3.1: Grain Handling Equipment

Grain handling equipment refers to machinery used to move grain between different points in the post-harvest chain — from the field/combine to transport vehicles, into storage structures, between processing stages, and out to dispatch — efficiently and with minimal loss or damage, replacing manual bag-carrying/lifting methods.

3.2 Need for Mechanized Grain Handling

1. Manual handling (headloading, bag carrying) is labour-intensive, slow, and physically demanding.

2. Mechanized handling reduces grain loss/spillage and contamination associated with repeated manual handling.

3. Enables efficient bulk handling (loose grain) rather than requiring bagging at every stage, saving bag cost and handling time.

4. Essential for the throughput required at commercial storage, processing, and procurement centers.

3.3 Types of Grain Handling Equipment

1. Bucket elevator – A vertical conveying device consisting of buckets attached to an endless belt or chain, which scoop grain at the bottom and carry it upward, discharging it at the top; widely used for vertical lifting of grain into storage bins/silos or between processing stages.

2. Screw conveyor (auger) – A rotating helical screw (auger) within a tube or trough that moves grain along its length (horizontally, or at an incline); commonly used for loading/unloading bins, moving grain short-to-moderate distances, and metering grain flow.

3. Belt conveyor– A continuous belt (flat or troughed) that carries grain horizontally or at a moderate incline; suited to high-capacity, relatively gentle (low grain damage) movement over longer distances compared to augers.

4. Chain conveyor (drag/flight conveyor) – Uses a chain fitted with flights/paddles that drag grain along an enclosed trough; suited to handling grain along with some tolerance for handling other bulk materials, often used within processing plants.

5. Pneumatic conveyor – Uses air pressure/vacuum to move grain through pipes/ducts; suited for handling grain over complex routing paths (vertical and horizontal combined) with a compact system footprint, though generally requires more power and can cause more grain damage (due to impact within the pipe) than mechanical conveyors if not properly designed.

6. Grain elevator leg (combination system) – A tall vertical structure combining a bucket elevator with distribution equipment (spouts, conveyors) at the top to direct grain into different storage bins; common in commercial elevators/silos.

3.4 Selection Criteria for Grain Handling Equipment

- Capacity required (tonnes/hour).

- Distance and direction of movement (horizontal, vertical, inclined, or combined).

- Grain type and sensitivity to mechanical damage (some conveyors cause more grain breakage than others).

- Space availability and layout of the facility.

- Power availability and operating cost considerations.

3.5 Advantages of Mechanized Grain Handling

1. Significantly reduces labour requirement and handling time compared to manual bag handling.

2. Reduces grain loss, spillage, and contamination associated with repeated manual handling.

3. Enables efficient bulk (loose grain) handling, reducing bagging costs and associated labour.

4. Supports high-throughput operations needed at commercial storage/processing facilities.

3.6 Limitations

- Initial investment cost for handling equipment, particularly bucket elevators, conveyors, and associated structures.

- Some conveyor types (pneumatic, certain chain conveyors) can cause grain damage if not properly designed/operated.

- Requires regular maintenance (belts, chains, bearings) to avoid breakdowns that disrupt the handling chain.

- Power requirement adds to operating cost, particularly for pneumatic systems.

4.1: Cleaning and Grading Equipment

While grain cleaning (removal of impurities such as chaff, dust, and foreign matter) was discussed, this chapter extends the discussion to grading — the process of sorting cleaned produce into uniform quality classes/categories based on size, shape, weight, colour, or other quality parameters — which is a distinct but closely related post-harvest operation important for both grain and horticultural produce.

4.2 Difference Between Cleaning and Grading

Aspect	**Cleaning**	**Grading**
Purpose	Removes foreign/unwanted material (chaff, dust, stones)	Sorts good produce into quality classes (size, shape, weight, etc.)
Output	One cleaned lot (impurities removed)	Multiple graded lots/categories of the same produce
Basis	Difference between grain/produce and impurities	Difference among good produce items themselves

4.3 Common Grading Parameters

1. Size – Diameter, length, or overall dimension (e.g., grading fruits by diameter, grains by length/width).

2. Weight – Especially for fruits/vegetables, where market categories are often weight-based.

3. Shape – Roundness, uniformity, presence of deformities.

4. Colour/maturity – Used especially for fruits, based on ripeness-related colour change.

5. Density/specific gravity – Used to separate immature/hollow grains or produce from sound, well-filled ones.

6. Surface defects – Presence of blemishes, cracks, insect damage, or disease spots (often assessed visually or, in modern systems, by machine vision).

4.4 Types of Grading Equipment

1. Screen/sieve graders – Use sieves/screens of different mesh sizes (similar principle to size-based cleaning equipment) to sort grain or small produce into size categories.

2. Roller/belt graders – Produce (e.g., fruits) passes over diverging rollers or belts with progressively wider gaps; smaller items drop through earlier gaps while larger items travel further before dropping, achieving size-based sorting.

3. Weight graders – Use a weighing mechanism (often a series of calibrated weighing cups/pockets on a conveyor) that automatically sorts produce into weight categories as it moves along the machine.

4. Specific gravity graders – Separate produce/grain based on density differences , useful for identifying immature or damaged items that float/sink differently from sound produce.

5. Colour sorters (optical graders) – Use cameras/optical sensors to detect colour (and sometimes surface defects) and automatically reject or sort items that don't meet the set colour/quality criteria, often using a jet-of-air ejection mechanism to remove off-grade items from the main stream. Widely used for grains (removing discolored grains) and for fruits/vegetables.

