ton beef. The main challenges that hinder the progress of the abattoir development are lack of credit services, shortage of livestock supply, and complex bureaucracy of concerned offices like banks and customs (EMDIDI, 2014).

Addis Abeba Abattoirs Enterprise Export Standard Abattoir:- has planned to relocate the existing Kera and establish an appropriate modern infrastructure that have a capacity of 20,000 animals slaughter per day (AAAE).

7. Identified Drivers

7.1 Social Drivers

- **Population Growth and Urban Development Social Driver**

In Ethiopia total population estimated to be 84 million from which 83% of the total population living in rural area, the country has a relatively high urbanization rate. In total 14.28 million people live in urban areas. This is 17% of the total population of Ethiopia. The average growth of the urban population is one of the highest in Africa. Central Statistics Agency of Ethiopia projected the country's population to increase at a rate of 2.7 percent per annum over the following five years from 2007 to reach an estimated 83.742 million inhabitants by 2012. A declining rate of growth was then applied to the following years beginning at 2.5 percent in 2013/14 and reducing to less than 1.6 percent in 2036/37, to arrive at a forecast of 136.7 million people by the year 2037. CSA also forecast significant change in the urban/rural composition of the population over the coming decades to the effect that by 2037 over 31 percent of the population will live in urban areas. Therefore, it is forecasted that in regard to Addis Ababa, CSA forecast its population to swell from 2.7 million people, indicated earlier, to be almost 10 million by 2037. With this fact the meat industry as one of the meat industry expected to be respondent to this demand.

- **Income Improvement Driven Demand Social Driver**

Ethiopia has shown tremendous economic growth in the last ten years. The country's GDP growth rate had been around 10% between 2006 and 2013. It is noted that the FAO per capita estimates Household Income, Consumption and expenditure Survey which placed annual consumption at around 50.6 kg per household. The time series for Ethiopia indicated that a slight increase in per capita consumption levels has occurred over the past decade. In the absence of more recent information, Addis Ababa's meat consumption patterns are assumed to be in line overall with national data and that meat consumption is predominantly beef and veal (67%), mutton and lamb (13%), goat (12%), poultry

(5%) camel or other meats (3%). Pork consumption is effectively nil. With the rise the individuals per capital income improved and in return it creates population clamming better hygienic and standard wholesome meat products.

- **Traceability Social Driver**

One of critical public-health safeguard is the ability to determine the origin of meat products that may be related to known incidents of food-borne illness. The ability to trace products to their farm of origin and to any establishments involved in processing is essential so that products posing a risk to consumers can be effectively recalled from the market. Ensure the proper copy of the manifest or bill of sale is delivered with any beef carcass, as required in designated areas of the province. Ensure proper labeling (e.g., tags, package labels or stamps) is provided on all carcasses or packages originating from licensed facilities or cut-and-wrap facilities. Conclusion where meat products cannot be protected from contamination or where temperatures cannot be properly maintained, alternate means of transport must be obtained. Discard any products that became contaminated or were not properly temperature controlled during transport. So that operators of food premises, including individuals transporting or distributing meat products, are responsible for ensuring meat products intended for sale to the public are fit for human consumption. Therefore, from this ground it becomes one of the necessity drivers.

- **Public Health Social Driver**

The meat industry operators who handles, transports, distributes and stores meat products and carcasses destined for public sale and human consumption. This includes owners and operators of food premises, such as licensed slaughter facilities, butcher shops, food retailers and those who transport meat products to any of these facilities. Background Operators of food premises in Ethiopia must ensure that meat intended for public sale is fit for human consumption. Operators and those who transport meat products are required to protect meat from contamination.

Meat processer must also store, handle, prepare, display and dispense these foods in a sanitary manner as part of their routine operations and inspection program. Meat products processed at slaughter or cut-and-wrap facilities have the potential to be soiled with a variety of biological, chemical and physical contaminants if not handled, stored and transported under appropriate conditions. Inadequate controls to protect meat can endanger the safety of meat products and create unacceptable levels of risk for consumers. If meat products are not maintained at appropriate temperatures, spoilage or the multiplication of disease-causing microorganisms or parasites could present a risk to human health.

Proper transportation of carcasses and meat products will reduce the potential for contamination. The following points are the main health issue drivers for transport of meat products.

- Ensure carcasses intended for human consumption and destined for sale have been slaughtered at a licensed facility.
- Carcasses from a Municipal licensed slaughter facility have been examined and deemed to be clean, wholesome and fit for human consumption, which is an important quality-control step.
- Ensure carcasses being transported to an approved cut-and-wrap facility are clean and -not contaminated before or during transport. Carcasses should be free from contaminants such as blood, hair, offal, manure or vegetation.
- The operator of an approved cut-and-wrap facility should refuse any meat that appears to be diseased, unwholesome, spoiled or otherwise unfit, so it is essential to ensure protection of the carcass during transport.
- Inspect the vehicle before loading. Remove items that may contaminate meat products, including fuel, oil, antifreeze, or residues such as wood fragments, gravel, sand and garbage. Wash the vehicle, containers and equipment used for transport, and allow to air dry. Sanitize food contact surfaces.
- Ensure loading and unloading methods prevent product contact with the floor, ground or other surfaces that may be contaminated. Ensure any equipment or surfaces that contact meat products are made of nontoxic, noncorrosive materials that can be effectively cleaned.
- Practice good personal hygiene. Wash hands and exposed portions of arms thoroughly in an adequate hand-washing facility before loading and unloading, and as often as necessary—especially after smoking, eating, drinking or using the toilet or urinal. Do not eat food, drink beverages or use tobacco in any form while loading and unloading. Wear clean outer garments and some form of hair restraint. Provide insulated containers with securely attached lids for smaller-sized products.
- Provide a clean, designated protective tarp, industry-approved shipping bags/ shrouds or other suitable covers for products too large to fit in insulated containers. Tarps should be thoroughly sanitized and properly stored for future use (consider storing in freezer). Securely fasten covers during transport. Pack meat products in a manner that separates them from other products to prevent cross contamination. Use separate containers for raw and cooked or ready-to-eat products.
- Limit transport time when meat products are without refrigeration.
- Travel on dirt or gravel roads and exposure to wind, rain and direct sun may increase the risk of contamination or product damage, especially if meat products are unpackaged. Transport in open environments may also expose meat products to pests. As pests can carry diseases, products must not be exposed to conditions that permit pest access. Ensure tarps or covers are secured and consider double coverings. Keep containers closed, and minimize loading and unloading times.

