CODEX ALIMENTARIUS COMMISSION E

Food and Agriculture Organization of the United Nations

World Health Organization

Viale delle Terme di Caracalla, 00153 Rome, Italy - Tel: (+39) 06 57051 - Fax: (+39) 06 5705 4593 - E-mail: codex@fao.org - www.codexalimentarius.org

**Agenda Item 4** **CX/FH 15/47/5**
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**JOINT FAO/WHO FOOD STANDARDS PROGRAMME**

**CODEX COMMITTEE ON FOOD HYGIENE**

**Forty-seventh Session**

**Boston, Massachusetts, United States of America, 9 – 13 November 2015**

# PROPOSED DRAFT GUIDELINES FOR THE CONTROL OF NONTYPHOIDAL *SALMONELLA* SPP. IN BEEF AND PORK MEAT

Prepared by the Electronic Working Group led by the United States and co-chaired by Denmark

**(At Step 3)**

Governments and interested international organizations are invited to submit comments on the attached Proposed Draft Guidelines for the Control of NonThyphoidal *Salmonella* Spp. in Beef and Pork Meat at Step 3 (*see* Appendix I) and should do so in writing in conformity with the Uniform Procedure for the Elaboration of Codex Standards and Related Texts (see *Procedural Manual of the Codex Alimentarius Commission*) **to**: Ms Barbara McNiff, US Department of Agriculture, Food Safety and Inspection Service, US Codex Office, email: Barbara.McNiff@fsis.usda.gov with a copy **to**: The Secretariat, Codex Alimentarius Commission, Joint WHO/FAO Food Standards Programme, FAO, Rome, Italy, email codex@fao.org **by 30 September 2015.**

**Format for submitting comments:** In order to facilitate the compilation of comments and prepare a more useful comments document, Members and Observers, which are not yet doing so, are requested to provide their comments in the format outlined in the Appendix II to this document.

## Background

1. New work on the Guidelines for the Control of Nontyphoidal *Salmonella* spp. in Beef and Pork Meat was approved by the 37th Session of the Commission as proposed by the 45th Session of the Codex Committee on Food Hygiene (CCFH45). The Committee agreed to establish an electronic working group (eWG), chaired by the United States and co-chaired by Denmark, and working in English only. The eWG prepared a draft document which was circulated for comment and considered at CCFH46.

2. The draft guidelines were not discussed in detail at CCFH46, however, the Committee agreed to:

- Retain the current three-part structure (common sections plus beef and pork specific sections);
- Request that FAO/WHO conduct a systematic literature review on control measures from primary production to consumption similar to that done when developing guidelines for control of Salmonella and Campylobacter in chicken meat;
- Establish an eWG and a physical working group (pWG), both led by the United states and co-chaired by Denmark;
- Request that FAO/WHO hold an Expert Meeting prior to CCFH47 to review the technical basis of the mitigation/intervention measures proposed by the working groups; this meeting will be held at the end of September 2015; and
- Convene a pWG meeting on the Sunday immediately preceding the 47th Session.

3. At the pWG meeting, held in May 2015 in Brussels, the draft guidelines were updated based on the comments received at CCFH46 and the literature review conducted by FAO/WHO.

4. The revised draft document was then considered by the eWG and revised based on the eWG comments (from Australia, Brazil, Canada, Denmark, Finland, France, Honduras, India, Japan, Mauritius, New Zealand, Spain, United States).

5. The major comments from both the pWG and eWG reflected mostly the need for clarifications and formatting changes and these were incorporated into the version to be considered at CCFH47. There were no outstanding major issues left unresolved. This updated version will be sent to FAO and WHO for the Expert Meeting.

6. The pWG, which will be held immediately prior to CCFH47, will consider the comments at Step 3 and any input from the FAO/WHO Expert Meeting.

7. Working in parallel, OIE also convened an ad hoc Group (AHG) to develop draft chapters on Salmonella in pigs and cattle for their Terrestrial Animal Health Code (TAHC). This OIE work is on-going and an update on the progress will be provided at the upcoming CCFH meeting. The TAHC will be referenced in the Codex guidance for pre-harvest measures. It is however understood that the OIE specific chapters for their TAHC on control of Salmonella in pigs and cattle will not be finalized for another year or two.

**Recommendations**

8. It is recommended that the Committee consider the revised Proposed Draft Guidelines for the Control of Nontyphoidal *Salmonella* spp. in Beef and Pork Meat with a view to progress it through the Codex step process.

**Appendix I**

# PROPOSED DRAFT GUIDELINES FOR THE CONTROL OF NONTYPHOIDAL *SALMONELLA* SPP. IN BEEF AND PORK MEAT

**(At Step 3)**

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## 1. INTRODUCTION

1. Salmonellosis is one of the most frequently reported foodborne diseases worldwide with beef and pork meat considered important food vehicles. The burden of the disease and the cost of control measures are significant in many countries and contamination with zoonotic nontyphoidal *Salmonella*[1] has the potential to disrupt trade between countries.

2. The large degree of variation exhibited by *Salmonella* in their biological properties, host preferences, and environmental survival presents a particular challenge for controlling the presence of *Salmonella* in animal production. In practice, this means that there is no "one size fits all" solution, and different production systems may require different approaches to control the various serovars of *Salmonella*.

3. These Guidelines apply a risk management framework (RMF) approach as advocated in *Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM)* (CAC/GL 63-2007). "Preliminary Risk Management Activities" and "Identification and Selection of Risk Management Options" are represented by the guidance developed for control measures at each step in the food chain. The following sections on "Implementation" and "Monitoring" complete the application of all the components of the RMF.

4. The Guidelines build on general food hygiene provisions already established in the Codex system and propose potential control measures specific for *Salmonella* strains of public health relevance in beef and pork meat. In this context, the Codex Alimentarius Commission (CAC) is committed to develop standards that are based on sound science[2]. Potential control measures for application at single or multiple steps of the food chain are presented in the following categories:

- Good hygienic practice (GHP) – based: They are generally qualitative in nature and are based on empirical scientific knowledge and experience. They are usually prescriptive and may differ considerably between countries.
- Hazard – based: They are developed from scientific knowledge of the likely level of control of a hazard at a step (or series of steps) in a food chain. They are based on a quantitative base estimate in the prevalence and/or concentration of *Salmonella,* and can be validated as to their efficacy in hazard control at a specific step. They have an effect on consumer protection, but the actual degree of protection is unknown.

5. Examples of control measures that are based on quantitative levels of hazard control have been subjected to a rigorous scientific evaluation in development of the Guidelines. Such examples are illustrative only and their use and approval may vary amongst member countries. Their inclusion in the Guidelines illustrates the value of a quantitative approach to hazard reduction throughout the food chain.

6. The Guidelines are presented in a flow diagram format so as to enhance practical application of a primary production-to-consumption approach to food safety.

7. This format:

- Demonstrates the range of the approaches of control measures for *Salmonella.*
- Illustrates relationships between control measures applied at different steps in the food chain.
- Highlights data gaps in terms of scientific justification / validation for control measures
- Facilitates development of hazard analysis and critical control points (HACCP) plans at individual establishments and at national levels.
- Assists in judging the equivalence[3] of control measures for beef and pork meat applied in different countries.
- Illustrates the interdependent relationship between Codex and OIE guidelines throughout the food chain. These guidelines do not deal with matters of animal health unless directly related to food safety or suitability.

8. In doing so, the guidelines provide flexibility for use at the national (and individual processing) level.

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[1] Human pathogens of public health relevance only. For the purposes of this document, all references to *Salmonella* relate only to human pathogens.
[2] Strategic Goal 2 of the Strategic Plan of the Codex Alimentarius Commission is to "Ensure the application of risk analysis principles in the development of Codex standards" and the CAC Procedural Manual states that "Health and safety aspects of Codex decisions and recommendations should be based on a risk assessment, as appropriate to the circumstances" - 23st Edition, page 218.
[3] *Guidelines on the Judgement of Equivalence of Sanitary Measures Associated with Food Inspection and Certification Systems* (CAC/GL 53-2003).

## 2. OBJECTIVES

9. These Guidelines provide information to governments and industry on the control of nontyphoidal *Salmonella* in beef and pork meat that aim to reduce foodborne disease whilst ensuring fair practices in the international food trade. The Guidelines provide a scientifically sound international tool for robust application of GHP- and hazard-based approaches for control of *Salmonella* in beef and pork meat according to national risk management decisions. The control measures that are selected can vary between countries and production systems.

10. The Guidelines do not set quantitative limits for *Salmonella* in beef and pork meat in international trade. Rather, the Guidelines follow the example of the overarching *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005) and provide an "enabling" framework which countries can utilise to establish control measures appropriate to their national situation.

## 3. SCOPE AND USE OF THE GUIDELINES

### 3.1. Scope

11. These Guidelines are applicable to all nontyphoidal *Salmonella* that may contaminate beef and pork meat (*Bos indicus*, *Bos taurus* and *Sus scrofa domesticus*) and cause foodborne disease. The primary focus is to provide information on practices that may be used to prevent, eliminate, or reduce nontyphoidal *Salmonella* in fresh[4] beef and pork meat.

12. These Guidelines in conjunction with the relevant OIE standards can apply from primary production to consumption for beef and pork meat produced in commercial production systems.

### 3.2. Use

13. The Guidelines provide specific guidance for control of nontyphoidal *Salmonella* in beef and pork meat according to a "primary production-to-consumption" food chain approach, with potential control measures being considered at each step, or group of steps, in the process flow. The Guidelines are supplementary to and should be used in conjunction with the *General Principles of Food Hygiene* (CAC/RCP 1 – 1969), the *Code of Hygienic Practice for Meat (*CAC/RCP 58-2005), the *Code of Practice on Good Animal Feeding* (CAC/RCP 54-2004) and the *Code of Practice for the Processing and Handling of Quick Frozen Foods* (CAC/RCP 8-1976).

14. These general and overarching provisions are referenced as appropriate and their content is not duplicated in these Guidelines.

15. The primary production section of these Guidelines is supplementary to and should be used in conjunction with the *OIE Terrestrial Animal Health Code*[5].

16. The Guidelines systematically present GHP-based control measures and examples of hazard-based control measures. GHPs are pre-requisites to making choices on hazard-based control measures. Examples of hazard-based control measures are limited to those that have been scientifically demonstrated as effective. Countries should note that these hazard-based control measures are indicative only and the references provided should be reviewed to assist application. The quantifiable outcomes reported for control measures are specific to the conditions of particular studies and would need to be validated under local commercial conditions to provide an estimate of hazard reduction[6]. Government and industry can use choices on hazard-based control measures to inform decisions on critical control points (CCPs) when applying HACCP principles to a particular food process.

17. Several hazard-based control measures as presented in these Guidelines are based on the use of physical, chemical and biological decontaminants to reduce the prevalence of *Salmonella* positive carcasses and/or its concentration on positive carcasses. The use of these control measures is subject to approval by the competent authority, where appropriate. Also these Guidelines do not preclude the choice of any other hazard-based control measure that is not included in the examples provided herein, and that may have been scientifically validated as being effective in a commercial setting.

18. Provision of flexibility in application of the Guidelines is an important attribute. They are primarily intended for use by government risk managers and industry in the design and implementation of food safety control systems. The control measures are articulated in this guideline at appropriate steps, however if they could be performed hygienically and effectively they could be applied in other steps in the food chain.

[4] Codex *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005)
[5] http://www.oie.int/international-standard-setting/terrestrial-code/access-online/
[6] FAO/WHO, 2009b

19. The Guidelines should be useful when comparing, or judging equivalence of, different food safety measures for beef and pork meat in different countries.

## 4. DEFINITIONS

Cattle: Animals of the species of *Bos indicus* and *Bos taurus*.

Lairage: Pens, yards and other holding areas used for accommodating animals in order to give them necessary attention (such as water, feed, rest) before they are moved on or used for specific purposes including slaughter.

Nontyphoidal *Salmonella*: Serovars belonging to the species *Salmonella* enterica excluding the typhoidal serovars of subspecies enterica: serovar Typhi, serovar Paratyphi var. A, B and C, and serovar Sendai[7].

Pigs: Animals of the species *Sus scrofa domesticus*.

## 5. PRINCIPLES APPLYING TO CONTROL OF *SALMONELLA* IN BEEF AND PORK MEAT

20. Overarching principles for good hygienic practice for meat production are presented in the *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005) section 4: *General Principles of Meat Hygiene*. Two principles that have particularly been taken into account in these Guidelines are:

i. The principles of food safety risk analysis should be incorporated wherever possible and appropriate in the control of *Salmonella* in beef and pork meat from primary production to consumption.

ii. Wherever possible and practical, competent authorities should formulate risk management metrics[8] so as to objectively express the level of control of *Salmonella* in beef and pork meat that is required to meet public health goals.

## 6. RISK PROFILES

21. Risk profiles were not produced for these guidelines.

## 7. PRIMARY PRODUCTION-TO-CONSUMPTION APPROACH TO CONTROL MEASURES

## 8. CONTROL MEASURES (PRIMARY PRODUCTION)

## 9. CONTROL MEASURES (PROCESSING)

## 10. CONTROL MEASURES (DISTRIBUTION CHANNELS)

22. Sections 7 through 10 contain beef and pork specific measures. The beef sections 7 to 10 are found in Annex I and the pork sections 7 to 10 are found in Annex II.

## 11. CONTROL MEASURES

23. GHP provides the foundation for most food safety control systems. Where possible and practicable, food safety control systems should incorporate hazard-based control measures and risk assessment. Identification and implementation of risk-based control measures based on risk assessment can be elaborated by application of a risk management framework (RMF) process as advocated in the *Principles and Guidelines for the Conduct of Microbiological Risk Management* (MRM) (CAC/GL 63-2007).

24. While these guidelines provide generic guidance on development of GHP-based and hazard-based control measures for *Salmonella*, development of risk-based control measures for application at single or multiple steps in the food chain are primarily the domain of competent authorities at the national level. Industry may derive risk-based measures to facilitate application of process control systems.

### 11.1. Development of risk-based control measures

25. Competent authorities operating at the national level should develop risk-based control measures for *Salmonella* where possible and practical.

26. The risk manager needs to understand the capability and limitations of risk modelling tools[9].

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[7] The zoonotic serovars *S*. Java and *S*. Miami share antigenic structure with *S*. Paratyphi B and *S*. Sendai, respectively, and confusion should be avoided.
[8] *Principles and Guidelines for the Conduct of Microbiological Risk Management* (MRM) (CAC/GL 63-2007).

27. When developing risk-based control measures, competent authorities may use the quantitative examples of the likely level of control of a hazard in this document.

28. Competent authorities formulating risk management metrics[10] as regulatory control measures should apply a methodology that is scientifically robust and transparent.

## 12. IMPLEMENTATION OF CONTROL MEASURES

29. Implementation[11] involves giving effect to the selected control measure(s), development of implementation plan, communication on the decision on control measure(s), ensuring a regulatory framework and infrastructure for implementation exists, and a monitoring and evaluation process to assess whether the control measure(s) have been properly implemented.

### 12.1 Prior to Validation

30. Prior to validation of the hazard-based control measures for *Salmonella*, the following tasks should be completed:

- Identification of the specific measure or measures to be validated. This would include consideration of any measures agreed to by the competent authority and whether any measure has already been validated in a way that is applicable and appropriate to specific commercial use, such that further validation is not necessary.
- Identification of any existing food safety outcome or target, established by the competent authority or industry. Industry may set stricter targets than those set by the competent authority.

### 12.2 Validation

31. Validation of measures may be carried out by industry and/or the competent authority.

32. Where validation is undertaken for a measure based on hazard control for *Salmonella,* evidence will need to be obtained to show that the measure is capable of controlling *Salmonella* to a specified target or outcome. This may be achieved by use of a single measure or a combination of measures. The *Guidelines for the Validation of Food Safety Control Measures* (CAC/GL 69-2008) provides detailed advice on the validation process (section VI).

### 12.3 Implementation

33. Refer to the *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005), section 9.2.

#### 12.3.1 Industry

34. Industry has the primary responsibility for implementing, documenting, applying and supervising process control systems to ensure the safety and suitability of beef and pork meat, and these should incorporate GHP and hazard-based measures for control of *Salmonella* as appropriate to national government requirements and industry's specific circumstances.

35. The documented process control systems should describe the activities applied including any sampling procedures, specified targets (eg, performance objectives or performance criteria), set for *Salmonella*, industry verification activities, and corrective and preventive actions.

36. The industry and/or the competent authority should provide guidelines and other implementation tools to industry as appropriate, for the development of the process control systems.

#### 12.3.2 Regulatory systems

37. The competent authority may approve the documented process control systems and stipulate verification frequencies. Microbiological testing requirements should be provided for verification of HACCP systems where specific targets for control of *Salmonella* have been stipulated.

38. The competent authority may use a competent body to undertake specific verification activities in relation to the industry's process control systems. Where this occurs, the competent authority should stipulate specific functions to be carried out.

