Foreword

This *Code of Practice for the Prevention and Reduction of Ochratoxin A (OTA) Contamination in Coffee* was developed in response to the request of the Philippine Council for Agriculture and Fishery (PCAF) Committee on Commercial Crops to develop Good Agriculture Practice (GAP) for Coffee and other related standards. The Codex Alimentarius Commission developed a *Code of Practice for the Prevention and Reduction of Ochratoxin A (OTA) Contamination in Coffee* in 2009. This Code of Practice is therefore an adoption of this Codex Code of Practice with some modifications to suit the local production practices in the Philippines. This Code of Practice specific for *OTA* prevention and reduction is a supplement to the existing *Good Agriculture Practice for Coffee* (PNS/BAFS____:2014) and should be read in conjunction with it.

A Technical Working Group (TWG) was created through Special Order No. 320 Series of 2014 to develop the draft Code of Practice. The TWG represented the relevant agencies of the Department of Agriculture (DA), Department of Science and Technology (DOST), Academe and the non-profit organizations. Public consultations were conducted in Cordillera Administrative Region (CAR), Regions 4A, 10, 11 and 12 representing the major hubs of coffee production and trade. Comments and recommendations were solicited from the relevant government agencies, academe, private sector and non-government organizations. Therefore, this Code of Practice is the final output of the public-private sector collaboration between, and among the TWG and the relevant stakeholders who participated in the public consultations.

I. Introduction

1. This document is intended to provide guidance for all interested parties producing and handling coffee for human consumption to prevent and reduce *Ochratoxin* A (*OTA)* contamination in coffee. All coffee beans should be prepared and handled in accordance with the *Codex General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4, 2003)*, which are relevant for all foods being prepared for human consumption. This Code of Practice indicates the measures that should be implemented by all persons that have the responsibility for assuring that food is safe and suitable for human consumption.

2. *Ochratoxin A* (*OTA*) is a toxic fungal metabolite classified by the International Agency for Research on Cancer (IARC) as a possible human carcinogen (group 2B). The Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Committee on Food Additives (JECFA) established a Provisional Tolerable Weekly Intake (PTWI) of 100ng/kg bodyweight for *OTA*. In recognition of this global concern,

FAO developed Guidelines for the Prevention of Mould Formation in Coffee in 2006 as a strategy to enable coffee-producing countries to develop and implement their own national programs for the prevention and reduction of *OTA* contamination.

3. OTA is produced by a few species in the genera *Aspergillus* and *Penicillium*. In coffee beans, only *Aspergillus* species, specifically *A. ochraceus* and related species (*A. westerdijkae* and *A. steynii*), *A. niger* and related species, and A*. carbonarius* are involved in *OTA* production. *OTA* is produced when favorable conditions of water activity, nutrition and temperature required for growth of fungi and *OTA* biosynthesis are present.

4. The coffee fruit is composed of the pericarp and perisperm tissue. The perisperm gradually disappears and is progressively replaced by the endosperm (true seed). Initially present in a "liquid" state, the endosperm hardens as it ripens during the maturation phase, as a result of accumulation of storage proteins, sucrose and complex polysaccharides representing the main reserves of the seed. The last step of maturation is characterized by the dehydration of the endosperm and the color change of the pericarp.

5. The main commercial coffee varieties produced and traded are *Coffea canephora* (robusta coffee) and *Coffea arabica* (Arabica coffee). *Coffea liberica* and *Coffea excelsa* is likewise cultivated. The major coffee variety produced in the Philippines is the robusta coffee.

6. After harvest, the crop is sorted, dried (as cherries/berries or as beans), stored and traded. The moisture content of the beans is reduced to a maximum of 12% to prevent *OTA* production.

7. Possible contamination routes for infection of *OTA*-producing fungi in the coffee [fruit] are through the flowers (without visible sign) and through the soils, or by insect invasion such as coffee berry borer (CBB) (*Hypothemeus hampei*), that can carry spores to the fruit by making hole in the cherries and one or more tunnels in the beans leaving visible signs. In the subsequent stages, it is in the drying process that provides for *OTA*-producing fungi opportunities for growth. Consequently, the roasting process can significantly reduce *OTA* between 65 and 100%.

8. In the Philippines, the mycoflora of coffee had been investigated by the Philippine Center for Postharvest Development and Mechanization (PhilMech). The dominant *Ochratoxin A* (*OTA*) forming fungus associated with coffee was *Aspergillus niger*. Other *Ochratoxin A* forming fungi isolated include *A. fumigatus*, *A. ochraceous and A.*

carbonarius. Ochratoxin A contamination in coffee had been detected in *Coffea liberica* and in *Coffea robusta* to a lesser extent.

II. Definitions

For the purpose of this Code, the following terms are operationally defined based on International Organization for Standardization. Coffee and Coffee Products – Vocabulary (ISO 3509:2005):

Section 1. Parts of the coffee fruit, undried (please see Figure 1)

Bean, fresh bean - endosperm (seed) of the coffee fruit. There are generally two beans per fruit.

Coffee Cherry – also known as coffee berry; fresh, complete fruit of the coffee tree.

Endocarp - scientific term for "parchment." The tough integument tightly pressed to the seed when fresh but from which the seed shrinks during drying.

Endosperm - scientific term designating the tissues that feed the embryo during germination. The bean consists of the endosperm and embryo (i.e., the material inside the developing fruit), which ultimately forms the coffee beans. The endosperm fill the integument as the coffee cherry ripens.

Epicarp or Exocarp - scientific word designating the skin of the fruit, a mono-cellular layer covered with a waxy substance ensuring protection of the fruit.

