1.1: Principles of Harvesting

Harvesting is the operation of collecting a mature crop from the field. It is one of the most critical farm operations, since even a well-managed crop can suffer significant yield and quality loss if harvesting is not done at the right time and in the right manner.

1.2 Objectives of Harvesting

1. To collect the crop at the optimum stage of maturity for maximum yield and quality.

2. To minimize losses (shattering, dropping, spillage) during the harvesting process.

3. To harvest within the shortest possible time window, reducing exposure to weather risk (rain, wind, lodging) and pest/bird damage.

4. To keep grain/produce quality suitable for storage, processing, or marketing (proper moisture content, minimal damage/impurities).

1.3 Determining the Right Time of Harvest

- Physiological maturity – The stage at which the crop/grain has accumulated maximum dry matter and further growth/filling has ceased; harvesting too early results in shriveled, immature produce.

- Harvest maturity/moisture content – Different crops have a recommended moisture content range for harvest (e.g., cereals are typically harvested at 20–25% grain moisture for combine harvesting, with further drying afterward); harvesting too wet increases drying cost and risk of spoilage, while harvesting too dry increases shattering losses.

- Visual/physical indicators – Colour change of grain/pod/fruit, hardness, ease of separation from the plant, drying of straw/leaves, etc., are used as practical field indicators of maturity.

1.4 General Principles Governing Harvesting Operations

1. Timeliness – Harvesting should be completed within the optimum maturity window specific to the crop, as delays increase losses due to shattering, lodging, pest damage, and adverse weather.

2. Minimizing mechanical damage – The harvesting method/machine should be adjusted (speed, cutting height, cylinder speed in case of threshing) to minimize damage to grain, seed viability, or produce quality.

3. Matching method to crop and scale – The harvesting method (manual, semi-mechanized, or fully mechanized) should be selected based on crop type, field size, terrain, and economic feasibility.

4. Sequential operations – Harvesting typically involves a sequence of operations: cutting/reaping → gathering/collecting → transporting → threshing → cleaning → drying → storage; each stage should be planned to minimize losses and maintain quality through the chain.

5. Weather consideration – Harvesting operations should ideally be planned and executed avoiding rain or excessive humidity, which can cause spoilage, fungal growth, and difficulty in threshing/drying.

1.5 Classification of Harvesting Methods

1. Manual harvesting – Using hand tools (sickle); labour-intensive but allows selective/careful harvesting, useful for small farms or crops needing careful handling.

2. Semi-mechanized harvesting – Using power-operated but partial machines (e.g., reapers, mowers) that cut the crop but require separate manual/mechanical operations for gathering, threshing, etc.

3. Fully mechanized harvesting – Using combine harvesters that perform cutting, threshing, and cleaning in a single integrated operation.

2.1: Harvesting Losses

Harvesting losses refer to the quantity of grain/produce lost during the harvesting process, either in the field before harvest, during the cutting/gathering operation, or during threshing and cleaning. Understanding the types and causes of these losses is essential for selecting the right harvesting method/machine and adjusting it correctly to minimize loss.

2.2 Stages at Which Harvesting Losses Occur

1. Pre-harvest losses – Losses occurring in the standing crop before the harvesting operation begins (e.g., natural shattering, bird/rodent damage, lodging-related loss).

2. Header/cutting losses – Losses occurring at the cutting/gathering stage (reel, cutter bar, platform of a reaper/combine), such as shattered grain falling before the cutting mechanism reaches it, or uncut/missed plants.

3. Threshing losses – Losses occurring during separation of grain from the panicle/pod/ear, including:

- Unthreshed grain that remains attached to straw and passes out with it.

- Grain damage (cracked/broken kernels) due to excessive cylinder speed.

4. Separation losses – Grain lost along with straw/chaff during the straw-walker/separation process in a thresher or combine.

5. Cleaning losses – Grain lost along with chaff/trash during the cleaning (winnowing) operation, due to excessive fan air speed blowing grain out with the lighter material.

2.3 Factors Affecting Harvesting Losses

1. Crop maturity stage at harvest – Over-mature crops shatter more easily, increasing pre-harvest and header losses; under-mature crops increase threshing difficulty.

2. Machine adjustment – Cylinder speed, concave clearance, fan speed, sieve settings, reel speed, and ground speed of the machine all directly affect loss levels if not properly adjusted for the crop and its condition.