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[9] Basic Food Hygiene texts Guidelines for Microbiological Risk Assessment 1996
[10] *Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM)* (CAC/GL 63-2007).
[11] See Section 7 of the *Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM)*(CAC/GL 63-2007 ) .

### 12.4 Verification of control measures

39. Refer to the *Code of Hygienic Practice for Meat* (CAC/RCP 58-2005), section 9.2 and the *Guidelines for the Validation of Food Safety Control Measures* (CAC/GL 69 -2008), Section IV.

#### 12.4.1 Industry

40. Industry verification should demonstrate that all control measures for *Salmonella* have been implemented as intended. Verification should include observation of monitoring activities, documentary verification, and sampling for *Salmonella* testing as appropriate.

41. Verification frequency should vary according to the operational aspects of process control, the historical performance of the establishment and the results of verification itself.

42. Record keeping is important to facilitate verification and for traceability purposes.

#### 12.4.2 Regulatory systems

43. The competent authority and/or competent body should verify that all regulatory control measures implemented by industry comply with regulatory requirements, as appropriate, for control of *Salmonella*.

## 13. MONITORING AND REVIEW

44. Monitoring and review of food safety control systems is an essential component of application of a risk management framework (RMF)[12]. It contributes to verification of process control and demonstrating progress towards achievement of public health goals.

45. Information on the level of control of *Salmonella* at appropriate points in the food chain can be used for several purposes, eg, to validate and/or verify outcomes of food control measures, to monitor compliance with hazard-based and risk-based regulatory goals, and to help prioritize regulatory efforts to reduce foodborne illness. Systematic review of monitoring information allows the competent authority and relevant stakeholders to make decisions in terms of the overall effectiveness of the food safety control systems and make improvements where necessary.

### 13.1 Monitoring

46. Monitoring should be carried out at appropriate steps throughout the food chain using a validated diagnostic test and randomized or targeted sampling as appropriate[13].

47. For instance the monitoring systems for *Salmonella* and/or indicator organisms, where appropriate, in beef and pork may include testing at the farm and animal level, in the slaughter and processing establishments, and the retail distribution chains.

48. Regulatory monitoring programmes should be designed in consultation with relevant stakeholders, taking into account the most cost-efficient resourcing option for collection and testing of samples. Given the importance of monitoring data for risk management activities, sampling and testing components should be standardized on a national basis and be subject to quality assurance.

49. The type of samples and data collected in monitoring systems should be appropriate for the outcomes sought[14].

50. Monitoring information should be made available to relevant stakeholders in a timely manner (eg, to producers, processing industry, consumers).

51. Wherever possible, monitoring information from the food chain should be combined with human health surveillance data and food source attribution data to validate risk-based control measures and verify progress towards risk-reduction goals. Activities supporting an integrated response include:

- Surveillance of clinical salmonellosis in humans
- Epidemiological investigations including outbreaks and sporadic cases

[12] See section 8 *Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM)* (CAC/GL 63-2007).
[13] Refer to OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 2014, Chapter 2.9.9 Salmonellosis and the relevant chapters of the OIE Terrestrial Animal Health Code.
[14] Enumeration and sub-typing of microorganisms generally provides more information for risk management purposes than presence or absence testing.

### 13.2 Review

52. Periodic review of monitoring data at relevant process steps should be used to inform the effectiveness of risk management decisions and actions, as well as future decisions on the selection of specific control measures, and provide a basis for their validation and verification.

53. Information gained from monitoring in the food chain should be integrated with public health surveillance, food source attribution data, and withdrawal and recall data, where available to evaluate and review the effectiveness of control measures.

54. Where monitoring of hazards or risks indicates that regulatory performance goals are not being met, risk management strategies and/or control measures should be reviewed.

### 13.3 Public health goals

55. Countries should consider the results of monitoring and review when revaluating and updating public health goals for control of *Salmonella* in foods, and when evaluating progress. Monitoring of food chain information in combination with source attribution and human health surveillance data are important components[15].

[15] International organisations such as WHO provide guidance for establishing and implementing public health monitoring programmes. WHO Global Foodborne Infections Network (GFN) http://www.who.int/salmsurv/en/

**ANNEX I**

## CONTROL MEASURES FOR BEEF
## (For Sections 7 to 10)

## 7. PRIMARY PRODUCTION-TO-CONSUMPTION APPROACH TO CONTROL MEASURES

1. These Guidelines incorporate a "primary production-to-consumption" flow diagram that identifies the main steps in the food chain where control measures for *Salmonella* may potentially be applied in the production of beef. While control in the primary production phase can decrease the number of animals carrying and/or shedding *Salmonella,* controls after primary production are important to prevent the contamination and cross-contamination of carcasses and meat products. The systematic approach to the identification and evaluation of potential control measures allows consideration of the use of controls in the food chain and allows different combinations of control measures to be developed. This is particularly important where differences occur in primary production and processing systems between countries. Risk managers need the flexibility to choose risk management options that are appropriate to their national context.

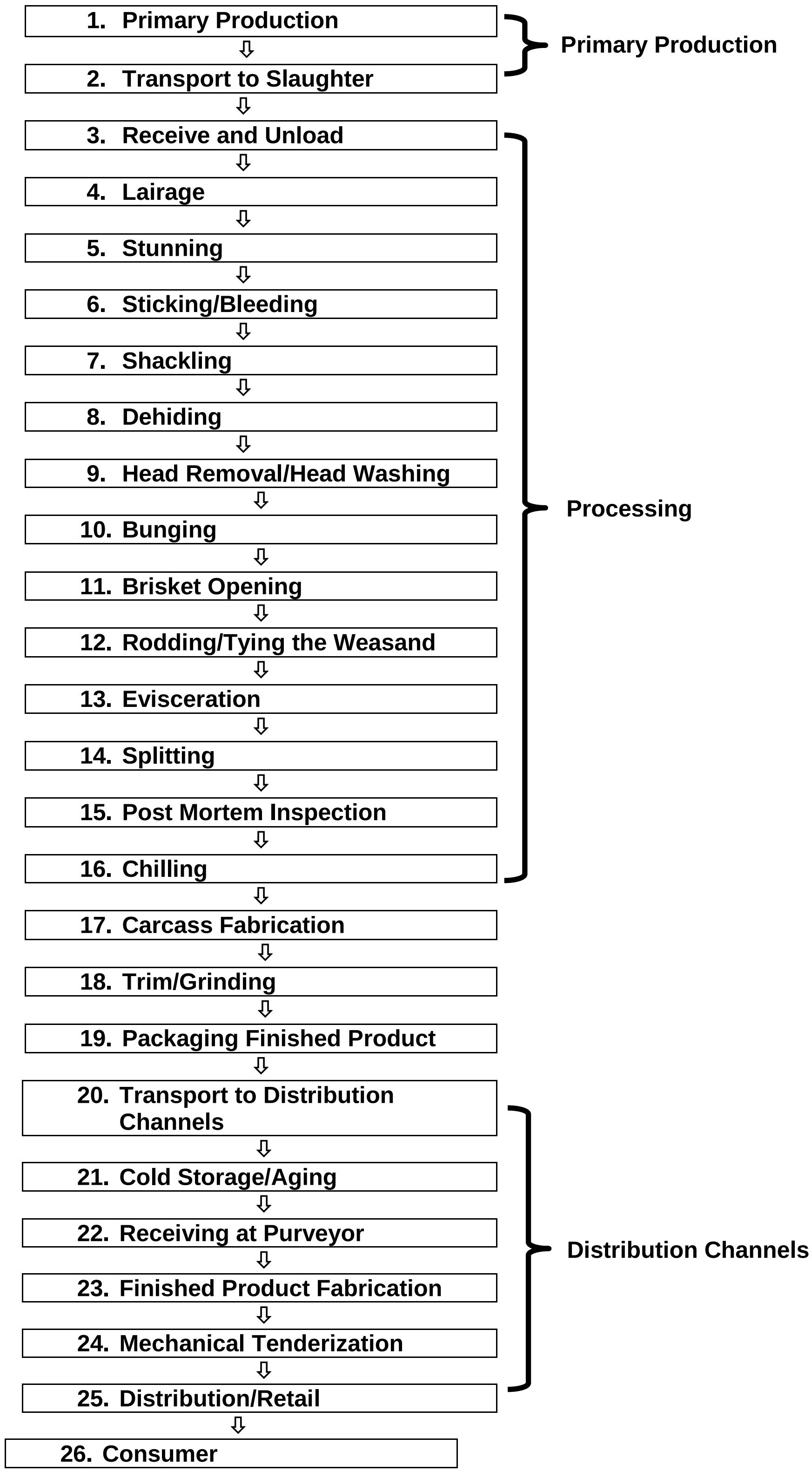
### 7.1. Generic flow diagram for application of control measures

2. A generic flow diagram of the basic beef production processes is presented on the following pages. GHP- or hazard-based interventions that may be applied during processing have been identified at the appropriate process step(s) in the flow diagram

3. Individual establishments will have variations in process flow and, if possible or required by national law, should develop and adapt HACCP plans accordingly. In countries where HACCP is not widely used, the fundamental principles and practices of HACCP may still be applicable.

4. The basic steps in the slaughter process are to a large extent common but they may be carried out differently in different slaughterhouses or countries. Therefore the necessity to use supplementary mitigation steps will also vary among individual slaughterhouses and countries. The use of supplementary mitigation steps will depend on the food safety targets set, for example, by the competent authorities or customers (eg, retail chains) and will be influenced by a range of factors, eg, animal feed, hygienic slaughter procedures, age of livestock, farming practices, size of establishment, equipment, automation, slaughter line speed, and the initial *Salmonella* load from incoming animals (for example, seasonal variation). A variety of interventions may be used to reduce contamination with *Salmonella* throughout processing. While the effect on *Salmonella* of the individual interventions can be variable, there is clear evidence that use of multiple interventions throughout processing as part of a "multiple-hurdle" strategy will provide a more consistent reduction of *Salmonella*.

**Process Flow Diagram 1: Primary Production to Consumption – Beef**




These process steps are generic and the order may be varied as appropriate. This flow diagram is for illustrative purposes only. For application of control measures in a specific country or an establishment, a complete and comprehensive flow diagram should be drawn up.

### 7.2. Availability of control measures at specific process flow steps addressed in these Guidelines

5. The following table illustrates where specific control measures for *Salmonella* may be applied at each of the process flow steps of the food chain. Control measures are indicated by a check mark and their details are provided in these Guidelines and the OIE Terrestrial Animal Health Code[16] in the case of GHP. A blank cell means that a specific control measure for *Salmonella* has not been identified for the process flow step.

6. Decontamination treatments may be applied at multiple steps within the process flow and may vary between countries, establishments or type of process flow.

[16] Refer to website: www.oie.int.

**Availability of Control Measures at Specific Steps in the Process Flow**

| Process Step | GHP-based Control Measures | Hazard-based Control Measures |
|---|---|---|
| 1. Primary Production ↓ | Refer to[17,18] | |
| 2. Transport to Slaughter ↓ | Refer to[2,3] | |
| 3. Receive and Unload ↓ | Refer to[2,3] | |
| 4. Lairage ↓ | Refer to[2,3] | ✓ |
| 5. Stunning ↓ | ✓ | |
| 6. Sticking/Bleeding ↓ | ✓ | |
| 7. Shackling ↓ | ✓ | |
| 8. Dehiding ↓ | ✓ | ✓ |
| 9. Head Removal/Head Washing ↓ | ✓ | ✓ |
| 10. Bunging ↓ | ✓ | ✓ |
| 11. Brisket Opening ↓ | ✓ | |
| 12. Rodding/Tying the Weasand ↓ | ✓ | ✓* |
| 13. Evisceration ↓ | ✓ | ✓* |
| 14. Splitting ↓ | ✓ | ✓* |
| 15.Post Mortem Inspection ↓ | ✓ | |
| 16. Chilling ↓ | ✓ | ✓ |
| 17. Carcass Fabrication ↓ | ✓ | |
| 18. Trim/Grinding ↓ | ✓ | ✓ |
| 19. Packaging Finished Product ↓ | ✓ | ✓ |
| 20. Transport to Distribution Channels ↓ | ✓ | |
| 21. Cold Storage/Aging ↓ | ✓ | |
| 22. Receiving at Purveyor ↓ | ✓ | |
| 23. Finished Product Fabrication ↓ | ✓ | |
| 24. Mechanical Tenderization ↓ | ✓ | |
| 25. Distribution/Retail ↓ | ✓ | |
| 26. Consumer | ✓ | |

*Details for specific hazard-based controls can be found under Step 8, Dehiding

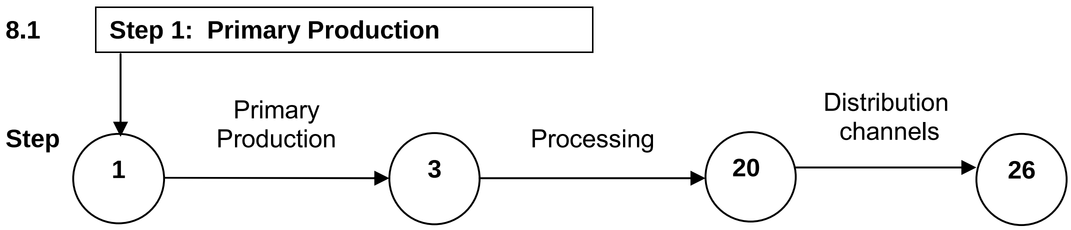
17 OIE Terrestrial Animal Health Code: www.oie.int
18 Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005)

## 8. CONTROL MEASURES FOR PRIMARY PRODUCTION (STEPS 1 TO 2)

7. These Guidelines should be used in conjunction with, the OIE Terrestrial Animal Health Code[2], the *Code of Practice on* Good *Animal Feeding* CAC/RCP 54-2004 and Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005).

8. It has been shown in some production systems that control of *Salmonella* in beef can begin on the farm. Practical measures to control *Salmonella* during primary production should be implemented where possible.

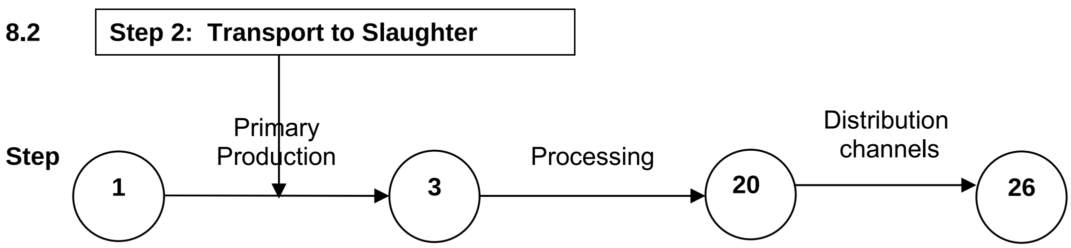
### 8.1 Step 1: Primary Production




#### 8.1.1 GHP-based control measures

9. Refer to the OIE Terrestrial Animal Health Code[2].

### 8.2 Step 2: Transport to Slaughter




#### 8.2.1 GHP-based control measures

10. Refer to the OIE Terrestrial Animal Health Code[2] and Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005).

## 9. CONTROL MEASURES FOR PROCESSING (STEPS 3 TO 19)

11. General control measures including those identified in the Code of Hygienic Practice for Meat (*CAC/RCP 58*-2005) should be implemented to prevent the contamination or cross-contamination of carcasses throughout the slaughter process. Control measures that may have particular impact on the control of *Salmonella* include:

a. Personal equipment and the environment should be kept clean and disinfected as required.

b. Cleaning and disinfection procedures should be employed regularly and performed in a manner to prevent spread of pathogens.

c. Water accumulation on the floor should be avoided and good floor drainage design should be ensured.

d. Equipment should be maintained and designed to avoid contamination and build-up of organic material.

e. Knives should be cleaned and disinfected between carcasses.

f. Personnel should be trained both on operations and food safety aspects of slaughtering the line speed should leave adequate time to perform all process steps in the operations.

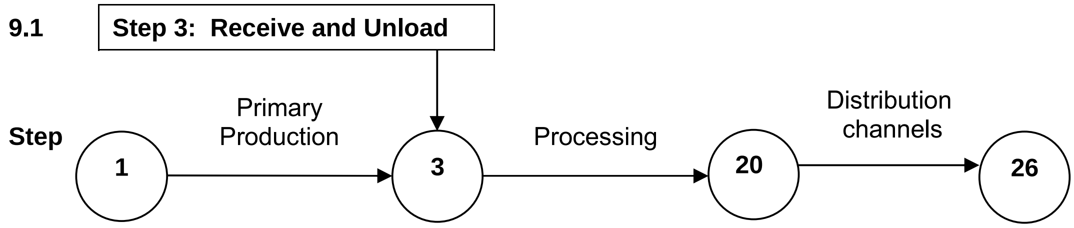
g. Maintain proper employee hygiene practices to prevent the creation of unsanitary conditions (eg, touching product with soiled hands, tools, or garments). Personal hygiene should include the washing of hands to prevent cross-contamination.

h. Water used for decontamination or cleaning and disinfection of equipment should be potable. In steps prior to stunning clean water may be used.

i. Personnel health.