4.5 Working Principle (General – Roller Grader Example)

- Produce is fed onto a series of rotating rollers or a moving belt set with progressively increasing gaps/spacing.

- As produce moves along, smaller items fall through the narrower initial gaps into a collection bin, while larger items continue further before falling through wider gaps.

- This results in the produce being automatically sorted into several size-based grade categories by the time it reaches the end of the machine.

4.6 Advantages of Mechanized Cleaning and Grading

1. Achieves uniform, consistent grading standards compared to manual/visual sorting.

2. Increases market value by enabling premium pricing for higher grades and appropriate pricing for lower grades.

3. Saves labour and time compared to manual grading.

4. Colour/optical sorters can detect and remove defective items more reliably and quickly than manual visual inspection, especially at high throughput.

4.7 Limitations

- Initial equipment cost, particularly for advanced optical/colour sorters.

- Mechanical grading (size/weight-based) may still miss certain quality defects (internal damage, taste/quality issues) not related to size/weight/colour.

- Requires proper calibration and maintenance to ensure accurate, consistent grading over time.

- Delicate produce may still require some gentle/manual handling to avoid damage during mechanized grading.

5.1: Milling and Processing Machinery

Milling and processing machinery converts cleaned, graded raw grain/produce into consumable or market-ready forms — such as converting paddy to rice, wheat to flour, or oilseeds to oil — through mechanical operations like dehusking, grinding, pressing, or other processing methods.

5.2 Rice Milling Machinery

1. Paddy cleaner – Removes straw, dust, and other impurities from harvested paddy before milling (similar principle to general grain cleaning equipment).

2. Husker/dehusker (rubber roll sheller) – Removes the outer husk (hull) from paddy grains using a pair of counter-rotating rubber rolls running at slightly different speeds, which creates a shearing action that strips the husk without excessively damaging the grain (brown rice/kernel).

3. Paddy separator – Separates unhusked paddy (which passes through the husker without being dehusked) from husked brown rice, so that unhusked paddy can be recirculated back to the husker.

4. Whitener/polisher – Removes the bran layer from brown rice to produce white (polished) rice, using friction and abrasive action (friction-type or abrasive-type whitening rolls).

5. Grader/sorter– Separates milled rice by size, and removes broken grains, producing head rice (whole grains) as the primary marketable product, with broken rice as a by-product.

5.3 Wheat Milling (Flour Milling) Machinery

1. Wheat cleaner/conditioner – Cleans wheat grain and adjusts its moisture content (conditioning/tempering) to optimize milling performance (proper bran separation from endosperm).

2. Break rolls – A series of corrugated rollers that progressively break open the wheat grain and separate bran/germ from the endosperm (the starchy part that becomes flour).

3. Reduction rolls – Smooth rollers that further grind the coarser endosperm particles (semolina/middlings) from the break system into fine flour.

4. Sifters (plansifters) – Sieve the ground material after each rolling stage, separating flour (fine particles) from coarser material that needs further grinding, and from bran (which is removed as a by-product).

5. Purifiers – Use air currents combined with sieving to further clean semolina/middlings of any adhering bran particles before final reduction to flour.

5.4 Oilseed Processing Machinery

1. Oilseed cleaner – Removes foreign matter from harvested oilseeds before processing.

2. Decorticator/dehuller – Removes the outer shell/hull from oilseeds (e.g., groundnut) where applicable, before oil extraction.

3. Expeller (screw press) – Mechanically extracts oil from oilseeds by subjecting them to high pressure within a rotating screw press; the residual solid material (oil cake) is discharged separately and used as animal feed or fertilizer.

4. Solvent extraction unit – Used in larger commercial oil mills; extracts residual oil from the oil cake using a chemical solvent (e.g., hexane), followed by solvent recovery, giving higher oil recovery than mechanical expelling alone.

5. Oil filtration/refining equipment – Removes remaining solid particles and impurities from extracted crude oil to produce clear, filtered/refined oil suitable for consumption.

5.5 Other Processing Machinery (General Examples)

- Pulse milling (dal mills) – Machinery for dehusking and splitting pulses (e.g., pigeon pea, black gram) into dal, involving similar principles of dehusking, splitting rollers, and grading.

- Spice processing machinery – Grinders/pulverizers for converting dried spices into powder form.

- Fruit/vegetable processing machinery – Equipment for washing, peeling, slicing, pulping, and further processing (e.g., juice extraction, drying) of horticultural produce.

5.6 Advantages of Mechanized Milling/Processing

1. Higher processing capacity and consistency compared to traditional manual/animal-powered methods (e.g., traditional stone chakki, hand pounding).

2. Better recovery rates (e.g., higher head rice recovery in modern rice mills compared to traditional methods).3. Produces standardized, market-ready products meeting quality/grading requirements.

4. Generates valuable by-products (bran, husk, oil cake) that can be utilized for other purposes (fuel, animal feed, fertilizer).

5.7 Limitations

- High capital investment for modern milling plants (especially rice mills, flour mills, oil expellers with solvent extraction).

- Requires skilled operation and regular maintenance for consistent quality output.

- Energy-intensive processes (grinding, pressing, drying stages within processing), adding to operating cost.

- Smaller/traditional processors may struggle to compete with large, efficient commercial mills on cost and recovery rate.