- **Job Creation by Value Chain Social Driver**

The industry currently run by unqualified employees, there also exist lack of training, inefficient management and leadership which affect the overall goal attainment of industry which set forth in the GTP plan. The industry also challenged by the market share of illegal slaughtering due to luck of facilities and technologies caused by also luck of public awareness. The proper handling of the industry can create considerable amount of employment creation especially from the value chain of Animal Supply ☛ Meat Production ☛ Meat Processing ☛ Meat Distribution ☛ Meat Retail as well by processing the byproduct and the inputs process practice of the industry like hide and skin. Considering the population demography of the country this Job creation will be very essential driving factors for the overall goal/s attainment of the industry.

7.2 Technological Drivers

In order to solve the shortcomings of the industry the art of science of meat production and further meat processing has to be applied in the industry in the manner of modern slaughtering practices as described below:-

- Lairage and Animal Welfare
- Stunning
- Bleeding
- De hiding / flaying
- Complete Slaughter Lines
- Carcass washing
- Deboning
- Meat Packaging
- Special Refrigerated Tracks for Distribution

Facilities in slaughter house:-

- Slaughtering Amenities
- Cold storage including Chillers, Freezers rooms
- Hide and skin preservation facilities
- Emergency slaughter technology
- Laboratory technology slaughter service
- Emergency slaughter technology
- Incinerations technology

Integrated and/or central shared point by-product processing and waste management plant.

Generally Animal Welfare, Capacity utilization, Standard Slathering Facility, Long shelf life regiment, Packaging and Research and Development are the key technology drivers.

7.3 Economical Drivers

There is an export targeted plan that to reach meat export volume in tone of 17854.72 from base year of 2015 to tone of 78764.94 by 2025. And to get export currency amounting USD 112,169.20 from the base year of 2015 to USD 5655757 by 2025 by utilizing the trade relationship growth of Ethiopia's bilateral relationship COMESA, AGOA, effort of accession WTO. Ethiopia imports around 20 tons of different types of meat per year from different countries on average at a cost of more than a million ETB.

Question can be raised: why would Ethiopia, rich in livestock resource, import meat from abroad? Considering the available livestock resource, Ethiopia is supposed to be self-sufficient in meat supply. Status of meat imported Based on Ethiopia's Revenues and Custom Authority's (ERCA) data Ethiopia imported about 100 tons of meat paying around five millions ETB during the years of 2005-2009. Beef (31%) was the most imported meat type followed by offal (25%), pork (21%), poultry meat (15%), edible flours and meals of meat and meat products (5%) and mutton (3%).

Why import? The main reason given by firms for importing meat from abroad is the unavailability of some types of meat (eg, frog legs, pork sausages) and higher quality meat in domestic markets. These firms require tender meat mostly from young animals produced with strict food safety standards. They also indicated that effort made to get quality meat such as beef cuts (tenderloin, etc.) and pork (ham) from the domestic was unsuccessful. The ERCA data indicated that Ethiopia imported meat products from 24 countries during the period under review. Of these, the major sources were United States of America (USA), United Arab Emirates (UAE), Italy, Netherlands, China, South Africa, etc. USA (28%) was the leading meat exporter to Ethiopia followed by UAE (25%) and Italy (10%). Here it is important to note that United Arab Emirates (UAE) and Kingdom Saudi Arabia (KSA) are not important meat importers only, but also important exporters to Ethiopia.

Ethiopian production of high-quality substitutes for imported meat products Even though the volume of imported meat is low; producing substitutes for imported meat products from the domestic sources has two major advantages. Saving foreign currency spent for importing meat is the immediate advantage, while the long lasting effect would be that the preparations made to produce quality local products (export standard) would enhance the capacity of Ethiopian producers for meeting requirements for the export market. To this end, beyond the need to work

with pastoralists and feedlot operators to produce better quality beef from younger bulls as well as working with abattoir operators and government meat inspectors to improve cold chain management and sanitation to insure that Ethiopian meat products meet international safety and quality standards.

7.4 Environmental Drivers

- **The Constitution of the Federal Democratic Republic of Ethiopia (1995):-** The constitution sets out the principles and guidelines for environmental protection and management. The Constitution specifically states that everyone has the right to live in a clean and healthy environment and the government will make every effort to provide such an environment (Art.44).
- **Environmental Policy of Ethiopia (EPE):**- The goal of the EPE is to improve and enhance the health and quality of life of all Ethiopians, and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole, so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.
- **Government concern for the livestock sector: -** The policy entitled "Livestock Development Policy" which issued in 2014 addresses a legal framework and development strategies and has an action plan for farmers using livestock as supplementary source of income. The Policy aims at 3 development of small and medium enterprises and large businesses in the livestock sector. The policy aims to bring about a radical change in the current livestock production system and will help in exploitation of potentials of the livestock sector. Two private sector led companies namely "Livestock and Dairy Development Board" and "Pakistan Dairy Development Company" have been established to increase the pace of development in the livestock sector. Import of dairy and livestock machinery/equipment not manufactured locally, is allowed duty free. To provide access to credit to small holders, micro credit schemes have been initiated through commercial banks. Establishment of slaughterhouses and temporary quarantine stations is encouraged in private sector.

7.5 Political Drivers

Political stability, Government Commitment are the major political drivers the followings are a few government commitment indicators that express the political driver:

The major policies, strategies and plans of the country

- Urban Development Policy
- Climate Resilient Green Economy Strategy (CRGE)
- Integrated solid waste management strategy
- Animals and Animal Products Import And Export Regulations
- Animal Diseases Prevention and Control Proclamation (No.267/2002)
- Animal Trade Control Regulation Proclamation (No. 819/2006)
- Legal Notice No. 428 of 1972. Meat Inspection Regulations
- The Slaughtering, Meat Processing and Rendering Environmental Standard

Table 10: Meat Industry STEEP ANALYSIS

STEEP	Drivers
Social	➢ Population growth ➢ Urban development, ➢ Income improvement driven demand, ➢ Traceability, ➢ Public Health, ➢ Job creation by value chain
Technological	➢ Animal Welfare of animals, ➢ Capacity utilization, ➢ Standard Slathering Facility, ➢ Long shelf life regiment, ➢ R&D,,
Economic	➢ Export Oriented Market Demand, ➢ Regional Economic Integration, ➢ Import substitution
Environmental	➢ Climate change, ➢ Environmental regulation, ➢ Abattoir waste management
Political	➢ Political stability, ➢ Government Commitment express by the major policies, strategies and plans of the country

8 SWOT Analysis of the Meat Industry

8.1 Strength of the Ethiopian Meat Industry

Industry consolidation

- Establishment of supporting associations Like Live animal and meat export associations

Processing company expansion

- The construction of new processing and expansion of companies(meat and feed)

Accreditation

- Tendency and initiation for applying internationally accepted /standard quality and safety control

Product Diversification

- Tendency of Increasing (Limited) diversification of meat products such as the processing of sausages and other similar types of meat