Floating coffee (floaters)- cherry coffee of low density, buoyant in water.

Mesocarp - intermediate layer of tissues between the epicarp and the endocarp (parchment). It consists mainly of pectinacious mucilage and pulp.

Mucilage - common word to describe the sweet slimy layer found between the pulp and adhering to the parchment inside a coffee cherry, but not removed by pulping. Not present in unripe cherries.

Naked beans or endosperm - parchment coffee that has been partly or entirely peeled of its parch during pulping and/or washing.

Pulp - part of the coffee cherry composed of the external exocarp and most of the internal mesocarp (mucilaginous tissue).

Section 2. Parts of the coffee fruit, dried

Parchment coffee – coffee bean entirely or partially enclosed in its parchment (endocarp, pergamino).

Coffee Bean - commercial term designating the dried seed of the coffee plant.

Defects - the general term for common undesirable particles, which can include various types of beans, parts of beans, fruit tissue and foreign matter, found in green and roasted coffee beans. Diverse and specific terms, according to the producing country, are used to describe the defects. The fruit defects are generally caused by faulty processing, pest damage, or adverse climatic conditions. Defects receive specific weight values to assist in the classification and grading of coffee lots under various national and international systems.

Green coffee bean - the dried seed of the coffee plant, separated from non-food tissues of the fruit.

Hull, dried parchment - dried endocarp of the coffee fruit.

Husk, dried cherry pulp - assembled external envelopes (pericarp) of the dried coffee fruit.

Natural coffee, dried coffee cherry - dried fruit of the coffee tree, comprising its external envelops and one or more beans.

Parchment (or Parch) or endocarp - the coffee fruit endocarp located between the fleshy part (pulp) and the silver skin. It is a thin, crumbly paper-like covering left on wet-processed beans after pulping and fermentation, removed during hulling.

Silverskin, dried testa, dried seed perisperm - coat of the coffee bean. It has generally a silvery or coppery appearance.

Washed and cleaned coffee –processed green coffee from which the silverskin has been removed by mechanical means in the presence of water.

Section III. Processes

Dehusking - mechanical removal of the husks (pericarp) from dry coffee cherries.

Drying of parchment coffee - operation to reduce the moisture content of parchment coffee to a level that allows hulling under satisfactory technical conditions and that will not be detrimental to further storage of the coffee.

Dry process - treatment of coffee cherries consisting in drying them, either under sunlight

or in drying machines, to give husk coffee. This is usually followed by mechanical removal of the dried pericarp (husk) to produce "natural" green coffee.

Fermentation process - treatment intended to digest the mucilaginous mesocarp adhering to the parchment of the pulped coffee, allowing its elimination by washing. The fermentation process can be replaced by a mechanical demucilaging system to remove the mucilage by friction.

Gleaning (or sweeping) - coffee fruit found lying on the ground beneath coffee bushes, detached during harvest or abscised during development.

Hulling - removal of the dried endocarp of parchment coffee to produce green coffee. Polishing: technological operation to remove the residual silverskin (perisperm) from green coffee by purely mechanical means.

Pulping – technological operation used in the wet process to remove the pulp (exocarp) and as much as possible of the mucilage (mesocarp) by mechanical means. A portion of the mucilaginous mesocarp usually remains adhering to the parchment (endocarp).

Roasting - heat treatment that produces fundamental chemical and physical changes in the structure and composition of green coffee, bringing about darkening of the beans and the development of the characteristic flavor of roasted coffee.

Selection - technological operation intended to eliminate foreign matters (e.g. stones, twigs, leaves) and to sort coffee cherries according to size, density and degree of maturity.

Sorting - operation intended to remove foreign matter, fragments of coffee and defective beans from green coffee.

Splitting of cherry - a variation of dry processing wherein the cherry is mechanically split open and the fruit and seeds maintained together in a mass.

Washing - operation intended to remove by water all traces of the mucilaginous mesocarp from the surface of the parchment bean.

Wet process - treatment of coffee cherries consisting of the mechanical removal of the exocarp (pulp) in the presence of water, alternatively followed by either (1) removal of the mucilage (mesocarp) by fermentation or other methods, followed by washing to give parchment coffee, or, (2) direct drying of the pulped beans within their mucilaginous parchment, followed by hulling to produce "semi-washed" green coffee. Removal of the mucilage is usually followed by drying and hulling to produce "washed" green coffee.

III. Processing of Coffee Cherries

9. The coffee cherries are processed under two basic systems (Figures 2 and 3): a) the dry processing system which produces what is called natural coffee or dried coffee cherry (the seed is enclosed in the whole fruit), and b) the wet processing system, that generates what is called parchment coffee, where the seed is enclosed in the inner integument or endocarp.

10. In the dry processing system of natural coffee, the whole fruit is either directly sun-dried, on bare soil, bricks, laminated sacks, tiles and concrete pavement, or dried using a combination of sun and mechanical drying (particularly more technologically advanced farms).

11. In wet processing system of parchment coffee, the fruit parts are mechanically separated, making the pulp as the by-product and the parchment coffee as the main product. The latter is coated with mucilage, which can be degraded by fermentation and then washed or mechanically removed directly, with or without fermentation. After removing or not removing the mucilage, the parchment coffee is usually sun-dried, in a drying yard, or on suspended tables with many variations and technological innovations. Sun and mechanical drying can be used in combination.

12. After dehulling or dehusking, the dried green coffee beans will passed through sizing (grading), sorting, polishing, cleaning and bagging before being sold.

13. Coffee roasting can remove a very significant percentage of *OTA*. Depending on the roasting process, 65 to 100% reduction of *OTA* can be achieved.