3. Crop variety and lodging – Varieties prone to lodging (falling over) or shattering are more susceptible to higher harvesting losses.

4. Weather conditions – Rain, wind, and high humidity at harvest time can increase both pre-harvest losses (lodging, shattering) and threshing difficulty.

5. Operator skill – Proper machine operation and timely adjustment based on field/crop conditions significantly influence loss levels.

6. Ground speed of the machine – Excessive forward speed can increase header and separation losses due to inadequate time for proper cutting/threshing/separation.

2.4 Methods to Reduce Harvesting Losses

1. Harvest at the optimum maturity stage/moisture content for the crop.

2. Properly calibrate and adjust the harvesting machine (cylinder speed, concave clearance, fan speed, sieve opening) according to crop type and condition.

3. Maintain appropriate ground speed suited to crop density and machine capacity.

4. Regular maintenance of cutting/threshing components (sharp cutter bar/blades, properly set concave) to ensure efficient operation.

5. Harvest during favourable weather conditions where possible, avoiding excessively wet or windy periods.

6. Select varieties with better lodging/shattering resistance where feasible.

2.5 Measurement of Harvesting Losses

- Harvesting losses are commonly expressed as a percentage of total grain yield and measured by collecting and weighing the grain lost at specific stages (e.g., using a frame of known area placed behind the machine to collect and count/weigh lost grain, then extrapolating to the whole field).

- Losses are typically assessed separately for header loss, threshing loss, separation loss, and cleaning loss to identify which stage/adjustment needs correction.

3.1: Reapers

A reaper is a harvesting machine used to cut standing crop (mainly cereals like wheat, rice, and similar close-growing crops) and lay it in a windrow or bundle form for subsequent manual/mechanical gathering, bundling, and threshing. Unlike a combine harvester, a reaper only performs the cutting (and sometimes windrowing) operation — threshing is done separately.

3.2 Main Components of a Reaper

1. Cutter bar – The main cutting mechanism, consisting of a series of triangular knife sections that reciprocate rapidly against fixed guard fingers, shearing the crop stem close to ground level (similar cutting principle to a sickle-bar mower).

2. Reel – A rotating, slatted wheel positioned above the cutter bar that gently pushes/gathers standing crop toward the cutter bar and helps lay the cut crop onto the platform or conveyor in an orderly manner, reducing shattering/grain loss.

3. Platform/conveyor (canvas or belt type) – Receives the cut crop from the cutter bar and reel, and conveys it sideways to be deposited in a windrow, or toward a bundling/tying mechanism (in self-tying/binder types).

4. Star wheel/divider – Separates the crop to be cut from the standing crop on either side, guiding an even swath into the cutter bar.

5. Ground wheels – Support the machine and, in mechanically driven types, provide drive to the cutter bar and reel through a chain/gear transmission.

6. Power source/engine – Small petrol/diesel engine (in self-propelled/walking-type reapers) or PTO drive (in tractor-mounted types) that powers the cutter bar, reel, and conveyor mechanisms.

3.3 Types of Reapers

1. Based on power source:

- Manual reaper (sickle) – simple hand tool, most basic form of "reaping."

- Self-propelled reaper – walking-type, with its own small engine; operator walks behind guiding the machine.

- Tractor-mounted/vertical conveyor reaper (VCR) – mounted on the front or side of a tractor, driven by the tractor's PTO/hydraulics.

2. Based on function:

- Reaper (windrower type) – Cuts the crop and lays it in a windrow on the ground for manual/mechanical pickup and bundling.

- Reaper binder – Cuts the crop and additionally ties it into bundles/sheaves automatically using a knotting mechanism, ready for stacking/transport.

- Vertical Conveyor Reaper (VCR) – Uses a vertical conveyor belt system to lift and lay the cut crop neatly to one side in a continuous windrow, commonly used for paddy and wheat in South Asian conditions.

3.4 Working Principle

- The divider separates the crop swath to be harvested from adjoining standing crop.

- As the machine advances, the reel sweeps the standing crop gently toward the cutter bar.

- The reciprocating cutter bar shears the crop stems near ground level.

- The cut crop falls onto the platform/conveyor, which carries it sideways and deposits it in a windrow (or feeds it to a binder mechanism for bundling, in binder-type reapers).