Ample amount of resource, Infrastructure and Market proximity

8.2 Weakness of the Ethiopian Meat Industry

Capacity Utilization

- Underutilization of capacities slow construction of some of the ongoing abattoirs and non-functionality of some abattoirs
- Inadequate investment on further expansion due to limited finance access and others

Poor Processing Technology

- Limited further processing technologies
- Poor meat product handling/packaging , cool chain management, adoption and innovation of products and technology
- Poor slaughter house design of abattoirs

Meat production and Supply

- Unreliable meat and its by product production and supply – seasonal – do not meet market demand

Low Value Addition

- Low value addition ➔Limited scope and engagement in meat/feed processing and by product utilization
- Inadequate meat by product (offal) processing

Industry Consolidation

- weak organizational structure and management
- Weak alliance and relationship with stakeholders
- Stakeholder's engagement Shared vision/common goals

Small Scale Processors/Local Abattoirs

- Limited to local consumption only
- Totally manual operation
- Abattoirs are too old about 70 years old age and too small in general
- Entitled with poor hygienic status
- Inadequate infrastructural facilities
- Poor in facilities like basic equipment's (shoe, knife, axe, uniform, vehicle)

Industry research capacity

- Very limited research efforts and on meat and its by product

Quality and safety of product

- Limited quality control facilities , system and waste treatment system ➔Low quality and safety system

Industrial human resource, skill, knowhow and management

- Shortage of appropriate skill labor for abattoirs- lack of trained and experienced manpower professional as well as machine operators
- Unsafe working environment , limited capacity building and low motivation

Industry Supporting Regulation and Institutions

- Inadequate and ineffective regulation
- Weak institutions

Infrastructural Facilities

- Inadequate and poor infrastructural facilities

Meat Service Providers

- Inadequate and poor service provisions

8.3 Opportunity of the Ethiopian Meat Industry

Infrastructures

- Expansion and availability of infrastructure like road, network, dependable power, water supply, telecom, etc.…

Political and Economic Stability

- Continued Peace and stability

Policy and Institutional Support

- Presence of strong government support for agro processing sector
- Strong commitment government of delivering investment land

Investment Condition

- Establishment of industrial zone corridors
- Good investment attractive policy through various Incentive packages (duty free of imports of capital goods , tax holidays up to five years , exemption from export duties , keep 10% of foreign currency earning in private account etc.)
- Rising of investment demand by foreigners on the subsector

Input supply

- Cheap labor
- Huge livestock population even of there is quality issue

Industry Diversification

- Expansion of Modern Feedlot operation
- Expansion Strengthening of Feed By product (offal) processing

Financial Support

- Facilitating the financial support through financial institution like development with 30%/70%, 20/80%(optional based on viability of the project)

Environment

- Good weather/Favorable climate condition

Trade Relationship

- Growth of Ethiopia's bilateral relationship COMESA, AGOA, effort of accession WTO

8.4 Treat of the Ethiopian Meat Industry

Consumer Requirement

- Rising Public concern for food safety and welfare

Input shortage and Traceability

- Due to quality issues, Existing meat animal don't meet abattoirs requirement for meat export ➔ shortage of meat animals for abattoirs
- Illegal live animal trading ➔ shortage of meat animal for abattoirs

- Input price rising such as livestock price rising➔ shortage of meat animal for abattoirs
- Rebranding and Re-exporting of Ethiopian origin products through re-package the meat as Somalian or , Sundance ,Egyptian, Indian etc

Inconsistence Demand

- Seasonality of demand/ lack of fixed customers for the ready product
- Frequent import bans

Importing Countries Requirement

- Stringent SPS standards in export market
- Strict halal certification requirement from importing countries /un trust of Ethiopia's halal certification

Supporting Institution and Regulation

- Existence of inadequate and illegal municipal abattoirs

8.5 Lessen Learning from the SWOT Analysis

The current meat industry is not as expected considering the ample supply of animals and increasing domestic and international market demand of meat. Therefore, there should be a market linkage between the livestock market and meat processers. Above all the core lesson is that the meat industry has to equipped with the applicable technologies in order to produced customer based requirements of quality and quantity. To do so the industry should focused on some strategic products which are supported by a linkage with their key technologies for the future market opportunity. Therefore, it shows that the technology have a great role to Shine the weakness and treats by properly utilizing the opportunities with the current strengthen the industry have in hand.

9. Strategic Products of the Ethiopian Meat Industry

Based on the analysis of the industry in part one and part two of the technology development process the critical points set out as the vision, goal, and objectives of the meat industry with the critical assessment of Trend Analysis, Environmental Analysis, SWOT Analysis, Drivers Analysis the following products are prioritized as strategic products which are put under three major categories. The first category of carcass is identified as the strategic product mainly targeted for domestic market and partially for export market for Middle East countries. The Second category of Value Added Processed Meat Products mainly targeted for international export market and also for urban areas of domestic market. The third category of valued Added by-products targeted for both export as well as domestic industrial processers for further value added product manufacturing firms as extension of the market chain forward linkage. All strategic products also presumed to be import substitution.

Strategic Products

Carcass

- Beef Carcass
- Shout Carcass

Value Added Processed Meat

- Fresh Processed Meat Products;
- Cured Meat Pieces
- Row Cooked Meat Products;
- Precooked – Cooked Meat Products;
- Raw (dry) Fermented Sausages
- Dried Meat Products;
- Precooked – Cooked Green Offal Product

Value Added Processed By-product

- Blood & Bone Meal
- Gelatin & Glue
- Pet Food
- Tallow
- Horn & Hoofs

Vision & Goal	**Vision** **To see Ethiopia Meat Industry wholesome meat and by-products to meet international standard to reach at domestic market coverage with pugnacious export volume thoroughfare applicable technology in 2025.** **Goals** • **Enabled meat export volume in tone of 17854.72 from 2015 to tone of 78764.94 by 2025.** • **Enablement export from USD 112169.2 (2015) to USD 5655757 by 2025.** • **Enabled Meat Production in thousands tons of beef 980 from 2015 to 2400 in 2025, of Goat 97 from 2015 to 207 in 2025, of Sheep 115 from 2015 to 237 in 2025.** • **Enabled Meat Consumption in thousands tons of beef from 824 2015 to 2100 in 2025, of Goat 76 169, Sheep from 79 2015 to 169 in 2025.** • **To reach 100% hygienic and healthy slaughtering service of cattle, sheep and goats wholesome meat to the public and export market with competitive price in a speedy and trustfulness.** • **Introduce 2 value added meat products of processed meat & by-products.** • **Assured 100% hides and skins production quality** • **Double employment opportunity through transform and adapt applicable meat processing technology.**

- Hide & Skin
- Industrial Red Offal
- Animal Feed
- Natural Compost
- Biogas Energy