12. Also refer to the OIE Terrestrial Animal Health Code[2].

**9.1**




13. This is the point where cattle arrive at the establishment. There is an increased potential for contamination with enteric pathogens such as *Salmonella* during this time because of their presence on the hide and in feces of cattle. Additionally, transportation to the slaughter facility, handling during transport and unloading, and interaction with other cattle may cause stress and increased shedding of pathogens. Also refer to the OIE Terrestrial Animal Health Code[2] and Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005).

**9.1.1 GHP-based control measures**

14. Loading docks should be maintained clean and should be disinfected as often as practical, taking into account environmental conditions.

15. When receiving the cattle the slaughterhouse should

a. Consider any information provided by the farm or feedlot, on the production systems or feedlot controls for *Salmonella*. Effective farm and feedlot management and control can reduce fecal shedding of the organism, as well as reduce the microbial load on the animals, and in the intestinal tract.

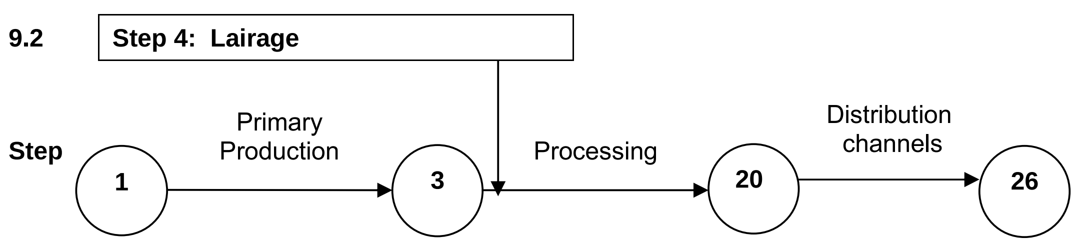
   Where the *Salmonella* status is known, this information should be communicated to the slaughter house before arrival/receiving. For example, food chain information in the form of electronic or paper records should be applied to improve hygiene interventions at slaughter. The availability of food chain information prior to slaughter would allow food business operators, meat inspectors and risk managers to take steps to minimize cross-contamination during slaughter.

b. If food chain information is available, herds with a high incidence of *Salmonella* can be segregated and processed at the end of the production day.

c. Consider other factors that may contribute to the spread of *Salmonella,* for example the age, type of cattle received (eg, veal calves), season (ie, high prevalence season) or geography represent a concern related to pathogen load and therefore whether adjustments to the food safety system need to be made.

d. Establishments should make determinations at receiving/holding about the overall cleanliness of cattle received and classify lots of cattle according to their level of cleanliness. Specific contamination or cross-contamination control measures can be taken by mud score classification. For example, establishments may decide to slow the line speed down to give employees more time to effectively dress the cattle with higher mud scores.

**9.2**




16. This is the point where the cattle are held before slaughter. There is an increased potential for contamination with *Salmonella* during this time because of their presence on the hide and in feces of cattle. Additionally, interaction with other cattle may cause stress and increased shedding of pathogens.

**9.2.1 GHP-based control measures**

17. Applying a water mist in the holding pens may reduce dust and dirt particles that may carry *Salmonella*.

18. Routinely cleaning the unloading areas, pens and water sources may help reduce cross-contamination. Cleaning of areas when stock are not in the pens and walkways could avoid contamination of cattle through aerosols.

19. Care should be taken to control pest animals (eg, birds and rodents) in the lairage areas in order to reduce the cross-contamination by these animal vectors.

20. Hide washing measures can be performed on the live animal or on a slaughtered animal before the hide is removed. To prevent the spread of contamination to the environment and subsequently to carcasses (ie, cross-contamination of carcasses) the following strategies may be employed:

a. Identify or segregate animals with excessive macroscopic contamination. Limit the overspray of water.

b. Remove excess water from the hide after the wash to decrease cross-contamination during dehiding.

c. Avoid pooling of water around the anus of the carcass prior to dropping the bung.

21. Applying a bacteriophage treatment to incoming cattle and allowing the bacteriophage appropriate contact time can reduce the bacterial load present on the animal prior to slaughter.

22. Time spent at lairage and stocking density should be kept to a minimum.

23. Also refer to the OIE Terrestrial Animal Health Code[2].

### 9.2.2 Hazard-based control measures

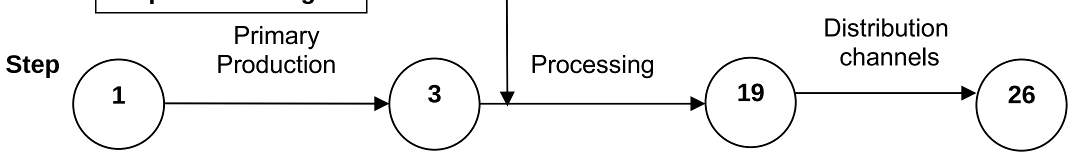
24. Decontamination treatments have been shown to be effective in the reduction of pathogens including *Salmonella* on cattle hides. Examples of decontamination treatments are listed below. These hide-on treatments can be used at this or a subsequent step until dehiding. Care should be taken to minimize cross-contamination especially after the hide has been opened at any time.

25. Potable water spray followed by a chlorine spray (100 to 200 ppm) in a hide cabinet has shown to reduce *Salmonella*, and studies have shown a 27% drop in *Salmonella* prevalence. A drop in *Salmonella* enumeration was also observed (Arthur et al., 2007).

26. Washes containing either organic acids or other chemicals may be effective to reduce *Salmonella.* Some studies have shown that the levels on hides compared to water washes were reduced by 0.57 to 2.75 $\log_{10}$ CFU/cm$^2$ (Mies et al., 2004; Carlson et al., 2008; Jadeja and Hung, 2014). In addition, *Salmonella* was reduced by 24.0% and 17.1% following the application of acetic acid and sodium hydroxide wash, respectively (Scanga et al., 2011). Washes containing chlorine and hydrogen bromide tended to reduce *Salmonella* prevalence by approximately one third (Mies et al., 2004; Bosilevac et al., 2009; Schmidt et al., 2012).

27. Chemical dehairing has been shown to reduce microbial counts on hide prior to dehiding. *Salmonella* populations were significantly reduced from 5.1 $\log_{10}$ CFU/cm$^2$ to levels below the detection limit of 0.5 $\log_{10}$ CFU/cm$^2$ after chemical dehairing (Castillo et al., 1998a).

### 9.3 Step 5: Stunning



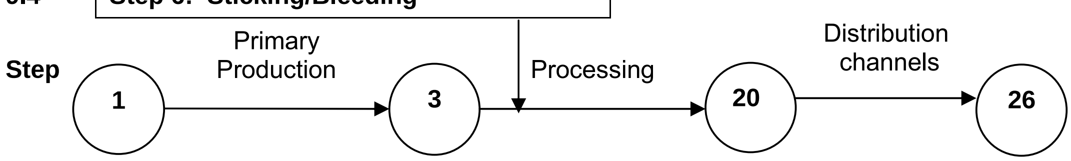

28. This is the point where the animal is rendered unconscious. This can result in a shedding reflex and become a cross-contamination point due to animal contact with the ground after stunning.

### 9.3.1 GHP-based control measures

29. Keep skids outside and inside the stunning box clean.

30. In case of shedding reflex, feces should be removed in a sanitary manner

### 9.4 Step 6: Sticking/Bleeding



31. This is the point in the process where the animal is bled. Regardless of the slaughter method, it is important for the establishment to minimize contamination of the carcass during any cut made at this step, avoiding any contamination by opening.

### 9.4.1 GHP-based control measures

32. Measures to prevent contamination of the carcass underlying the hide during the initial cut include:

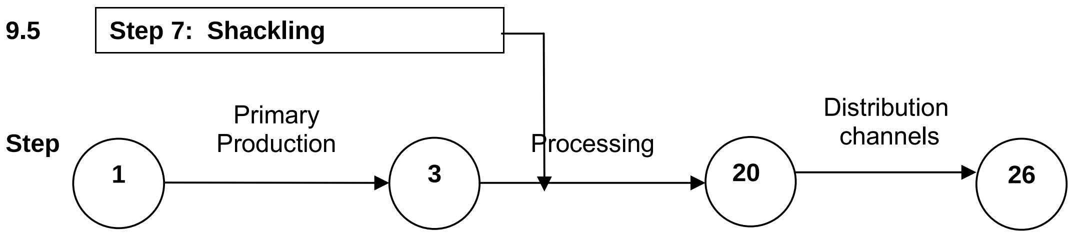
33. Using the smallest effective cut possible to accomplish bleeding.

a. Using a validated one- or two-knife system including the hand and knife cleaning and knife disinfecting between sticking each carcass.

b. It may be necessary to clean the carcass area prior to sticking. Decontamination, a mechanical process like scraping the hide surface to remove physical contamination, can be utilized.

c. Be aware of mud-contamination moving downwards into the cut.

## 9.5 Step 7: Shackling



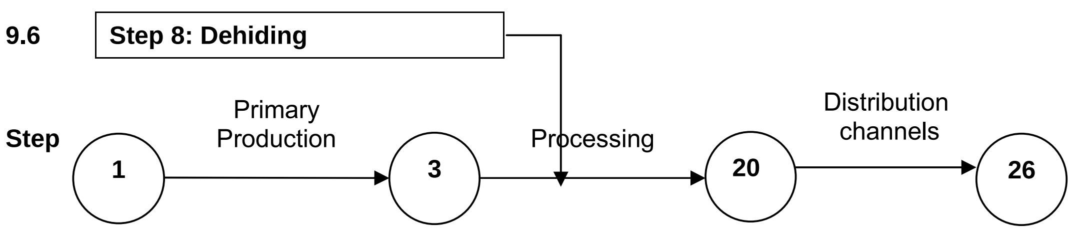

34. This is the area where the carcass is attached to a device to suspend it to facilitate bleeding and/or dressing.

### 9.5.1 GHP-based control measures

35. Animals should be shackled, hung or placed in the bleeding area in such a way that contact between stick wounds and external surfaces of this or other animals (eg hide/hooves) is avoided.

36. Electrical stimulation can be used to hasten the attainment of rigor-mortis and reduction of pH.

## 9.6 Step 8: Dehiding




37. This is the point in the process where the hide is removed from the animal. Hides are a significant source of potential contamination with *Salmonella*. It is important to maintain sanitary conditions when handling the hide.

### 9.6.1 GHP-based control measures

38. Hide-removal measures to prevent direct contamination of the carcass during the opening of the hide (other than sticking) include:

a. Removing visible contamination at the intended cut line (eg, with air knives, by using dedaggers or by steam vacuuming).

b. Using a two-knife system whereby one knife is used for opening the hide and another disinfected knife is used for dehiding by leading the knife between skin and meat surface.

c. Removing the udder in such a way that the contents do not contaminate the carcass.

d. Following procedures to prevent contamination of the exposed carcass from the hide, a soiled knife or other utensils or employee hand, for example.

39. Measures to limit cross-contamination of carcasses during hide removal include:

a. Employing shields/barriers (eg, legging papers) to prevent contamination and cross-contamination of carcasses.

b. Severing or removing the switch on the tail when using hide pullers to minimize the possibility that contaminants become airborne from splattering or flapping of the hide.

c. Employing a mechanical hide puller.

   i. Ensuring mechanical hide pullers pull the hide away from the carcass in a downward or backwards motion (ie, not upward), thereby reducing the potential for contamination to drip, splatter, or flap onto the carcass or employees handling de-hided carcasses.

d. Ensuring the exterior side of the hide does not touch, slap, or flap onto the carcass when being removed.

e. Maintain equipment contacting the de-hided carcass clean including the mechanical hide puller contact points with the hide, hands and garments of the employees handling the hide and the carcass, knives, etc.

f. Ensuring adequate distance between carcasses throughout the slaughter dressing process to minimize carcass-to-carcass contact and cross-contamination.

40. Line speed and other process parameters should be monitored and adjusted during instances of excessive hide contamination to ensure proper removal of the hide.

41. Contamination detection techniques, for example, chlorophyll detection equipment, may be used, at this point or later in the dressing process, as a means to identify fecal material on carcasses.

### 9.6.2 Hazard-based control measures

42. Decontamination treatments after the hide has been removed have been shown to be effective in the reduction of pathogens including *Salmonella* on carcasses. A decontamination treatment may be used immediately after hide removal and serves to remove bacteria before they have the opportunity to attach to the carcass surface and grow (Bosilevac et al., 2006). Equipment for decontamination treatment should be monitored to ensure that the treatment is performed according to the validation parameters. Such treatments include:

43. Hot water (74 ºC (165 ºF)) in an appropriate combination of temperature and time was shown to reduce *Salmonella* on beef flanks between 1.04 and 2.1 $log_{10}$ $CFU/cm^2$ (Arthur et al., 2008). Other studies also found water alone tended to decrease *Salmonella* prevalence prior to chilling from 9.1% to 4.0% (Hajmeer et al., 1999; Trairatapiwan et al., 2011; Narváez-Bravo et al., 2013).

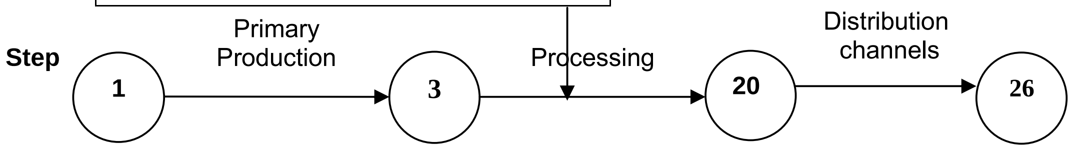
44. Steam pasteurization is a process by which the carcasses are placed in a slightly pressurized, closed chamber at room temperature and sprayed with steam that blankets and condenses over the entire carcass, raising the surface temperature (generally to 85 ºC (185 ºF)) and inactivating up to 95-99% of all vegetative bacterial cells present. Carcasses are then sprayed with cold water (Dorsa et al., 1996; Nutsch et al., 1997; Nutsch et al., 1998; Phebus et al., 1997; Trivedi et al., 2007). Steam vacuum treatment at 130 °C reduced inoculated *Salmonella* levels on post-chill beef carcasses by 0.2 $log_{10}$ compared to no treatment (Bacon et al., 2002).

45. Multiple interventions have been shown to reduce *Salmonella*. A sequence of ambient temperature water, hot water (82°C), then 4-5% lactic acid washes was shown to reduce *Salmonella* prevalence from 28.1% to 2.3% (Ruby et al., 2007). Warm and hot water washes and knife trimming of visible contamination significantly reduced *Salmonella* prevalence from 30.3% to 1.4% on carcasses that were deliberately contaminated with fecal material compared to a control group (Reagan et al., 1996). A combination of a lactic acid wash followed by 200 ppm peroxyacetic acid wash reduced inoculated *Salmonella* concentrations on carcasses compared to samples measured after a pre-chill water wash (King et al., 2005).

46. Lactic acid reduced Salmonella prevalence from 1.0% to 0.3% (Ruby et al., 2007).

47. Several challenge studies on beef carcasses under simulated commercial conditions using water washes, thermal washes, organic acid washes, other chemical/oxidizer washes, trimming or multiple interventions found a 0.25 to 2.88 $log_{10}$ CFU/g reduction in *Salmonella* (Smith, 1992; Hardin et al., 1995; Bell et al., 1997; Cutter et al., 1997; Phebus et al., 1997; Castillo et al., 1998b; Castillo et al., 1998c; Dorsa et al., 1998a; Dorsa et al., 1998b; Castillo et al., 1999; Cutter, 1999a; Cutter and Rivera-Betancourt, 2000; Cutter et al., 2000; Castillo et al., 2001; Castillo et al., 2003; Retzlaff et al., 2004; Ellebracht et al., 2005; King et al., 2005; Niebuhr et al., 2008; Sawyer et al., 2008; Kalchayanand et al., 2009; Laury et al., 2009; Yoder et al., 2010; Njongmeta et al., 2011; Wolf et al., 2012; Yoder et al., 2012).

**9.7 Step 9: Head Removal/Head Washing**




48. This is the point in the slaughter process where the head is removed from the carcass. It is important to maintain sanitary conditions because cross-contamination can occur if the head comes into contact with other carcasses or heads, equipment and employees.

### 9.7.1 GHP-based control measures

49. Measures to minimize contamination of heads, equipment, and employees can include:

a. Removing heads in a manner that avoids contamination with digestive tract contents.

b. Tying the esophagus (weasand) as soon as possible after stunning to minimize contamination of buccal cavity and head with ingesta.

c. If necessary, adequately washing heads, including thoroughly flushing the nasal cavities and mouth, before washing the outside surfaces.

d. Limiting the splashing of water when washing heads in order to prevent cross-contamination and to limit airborne contaminants.

e. Properly maintaining, cleaning and disinfecting knives as needed.

f. Ensuring that:

   1. excessively contaminated heads do not enter the cabinet,

   2. the equipment holding the head does not contaminate the head,

   3. spray from the cabinet does not spread contamination to adjacent heads if a head wash cabinet is used at this point in the slaughter process, or

   4. if a wash is being used, it does not contaminate the cheek meat and tongue of the head being washed and inspected.

g. Horns should be removed with surrounding hides to minimize contamination.