14. While this Code of Practice is focused on the reduction of *OTA* contamination, which is the primary food safety issue in the production of green coffee bean, industry food safety programs must also effectively manage other potential hazards associated with the production, processing and handling of coffee.

IV. Recommended Practices

4.1 Pre-Harvest

15. It is not certain whether *OTA*-producing fungi can infect coffee fruits and grow to produce *OTA* still on the plant. It is possible that infection on the plant may involve two different contamination routes, either through (1) the flowers without visible sign, or (2) by insect invasion such as the coffee berry borer (CBB) (*Hypothenemus*

hampei), that can carry spores to the fruit by making holes in the cherries and one or more tunnels in the beans, leaving visible signs.

16. Recommended practices to reduce the development and spore load from *OTA*-producing fungi on coffee plants and beans are:

a) Keep coffee plants vigorous, through the regular use of Good Agriculture Practices (GAP), such as weeding, improving soil texture, pruning, fertilization, pest and disease control, and irrigation.
b) Do not use overhead irrigation during the flowering period. This could augment normal spore dispersal rate and increase the chance of infection of beans by *OTA* producers.
c) Use traps (such as alcohol traps) for coffee berry borer control before harvesting, and encourage the use of the integrated pest management (IPM) program.
d) Avoid disposal of uncomposted organic wastes, from coffee or any other source, in or around plantation. Coffee seeds and seed-associated material, such as dust, earth, parchment and other seed processing residues can allow proliferation of *OTA*-producing fungi.

4.2 Harvesting

17. The harvesting method chosen on any farm is a conjunction of the requirements of the processing method, economic considerations and labor availability.

Two (2) basic harvesting systems are known: (1) single-pass stripping, where all branches bearing fruit are harvested at once and (2) multi-pass selective picking (finger picking), where only ripe cherries are harvested. Of the two (2) systems, selective picking of ripe cherries is highly recommended.

18. In general, berries that fall naturally onto the ground should not be collected, particularly in humid conditions, as fungal growth may occur, which can give rise to *OTA* contamination. However, during harvest fallen beans should be immediately collected within the day. To avoid the risk of contaminating the rest of the crop, care should be taken to ensure that any fallen berries that are collected are rapidly subjected to the processing and drying stages, as these commodities may have a higher likelihood of fungal growth.

19. The harvest should be started as soon as there are sufficient ripe cherries for it to be economically viable. When the right time to commence harvest is decided, the following should first be carried out:

a. Remove weeds, fallen cherries and brush from the proximity of the trees before harvest.

b. Place canvas, mats, or tarpaulins beneath the trees to prevent.

c. Ensure that there are adequate arrangements for the subsequent storage and processing of the crop, so that conditions favour mold growth or other damage are avoided.

20. Coffee cherries should be processed as soon as possible after harvesting. The harvest rate, processing performance and labor availability must follow the pace of the drying rate.

21. Coffee cherries ready to be processed should be sorted by water flotation to remove the low quality cherries or floaters (e.g. immature fruit, insect damaged cherries) and foreign matters. It should be ensured that any material that is ~~out~~ sorted out is disposed off in an appropriate manner.

4.3 Post-Harvest

22. Senescence and changes follow once coffee cherry is detached from the plant. The post-harvest period is characterized by initial, transitional and final phases.

23. The initial or high moisture phase starts with harvest. The product is then in an unstable state, and spoilage can be controlled through competitor microorganisms, restricting oxygen and reducing the time which is critical in this state. In wet processing the high moisture phase may be extended and controlled through fermentation (i.e. 12 to 36 hours), but it is desirable to reduce the time.

24. The transitional phase is the least stable and most difficult to predict, when spoilage can only be controlled by time limitation. Mesophilic and xerophilic spoilage microorganisms have enough water to grow but not their hydrophilic competitors. Turning or stirring of the coffee is essential to promote uniform drying. When harvest coincides with a rainy or high humidity season, measures to optimize drying, must be adopted.

25. The final or low moisture phase starts at the end of drying and continues until roasting. The product is in a stable condition and control is necessary to prevent water re-introduction or redistribution in the bulk coffee beans. At some point during drying, there is no further growth as the product reaches the low moisture phase.

4.4 Dry Processing

26. In the dry processing system (*Figure 2*) the whole harvested fruit is dried. Although it is a simpler process compared to wet processing, a good quality finished product can only be obtained through the application of good practices and proper management.

27. Wherever possible, freshly picked cherries should be dried on the same day that they are harvested. In some instances, the harvested fruit is retained in bags or heaps for up to a week. This practice leads to high temperatures and quick fermentation, different in nature from the fermentation process employed in wet processing, causing quality losses and increasing the risk of *OTA* in the product.

28. Prior to drying, the harvested fruit should be sorted to remove immature and over mature cherries, and cherries damaged by CBD (Coffee Berry Disease). Sorting may be done either manually, or in combination with water flotation.

4.5 Wet Processing

29. Wet or washed processing (*Figure 3*) requires a raw material composed of only ripe cherries that have been selectively picked or are mechanically separated in the process itself. Green immature cherries and dried fruits are removed in a water separator. The mucilage is removed, either by fermentation, mechanically or by using chemicals.

30. In the fermentation process, the mucilage is broken down by fermenting the beans in water at ambient temperatures (using microorganisms) for between 12 and 36 hours. The fermentation process must be carefully monitored to ensure that the coffee beans do not acquire undesirable (sour) flavors. After fermentation is complete, the coffee beans are washed in clean water tanks or in special washing machines.