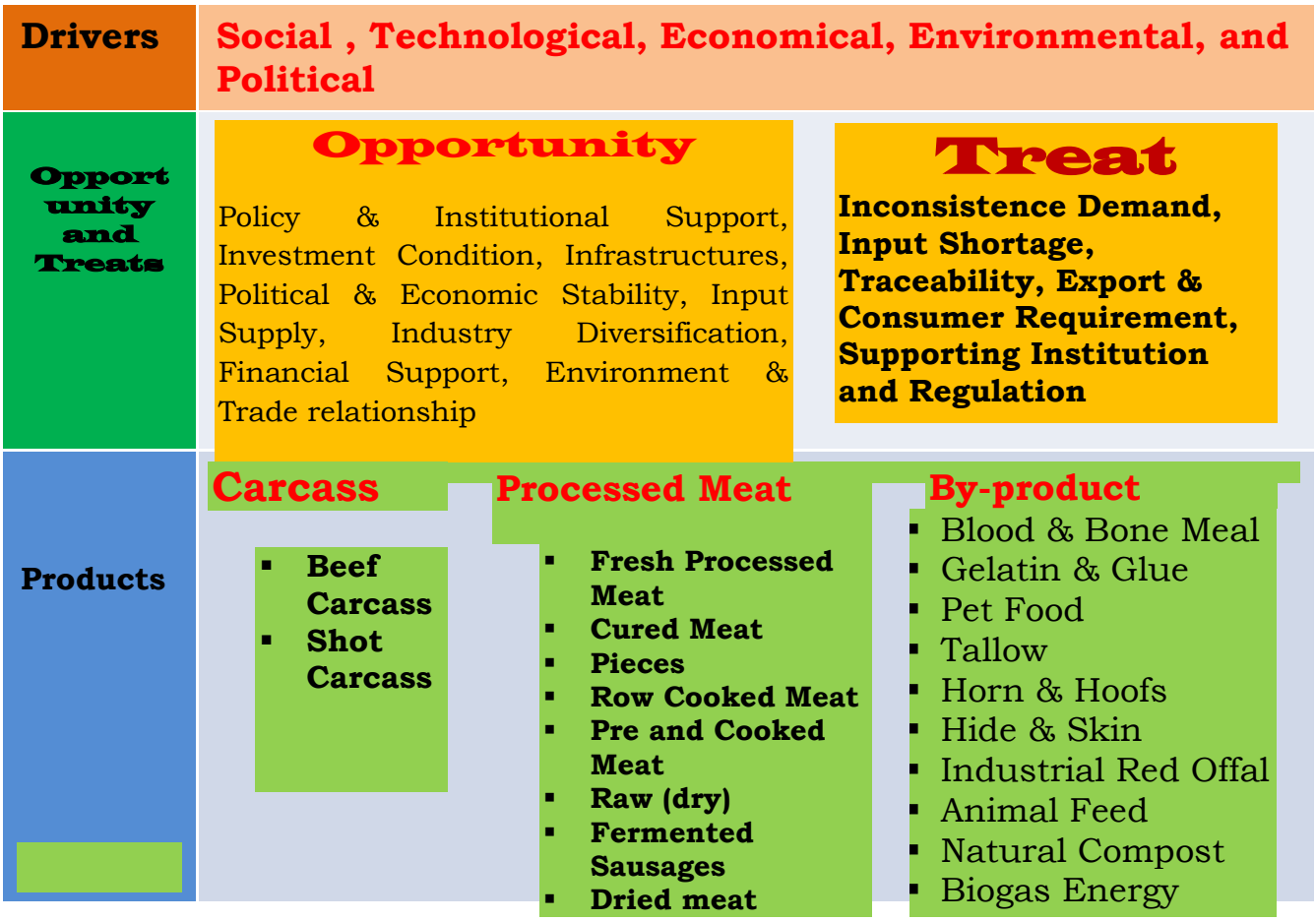


Figure 12: Initial Indicative of technology Road map

10. Technology Identification and Selection

10.1 The Current Technology and its Shortcomings

The Ethiopian meat industry is operated by slaughterhouses found in different towns under direct supervision of municipals with a few export abattoirs found around Debrezeit and Mojo. Almost all the municipals slaughter houses in the country are in the level of slabs. Nowadays there was an attempt to establish modern abattoirs but almost all are not constructed with the art of modern slaughterhouse with an integrated byproduct and waste management plant. The drainage system, process lay out, slaughter equipment, facilities are not available in an adequate manner and also substandard. Above it the industry lacks technical and managerial capability. Currently, abattoirs and other processors in Ethiopia are found in different status. Some of them are non-functional and others are under construction. Even, the functional abattoirs are working under their capacity.

It lack of modern abattoirs and meat processing industries of international standard with all the necessary facilities to qualify for exporting processed and further processed meat products. Slaughtering, de-hiding, deboning and further meat processing technologies are inadequate in number and quality. The existing technologies used by Ethiopian export abattoirs are limited to fresh and deboned meat products. It is reported that four out of five of the export slaughterhouses identified have achieved accreditation under ISO 22000, however, their Hazards Analytical Critical Control Point (HACCP) operations and documentation were not considered satisfactory to the federal authorities, with no sound HACCP plans being available and key breaches of HACCP planning being in evidence during recent inspections in chillers and during carcass spray and trimming operations. It seems that on occasion the ISO accreditation is gained for promotional value but has no real impact on day-to-day operations.

Contrary, there is considerable number of slaughterhouses of different throughputs which generates environmentally impact able amount, if not managed of by-products and wastewater and they are devoid of any measures for control of environmental pollution. But Except the hides and skins and very recently horn in some places have little values. The rest by-products which are useful to produce a variety of industrial products, and that could fetch very huge amount of revenue and create very vast job opportunity discarded as waste creating serious environmental pollution in the area around. Abattoir's by-products continue to be important in production of edible and inedible products. The export of by-products is a significant economic activity that offers additional potential for expanded uses of by-products in industrial applications. However, the country is very far to utilize fully the by-products both for domestic and Export markets. Generally there is poor water treatment system and very limited and poor by- product utilization.