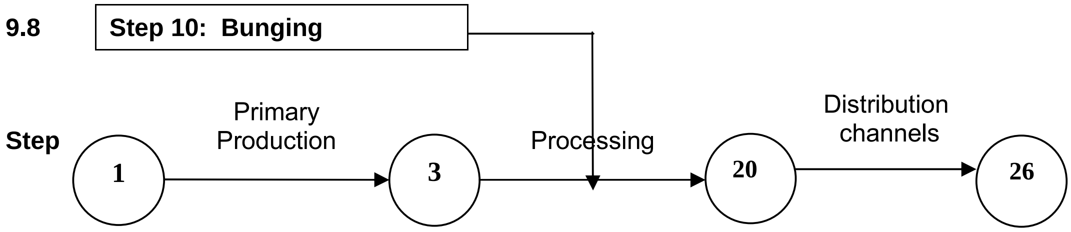
h. De-hided heads should be kept in a manner to minimize contamination with other hides, floors or inner walls.

50. After dehiding and removal of the head and before passing the carcass on to brisket/midline opening, any visible fecal contamination and residual hairs should be removed. This can be done by knife trimming where visible contamination is cut off and discarded. Knives should be cleaned and disinfected regularly, at least between each carcass trimmed, and hands should also be washed between carcasses.

### 9.7.2 Hazard-based control measures

51. Visible contamination can be removed using a steam vacuum system. The hot water/steam sprayed onto a carcass kills bacteria and detaches contamination such as ingesta or feces, which can then be vacuumed off (Kochevar et al., 1997; Castillo et al., 1999; Phebus et al., 1997). Many establishments utilize the steam vacuum system at multiple points in the slaughter process.

**9.8 Step 10: Bunging**




52. This is the point in the slaughter process where a cut is made around the rectum (ie, terminal portion of the large intestine) to free it from the carcass, and then it is tied off to prevent spillage of fecal material.

### 9.8.1 GHP-based control measures

53. Measures to prevent carcass contamination during bunging include:

a. Completing bunging operations prior to hide removal.

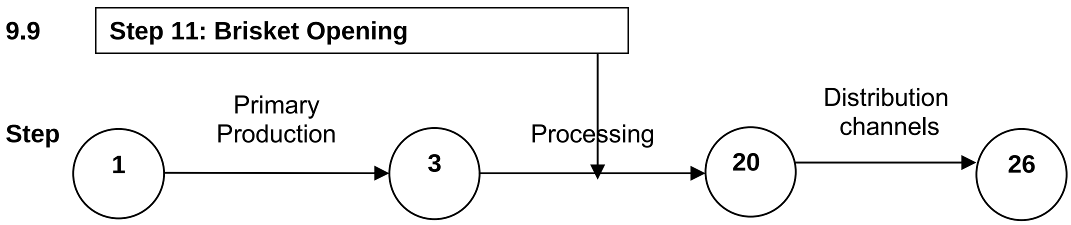
b. Putting plastic bags and ties on the bung in a sanitary manner.

54. Clean and disinfect equipment between carcasses, for example by using organic acids or heat, where applicable.

#### 9.8.2 Hazard-based control measures

55. A significant reduction in *Salmonella* prevalence, from 8.3% to 0.8% prevalence, was found in intervention carcasses compared to those where no bung bagging was conducted before the pre-evisceration wash (Stopforth et al., 2006).

### 9.9



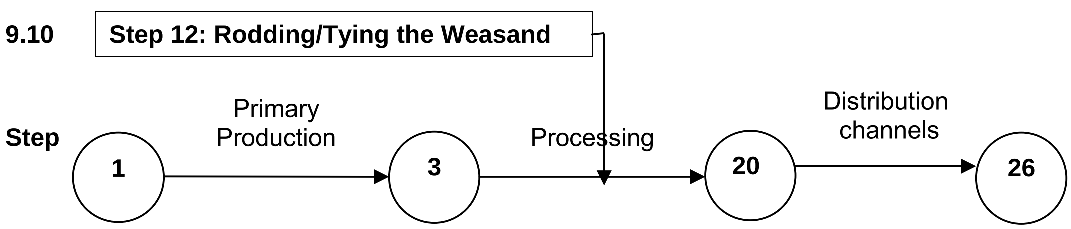

56. This is the point in the process where the brisket is split (ie, cut along the centerline).

#### 9.9.1 GHP-based control measures

57. Measures to prevent the introduction of contamination into the carcass during brisket opening include:

a. Cleaning and disinfecting the brisket saw and knife between each carcass and ensuring that the gastrointestinal tract is not punctured.

### 9.10




58. This is the point in the process where the establishment uses a metal rod to free the esophagus (weasand) from the trachea and surrounding tissues. Weasand meat may be recovered from the gastrointestinal tract for use in raw ground beef production. The weasand should be closed (ie, tied) to prevent rumen spillage. It is important, at this point in the process, that contamination is not transferred from the exterior of the carcass to the interior or onto the weasand. In addition, if, during the rodding process, the gastro-intestinal tract is punctured, it can cause contamination of the carcass interior and exterior with ingesta content.

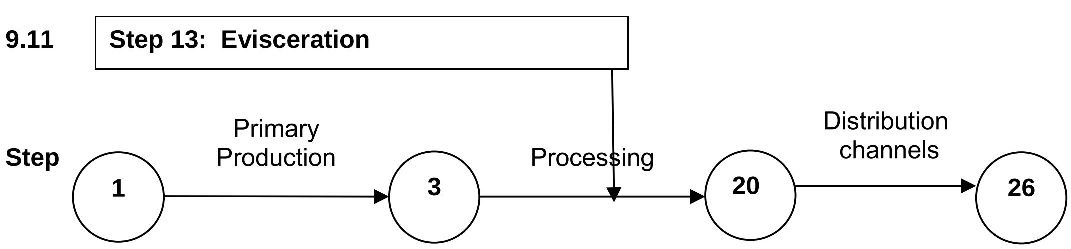
#### 9.10.1 GHP-based control measures

59. Measures to prevent cross-contamination of the carcass during rodding the weasand include:

a. Changing or sanitizing the weasand rod between each carcass.

b. Cleaning the weasand to minimize cross-contamination, and chilling it quickly to prevent the growth of Salmonella.

### 9.11



60. This is the point in the process where the removal of the viscera (eg, the edible offal that includes the heart, intestines, rumen, liver, spleen, and kidneys when presented with viscera) occurs. If the viscera are not handled properly, or if employee hygiene practices are not being followed, contamination of the carcass and edible offal can occur.

**9.11.1 GHP-based control measures**

61. Measures to prevent contamination of the viscera during removal include:

a. Removing visible contamination from the area to be cut (eg, by trimming, by using air knives, or by steam vacuuming) before the cut is made.

b. If pregnant, removing the uterus in a manner that prevents contamination of the carcass and viscera.

c. Removing contamination in a timely manner and in accordance with commonly accepted reconditioning procedures.

d. If possible, avoid cutting through tonsils, due to the risk of spreading Salmonella from tonsil tissue.

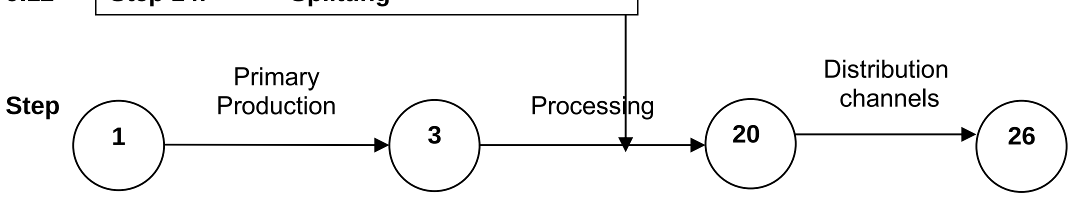
62. Measures to ensure that employees do not contaminate carcasses during evisceration include:

a. Properly using knives to prevent damage (ie, puncturing) to the rumen and intestines.

b. Using footbaths or separate footwear by employees on moving evisceration lines to prevent contaminating other parts of the operation.

c. Only skilled, trained individuals should perform the evisceration; experienced individuals are needed at higher line speeds.

**9.12 Step 14: Splitting**




63. This is the point in the process where carcasses are split vertically into two halves.

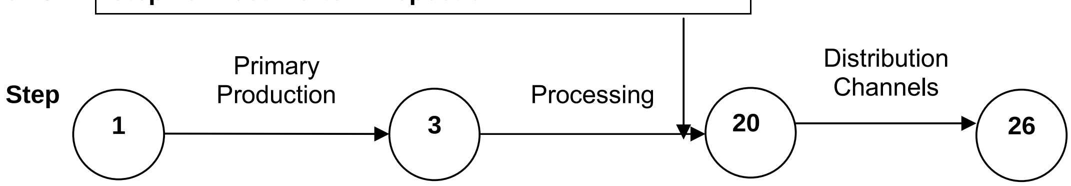
**9.12.1 GHP-based control measures**

64. Measures to prevent the split carcass from becoming contaminated include:

a. Cleaning to remove organic material and disinfecting the saws and knives between each carcass.

b. Allowing adequate distance between carcasses (ie, avoid carcass-to-carcass contact) and walls and equipment.

**9.13 Step 15: Post Mortem Inspection**



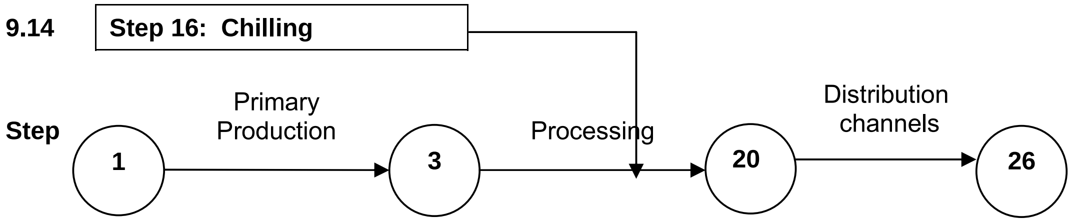

65. This is the point in the process where detailed inspection of carcasses is carried out, so it is a key point to characterize a healthy carcass.

**9.13.1 GHP-based control measures**

66. Line speeds and the amount of light should be appropriate for effective post-mortem inspection of carcasses.

67. The procedures should be planned to avoid cross-contamination. Touching the carcasses with hands, tools or garments may cause cross-contamination (Vieira-Pinto et al., 2006).

### 9.14 Step 16: Chilling




68. This is the point in the process where the carcass is chilled.

#### 9.14.1 GHP-based control measures

69. Carcass chilling should begin within one hour of bleed-out. The chilling room should be kept at temperatures that will prevent the growth of *Salmonella*.

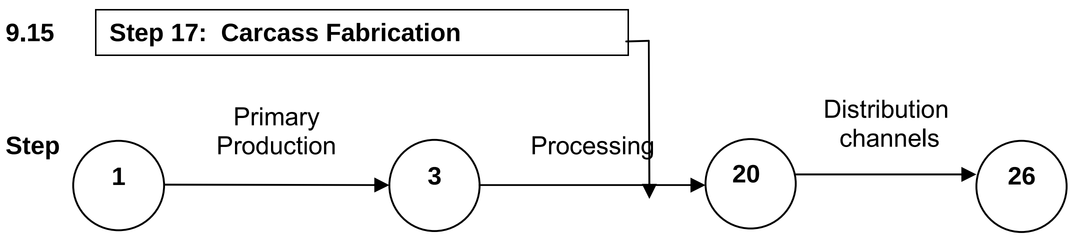
70. Implement temperature control and sanitation procedures (eg, define and monitor refrigeration parameters so that carcasses reach a temperature that will prevent the growth of *Salmonella*).

71. Ensure efficient air circulation by providing adequate distance between carcasses, walls, and equipment, to prevent cross-contamination and provide effective chilling.

#### 9.14.2 Hazard-based control measures

72. Spray chilling vs. dry chilling reduced inoculated *Salmonella* levels when sampled within 48 hours of chilling (0.28 to 0.36 $\log_{10}$ CFU/cm$^2$), but after extended storage of 7-28 days, *Salmonella* counts were lower on dry chilled carcasses (-0.2 to -2.4 $\log_{10}$ CFU/cm$^2$) (Tittor et al., 2011).

### 9.15 Step 17: Carcass Fabrication




73. These steps include cutting and deboning that can result in wholesale pieces. Maintain a cool processing room temperature to reduce the potential for *Salmonella* growth.

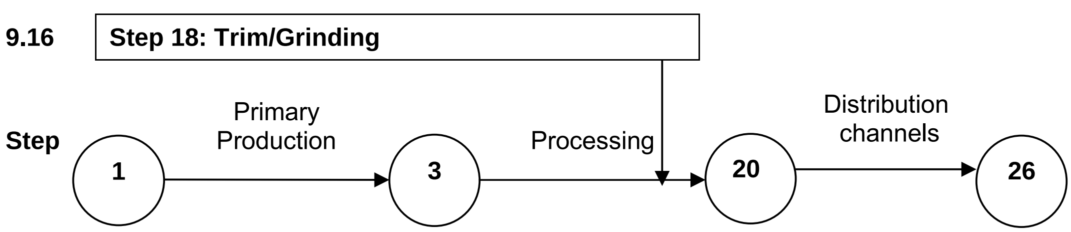
#### 9.15.1 GHP-based control measures

74. Ensure a reasonable flow of products, to reduce time out of chilling room.

75. Clean and disinfect knives, saws, slicers, and other food contact surfaces as frequently as necessary to prevent the creation of unsanitary conditions.

76. Prevent cross-contamination from slaughter operations by maintaining adequate airflow.

### 9.16 Step 18: Trim/Grinding




77. This is the point in the process where the meat is subjected to the process of breaking fibers mechanically or manually. During carcass fabrication, trim may be generated and used for the production of ground beef.

#### 9.16.1 GHP-based control measures

78. Products should be stored at temperatures to prevent the growth of *Salmonella*.

79. Equipment used for this operation should be adequately maintenance and adjusted.

80. In order to avoid cross-contamination, equipment and environment should be cleaned on a regular basis and good personal hygiene practices should be followed by employees.

81. Processes such as mechanical tenderization or grinding, may potentially increase contamination in the meat. There should be increased awareness when handling of the meat throughout the rest of the food chain.

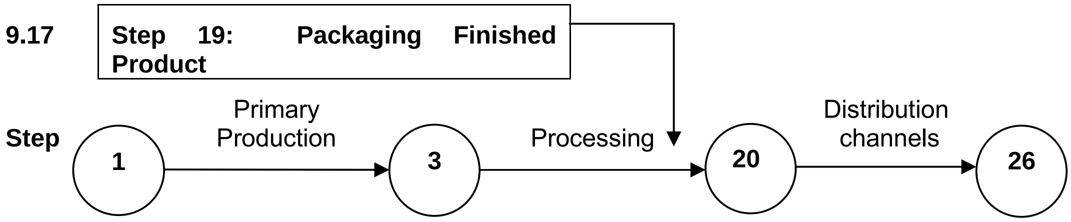
82. If equipment is used to process meat of a different risk profile (eg adult beef vs. veal) the equipment should be cleaned when changing from higher risk product to lower risk products. Alternatively lower risk product should be processed first.

**9.16.2 Hazard-based control measures**

83. Adequate beef trim treatment and storage under optimal conditions will reduce and prevent the growth of *Salmonella* in fabricated beef and ground beef products, if present. The use of a decontamination treatment, individually or in combinations, such as 2-4% acetic acid, 2-4% lactic acid, 1000-1200 ppm acidified sodium chlorite, 0.02% peroxyacetic acid, 2% malic acid, 0.04% octanoic acid, 2% potassium lactate, buffered water and sodium dodecyl sulfate/levulinic acid, injection of gaseous ammonia plus pelleted $CO_2$, 1% ozonated water at this point in the process, were found to reduce *Salmonella* between 0.11 and 4 $\log_{10}$ CFU/g (Harris et al., 2006; Harris et al., 2012; Mohan et al., 2012; Niebuhr et al., 2003; Stelzleni et al., 2013; Stivarius et al., 2002a, Stivarius et al., 2002b; Castillo et al., 2001; Ellebracht et al., 1999; Chung et al., 2000; Pohlman et al., 2002a; Pohlman et al., 2002b; Stivarius et al., 2002c; Ellebracht et al., 2005; Echeverry et al., 2009; Pohlman et al., 2009; Echeverry et al., 2010; Hughes et al., 2010; Quilo et al., 2010; McDaniel et al., 2012; Mehall et al., 2012; Dias-Morse et al., 2014; Kundu et al., 2014; Pohlman et al., 2014).