31. After passing through the water separators and before removal of the pulp, the separation of the green immature cherries from the ripe ones can be performed, using differences in pressure, in a green cherry separator. The soft ripe cherries pass through the holes of the screen. The hard, unripe cherries, which cannot pass through the holes, go to the edge of the cylinder where a counter weight controls their outflow.

32. Factors that need to be controlled are as follows:

a.) Any equipment should receive regular maintenance, to reduce the possibility of failures, which could delay processing and compromise coffee quality and safety.

a.1) Before the beginning of the harvest season: clean, reassemble and lubricate the processing equipment; inspect the installation and check if it is operational, so that there is enough time for repairs if any problem occurs.

a.2) At the end of the harvest season: clean, repair, lubricate, dust all equipment and protect from water. Check pulping surfaces for wear.

b.) Provide proper orientation/training to the workers and define their responsibilities. In addition, define quality and acceptability criteria, the monitoring procedures and frequencies, and the corrective measures for each key element of the process for the following:

b.1) Cherries – maximum acceptable proportion of immature and over-mature/tree-dried cherries.

b.2) Pulping - acceptable proportion of un-pulped cherries and nipped beans and cost-benefit to increase size uniformity of the cherries and effectiveness of skin removal. The efficiency of the operation can be improved based on the various estimates of monitoring the quality and safety of the product.

c.) Water quality - clean water (*i.e.* water that does not compromise food safety in the circumstances of its use) should be used for processing, as dirty water may lead to conditions favourable to *OTA* production.

d.) Fermentation should be as short as possible (12 to 36 hours), to get the mucilage degraded and the beans washable. Monitoring procedures should be established (e.g. temperature).

e.) Avoid the presence of fruit flies, as high populations can affect fermentation.

f.) Secondary coffee cherry, which can be defined as products separated by sorting or other procedures and are returned to the processing, should have a specific control program e.g. good drying practices should be applied, such as maintenance of separate facilities for drying.

g.) Washing protocols should be defined and implemented (e.g. by measuring the quantity of broken, nipped and naked beans and other foreign matters, and the quantity of water used).

4.6 Drying of Sorted and Processed Coffee Beans

33. The main purpose of the drying operation is to efficiently decrease the high water content of the just processed cherries to a safe level in order to get a stable, safe and good quality product.

34. There are two (2) basic types of processes: wet and dry. Most of the coffee produced is dried using direct sunlight.

35. In the sun-drying process, the product is spread on surfaces such as cement or brick terraces, plastic canvas, bamboo and sisal mats, raised tables covered in wire mesh, or farm netting.

36. The drying process can be divided into three (3) stages. In each stage *OTA*-producing fungi will have varying opportunities for growth.

37. At the first (1st) stage, there is a slight decrease in moisture content that takes a time interval between one (1) to three (3) days for cherry coffee and one day or less for parchment coffee. The high moisture content (a_w > 0.95) provides unsuitable conditions for *OTA*-producing fungi to grow.

38. The second (2nd) stage is the one of maximum loss in moisture content for both cherry and parchment coffee, under similar conditions at the same period of time. This is mainly dependent on drying conditions and drying yard technology. During this stage, there are favourable conditions for *OTA*-producing fungi to grow and therefore it is necessary to implement precautionary measures as recommended in *paragraph 42*.

39. At the third stage (3rd) both cherry and parchment coffee, is much drier compared to the previous two stages. There is a slower slight decrease in the remaining moisture content. Conditions at this stage do not favor the growth of *OTA*-producing fungi.

40. The *OTA*-producing fungi require favorable conditions during a certain period of time to grow and produce the toxin. The level of available water is the most important factor to be considered. At high water activity (a_w > 0.95) *OTA*-producing fungi will unlikely to grow, as fast-growing hydrophilic fungi and yeasts grow first. At lower activity (aw < 0.80) the *OTA*-producing fungi can be present but incapable of producing the toxin, and at a_w below 0.78-0.76, they cannot grow. Therefore the most important point is to control the period of time in which coffee remains in the drying yard, in the range of water activity where *OTA*-producing fungi can grow (aw > 0.8-

0.95). According to experimental results, 5 days or less in the drying yard is enough and effective to prevent *OTA* accumulation. In general, maximum a_w of 0.67 to 0.70 and moisture content of 12% or below (wet basis) is sufficient for protecting parchment coffee from damage by fungi.

41. Recommended measures to dry the coffee beans efficiently are:

a.) The drying yard should be located away from the contaminant sources such as dusty areas and should receive maximum sun exposure and air circulation during most of the day, to speed up the drying of the beans. Shady and low areas should be avoided.

b.) The surface for the drying yard should be chosen according to the climate of the region, cost and quality of the dried product, as any type of surface has advantages and disadvantages. Bare soil is not recommended. Plastic canvass gets humid under the coffee layer, promoting fungal growth. In rainy or wet regions coffee must be covered and re-spread, once the surface has dried. If parchment coffee is to be dried, ensure that the drying surface is clean, in order to avoid picking up taints.

c.) The pace and total time of the harvest should be based on the available areas of the drying yard and average time necessary for drying, considering both good and bad weathers.

d.) The following practical measures should be incorporated into the drying process:

d.1) Dry coffee beans only in thin layers, *i.e.* 3 to 5 cm in depth which is equivalent to 25 to 35 kg/m^2 of fresh parchment of coffee cherry. In some cases (e.g. low air humidity, good air circulation and sun intensity, or in usually dry regions), thicker layers can be used.

d.2) Turn over the coffee beans layer constantly during the day time to allow faster drying, to reduce the risk of fungi growing and help to produce a better quality product.