Production Process Tech	**Current/Existing Technology**	**Short coming of the Current Technology**
Lairage and Animal Welfare	▪ Compacted lariage ▪ There is no animal welfare ▪ Lariages narrow and not well constructed	• Poor quality of meat • Poor pre mortal test • Dieses Contamination
Incinerations technology	▪ Simple bricks constructed ▪ It need fuel and wood as input for incineration of the dead anima	• Health Problem unto employee • Environmental Pollution
Laboratory technology slaughter service	▪ Simple Vet laband ▪ No Product Accrediting lab ▪ Pure lab procedure and ▪ Old Outdated Screening Equipment	• Difficulty in Accreditation • Product ban from export • Health and Hygiene Assurance Problem
Emergency slaughter technology	▪ There exist none	• Contamination and transfer of diseases so that create a public health problem

Complete Slaughter Lines	▪ Mechanical line without stunning box, dehiding and contact part are not food grade (stainless steel), ▪ Dirty and clean part of the line is not separated	• Poor hygienically and Quality Product • Substandard for Export Market • Inefficient Operation
Slaughtering Amenities	▪ Poor	• Poor Hygiene, Safety and Quality
Cold storage including Chillers, Freezers rooms	▪ old small size freezers (up to – 18 oC) ▪ Small size freezers and chiller Only used for retains "suspects" carcass ▪ Environmental unfriendly gas	• Short Product Shelf Life • Depletion of ozone • The line leak gas
Deboning and its Packaging	▪ There exist none except a few export abattoirs	• Have no Value-added Product • Loss of Income
De hiding technology	▪ There exist none except a few export abattoirs	• Defect on slaughter on hide and skin • Loss of Income
Hide and skin preservation facilities	▪ There exist none	• Short Product Shelf Life • Defect on hide and skin • Loss of Income
Carcass washing	▪ There exist none except a few export abattoirs	• Poor Hygiene, Safety and Quality
Meat Packaging technology	▪ There exist none except a few export abattoirs	• Short Product Shelf Life • Lose of Employment • Underutilization • Loss of Income
Special Refrigerated Tracks	▪ There exist none	• Short Product Shelf Life • Poor Hygiene, Safety and Quality • Loss of Income

Table 11: The Current Technology and its Shortcomings

Production Process Tech	**Current/Existing Technology**	**Short coming of the Current Technology**
Rendering plant technology	▪ Batch rendering plant only in Addis Ababa Abattoirs Enterprise	• Over cooking of meat and bone meal • Loss or destruction of the desirable protein and amino acids content • Darkness to tallow • Have no Value-added Product • Lose of Employment • Underutilization • Loss of Income
Pet food processing technology	▪ Batch rendering plant only in Addis Ababa Abattoirs Enterprise ✓ Obsolete and the contact part with products are not	• Drying problem • Have no Value-added Product • Lose of Employment • Underutilization • Loss of Income

	stainless steel ✓ Open bed drying ▪ Pilot workshop modified pet food processing plant in export abattoirs	
Blood Processing technology	▪ There exist none	• Have no Value-added Product • Lose of Employment • Underutilization • Loss of Income
Gelatin and Glue processing technology	▪ There exist none	• Have no Value-added Product • Lose of Employment • Underutilization • Loss of Income
Offal processing technology	▪ Collection and cleaning of offal ▪ Manual cleaning only	• Have no Value-added Product • Lose of Employment • Underutilization • Loss of Income
Waste treatment technology	▪ There exist none	• Difficult blood and manure segregation • Have no Value-added Product • Lose of Employment • Underutilization • Loss of Income
Biogas, Combined heat and power generation Technology	▪ There exist none (except a few export abattoirs under pilot project)	• Lose alternative energy • Lose of Employment • Underutilization • Loss of Income
Compositing facilities technology	▪ There exist none	• Have no Value-added Product • Lose of Employment • Underutilization • Loss of Income

Table 11: The Current Technology and its Shortcomings

10.2 Products, Key and Alternatives Technology

Products	Key Technology	Technology Alternatives
Carcass Meat Production Technologies	Animal Receiving Pen	▸ Receiving pen ▸ Adjustable off loading Ramp ▸ Digital washing system ▸ Isolation pen
	Lairage	▸ Concrete Lairage ▸ Pressurized water supply ▸ Foot bath, Showering ▸ Animal Driving devises ▸ Electric stick
	Incinerations	▸ Refractory bricks Incinerator

	Slaughter Laboratory	▸ ISO Standard Laboratory ▸ Food Scan Technologies ▸ Microbial Testing facilities
	Emergency Slaughter	▸ Independent Emergency Complete slaughtering Lines
	Complete Slaughter Lines	▸ Gravity Complete Slaughter Lines ▸ Fully Mechanized Lines, ▸ Conveyors, ▸ Leg & Horn cutter ▸ Splitter, ▸ Sterilizers, ▸ Plat forms, Stunning, ▸ Rails, Hooks, Hanging
	Slaughtering Amenities	▸ ISO Safety Materials ▸ Chemical Hand washing ▸ Sensor Hand Washing ▸ Aprons, ▸ Chain gloves, ▸ Sterilizer and Stainless Still knives
	Cold Storage	▸ Chillers ▸ Freezers room ▸ Ammonia system
	Deboning	▸ Deboning Cutting machineries ▸ Electrical type saw blade
	De-Hiding	▸ Hydraulic De hiding systems ▸ Electrical Motor rolling systems
	Hide and skin Preservation	▸ Solti Preservation ▸ Brained Solution
	Carcass Washing	▸ Spray carcass washing ▸ Stainless steel tunnel
	Refrigerated Tracks	▸ Refrigerated Trucks

Table 12: Products, Key and Alternatives Technology

Product	Key Technology	Technology Alternative
By-Products Processing Technology	Rendering Plant	▸ Semi-automatic controlled ▸ Computerized parameter controlled batch rendering plant
	Pet food Processing Plant	▸ Bach System pet food processing plant ▸ Continuous system pet food processing plant
	Blood Processing	▸ Continuous ring dryer blood processing
	Gelatin and Glue Processing Plant	▸ Gelatin extraction and processing plant, ▸ Milling, calibration ▸ Mixing of gelatin unit

	Offal Processing Plant	▸ Advanced sausage product, ▸ Intestine as raw material processed for surgical suture , ▸ Different pharmaceutical product and etc
	Waste Treatment Plant	▸ Micro-screening to 50 micron ("Baleen" system) ▸ Coupled with a Sequential Batch Reactor (SBR
	Biogas, Combined Heat and Power Generation Plant	▸ Combined heat and power generation ▸ Advanced biogas facilities use developing a reliable mono digestion process using slaughterhouse waste as the sole substrate for anaerobic digestion then use biogas for generation power.
	Compost Processing Plant	▸ Composting in remote area by transporting from each plant
Meat Processed Technology	Vale added Meat Processing Technology	▸ Meat grinder (Mincer) ▸ Bowl cutter (bowl chopper) ▸ Piston stuffer ▸ Clipping machine ▸ Smokehouses ▸ Tumbler or Massager ▸ Vacuum packaging machine ▸ Mixer / blender ▸ Ice flaker ▸ Frozen meat cutter
Packaging Technology	Vale Added Meat Packaging Technology	▸ Food Graded, ▸ Biodegradable, ▸ Active Anti-Microbial Packaging ▸ Vacuum and frozen packaging, ▸ Electrical type saw blade, ▸ Labeling & printing