84. Exclusion of large carcass lymph nodes (subiliac, popliteal and superficial cervical) from the trim used for the production of ground beef may reduce the contamination with *Salmonella* (Koohmaraie et al., 2012)

**9.17 Step 19: Packaging Finished Product**




**9.17.1 GHP-based control measures**

85. Storage room temperature should be maintained at temperatures that will prevent the growth of *Salmonella*.

86. Monitor and document temperature of storage room and meat.

87. Use of various technology packaging may limit the growth of *Salmonella* (eg, modified atmosphere packaging).

**9.17.2 Hazard-based control measures**

88. Various doses of Gamma rays or electron beams applied to warm, chilled, or frozen carcasses have been shown to be effective at eliminating *Salmonella*. Where irradiation is permitted, levels should be validated and approved by the competent authority (*General Standard for Irradiated Foods* (CODEX STAN 106-1983)).

89. Natural extracts, including various spice (oregano, lemon grass, garlic, turmeric, cinnamon, mustard), fruit (pomegranate, grape seed, cranberry), or other plant extracts (roselle, pine bark, *Artemisia absinthium, Salvia officinalis* and *Schinus molle* were found to reduce *Salmonella* contamination in beef products (Cutter, 2000; Skandamis et al., 2002; Ahn et al., 2004; Uhart et al., 2006; Qiu and Wu, 2007; Hayouni et al., 2008; Turgis et al., 2008; Chao and Yin, 2009; Tayel et al., 2012; Cruz-Galvez et al., 2013; De Oliveira et al., 2013).

90. *Lactobacillus spp.* were found to decrease *Salmonella* contamination on beef products Gomólka-Pawlicka and Uradzinski, 2003; Smith et al., 2005; Hoyle et al., 2009; Ruby and Ingham, 2009; Olaoye and Onilude, 2010; Chaillou et al., 2014).

91. Modified atmosphere packaging interventions were found to decrease *Salmonella* contamination on beef products (Gill and DeLacy, 1991; Cutter, 1999b; Skandamis et al., 2002; Brooks et al., 2008; Miya et al., 2014).

92. The use of gaseous anhydrous ammonia (5100 ppm) was shown to result in an up to 7 log reduction of *Salmonella* in textured beef in one study, whereas liquid ammonia and ammonium hydroxide were not effective (Jensen et al., 2009).

93. Treatment with nisin, a polypeptide, resulted in a 0.4 $log_{10}$ reduction in conjugation with lactate (Cutter and Siragusa, 1995).

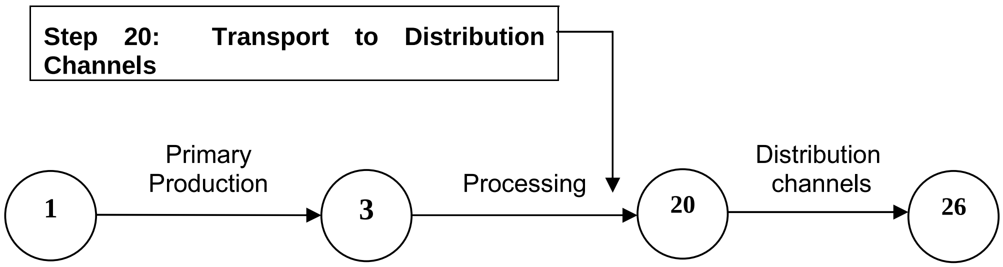
94. A mixture of volatile compounds resulted in a 1.7-2.2 $log_{10}$ reduction of *Salmonella* in ground beef during a 5 day storage period at 8 °C (Faith et al., 2015).

95. Treatment with ε-polylysine reduced *Salmonella* levels by 1.5-2.4 logs in fresh beef over 7 days depending on the storage conditions (Miya et al., 2014).

## 10. CONTROL MEASURES FOR DISTRIBUTION CHANNELS (STEPS 20 TO 26)

### 10.1 Step 20: Transport to Distribution Channels

Step




#### 10.1.1 GHP-based control measures

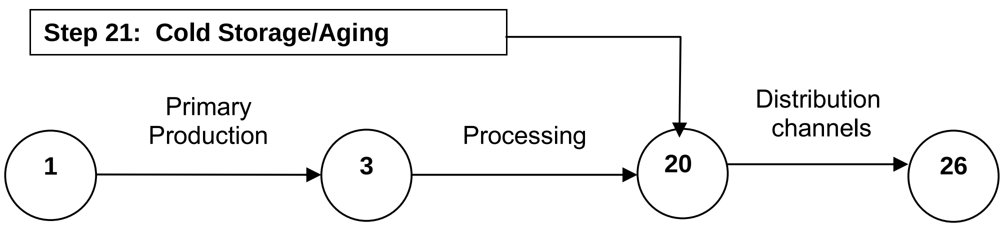
96. Transportation vehicles should be kept clean and free of pests.

97. Transportation vehicle temperature should be maintained to prevent the growth of Salmonella.

98. Temperature of vehicle and meat should be monitored and documented. Meat should be chilled before loading onto the vehicle for transport.

### 10.2 Step 21: Cold Storage/Aging

Step



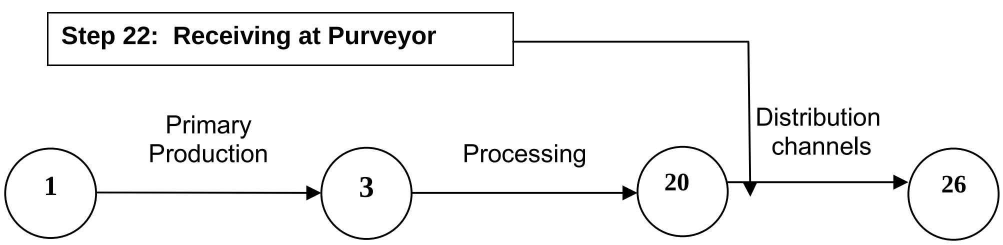

#### 10.2.1 GHP-based control measures

99. Products should be stored at temperatures to prevent the growth of *Salmonella*.

100. During dry-aging, the humidity should be kept low to prevent the growth of *Salmonella*.

### 10.3 Step 22: Receiving at Purveyor

Step



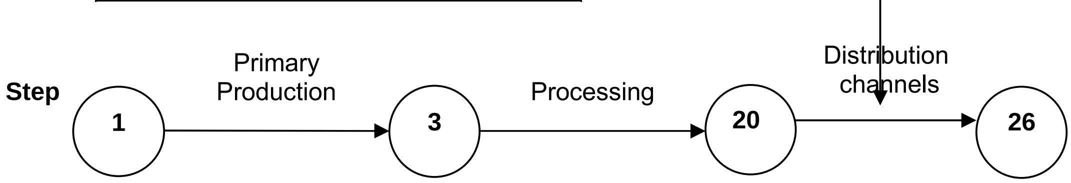

#### 10.3.1 GHP-based control measures

101. The state of products shipped, the containers, their content and the temperature of the product should be verified.

102. An agreement between the abattoir and the purveyors for sharing microbiological testing results of the material received may need to be established. The agreement could include whether presumptive or confirmed results are required and the actions that will be taken in the event of a positive result.

103. Products should be kept at a temperature to prevent the growth of *Salmonella*.

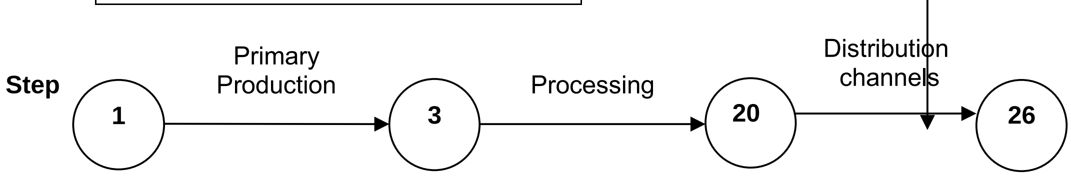
### 10.4 Step 23: Finished Product Fabrication




#### 10.4.1 GHP-based control measures

104. Products should be stored at temperatures to prevent the growth of *Salmonella*.

### 10.5 Step 24: Mechanical Tenderization




#### 10.5.1 GHP-based control measures

105. Products should be stored at temperatures to prevent the growth of Salmonella

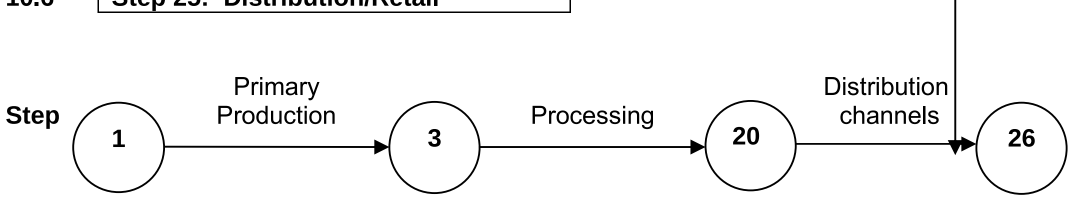
106. Adequate maintenance and adjustment of the equipment used for this operation.

107. Regular cleaning of equipment, the environment and adherence to good personal hygiene practices by employees to avoid cross-contamination and avoid build up.

108. Processes such as mechanical tenderization may potentially increase contamination in the meat. There should be increased awareness when handling of the meat throughout the rest of the food chain.

109. Recycling of brine or marinade during injection should be discouraged to minimize the potential for cross-contamination or spread of contamination.

### 10.6 Step 25: Distribution/Retail




#### 10.6.1 GHP-based control measures

110. Fresh meat should be stored at a temperature that prevents the growth of Salmonella.

111. Monitor and document temperature of storage room and meat.

112. Prevent cross-contamination from or to other food items.

113. Food business operators serving meat for direct consumption to consumers (eg, caterers, restaurateurs) should take appropriate measures to:

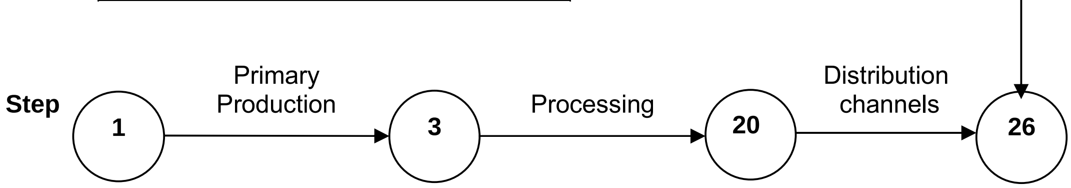
a. Prevent cross-contamination.

b. Maintain appropriate storage temperature.

c. Ensure proper cleaning.

d. Ensure thorough cooking.

## 10.7 Step 26: Consumer




### 10.7.1 GHP-based control measures

114. Consumers should be informed on the potential risk associated with finished beef product in order to follow instruction and make informed choices on how to avoid the spread and growth of *Salmonella* (eg, storage temperature, hygiene and cooking temperature). This information should be provided by the local government, health agencies, manufacturers, retailers or other consumer sources.

115. Cooking of beef can reduce or eliminate the level of *Salmonella*.

116. Consumers should be appropriately informed of raw treated meat (eg, mechanically tenderized, minced meat) so they can take appropriate actions to make sure meat is properly cooked.

117. Consumer education should focus on handling, hand washing, cooking, storage, thawing, prevention of cross contamination, and prevention of temperature abuse. The WHO Five keys to safer food[19] assists in this process.

118. Special attention should be paid to the education of all persons preparing food, and particularly to persons preparing food for the young, old, pregnant and immuno-compromised.

119. The above information to consumers should be provided through multiple channels such as national media, health care professionals, food hygiene trainers, product labels, pamphlets, school curriculae and cooking demonstrations.

120. Consumers should wash and disinfect food contact surfaces and utensils after raw beef preparation to significantly reduce the potential for cross-contamination in the kitchen.

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**ANNEX II**

**CONTROL MEASURES FOR PORK**
**(For Sections 7 to 10)**

## 7. PRIMARY PRODUCTION-TO-CONSUMPTION APPROACH TO CONTROL MEASURES

1. These Guidelines incorporate a "primary production-to-consumption" flow diagram that identifies the main steps in the food chain where control measures for *Salmonella* may potentially be applied in the production of pork. While control in the primary production phase can decrease the number of animals carrying and/or shedding *Salmonella,* controls after primary production are important to prevent the contamination and cross-contamination of carcasses and meat products. The systematic approach to the identification and evaluation of potential control measures allows consideration of the use of controls in the food chain and allows different combinations of control measures to be developed. This is particularly important where differences occur in primary production and processing systems between countries. Risk managers need the flexibility to choose risk management options that are appropriate to their national context.

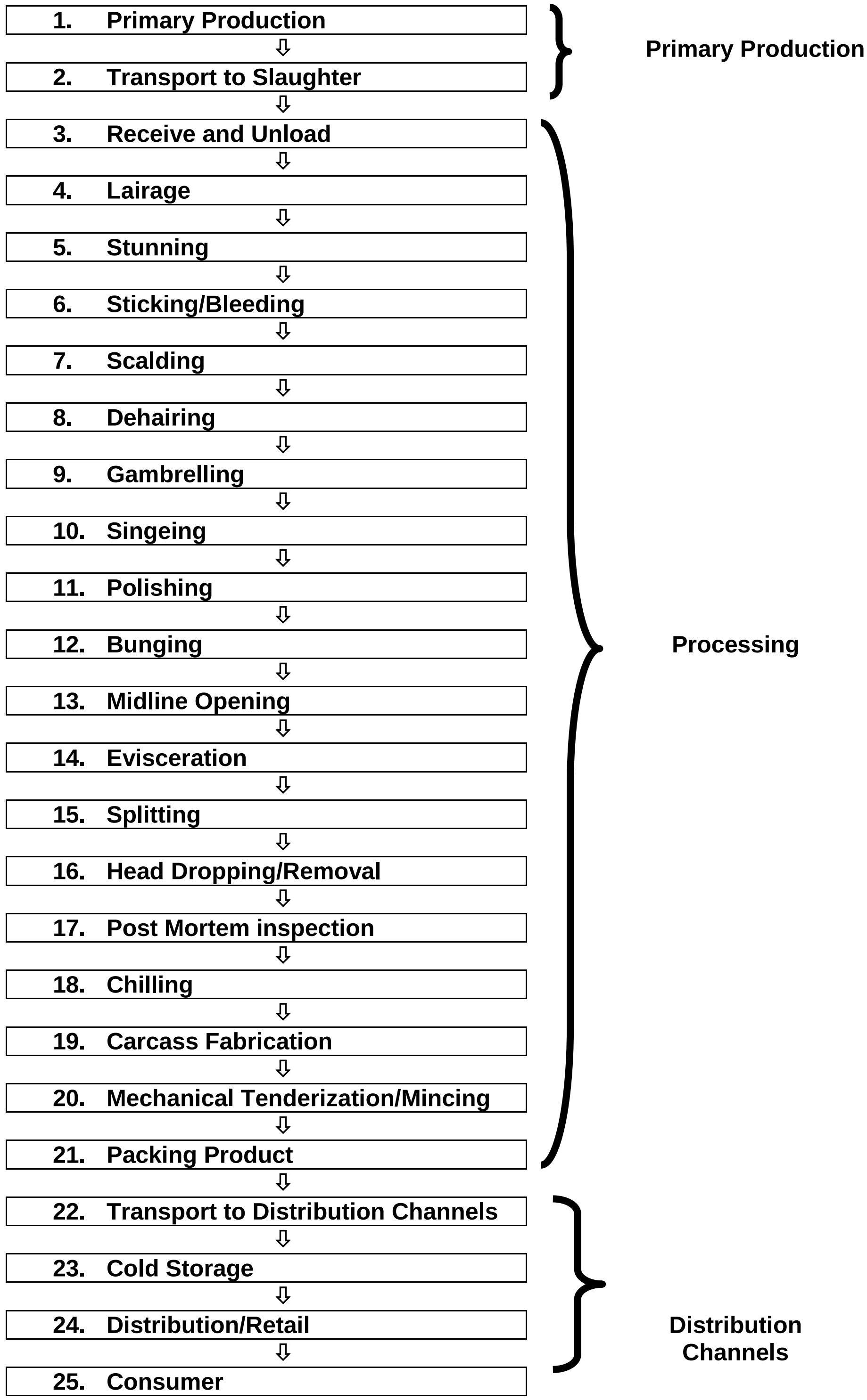
### 7.1. Generic flow diagram for application of control measures

2. A generic flow diagram of the basic pork production processes is presented on the following pages. GHP- or hazard-based interventions that may be applied during processing skin-on carcasses have been identified at the appropriate process step(s) in the flow diagram.

3. Individual establishments will have variations in process flow and, if possible or required by national law, should develop and adapt HACCP plans accordingly. In countries where HACCP is not widely used, the fundamental principles and practices of HACCP may still be applicable.

