8.1 : Grain Cleaning Equipment

Grain cleaning is the process of removing unwanted material — chaff, dust, broken/immature grains, weed seeds, straw pieces, and other foreign matter — from the threshed/harvested grain, to obtain a clean, marketable, and storage-ready product. While combines and threshers have integrated basic cleaning units, dedicated grain cleaning equipment is often used for further/final cleaning and grading before storage, processing, or sale.

8.2 Need for Grain Cleaning

1. Removes impurities (chaff, dust, weed seeds, stones, broken grain) that reduce grain quality and market value.

2. Improves storability — clean grain with less trash and broken material is less prone to insect infestation, mould growth, and spoilage during storage.

3. Meets quality standards/grading requirements for sale, especially for premium markets or export.

4. Improves the efficiency of downstream operations like milling/processing, which perform better on clean, uniform grain.

8.3 Principles Used in Grain Cleaning

Grain cleaning equipment generally separates material based on differences in physical properties between grain and impurities:

1. Size (screening/sieving) – Using sieves/screens with specific hole sizes and shapes to separate grain from larger (straw, stones) or smaller (dust, small weed seeds) material.

2. Aerodynamic property (air/wind separation) – Using an air blast (fan) to blow away lighter material (chaff, dust, empty/immature grains) while heavier, sound grain falls through.

3. Specific gravity/density (gravity separation) – Separating materials of similar size but different density/weight, useful for removing stones or unfilled grains that a simple sieve alone might not separate well.

4. Shape and surface texture – Some specialized equipment (e.g., indented cylinder separators) exploits differences in shape (round vs elongated) to separate grain from certain weed seeds/broken grains.

8.4 Types of Grain Cleaning Equipment

1. Winnower (hand or power-operated) – Uses an air blast (manually cranked fan or motor-driven blower) combined with gravity to separate grain from chaff/dust as the mixture is dropped through the air stream; the traditional and simplest form of grain cleaning.

2. Sieve/screen cleaner – Uses oscillating or rotating sieves/screens with specific mesh sizes to sort grain by size, removing oversized (straw bits) and undersized (dust, small seeds) material.

3. Air-screen cleaner – Combines both air blast and sieve/screen action in a single machine (similar in principle to the cleaning unit of a combine harvester, but as a stand-alone unit); widely used for general-purpose grain cleaning on farms and at grain markets.

4. Specific gravity separator – Uses a combination of air flow and an oscillating, inclined deck to stratify and separate grain by density, effectively removing stones, unfilled/light grains, or other material of similar size but different weight.

5. Indented cylinder/disc separator – A rotating cylinder or disc with specifically sized/shaped indentations picks up grains or impurities of a particular size/shape (e.g., separating round weed seeds from elongated wheat grains) and lifts them out separately.

6. Magnetic separator – Removes ferrous (iron/metal) contaminants from grain using magnets, important for protecting downstream milling machinery and ensuring product safety.

8.5 Working Principle (General – Air-Screen Cleaner Example)

- Threshed grain (mixed with chaff, dust, and other impurities) is fed onto the top sieve/screen.

- The screen(s) oscillate, allowing grain of the correct size to pass through while retaining larger trash on top (discharged separately) and allowing smaller dust/impurities to pass through a lower, finer screen.

- Simultaneously, an air blast from a blower passes through the falling grain stream, carrying away lighter chaff and dust, while heavier clean grain falls into a collection point/outlet.

8.6 Advantages of Grain Cleaning Equipment

1. Produces clean, marketable grain meeting quality/grading standards.

2. Improves storage life by reducing trash/moisture-retaining material and reducing insect/mould risk.

3. Reduces manual labour compared to traditional hand winnowing.

4. Specialized separators (gravity, indented cylinder, magnetic) allow removal of specific contaminants that basic sieving/winnowing cannot address.

8.7 Limitations

- Additional equipment and processing step adds to post-harvest handling cost and time.

- Specialized separators (gravity table, indented cylinder) have higher initial cost and are typically used at larger processing/grading centers rather than on individual small farms.

- Requires proper adjustment (screen size, air speed) matched to the specific grain and impurity type for effective cleaning.

9.1: Mechanized Harvesting of Cereals, Pulses, and Horticultural Crops

Different crop groups — cereals, pulses, and horticultural crops (fruits/vegetables) — differ significantly in plant structure, maturity behaviour, and produce sensitivity, requiring different approaches and equipment for mechanized harvesting. This chapter discusses the specific considerations and machinery used for each group.