Table 12: Products, Key and Alternatives Technology

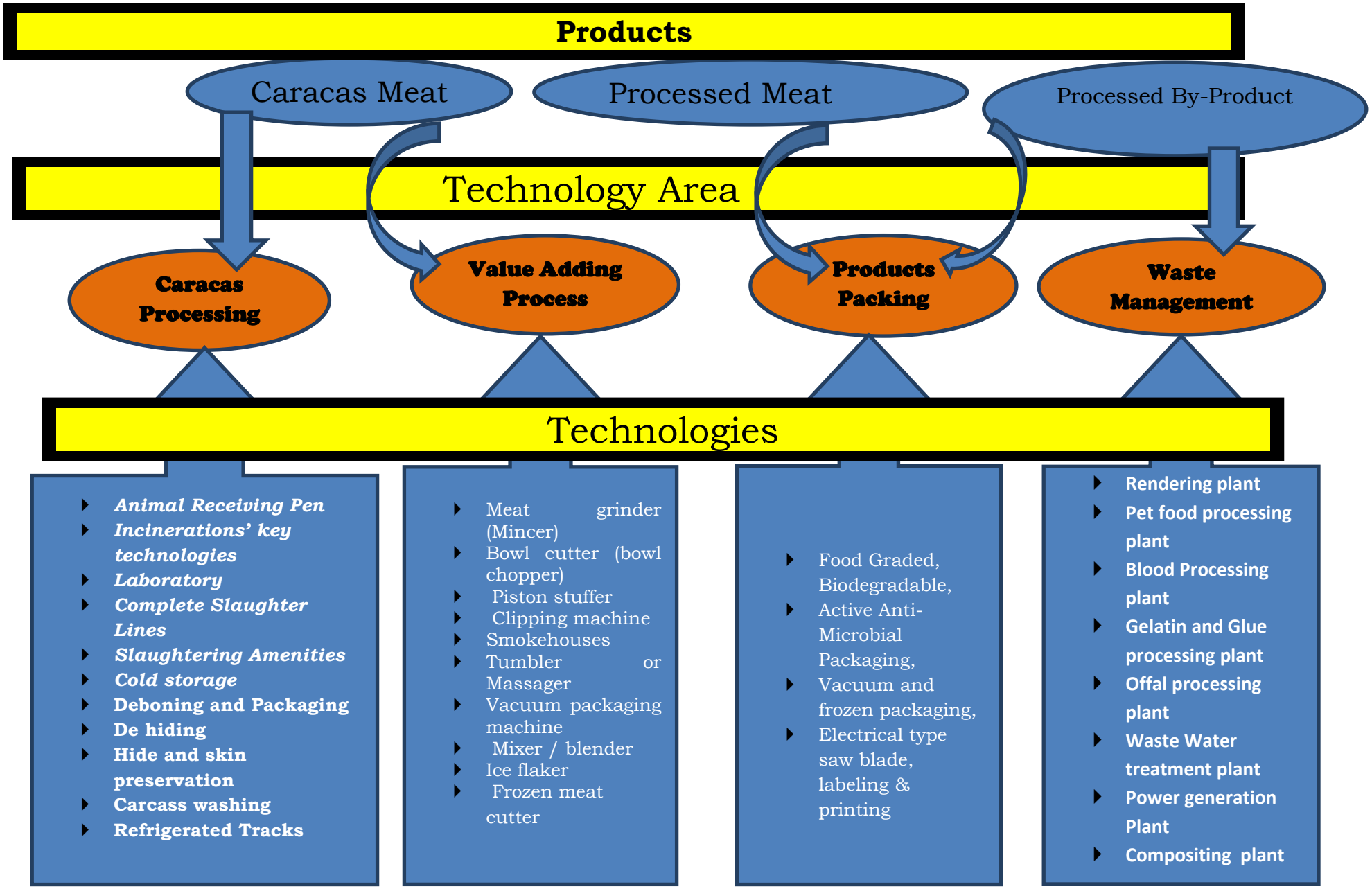
10.3 Performance Dimension & Target

Products	**Performance Dimension**			
	First Stage Performance Target (206-2018)		**Second Stage Performance Target (2019-2022)**	**Third Stage Performance Target (2023-2025)**
	Quality and Quantity	**Safety and Hygiene**	**Packaging**	**Standardization**
	Meet Basic Food Safety Standard and	Free from foreign Particles	Food Graded, Biodegradable, Active Anti-	Meet International Standard HASB

Caracas Meat	GTP 2 and 3 Targeted Production, Consumption and Export Volume	and contaminants	Microbial Packaging	
By-Product	Optimize by Product Utilization and Waste Management.	Free from foreign Particles and contaminants	Food Graded, Biodegradable, Active Anti-Microbial Packaging	Meet International Standard HASB
Processed Meat	Meet Basic Food Safety Standard and Targeted GTP 2 and 3 Production, Consumption and Export Volume	Free from foreign Particles and contaminants	Food Graded, Biodegradable, Active Anti-Microbial Packaging	Meet International Standard HASB

Table 13: Performance Dimension & Target

10.4 Technology Tree Diagram (Figure 13)



10.5 Key Technologies' Performance Dimension and Target (Table 14)

Key Technology	Final Target	Element technology		
		201-2018	2019-2022	2023-2025
Animal Receiving Pen	100% **Improved Animal Handling & Welfare No Rejection**	✓		
Lairage	100% Improved carcass quality and Improved Animal Handling & Welfare	✓		
Incinerations	100% Reduction of Contamination and Healthy environment	✓		
Laboratory slaughter service	100% Verification for safety of product			✓
Emergency slaughter	100% Improved Animal Handling & Welfare And Proper Resource utilization	✓		
Complete Slaughter Lines - Gravity	Increase Productivity 70%	✓		
Complete Slaughter Lines - Mechanized	Increase Productivity 100% (Capacity, Safe product and Time effective)		✓	
Slaughtering Amenities	100% product quality improved	✓		
Cold storage	9% product quality improved (Shelf life)		✓	
Deboning:-	80% product value increased and product diversity		✓	
De hiding :-	100% Damaging rate will reduced and no contamination 90% time effective		✓	
Hide and Skin Preservation	90% quality hide and skin production	✓		
Carcass washing	100% carcass neatness and hygiene	✓		
Special Refrigerated Tracks :-	100% improved carcass neatness and hygiene			✓
Rendering plant	Optimize by-product utilization by 90%			✓
Pet food processing Plant	Optimize by-product utilization by 90%			✓
Blood Processing Plant	Optimize by-product utilization by 90%			✓
Gelatin and Glue processing plant	Optimize by-product utilization by 90%			✓
Offal processing plant	Optimize by-product utilization by 90%	✓		
Waste Water treatment plant	Optimize by-product utilization by 90%			✓
Power generation plant	Optimize by-product utilization by 90%		✓	
Compositing Plant	Optimize by-product utilization by 90%		✓	
Meat processing technologies	Value Added 90% Efficiency		✓	
Packaging Technology	Vale added meat Packaging Technology		✓	