4. The basic steps in the slaughter process are to a large extent common for processing pigs skin-on, but they may be carried out differently in different slaughterhouses or countries. Therefore the necessity to use supplementary mitigation steps will also vary among individual slaughterhouses and countries. The use of supplementary mitigation steps will depend on the food safety targets set, for example, by the competent authorities or customers (eg retail chains) and will be influenced by a range of factors, eg, animal feed, hygienic slaughter procedures, age of livestock, farming practices, size of establishment, equipment, automation, slaughter line speed, and the initial *Salmonella* load from incoming animals (for example, seasonal variation). A variety of interventions may be used to reduce contamination with *Salmonella* throughout processing. While the effect on *Salmonella* of the individual interventions can be variable, there is clear evidence that use of multiple interventions throughout processing as part of a "multiple-hurdle" strategy will provide a more consistent reduction of *Salmonella*.

**Process Flow Diagram: Primary Production to Consumption -Pork**




These process steps are generic and the order may be varied as appropriate. This flow diagram is for illustrative purposes only. For application of control measures in a specific country or an establishment, a complete and comprehensive flow diagram should be drawn up.

**7.2. Availability of Salmonella control measures at specific process flow steps addressed in these Guidelines**

5. The following table illustrates where specific control measures for *Salmonella* may be applied at each of the process flow steps of the food chain. Control measures are indicated by a check mark and their details are provided in these Guidelines and the OIE Terrestrial Animal Health Code in the case of GHP. A blank cell means that a specific control measure for *Salmonella* has not been identified for the process flow step.

6. Decontamination treatments may be applied at multiple steps within the process flow and may vary between countries, establishments or type of process flow.

**Availability of Control Measures at Specific Steps in the Process Flow**

| Process Step | GHP-based control measures | Hazard-based Control Measures |
|---|---|---|
| 1. Primary Production ↓ | Refer to [20],[21] | |
| 2. Transport ↓ | Refer to[2,3] | |
| 3. Receive and Unload ↓ | Refer to[2,3] | |
| 4. Lairage ↓ | Refer to[2,3] | |
| 5. Stunning ↓ | | |
| 6. Sticking/Bleeding ↓ | ✓ | |
| 7. Scalding ↓ | ✓ | ✓ |
| 8. Dehairing ↓ | ✓ | ✓ |
| 9. Gambrelling ↓ | ✓ | |
| 10. Singeing ↓ | | ✓ |
| 11. Polishing ↓ | ✓ | ✓ |
| 12. Bunging ↓ | ✓ | |
| 13. Midline Brisket Opening ↓ | ✓ | |
| 14. Evisceration ↓ | ✓ | |
| 15. Splitting ↓ | ✓ | |
| 16. Head Dropping/Removal ↓ | ✓ | ✓ |
| 17. Post Mortem Inspection ↓ | ✓ | |
| 18. Chilling ↓ | ✓ | ✓ |
| 19. Carcass Fabrication ↓ | ✓ | |
| 20. Mechanical Tenderization/Mincing ↓ | ✓ | ✓ |
| 21. Packing Product ↓ | ✓ | |
| 22. Transport to Distribution Channels ↓ | ✓ | |
| 23. Cold Storage ↓ | ✓ | |
| 24. Distribution/Retail ↓ | ✓ | |
| 25. Consumer | ✓ | |

[20] OIE Terrestrial Animal Health Code: www.oie.int.
[21] Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005

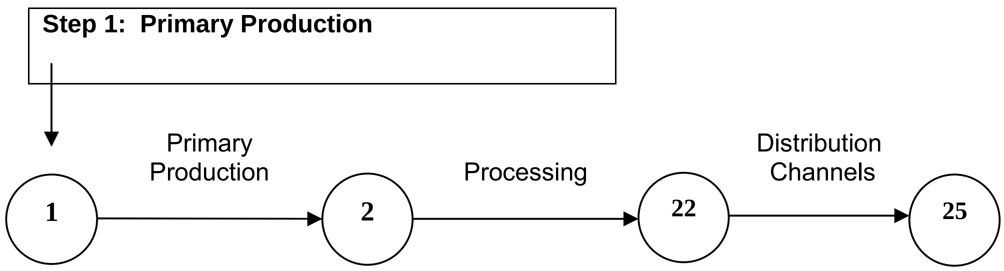
## 8. CONTROL MEASURES FOR STEP 1 TO 2 (PRIMARY PRODUCTION)

7. These Guidelines should be used in conjunction with the OIE Terrestrial Animal Health Code, the *Code of Practice on Good Animal Feeding* CAC/RCP 54-2004, and Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005).

8. It has been shown in some production systems that control of *Salmonella* in pork can begin on the farm. It has been shown that *Salmonella* prevalence in the herd is a factor for determining the *Salmonella* prevalence and numbers on carcasses (Alban and Stark, 2005). Practical measures to control *Salmonella* during primary production should be implemented where possible.

**8.1**

**Step**

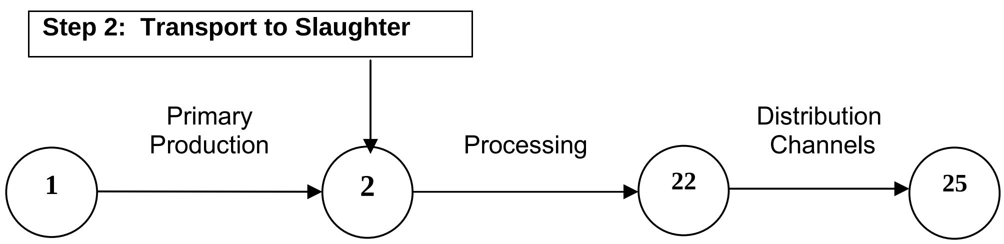



### 8.1.1 GHP-based control measures

9. Refer to the OIE Terrestrial Animal Health Code[2] .

**8.2**

**Step**




### 8.2.1 GHP-based control measures

10. Refer to the OIE Terrestrial Animal Health Code[2] and Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005).

## 9. CONTROL MEASURES FOR STEPS 3 TO 21 (PROCESSING)

11. An increased diversity of S. *enterica* serovars has been observed after slaughter compared to that of isolates from pen mates necropsied on the farm (Hurd et al., 2002). This increase in diversity suggests that pigs may be exposed to new serovars after leaving the farm.

12. General control measures including those identified in the Code of Hygienic Practice for Meat (*CAC/RCP* 58-*2005*) should be implemented to prevent the contamination or cross-contamination of carcasses throughout the slaughter process. Control measures that may have particular impact on the control of *Salmonella* include:

a. Personal equipment and the environment should be kept clean and disinfected as required.

b. Cleaning and disinfection procedures should be employed regularly and performed in a manner to prevent spread of pathogens.

c. Water accumulation on the floor should be avoided and good floor drainage design should be ensured.

d. Equipment should be maintained and designed to avoid contamination and build-up of organic material.

e. Knives should be cleaned and disinfected between carcasses.

f. Personnel should be trained both on operations and food safety aspects of slaughtering. The line speed should leave adequate time to perform all process steps in the operations.

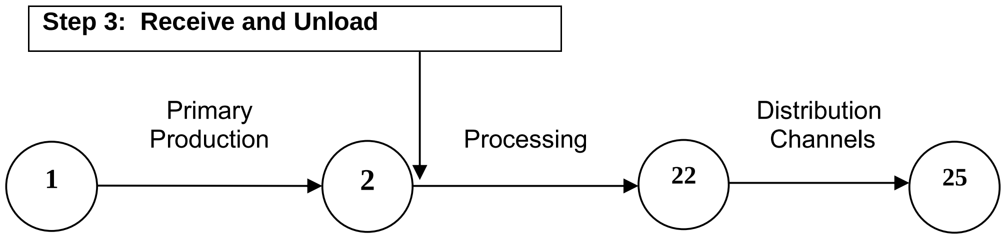
g. Maintain proper employee hygiene practices to prevent the creation of unsanitary conditions (eg, touching product with soiled hands, tools, or garments). Personal hygiene should include the washing of hands to prevent cross-contamination.

h. Water used for decontamination or cleaning and disinfection of equipment should be potable. At steps prior to stunning clean water may be used.

i. Personnel health (Gomes-Neves et al., 2012)

13. Also refer to the OIE Terrestrial Animal Health Code[2] .

**9.1**




14. This is the point where the pigs arrive at the establishment. There is an increased potential for contamination with enteric pathogens such as *Salmonella* during this time because of their presence in pig´s feces. Additionally, transportation to the slaughter facility, handling during transport and unloading, and interaction with other pigs may cause stress and increased shedding of pathogens.

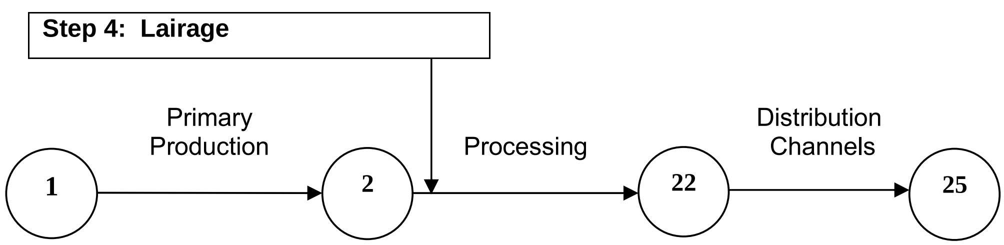
### 9.1.1 GHP-based control measures

15. Loading docks should be maintained clean and should be disinfected as often as practical, taking into account environmental conditions.

16. Where the *Salmonella* status is known, this information should be communicated to the slaughter house before arrival/receiving. For example, food chain information in the form of electronic or paper records should be applied to improve hygiene interventions at slaughter. The availability of Food chain information prior to slaughter would allow food business operators, meat inspectors and risk managers to take steps to minimize cross-contamination during slaughter. For example the establishment may choose to segregate and process pigs from herds with a high incidence of *Salmonella* at the end of the production day (Alban and Stark 2005).

17. Also refer to the OIE Terrestrial Animal Health Code[2] and Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005).

**9.2**




18. This is the point where the pigs are held before slaughter. There is an increased potential for contamination with *Salmonella* during this time because of their presence in pig´s feces. Additionally, interaction with other pigs may cause stress and increased shedding of pathogens. .

### 9.2.1 GHP-based control measures

19. Refer to the OIE Terrestrial Animal Health Code[2] and Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005).

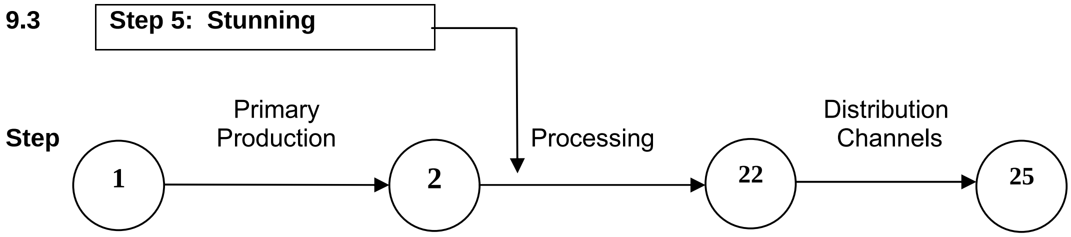
20. Particular attention to be paid to cleaning process to avoid cross contamination: Normal cleaning and disinfection at lairage reduced the level of Salmonella contamination to 25%. Improved cleaning and disinfection of further reduced the level of Salmonella contamination to 10%. Cleaning protocols could be improved by the addition of foaming and sanitizing solutions. The design and maintenance at lairage should also be appropriate to allow effective cleaning process. In addition limiting the time spent at this point to up to 6 hr can reduce the risk of cross contamination. (Arguello et al., 2012).

21. Care should be taken to control pest animals (eg birds and rodents) in the lairage areas in order to reduce the cross-contamination by these animal vectors.

22. Applying a water shower in the holding pens may reduce dust and dirt particles that may carry Salmonella. Ensure that pigs are dry enough to prevent dripping at the time of stunning.

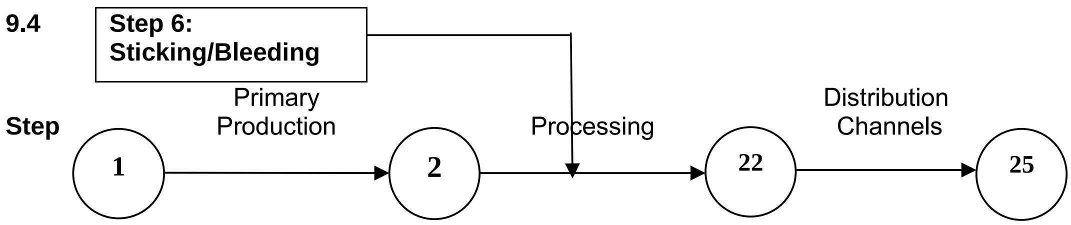
23. Time spent at lairage and stocking density should be kept to a minimum.

**9.3**




24. This is the point where the pig is rendered unconscious. This is the point where the animal is rendered unconscious. No control measures, relevant for the reduction of *Salmonella*, has been identified at this step.

**9.4**



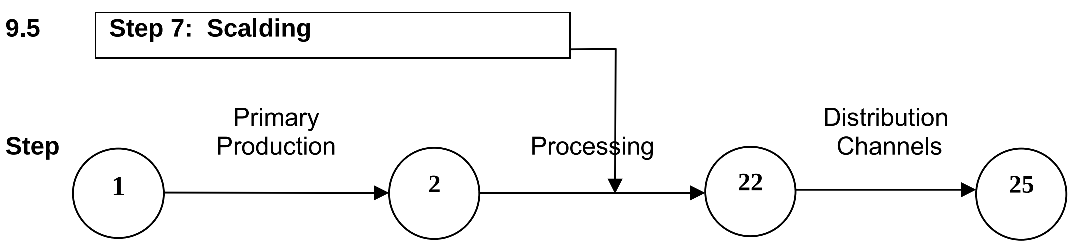

25. This is the point in the process where the animal is bled. Regardless of the slaughter method, it is important for the establishment to minimize contamination of the carcass during any cut made at this step, avoiding any contamination by openingwhere the pig is rendered unconscious.

#### 9.4.1 GHP-based control measures

26. Measures should be taken to avoid cross-contamination; sanitation of the processing environment should be maintained and limit carcass contact with the floor while being transferred to the line. (Bolton et al., 2002a).

27. Maintaining the hygiene of slaughter equipment such as knives is important as they may be a source of Salmonella and a potential vehicle for cross-contamination (Botteldoorn et al., 2003). Stick wound may be removed at a later step in the process thereby reducing the risk associated with this hazard.

**9.5**




28. This is the point in the process where the carcass is sprayed with or immersed into hot water to facilitate the removal of hair and hooves in the succeeding step.

#### 9.5.1 GHP-based control measures

29. As the cleanliness of the pigs and the microbiological status of the scald water are factors that are significantly associated with the presence of *Salmonella* on the carcasses at the end of the slaughter process (Letellier et al., 2009), the following measures or equivalent processes should be considered:

a. Maintain sanitary conditions. Ensure that the scalder is easy to clean and in good condition and repair. Drain and clean the scalder at least once a day. Pay particular attention to seams weld sites and rough, scratched areas in the interior of the tank to ensure adequate cleaning.

b. To maintain sanitary conditions, remove or prevent accumulations of hair and protein from the scalder before and during operations and control condensation as needed. Recirculation of water may result in greater accumulation of hair and residue and affect the control of temperature fluctuations.

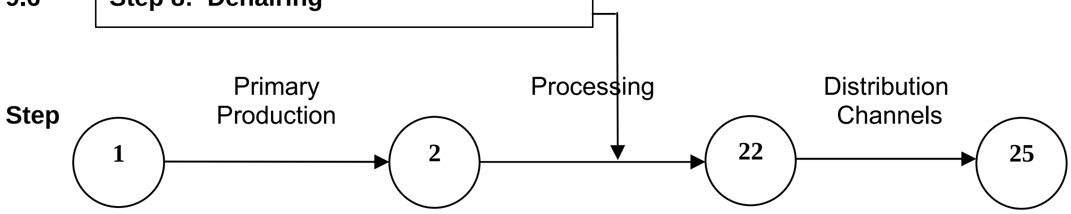
c. Maintain a clean supply of water. Re-use of the scalding tank water in multiple processing batches was associated with a higher *Salmonella* prevalence on carcass swabs (Tadee et al., 2014). Change the scald water at least once a day to prevent organic load build up. Adding an anti-foaming agent to the scald water reduces organic load build up in the form of foam (FAO Corporate Document Repository: Guidelines for slaughtering, meat cutting and further processing). Use counter current water flow (fresh or recirculated scald water that flows into the scalder in an opposite direction from that of the carcasses) to increase heating efficiency and water cleanliness.

d. Vertical scalding using steam may improve the bacteriological quality of the meat and prevent bacterial contamination of lungs (Gracey 1992). A vertical steam scald at 100 °C (212°F) allows for a constant supply of clean steam and prevents the accumulation of organic load as opposed to a water system.