d.3) Allow for the appropriate ventilation of the wet coffee beans during the night in order to avoid condensation. After one (1) day of drying for parchment and three (3) days for coffee cherry, the coffee cherries can be heaped and covered at night during rainy weather, to avoid re-wetting.

d.4) Do not mix different types of coffee beans nor coffee beans from different days of harvest. Use a specific identification for each one of them to identify each type of coffee beans and day of harvest.

d.5) Protect the drying yard area from animals, which can be a source of biological contamination in coffee beans during drying.

d.6) Regularly control CBB and other pest populations, using integrated pest management in drying yard.

d.7) Monitor the drying process regularly (maximum of 12% moisture content for both parchment and coffee cherry). Start taking samples from different points of each lot, two (2) or three days (3) before it is expected to be fully dry and continue re-evaluating it daily until it reaches the desired moisture content. Instrumental measurements should be adopted at field level. Moisture content should be measured according to International Organization for Standardization. Green Coffee – Determination of Loss in Mass at 105°C (ISO 6673:2003) method.

d.8) Avoid re-wetting the beans because it favors rapid fungal growth and the possibility of *OTA* production.

e.) Provide a clear and practical training for drying yard workers, including adequate use of moisture meters.

f.) Repair, clean, protect and keep equipment in a clean storage area until the next season. Moisture meters should be regularly cross-checked and calibrated once a year before harvest according to International Organization for Standardization. Green Coffee – Determination of Loss in Mass at 105oC (ISO 6673:2003) method.

42. Mechanical driers are generally used as complementary after sun-drying, but in some regions it plays a major role in the drying process. Mechanical driers usually need to have control of two (2) items: inlet temperature and duration of drying time. The most common problem with mechanical drying is over drying, causing weight loss and consequently income loss. The other problem is black beans from immature beans submitted to excessive inlet temperature, decreasing the quality of the product.

4.7 Storage, Transportation and Trading

43. Properly identified lots of dried cherries or the dried parchment coffee should be stored, at the farm level or in out-of-farm warehouses, in bulk or in clean bags under appropriate storage conditions.

44. Handling coffee in local trading varies in relation to the proper structure of the chain and the way the operations are performed. These functions include: post-cleaning, sorting, grading into size classes, re-bagging, sometimes re-drying, storage and

transport. These operations add value to the traded product, before it is sold and sent for roasting.

45. During the entire process, the coffee must also be protected from re-wetting, degradation and cross-contamination. In long-term storage conditions, humidity should be kept under strict control. Under a relative humidity below 60% coffee will continue to dry but if the relative humidity is above 80% the coffee will start to absorb water. Moisture in the storage place can originate from damp floors and walls, rain (wind-driven or through leaks), dead air, and the mixing of dry with wet coffee. Appropriate storage facilities, the use of good storage practice and regular monitoring can prevent or reduce problems.

46. In lower grade coffee, it has been observed that fruits with black and sour defects contained the highest levels of *OTA*. Tolerance for such defects in sorted green beans should be low and the sorted defective beans should not be re-blended into clean coffee or sold directly to roasters unless representative sampling plan and direct *OTA* analysis has shown them to be acceptable.

47. From the production areas coffee may be transported by different means of transportation to the trading points. The main aspect of concern here is to avoid re-wetting of coffee, due to possible climatic changes between different regions, and taking the necessary control measures.

48. In the production chain, the local market is the most sensitive part from where improvements in practice can be administered. The competent authorities, through regulatory and non-regulatory mechanisms, can enforce and influence practices in order to guarantee that producers reliably operate in a way as to assure the product safety.

49. Stakeholders should adopt procedures to protect coffee in each part of the chain, refuse coffee suspected of contamination, and avoid practices that could generate or increase a problem. Dried coffee must be protected from re-wetting through contact with water, mixture with wet lots, absorption from wet air or surfaces or redistribution of water within the lot. Protection from contamination by other materials is also necessary.

a) Minimum hygiene requirements and a rapid assessment method (including a sampling method with representative sub-sample of the incoming lot for moisture content determination, defect levels, general physical quality assessment and visual or smell signs of moldiness), should be established.

b) The warehouse design and structure should be adequate to maintain dryness and uniformity of the stored coffee.

b.1) The desirable characteristics are: cement floor with a damp-proof course; not subject to flooding; water pipelines properly located to avoid wetting coffee in case of plumbing problems; waterproof windows and roof; and a high ceiling to allow good air circulation.

b.2) Do not expose stored coffee to direct sunlight nor store it near heating sources, to avoid the possibility of temperature differentials and water migration.

c) The operation of a storage facility must be optimized to prevent cross contamination, the re-introduction of moisture, and to allow the best execution of receiving, sale and value-added operations that will preserve the coffee quality until it is sold to the next stakeholder in the production chain. The main recommendations are:

c.1) Record initial condition and age of the received stocks.

c.2) Arrange the coffee bags on pallets and away from walls, to allow good air circulation.

c.3) Implement cleaning and maintenance programs in order to ensure that storage facilities are periodically inspected, cleaned and renewed.

c.4) Check coffee bean weevil in the warehouse, implement integrated pest management.

c.5) Farms and other operations should separate coffee types. This requires planning of the storage area and adoption of a labeling system. Non-food materials should not be stored with coffee to prevent contamination or taints in the product.

d) Coffee cleaning and sorting should not physically damage the product as this will make it more susceptible to contamination/deterioration nor introduce new contamination and should assure reduction of undesirable materials to acceptable pre-determined levels.