9.2 Mechanized Harvesting of Cereals

Characteristics relevant to harvesting:

- Relatively uniform plant height and maturity across the field.

- Grain is the harvested product; straw is a secondary/by-product.

- Crops (wheat, rice, maize, sorghum, etc.) are generally suited to combine harvesting.

Common equipment:

- Combine harvesters (self-propelled or tractor-mounted) – for cutting, threshing, and cleaning in a single pass.

- Reapers/reaper-binders – where combines are not accessible/economical; crop is cut and later threshed separately.

- Maize-specific headers on combines – row-crop headers designed to snap/husk maize ears while handling the specific plant architecture of maize.

Key considerations: grain moisture content at harvest (typically 20–25% for direct combining, followed by drying), cylinder speed/concave clearance adjustment to minimize grain cracking (especially important for maize and rice, where grain damage affects quality/germination).

9.3 Mechanized Harvesting of Pulses

Characteristics relevant to harvesting:

- Many pulse crops (gram, pigeon pea, green gram, black gram, etc.) have a tendency toward uneven maturity (indeterminate flowering/podding) and are prone to pod shattering, making mechanical harvesting more challenging than cereals.

- Plant height and pod-bearing position vary widely between pulse species, requiring careful cutter bar height adjustment.

Common equipment:

- Pulse-specific combine attachments/settings – combines used for pulses require reduced cylinder speed and wider concave clearance compared to cereal settings, to minimize seed cracking/splitting (a critical quality issue for pulses, which are often consumed whole or split without further processing tolerance for damage).

- Reaper-cum-binders or simple reapers – often preferred over direct combining for many pulse crops, followed by a curing/drying period and separate threshing, to reduce shattering losses associated with direct combining of unevenly maturing pods.

- Specialized pulse threshers – adjusted with lower cylinder speed and appropriate concave settings to minimize splitting.

Key considerations: timing harvest to balance between over-maturity (shattering loss) and under-maturity (green/immature seed), gentle handling throughout to preserve seed quality (especially for pulses intended as planting seed, where germination viability is critical).

9.4 Mechanized Harvesting of Horticultural Crops

Characteristics relevant to harvesting:

- Horticultural produce (fruits, vegetables) is generally more delicate/perishable than grain, with quality (bruising, appearance) being critical to market value, unlike grain where minor mechanical marks are less consequential.

- Maturity often needs to be assessed per-fruit/individual basis (not uniformly across the whole plant/field), especially for fresh-market produce, making full mechanization more complex than for cereals/pulses.

- Some horticultural crops (root/tuber crops, once-over harvested vegetables) are more amenable to mechanization than others (delicate fresh-market fruits).

Common equipment/approaches:

- Root/tuber harvesters (e.g., potato digger/harvester, onion harvester) – Lift, separate soil from produce (often using shaker/screen mechanisms), and windrow or directly load the harvested produce.

- Vegetable harvesters for once-over crops (e.g., mechanical harvesters for processing tomatoes, peas) – Suited to crops harvested in a single pass where all produce is removed together (common for processing-grade produce where some damage tolerance exists, rather than premium fresh-market grade).

- Platform/aid harvesting systems – For fresh-market fruits and vegetables still requiring hand-picking (due to selective maturity and quality sensitivity), mechanized platforms assist workers by reducing physical strain (e.g., conveyor-assisted picking platforms in orchards) without fully automating the picking itself.

- Vibratory/shaker harvesters – Used for certain fruits (e.g., some nuts, certain fruit crops suited to once-over mechanical harvest) where the tree/plant is mechanically shaken to detach mature produce, which is then caught/collected.

Key considerations: minimizing bruising/mechanical damage, matching harvest method to whether produce is for fresh market (requires careful, often selective/manual harvesting) or processing (more tolerant of full mechanization and once-over harvest).

9.5 Comparative Summary

Aspect	**Cereals**	**Pulses**	**Horticultural Crops**
Maturity uniformity	High	Often uneven	Often uneven (fresh market)
Shattering/damage risk	Moderate	High (pod shattering, seed splitting)	High (bruising, quality loss)
Typical method	Combine harvesting	Reaper + separate threshing (gentle settings)	Manual/aided for fresh market; mechanical for processing-grade
Mechanization level	High	Moderate	Variable (low to moderate)