**9.5.2 Hazard-based control measures**

30. Scalding water temperature should be at least 62°C (145°F) for 5 minutes or an equivalent combination of time and temperature to avoid *Salmonella* survival (Hald et al., 2003).

**9.6 Step 8: Dehairing**




31. This is the point in the process where the hair is removed from the animal. Hairs are a significant source of contamination (eg, dust, dirt, feces, mud, bacteria). It is important to maintain sanitary conditions of dehairing equipment. *Salmonella* has been detected in air samples at the locations of dehairing and evisceration operations (Pearce et al 2006).

**9.6.1. GHP-based control measures**

32. To maintain sanitary conditions, remove or prevent accumulation of hair in the dehairing equipment, as necessary.

33. At the end of the shift, remove all organic material and debris from de-hairing equipment. Consider the importance of mechanical action and cleaning. Chemical cleaners and disinfectants should be selected based on several factors including but not limited to the soil type, equipment materials and water hardness.

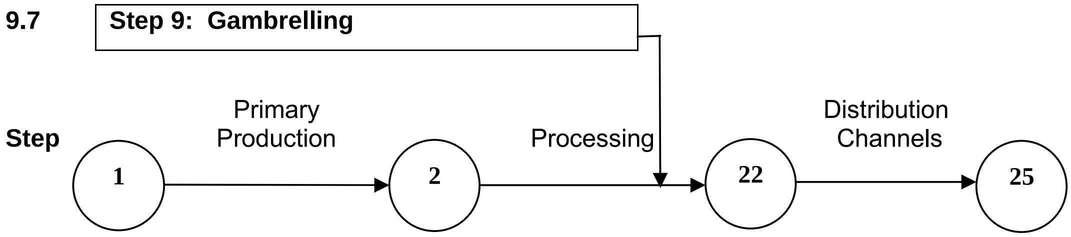
**9.6.2 Hazard-based control measures**

34. Among the operations carried out in the unclean area, dehairing and singeing/flaming operations especially affect the number of *Salmonella* on the rind side of the carcass. The combined effect of these two operations can lead to a low prevalence of *Salmonella* after the unclean area (Pearce *et al.,* 2004). During dehairing manure is pressed out of the rectum and the accumulation of manure and growth of *Salmonella* in the equipment can occur. Special care should be taken to prevent recontamination and increases in bacterial load when using a dehairing machine (Morgan et al 1987; Gill and Bryant, 1993; Davies et al 1999; Yu et al 1999; FRPERC 2007). Following preventive measures can be considered:

a. Use water between 60 ˚C to 62 ˚C (140°F to 144˚F ) in the dehairing machine if the water is not chemically treated (ICMSF 1998) or equivalent processes.

b. If possible, prior to dehairing, evaluate methods to prevent fecal voiding (Bolton et al., 2002b). Have in place procedures to clean contaminated carcasses that void fecal material after dehairing and prior to gambrelling and rehanging.

**9.7 Step 9: Gambrelling**

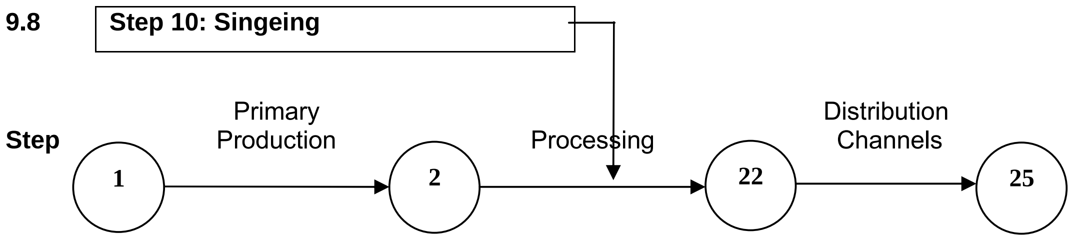



35. Gambrelling is the process of hanging the carcass by the hind legs on hooks.

### 9.7.1 GHP-based control measures

36. Minimize carcass contamination by cleaning and disinfecting gambrel table when needed to remove fecal materials before processing is resumed.

## 9.8 Step 10: Singeing




37. This is the point in the process where the carcass is subjected to direct-fire bursts on the animal surface in order to improve the hair removal and reduce or eliminate the pathogens of skin surface. This is an important step in the Salmonella control.

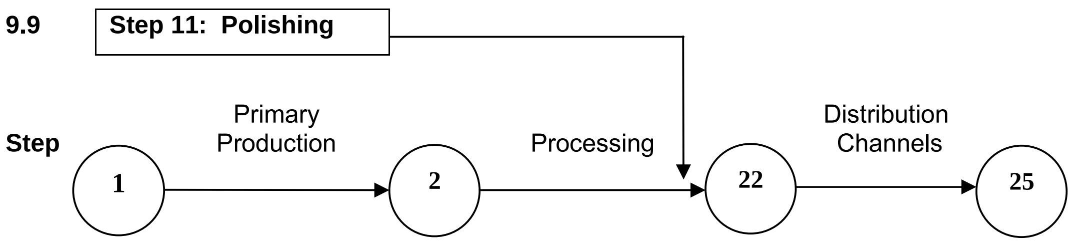
### 9.8.1 GHP-based control measures

38. Singeing is more effective on drier carcasses.

### 9.8.2 Hazard-based control measures

39. Singeing has been identified as a significant step for reducing *microbial* contamination on the surface of pig carcasses, including *Salmonella* (James et al., 2007; Alban and Stark 2005). Studies have shown that singeing can achieve a reduction of *Salmonella* incidence from 7% to 0% (Pearce et al., 2004). The reduction depends on the intensity of the singeing/flaming and the time used (Borch et al., 1996). Increasing time spent in the singeing unit was associated with lower *Salmonella* prevalence in carcass swabs (Marier et al., 2014).

## 9.9 Step 11: Polishing




40. This is the point in the process where the carcass is subjected to the mechanical finishing process (toilet) of remaining and burned hairs by the previous step. This step aims to eliminate the waste, but it is the main point of recontamination and cross-contamination, post singeing.

### 9.9.1 GHP-based control measures

41. Polishing is a primary mode of pork carcass recontamination following reductions achieved during singeing (James et al., 2007; Bolton et al., 2002a; Snijders et al., 1984; Hald et al., 2003. Any surviving bacteria may be mechanically disseminated by stainless steel scrapers or nylon brushes used in polishing (Delhalle et al., 2008). Polishers must be cleaned thoroughly because they harbor and allow bacteria to multiply to high numbers (Borsch et al., 1996; Huis in't Veld 1992). Thorough cleaning and disinfection of the equipment as needed and at the end of the shift will minimize the potential for carcass cross-contamination.

42. Before passing the carcasses on to the clean area (bunging) or to a pre-evisceration rinse or spray, a measure should be in place to prevent visibly contaminated carcasses from being passed on. If steam or hot water vacuuming is not available, knife trimming can be used to remove fecal contamination and other dressing defects.

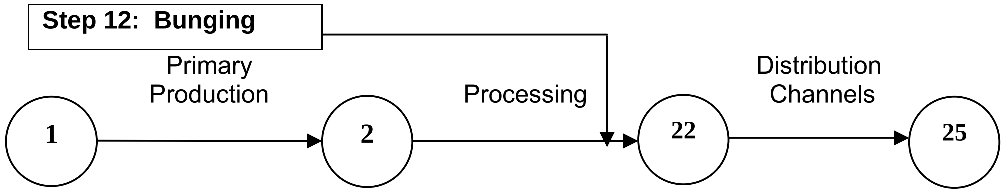
### 9.9.2 Hazard-based control measures

43. Prior to bunging and evisceration a validated decontamination treatment may be used, including the use of organic acids and steam vacuuming carcasses.

44. An additional singeing step, after polishing, may be added to reduce contamination introduced by polishing (Spescha et al., 2006; Delhalle et al., 2008). Consider whether carcasses have been adequately reconditioned in a sanitary manner, if contaminated by feces voided during the gambrelling step.

45. After polishing, a carcass rinse may be performed. Decontamination treatments that can be used for pre-evisceration rinsing or spraying could be considered.

**9.10 Step 12: Bunging**




46. This is the point in the slaughter process where a cut is made around the rectum (ie, terminal portion of the large intestine) to free it from the carcass, and then it is tied off to prevent spillage of fecal material.

**9.10.1 GHP-based control measures**

47. Tie bung, cut free from surrounding tissues with a single incision, and cover area with a protective covering.

48. During separation, prevent contact of bung with carcass or with viscera. A plastic bag can be used to avoid spilling from rectum. Secure bag with a tie or clip.

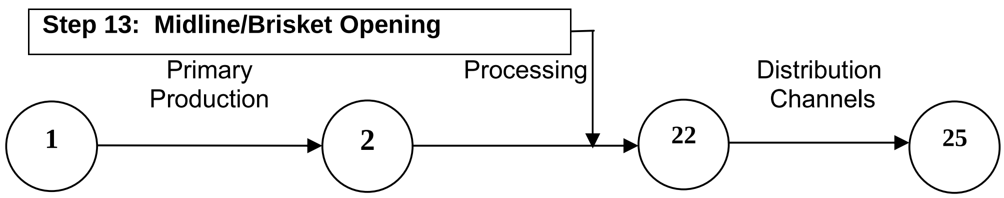
49. Immediately remove any contamination that results from bunging.

50. An automated bunging system will reduce cross-contamination by going around the anus and evacuating the rectum.

51. Clean and disinfect bung guns, knives, and hooks between each carcass.

52. Prevent contaminated water from dripping down the back of the carcass.

**9.11 Step 13: Midline/Brisket Opening**




53. This is the point in the process where the brisket is split (ie, cut along the centerline).

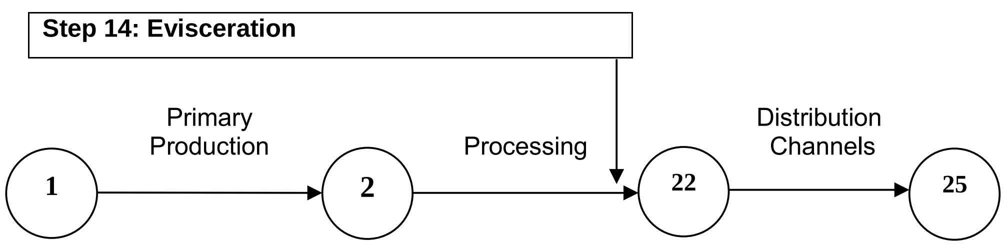
**9.11.1 GHP-based control measures**

54. Measures to prevent the introduction of contamination into the carcass during brisket opening include:

a. Cleaning and disinfecting the brisket saw and knife between each carcass and ensuring that the gastrointestinal tract is not punctured.

b. Maintaining proper employee hygiene practices to prevent the creation of unsanitary conditions (eg, touching the carcass with soiled hands, tools, or garments).

**9.12 Step 14: Evisceration**




55. This is the point in the process where the removal of the viscera (eg, the edible offal that includes the heart, intestines, stomach, liver, spleen, and kidneys when presented with viscera) occurs. If the viscera are not handled properly, or if employee hygiene practices are not being followed, contamination of the carcass and edible offal can occur.

**9.12.1 GHP-based control measures**

56. Evisceration should be performed carefully to minimize cross-contamination from intestinal contents.

57. Measures to ensure that employees do not contaminate carcasses during evisceration include:

a. Properly using knives to prevent damage (ie, puncturing) to the gastrointestinal tract.

b. Maintaining proper employee hygiene practices (eg, wash hands and arms often enough to prevent contamination of the carcass).

c. Using footbaths or separate footwear by employees on moving evisceration lines to prevent contaminating other parts of the operation.

58. To prevent contamination of the carcass or viscera, tie the rectum before evisceration. Remove the pluck with esophagus and viscera attached (so there is no leakage).

59. If possible, avoid cutting through tonsils, due to the risk of spreading *Salmonella* from tonsil tissue.

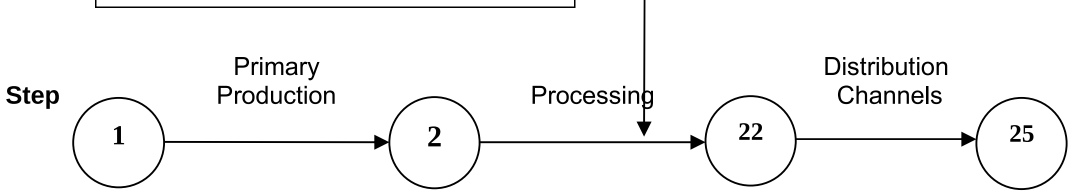
60. Only skilled, trained individuals should perform the evisceration; experienced individuals are needed at higher line speeds.

61. When removing stomach and intestines, be sure to leave a minimum of 2 cm of esophagus on the stomach to minimize leakage of stomach contents.

62. Avoid cutting or rupturing the gut. The critical operations are: cutting around the rectum, removal of the intestinal tract, and removal of the pluck.

63. Remove carcasses with visual contamination for reconditioning (knife trimming or steam vacuuming) before carcass splitting.

**9.13 Step 15: Splitting**




64. This is the point in the process where carcasses are split vertically into two halves.

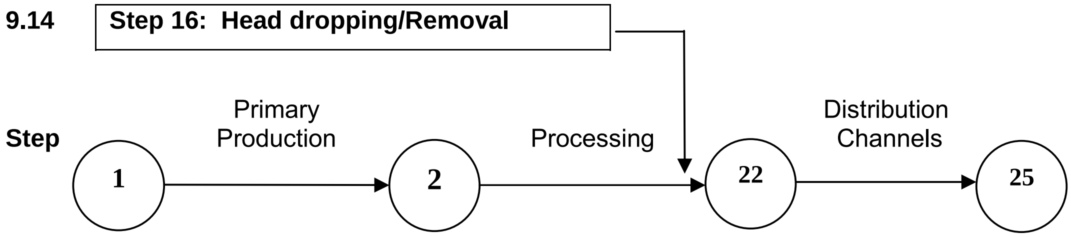
**9.13.1 GHP-based control measures**

65. Take care to avoid cross-contamination, which may occur when carcass splitting saw blades come in contact with the throat.

66. Clean and disinfect carcass splitting equipment during and after each carcass or as appropriate (van Hoek et al., 2012; Smid et al., 2013; Smid et al., 2014).

67. When using two blade axe systems, control contamination building up between blades by regular cleaning and disinfection with hot water. Allowing adequate distance between carcasses (ie, avoid carcass-to-carcass contact) and walls and equipment.

**9.14 Step 16: Head dropping/Removal**




68. This is the point in the slaughter process where the head is removed from the carcass. It is important to maintain sanitary conditions because cross-contamination can occur if the head comes into contact with other carcasses or heads, equipment and employees. Between this step and chilling is where decontamination treatments are likely to be most effective.

**9.14.1 GHP-based control measures**

69. Flush the oral cavity removing ingesta, bile, or other contaminants before head dropping and head inspection.

70. Clean and disinfect knives and head dropping equipment between carcasses and whenever sectioning of the esophagus occurs.

71. Be aware of potential contamination of the head, neck, and carcass by knives or equipment after incision of the oral-pharyngeal cavity or from exposure to fresh stomach contents when dropping heads and processing of head and cheek meat.

72. When a contaminated carcass is not adequately cleaned before the final wash, the carcass should be diverted to a holding rail until cleaned or reconditioned.

73. Measures to minimize contamination of heads, equipment, and employees can include:

a. Removing heads in a manner that avoids contamination with digestive tract contents.

b. Limiting the splashing of water when washing heads in order to prevent cross-contamination and to limit airborne contaminants.

### 9.14.2 Hazard-based control measures

74. At this stage or at a later stage decontamination treatments may be considered. The following decontamination treatments are examples from the scientific literature:

Hot water (76.5-81°C) pre-chill spray reduced *Salmonella* prevalence on pork carcasses compared to the control group from 16.0% to 2.7% (Hamilton et al., 2010). A warm (22-23°C) water wash at high pressure (8 bar) reduced *Salmonella* prevalence on carcasses that were artificially inoculated with fecal contamination from 91.7% before to 16.7% after treatment (Brustolin et al., 2014).

Simple ambient and warm water washes tend to be effective to reduce inoculated *Salmonella* concentrations on various pork carcass tissues with a reduction at 1.03 CFU/cm$^2$ (Frederick et al., 1994; Fabrizio and Cutter, 2004; Carpenter et al., 2011).

Organic acid washes, as lactic or acetic acid washes significantly reduce *Salmonella* prevalence on carcasses immediately and 24 hours after treatment, from 19.3% of un-treated carcasses to 6.4% of treated carcasses and from 13.9% before treatment to 6.7% after (Epling et al., 1993; Frederick et al., 1994; Larsen et al., 2003). Other studies show a reduction of 1.06 CFU/cm$^2$ compared to no treatment (Frederick et al., 1994; Fabrizio and Cutter, 2004; Carpenter et al., 2011).