d.1) Ensure the facilities and equipment are regularly inspected maintained and cleaned, through implementation of cleaning and maintenance programs.

d.2) When cleaning and sorting of coffee beans are done in the same storage facility, attention is required to avoid contamination of post-cured coffee with the curing by-products of dust and foreign matter, (e.g. through the use of partition walls or extractor fans).

d.3) Remove defects from main-crop production, discarding or screening them before their inclusion into the food chain. There is no uniform distribution of defects within the classes of beans separated from bulk coffee. Evidence shows that defective beans and husk (dried pulp also a defect) sometimes contain higher *OTA* levels than sound beans. Based on further investigations of *OTA* contamination of defects, competent authorities should provide clear guidance to the stakeholders.

e) Transport of coffee also requires the adoption of practices to avoid re-wetting, to maintain temperature as uniform as possible and to prevent contamination by other materials. The main requirements are:

e.1) Cover coffee loading and unloading areas to protect against rain;

e.2) Vehicles must be cleaned from residues of the previous cargo before receiving a new cargo;

e.3) Floor, side walls and the ceiling of closed vehicles must be checked for the presence of points where exhaust fumes or water from rain can be channeled into the coffee cargo. Tarpaulins and plastic canvass used to cover the cargo should also be regularly checked to ensure they are clean and without holes. The vehicles should also receive regular maintenance to be kept in good condition;

e.4) Select operators that have reliable transport service-providers that adopt the recommended good transportation practices.

4.7 Ship Transportation

50. Coffee is transported from the Philippines to other countries in jute bags, usually in to 20 to 40-footer containers. Temperature fluctuations, during the transportation time, can cause condensation of the remaining water (present even in well-dried beans) and local re-wetting. The redistribution of water can lead to fungal growth, with the possibility of *OTA* production. The recommended practices during transportation in the port are:

a.) Cover coffee loading and unloading areas to protect against rain.

b.) Check coffee lots to ensure that they are uniformly dried and with 12% moisture content or below, free of foreign matter and respecting the established defect levels.

c.) Check containers, before loading, to ensure they are clean, dry and without structural damage that could allow water entrance into the container.

d.) Bags should be well stacked and crossed over for mutual support in order to avoid the formation of empty vertical columns (chimneys). The top layer and sides of bags should be covered with materials that can absorb condensed water, such as silica gel or cardboard for protection against the growth of fungi that could result in *OTA* production.

e.) Choose an appropriate place, not directly exposed to the weather, aboard the ship to reduce the possibility of undesirable situations mentioned that can lead to *OTA* contamination.

f.) Keep the ventilation holes in the containers free.

g.) Avoid unprotected stowage on the deck (top layer) and stow away from boilers and heated tanks or bulkheads.

h.) The moisture content level should not exceed 12% anywhere, from the point where the coffee leaves the loading area to the point at which the coffee is unloaded, stored and/or subjected to other processing procedures such as roasting.

References:

Bureau of Agriculture and Fisheries Product Standards (BAFPS). Philippine National Standards (PNS): Green Coffee Beans (PNS/BAFPS 01:2012).

Bureau of Agriculture and Fisheries Product Standards (BAFPS). Philippine National Standards (PNS): Good Agriculture Practices for Coffee (PNS/BAFPS ____:2014).

Codex Alimentarius Commission (CAC). Code of Practice for the Prevention and Reduction of *Ochratoxin A* Contamination in Coffee (CAC/RCP 69-2009).

Codex Alimentarius Commission (CAC). Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4, 2003).

International Organization for Standardization (ISO). Coffee and Coffee Products - Vocabulary (ISO 3509:2005).

International Organization for Standardization (ISO). Green Coffee – Determination of Loss in Mass at 105°C (ISO 6673:2003).

Alvindia, D.G. & Acda. MA. 2010. Mycoflora of coffee bean in the Philippines. J. ISSAAS Vol. 16 (2). 116-125

Regpala, E., Esteves, L.A, Santiago M.C, Acda. MA. Incidence of Ochratoxin A in green coffee. (unpublished) PHilMech

657 **Department of Agriculture (DA)**
658 **Bureau of Agriculture and Fisheries Standards (BAFS)**
659
660 **Committee on Commercial Crops - Coffee Industry Development Sub-Committee of**
661 **the National Agriculture and Fishery Council (NAFC)**
662

Chair

Ruby J. Apilado, PhD/Leah N. Castillo
Food and Nutrition Research Institute (FNRI)
Department of Science and Technology
(DOST)

Members

Alexander Joel Gibe, PhD/Rogelio G. Idago
Philippine Center for Postharvest Development and Mechanization (PhilMech)
Department of Agriculture (DA)

Alejandro C Mojica, PhD
Cavite State University (CvSU)

David T. Santos/Josephine V. Ramos
Philippine Council for Agriculture and Fishery (PCAF)/
Organization for Partnerships, Teamworks and Initiatives on Opportunities for Nature Stewards (OPTIONS), Inc.