10.6 Key Technologies Acquisitions Performance Target (Table 15)

Key Technology	Target Performance			
	Small Scale	Medium Scale	Corporate level	Import
Animal Receiving Pen		✓		
Lairage	✓			
Incinerations			✓	
Slaughter Laboratory			✓	
Emergency slaughter				✓
Complete Slaughter Lines :- Gravity Lines				✓
Complete Slaughter Lines :- Fully Mechanized				✓
Slaughtering Amenities			✓	
Cold Storage			✓	
Deboning				✓
De hiding				✓
Hide and skin preservation	✓			
Carcass washing			✓	
Special Refrigerated Tracks			✓	✓
Rendering plant				✓
Pet food processing plant				✓
Blood Processing plant				✓
Gelatin and Glue processing Plant				✓
Offal processing Plant				✓
Waste Water treatment Plant	✓			✓
Power generation Plant				✓
Compositing Plant			✓	✓
Meat processing technology			✓`	✓`
Packaging Technology:-			✓	✓

10.7 Micro Level Key Technology – Mobile Abattoir

The potential benefits of multispecies mobile and/or modular abattoirs in the Ethiopia Meat industry is very important because many regions, particularly those across the country are challenged by gaining access to local processing facilities. In many instances the closest facility can be over considerably far from the farm gate. The lack of options and flexibility of marketing outlets is impeding the access and open a gate to potential of illegal slaughtering practice. These remote regions are challenged by isolation, climatic conditions and infrastructure shortage, all of which have prevented the development or maintenance of a permanent processing infrastructure. As a result of the lack of consistent livestock supply for the operation of traditional permanent abattoir facilities, these permanent operations are not viable.

A Mobile and/or Modular Slaughter Unit (MSU/MOSU) has the potential of lower capital investment with flexibility in slaughter location and niche marketing avenues. They will expand market options in suitable regions and also assist local communities who currently cannot access locally produced fresh quality meat. The fundamentals of the MSU include either a singular or series of trailers with both a slaughter and chilling section. Carcasses could either be transported to facilities that already exist or a central local processing system could be introduced. Hot boning techniques could also be considered to increase transport efficiencies and or reduce the extent of the processing facility requirements. Average throughput in similar systems examined 24 cattle in an eight-hour and 12 sheep and goat per day with two labor units. The mobile system has the greatest flexibility in slaughter location and sourcing of livestock.

MOSUs would be based on container arrangement; that is semi-permanent with flexibility to move units on a more seasonal basis. Containers could connect with dedicated slaughter, processing and chilling sections. Although capital outlay would be expected to be greater, these units would have the distinct advantage of a higher throughput, with an estimated fifty cattle per eight-hour day. There is also potential for both mobile and modular systems to work together, with a group of modular processing facilities to support them. The specific system and design of a unit is dependent on every individual circumstance. The system could be used as a buffer for an introductory processing outlet in regions that are currently considering the introduction of suitable permanent processing plants. Interested Butchers and Whole sellers must realize that the MSU/MOSU facility will simply be a marketing tool to provide alternative market avenues to those that are currently unavailable. They must therefore be willing to become vertically integrated and accept that the marketing and logistical management from the slaughtering process will be the major driver of MSU/MOSU system introduction.

Strength of Mobile Abattoir

- The ability to process livestock in isolated regions of the country
- The ability for producers to vertically integrate their businesses
- The capacity to avoid cost on live transport
- The unit is able to move with the seasonal flow and supply of animals that are raised on natural pastures.
- The unit being financially viable.
- Companies directly competing with the unit.
- Best way of reducing illegal and informal slaughter

Opportunities of Mobile Abattoir

- Provide a viable and economical option for producers in isolated regions of the country to process animals locally.
- To supply communities with their own local and processed meat.
- To value-add to rangeland livestock such as beef, goat, and sheep.
- Market the livestock as a grass-fed free-range product processed on farm
- New Skilled employment opportunities.
- Provide flexibility of market opportunity for livestock in isolated regions.
- Will enable marketing of a product with a reduction in the carbon footprint.
- Economical in capital infrastructure, once initial development understood.
- Increase the viability and profitability of livestock enterprises and butchers, wholesalers.
- Increase the quality of the meat product through the reduction of stress on livestock being transported to a processing facility.

Weakness of Mobile Abattoir

- Units have to be adapted to suit harsh environmental conditions, such as long distances, gravel roads, heat, high and low rainfall.
- The limitation of the lack of throughput of livestock processed through the unit.
- The lack of storage capacity in the unit, meaning extra capital outlay for chilling and boning storage

Treats of Mobile Abattoir

- The unit not new for the country.
- It may need Government new operational regulations linked with animal terminal market.
- Disease in livestock limiting the area where the unit could operate.
- Large waste management and by-product processing plants

Figure 14: Pictures of Mobile Abattoirs

10.8 Macro NSTI-RM for Meat Industry Strategic Products (Figure 15)

Vision	To see Ethiopia Meat Industry's wholesome processed meat and by-products domestically self-sufficient and reach at pugnacious export volume thoroughfare applicable technology in 2025.									
Objective	To provide a good information base regarding key technologies to enable making right decision and show direction of research and development of the future technology need of the meat industry of Agro Processing Sector									
Future Prospect	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	(1) Social (2) Economical (3) Political			**(1)Environmental: (2) Economical:**						
	1st stage performance Target			2nd stage performance Target				3rd stage performance Target		
Caracas Meat Production Technology	Animal Receiving Pen, Lairage, Incinerations, Emergency slaughter, Gravity Complete Slaughter Lines, Slaughtering Amenities, Hide and skin preservation facilities, Carcass washing,			Mechanized Complete Slaughter Lines, Cold storage, Deboning, De hiding,				Laboratory slaughter service, Special Refrigerated Tracks for Distribution		
Meat Processing and Packing Technology				Cutting/chopping/comminuting (size reduction), Mixing/tumbling, Salting/curing, Utilization of spices/non-meat additives, Stuffing/filling into casings or other containers, Fermentation and drying, Heat treatment, Smoking, Food Graded, Biodegradable, Active Anti-Microbial Packaging, Vacuum and frozen packaging, Electrical type saw blade, Labeling & printing						
By-Product Technology	Offal Processing Plant			Biogas, Combined heat and Power Generation Compositing Facilities				Rendering plant, Pet food processing plant, Blood Processing, Gelatin and Glue Processing, Waste Water Treatment plant		