Applying other chemicals can reduce *Salmonella* concentrations with 1.56 CFU/ cm$^2$ compared to no treatment (Fabrizio and Cutter, 2004; Morild et al., 2011), and acidified sodium chlorite (900-1100ppm) pre-chill spray reduced *Salmonella* prevalence on pork carcasses compared to the control group from 16.0% to 7.0% (Hamilton et al., 2010). One cross-sectional study found that use of chlorine in the wash water was associated with a lower *Salmonella* prevalence on carcass swabs (Tadee et al., 2014).

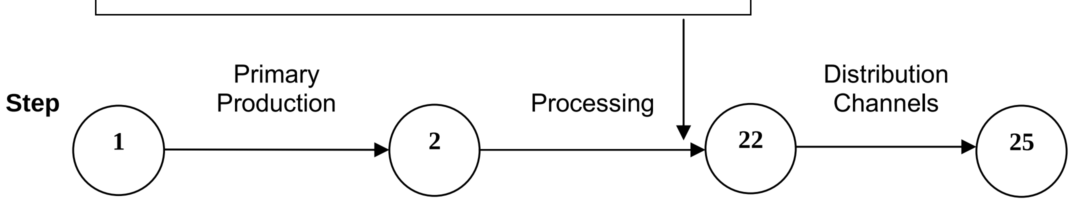
Enhanced washes do not always provide significant benefits compared to simple ambient and warm water washes alone. Applying organic acids reduced the number of *Salmonella* with 0.43 CFU/cm$^2$ compared to a water wash (Frederick et al., 1994; Fabrizio and Cutter, 2004; Carpenter et al., 2011), while applying other chemicals reduced the number of *Salmonella* with 0.17 CFU/cm$^2$ compared to a water wash (Fabrizio and Cutter, 2004). Cold (11°C) and hot (55°C) water washes containing 2% and 5% lactic acid reduced *Salmonella* prevalence on artificially contaminated pork carcasses compared to water washes alone from 13.3% to 9.3% (11°C) and 15.3% to 10.7% (55°C) (van Netten et al., 1995).

The following measures should be considered (Alban et al., 2010; Morild 2011; McMullen 2000; Eggenberger-Solorzano et al., 2002; Algino et al., 2009):

a. Clean the contaminated carcasses by removing visible contamination by trimming, steam or hot-water vacuuming prior to final inspection and final rinse.

b. Rinse carcasses from the top down. Minimize any splash onto other carcasses.

### 9.15 Step 17: Post Mortem Inspection



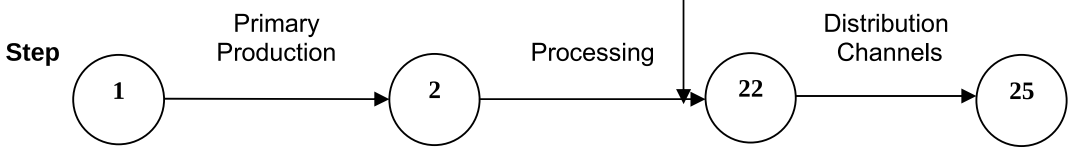

75. This is the point in the process where inspection of carcasses is carried out, so it is a key point to characterize a healthy carcass.

### 9.15.1 GHP-based control measures

76. Line speeds and the amount of light should be appropriate for effective post-mortem inspection of carcasses.

77. The procedures should be planned to avoid cross-contamination. Touching the carcasses with hands, tools or garments may cause cross-contamination (Vieira-Pinto et al., 2006).

**9.16 Step 18: Chilling**




78. This is the point in the process where the carcass is chilled.

**9.16.1 GHP-based control measures**

79. Ensure that carcasses are adequately spaced to allow for effective cooling.

80. Maintain the cooler at a temperature that ensures a decreasing temperature of the carcass surfaces until they are at a temperature which prevents the growth of *Salmonella.*

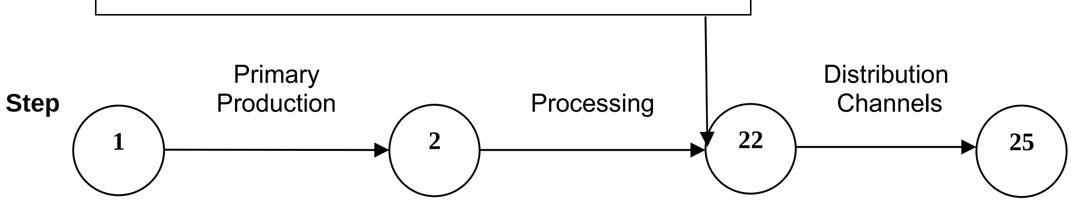
**9.16.2 Hazard-based control measures**

81. Chilling affects the prevalence of *Salmonella* on carcasses with significant reductions from 10.3% to 4.5% (Gonzales-Barron et al., 2013), but studies show large variations in the reduction (O'Conner, 2012; Barron, 2008). During conventional chilling, carcasses are blasted with air at temperatures above 0°C (32°F). Blast chilling involves initial blasting carcasses with air at temperatures below -15°C (5°F) resulting in a surface that is frozen. Freezing of the surface during blast chilling can be expected to give the biggest reduction in the prevalence of *Salmonella* on carcasses (EFSA 2014).

82. Spray chilling (intermittent water at 4°C every 20 min for 11s during the first 8hrs) reduced *Salmonella* on carcasses compared to conventional air chilling at 4°C from 13.3% to 9.3% immediately after chilling and from 15.1% to 10.7% 24 hours after (Epling et al., 1993)

83. Post-chill interventions as a steam spray (82-85°C) using a commercial household steam cleaner reduced an already very low post-chill *Salmonella* prevalence at 1.9% further to 0.2% compared in pre vs. post intervention samples (Trivedi et al., 2007).

**9.17 Step 19: Carcass Fabrication**




84. These steps include cutting and deboning that can result in wholesale pieces.

**9.17.1 GHP-based control measures**

85. Boning and fabrication rooms should be kept at a temperature that limits the ability for *Salmonella* to grow. Time out of the cooled conditions should be as short as possible to limit the growth of *Salmonella*.

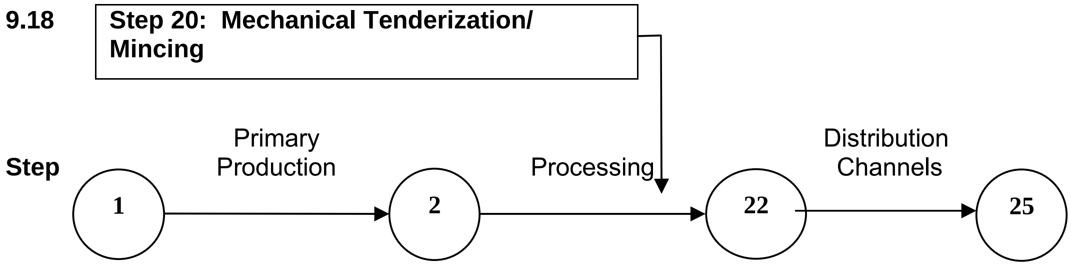
86. Clean and disinfect knives, saws, slicers, and other food contact surfaces as frequently as necessary (ie, ideally between each carcass) to prevent the creation of unsanitary conditions.

87. Maintain fabrication area and equipment in a sanitary condition.

88. Clean and disinfect conveyor belts frequently.

89. Prevent cross-contamination from slaughter operations by maintaining adequate airflow.

**9.18 Step 20: Mechanical Tenderization/ Mincing**



90. This is the point in the process where the meat is subjected to the process of breaking fibres mechanically or manually. This step can be a cross-contamination point if the procedures and handling are not performed in a sanitary manner and by skilled employees.

**9.18.1 GHP-based control measures**

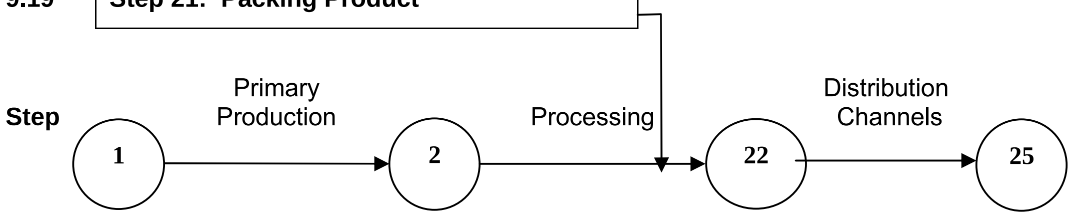
91. Products should be stored at temperatures to prevent the growth of *Salmonella*.

92. Equipment used for this operation should be adequately maintained and adjusted.

93. In order to avoid cross-contamination, equipment and environment should be cleaned on a regular basis and good personal hygiene practices should be followed by employees.

94. Processes such as mechanical tenderization or mincing, may potentially increase contamination in the meat. There should be increased awareness of the risk of contamination when handling of the meat throughout the rest of the food chain.

**9.19 Step 21: Packing Product**




**9.19.1 GHP-based control measures**

95. Use of various technology packaging may limit the growth of *Salmonella* (eg, modified atmosphere packaging).

96. Monitor and document temperature of storage room and meat.

97. Packing rooms should be kept at a temperature that limits the growth of *Salmonella*.

**9.19.2 Hazard-based control measures**

98. Laboratory challenge trials indicate that modified packaging and preservation with various chemicals and extracts have potential to mitigate *Salmonella* in pork products through distribution and storage.

Natural extracts of cinnamon oil and olive achieved significant reductions over 7 days storage, while cinnamon stick, oregano, clove, pomegranate peel, and grape seed extracts reduced *Salmonella* in pork over 9 days of storage by 1-2 logs (Shan et al., 2009; Chen et al.; 2013).

Salt preservatives as potassium sorbate and sodium lactate lowered the survival rate of *Salmonella* on raw pork during freezing for 72 hrs, while 5% potassium sorbate and a combination of 5% sodium chloride and 2.5% each of sodium acetate, sodium citrate, sodium lactate, and potassium sorbate applied to pork carcasses before deboning resulted in non-detectable levels of *Salmonella* compared to a nearly 3 log contamination in the control group after storage until spoilage (Nanasombat and Chooprang, 2009; Latha et al., 2009).

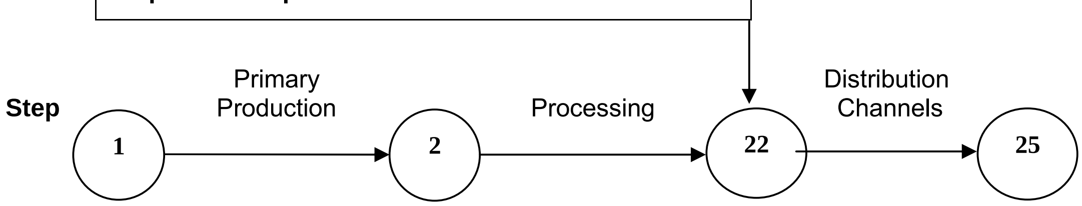
Vacuum packaging of pork loins prior to chilling resulted in enhanced reductions of *Salmonella* compared to vacuum packing after chilling and compared to unpacked loins (Van Laack et al., 1993).

Adding 0.2-0.4% water-based oligochitosan to ground pork reduced *Salmonella* to undetectable levels after 1-2 days of storage (Chantarasataporn et al., 2014).

Fresh pork treated with 2-4% potassium lactate and packaged with and without ozone injected at 200-1000 mg/hr reduced *Salmonella* levels by up to 0.8 logs over 15 days of storage compared to untreated, packaged control group (Piachin and Trachoo, 2011)

**10. CONTROL MEASURES FOR STEPS 22 TO 25(DISTRIBUTION CHANNELS)**

**10.1 Step 22: Transport to Distribution Channels**



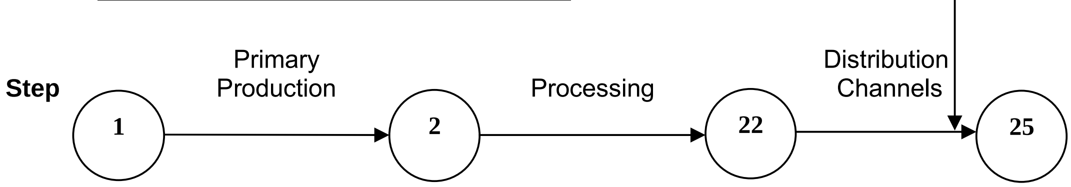
#### 10.1.1 GHP-based control measures

99. Transportation vehicles should be kept clean and free of pests.

100. Transportation vehicles should be maintained at a temperature that ensures the temperature of the chilled meat is adequate to prevent the growth of *Salmonella* (EFSA, 2014).

101. Monitor and document temperature of vehicle and meat. Meat should be chilled before loading onto the vehicle for transport.

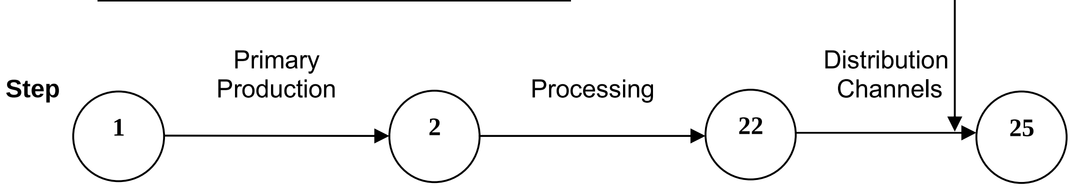
### 10.2 Step 23: Cold Storage




#### 10.2.1 GHP-based control measures

102. Storage room temperature should be maintained at a temperature that prevents the growth of Salmonella (EFSA, 2014).

### 10.3 Step 24: Distribution/Retail




#### 10.3.1 GHP-based control measures

10.3.1.1 Retail

103. Fresh meat should be stored at a temperature that prevents the growth of *Salmonella*.

104. Monitor and document temperature of storage room and meat.

105. Prevent cross-contamination from or to other food items.

106. Food business operators serving meat for direct consumption to consumers (eg, caterers, restaurateurs) should take appropriate measures to:

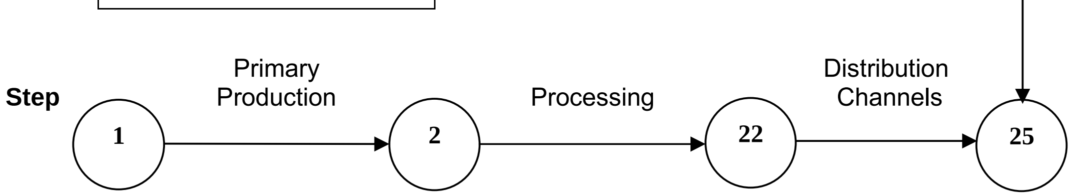
a. Prevent cross-contamination

b. Maintain appropriate storage temperature

c. Ensure proper cleaning

d. Ensure thorough cooking

### 10.4 Step 25: Consumer




#### 10.4.1 GHP-based control measures

107. Consumers should be informed on the potential risk associated with finished pork product in order to follow instruction and make informed choices on how to avoid the spread and growth of *Salmonella* (eg, storage temperature, hygiene and cooking temperature). This information should be provided by the local government, health agencies, manufacturers, retailers or other consumer sources.

108. Cooking of pork can reduce or eliminate the level of *Salmonella*.

109. Consumers should be appropriately informed of raw treated meat (eg, mechanically tenderized, minced meat) so they can take appropriate actions to make sure meat is properly cooked.

110. Consumer education should focus on handling, hand washing, cooking, storage, thawing, prevention of cross contamination, and prevention of temperature abuse. The WHO Five keys to safer food[22] assists in this process.

111. Special attention should be paid to the education of all persons preparing food, and particularly to persons preparing food for the young, old, pregnant and immuno-compromised.

112. The above information to consumers should be provided through multiple channels such as national media, health care professionals, food hygiene trainers, product labels, pamphlets, school curriculae and cooking demonstrations.

113. Consumers should wash and disinfect food contact surfaces and utensils after raw pork preparation to significantly reduce the potential for cross-contamination in the kitchen.

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**Appendix II**

## GENERAL GUIDANCE FOR THE PROVISION OF COMMENTS

In order to facilitate the compilation and prepare a more useful comments' document, Members and Observers, which are not yet doing so, are requested to provide their comments under the following headings:

(i) General Comments

(ii) Specific Comments

Specific comments should include a reference to the relevant section and/or paragraph of the document that the comments refer to.

When changes are proposed to specific paragraphs, Members and Observers are requested to provide their proposal for amendments accompanied by the related rationale. New texts should be presented in **underlined/bold font** and deletion in ~~strikethrough font~~.

In order to facilitate the work of the Secretariats to compile comments, Members and Observers are requested to refrain from using colour font/shading as documents are printed in black and white and from using track change mode, which might be lost when comments are copied / pasted into a consolidated document.

In order to reduce the translation work and save paper, Members and Observers are requested not to reproduce the complete document but only those parts of the texts for which any change and/or amendments is proposed.