Jocelyn M. Sales, PhD/Luz D. Padilla
Food Development Center (FDC)
Department of Agriculture (DA)

Secretariat

Chairpersons

Karen Kristine A. Roscom
OIC-Executive Director
BAFS- DA

Lara V. Navarro
OIC-Division Chief
Standards Development Division
BAFS-DA

Member

Maria Charissa B. Grepo
Research Assistant I
Standards Development Division
BAFS-DA

663

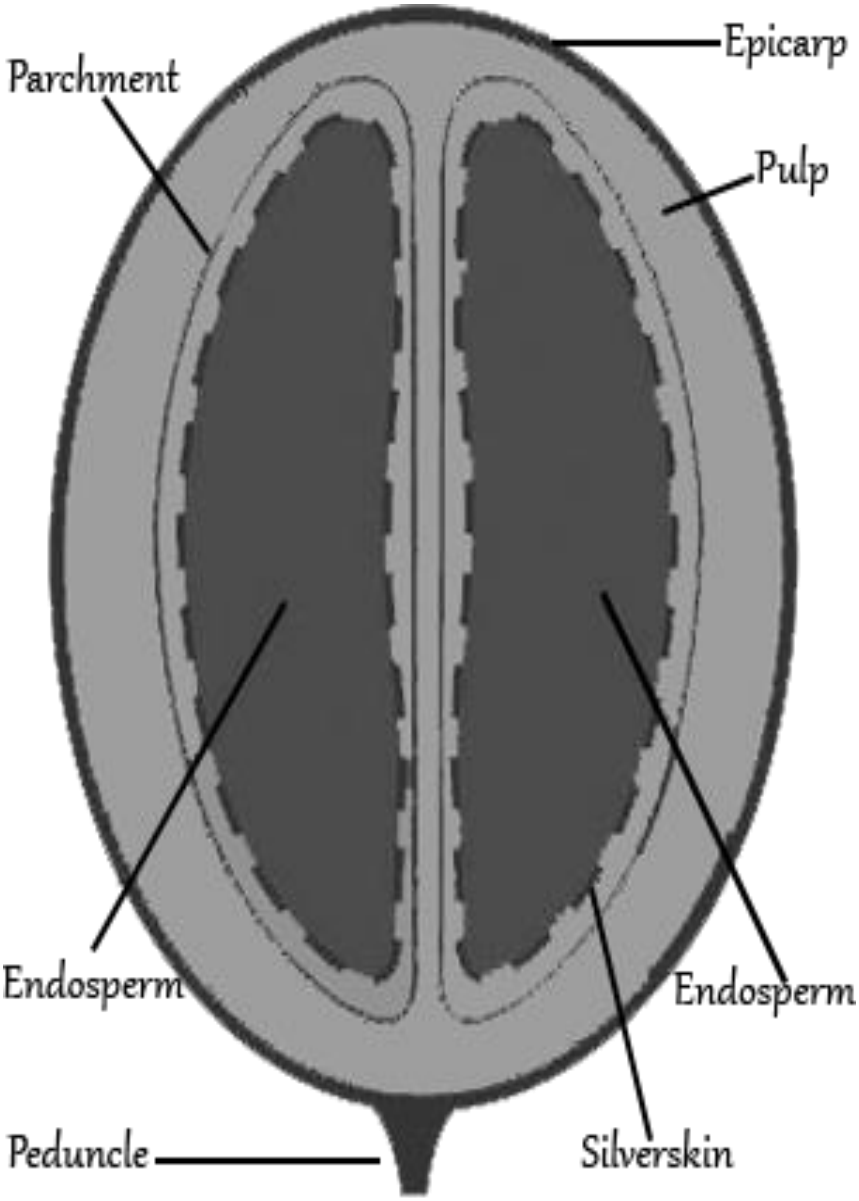
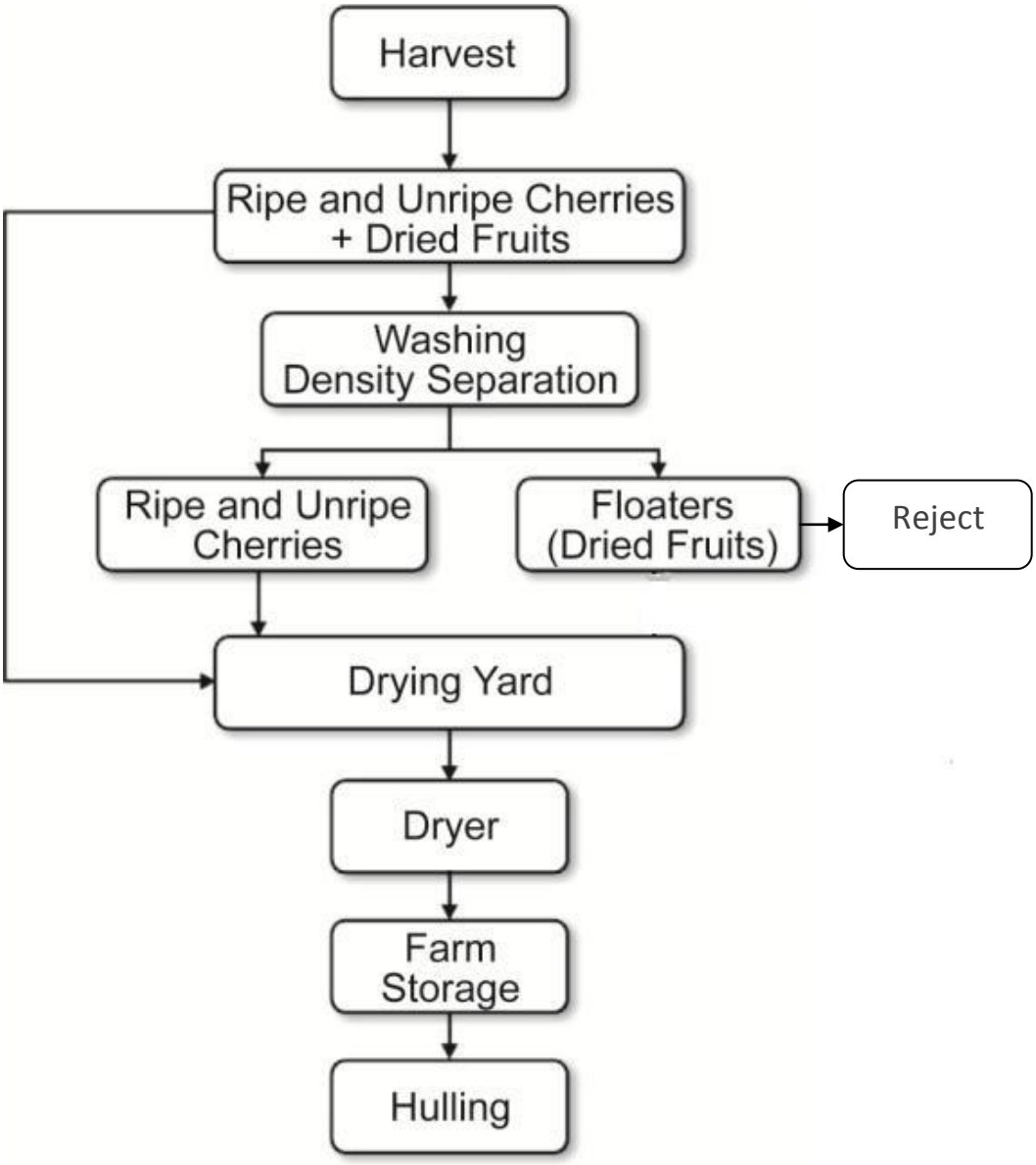