10.9 Micro NSTI-RM for Meat Industry Strategic Products (Figure 16)

Vision	To see Ethiopia Meat Industry's wholesome processed meat and by-products domestically self-sufficient and reach at pugnacious export volume thoroughfare applicable technology in 2025.								
Objective	To provide a good information base regarding key technologies to enable making right decision and show direction of research and development of the future technology need of the meat industry of Agro Processing Sector								
Future Prospect	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	(1) Social (2) Economical (3) Political				(2)Environmental: (2) Economical:					
	1st stage performance Target				2nd stage performance Target			3rd stage performance Target		
Caracas Meat Production Technology	Mobile Abattoir									
Meat Processing and Packing Technology					Cutting/chopping/comminuting (size reduction), Mixing/tumbling, Salting/curing, Utilization of spices/non-meat additives, Stuffing/filling into casings or other containers, Fermentation and drying, Heat treatment, Smoking, Food Graded, Biodegradable, Active Anti-Microbial Packaging, Vacuum and frozen packaging, Electrical type saw blade, Labeling & printing					
By-Product Technology	Central Offal Processing Unit				Biogas, Combined heat and Power Generation Compositing Facilities			Rendering plant , Pet food processing, Blood Processing , Gelatin and Glue Processing, Waste Water Treatment.		

Part 3 - Conclusion

11. Recommendations

The effective implementation of the Technology road map requires all stake holders' involvement and for better implementation the following recommendations should be considered during the implementation phase.

- Upgrade capacity level and utilization of abattoirs
- Support to expand capacity utilization of abattoirs to have reliable supply of meat at all seasons
- Enhance Linkage of abattoirs and livestock producers
- Conduct a cost benefit analysis of full slaughtering during the growing season versus the current situation
- Conduct study on the scope and effectiveness of current incentive package strategies
- Establishing role model national meat processing company, that have full facilities for slaughtering and processing of meat products with the international standards
- Enhance industry Consolidation through strong institutional support and stakeholders' cooperation
- Support the existing and the establishment new supportive associations and institutes for the industry like establishment of national meat industry advisory councils, Meat Board of Ethiopia etc.
- Establish strong supply linkage method between by-product processers and slaughter houses (local and export)
- Improving the policy and investment environment to attract and enable private investment in feedlots and slaughter houses
- Strengthen and support a team that is controlled by MoI to map a strategic scheme to improve the linkage between by-product processer and meat producers (local and export abattoirs)
- Prepare stakeholders' workshop to publicize the scheme and incorporate the feedback of the stakeholder to improve the scheme Launch the scheme
- Organize and invite intermediates (cooperatives, private organizations,,,) for collecting the raw by-products in every abattoirs and supplying it to the by-product processing industries according to the developed scheme
- Provide financial and infrastructural assistant to the meat industry operators to adapt and use the technology

- Capacity building and encourage technology usage of municipal slaughter houses/abattoirs handling and classifying of byproducts in type
- Support the local and export abattoirs to have byproduct handling and semi processing or treatment of byproducts area/room with trained human resource by applying basic kaizen principle.
- Promote and support the expansion, establishment and capacity improvement of the existing and new by-product processing industries.
- Assess the critical gaps of existing carcass, processed meat and by-product processing companies that hindering their capacity utilization and design ways of addressing the gap though benchmarking, and technical upgrading
- Promote and assist product diversification of by carcass, processed meat and by-product companies through adoption, copying and dissemination of new technologies
- Establishment of strategic and central carcass, processed meat and by-product processing industry location in various potential areas of the country through studies by assigning team which is controlled by EMDIDI
- Provide adequate assistance to meet the infrastructure to support the establishment of carcass, processed meat and by-product processing industry, improve the facilities of water and electric supply, cold chain facility of airport, proper road facility and other infrastructures that helps the growth of the industries to be established
- Strengthening Research and development
- Supporting and commissioning of research and development findings in the area of value adding products adoption and diversification process like blood, bone, brain, fat, and other offal products which are not produced currently
- Measure and evaluate the research and development out comes, encourage and invite byproduct processing industries to utilize the findings of R &D
- Work with a linkage with those working on the innovation and development of new technologies to increase carcass, processed meat and by-product processing industries.

12. Implementation Action Plan (Table 16)

Projects /Description of actions	Performance Indicators	Implementing body	Target by years										
			Phase I			Phase II				Phase III			
			16	17	18	19	20	21	22	23	24	25	26
1. Coordinate the implementation of the NSTI-RM													
1.1 Put in place a task force to drive the implementation of the **NSTI-RM**	Formed forces	MOST	x										
1.2 Develop operational plans at different levels	Developed operational of plan	MOST, MOI, EMDIDI		x									
1.3 Cleary identify and Assign mandate and responsibility of each implementing bodies	Clear assignment , responsibilities	MOST, MOI, EMDIDI		x									
1.4 Create conducive environments which enable all relevant stakeholders to actively participate in the implementation of the plan	Participation of stakeholders	MOST, MOI, EMDIDI	x	x									
1.5 Prepare and Provide operational budget at different level	Allocation of budget	MOST, MOI, EMDIDI		x	x	x	x	x	x	x	x	x	x
1.6 Develop and implement process monitoring and evaluation plan		MOST, MOI, EMDIDI		x	x	x	x	x	x	x	x	x	x
2. Coordinate impact monitoring													
2.1 Develop and implement an impact monitoring plan based on strategic plan log frame	Conducted Monitoring and impact evaluation	MOST, MOI, EMDIDI		x	x	x	x	x	x	x	x	x	x
3. Review current policies and legislation regarding meat production													
3.1 Conduct comprehensive policy and legislative review	Policies reviewed	MLFD, MOI, EMDIDI, MoT				x			x			x	x
3.2 Develop new policies and legislation to fill gaps	Developed policies	MLFD, MOI, EMDIDI, MOT				x			x			x	x

Part 4 - Appendices

13. Road mapping process

Extensive review of the relevant literature

The NSTI-RM preparation Technical Committee has been the subject of extensive investigation. The study team conducted a thorough review of published and unpublished work, national and international strategic documents, and ongoing study documents providing a starting point for the team's work. Further, an analysis of successful model countries cases provided a context within which to understand the enabling factors in other economies for successful interventions.

Workshop

It is conducted at the beginning of drawing the NSTI-RM toward the end of the draft document preparation to present, test and further refines the team's initial findings and strategies. Workshop was attended by multi- stakeholders from regional and federal government officials, private sector representatives, as well as national and international research organizations. (Figure 17: Work Shop photos)

14. Ministry of Science and Technology consultation:

Frequent discussions and consultations were also conducted with the industry players' and the Ministry of Science and Technology.

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