Figure 1. Coffee Cherry (CAC/RCP 69-2009)



673

674

675

676 **Figure 2. Dry Processing Flow (CAC/RCP 69-2009)**

677

678

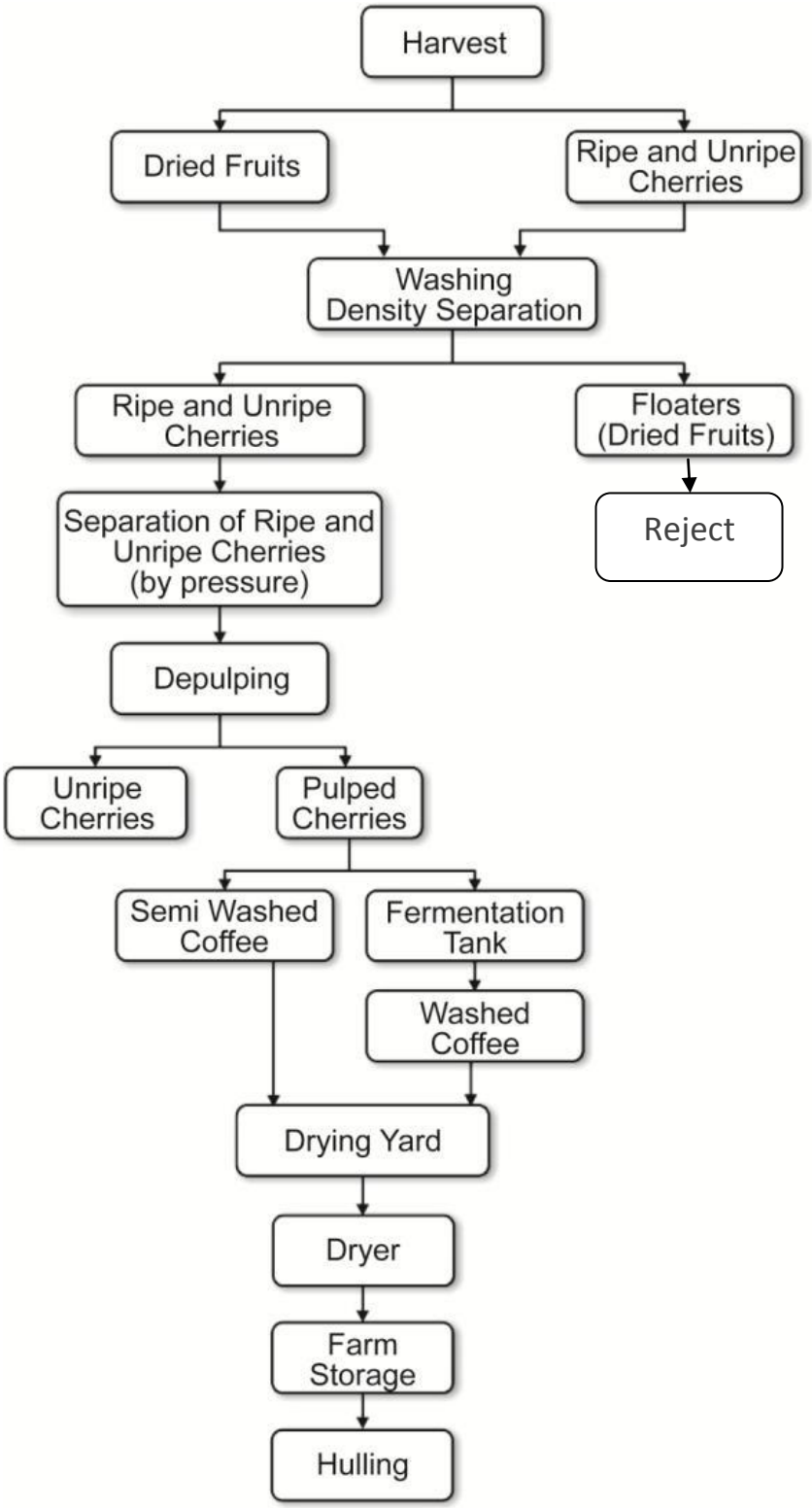


Figure 3. Wet Processing Flow (CAC/RCP 69-2009)