- The operator/machine proceeds along the field in successive passes, cutting the entire crop area.

3.5 Advantages of Reapers

1. Significantly faster than manual sickle harvesting, saving time and labour.

2. Reduces harvesting cost per unit area compared to manual cutting.

3. Windrowed/bundled crop is easier to handle for subsequent threshing compared to scattered manual cutting.

4. Suitable for small to medium farm sizes where a full combine harvester may not be economical or accessible (field size/shape constraints).

3.6 Limitations

- Only performs cutting (and windrowing/binding); threshing must be done as a separate operation, adding to overall harvesting time and cost compared to a combine.

- Requires reasonably erect, non-lodged crop for effective cutting; performance drops significantly in lodged crops.

- Cutting height and reel speed need adjustment based on crop condition to minimize shattering losses.

- Limited capacity compared to combine harvesters for large-scale operations.

4.1: Mowers

A mower is a machine used to cut standing forage/fodder crops (grasses, legumes, and similar close-growing crops grown for hay/silage) close to the ground and leave them in a swath for subsequent field curing, raking, and baling. While similar in cutting principle to a reaper, mowers are primarily used for forage/fodder crops rather than grain crops, and typically do not include a reel or grain-handling components.

4.2 Main Components of a Mower

1. Cutter bar (sickle bar type) – A reciprocating knife assembly (similar to the reaper's cutter bar) with triangular sections moving rapidly between fixed guard fingers, shearing the standing forage close to ground level.

2. Guards/fingers – Fixed guides along the cutter bar that support the crop stem against the reciprocating knife and protect the cutting edge from obstructions.

3. Pitman/wobble drive mechanism – Converts rotary motion from the power source into the reciprocating (back-and-forth) motion needed to drive the cutter bar knife.

4. Swath board – Deflects/arranges the cut forage into a neat windrow/swath as it falls off the cutter bar, facilitating subsequent curing and raking.

5. Skids/shoes – Support the cutter bar at the desired cutting height above ground level, sliding over the soil surface as the mower operates.

6. Frame and hitch – Structural frame connecting the mower to the tractor's three-point linkage or drawbar; may be side-mounted, rear-mounted, or front-mounted depending on design.

4.3 Types of Mowers

1. Based on cutting mechanism:

- Sickle-bar (reciprocating) mower – Traditional cutter-bar type, as described above; relatively simple and low-power requirement, but can be prone to clogging in heavy/tangled crop.

- Rotary disc mower – Uses one or more horizontally rotating discs, each fitted with small free-swinging or fixed blades, spinning at high speed to cut the crop by impact; handles heavier, denser, and lodged forage crops better than sickle-bar types, and is less prone to clogging.

- Drum mower – Similar to disc mower but uses vertically mounted rotating drums with cutting blades at the top; also suited to dense forage.

2. Based on mounting/attachment:

- Trailed mower – pulled behind the tractor via drawbar.

- Mounted mower – attached to the tractor's three-point linkage (front, side, or rear mounted).

3. Mower-conditioner – A combined machine that mows the crop and simultaneously passes it through conditioning rollers/flails that crush/crack the stems, speeding up field drying (curing) of the forage before baling.

4.4 Working Principle

- As the tractor moves forward, power is transmitted (via PTO shaft and gearbox, or hydraulic motor in some rotary types) to the cutting mechanism.

- In sickle-bar mowers, the pitman drive converts rotary power into the reciprocating motion of the cutter bar knife, which shears the crop against the fixed guards.

- In rotary/disc mowers, the discs spin at high speed, and the blades cut the crop by rapid impact rather than a shearing/reciprocating action.

- The cut forage falls or is deflected (via swath board or conditioning rollers) into a swath/windrow for subsequent curing in the field.

4.5 Advantages of Mowers

1. Fast, efficient cutting of forage crops over large areas compared to manual cutting (sickle).

2. Rotary/disc mowers handle dense, tangled, or lodged forage crops effectively with minimal clogging.

3. Mower-conditioners speed up field curing/drying time, reducing weather risk and improving forage quality.

4. Uniform swath formation facilitates efficient subsequent raking and baling operations.

4.6 Limitations

- Sickle-bar mowers are prone to clogging in heavy or lodged crop and require more frequent sharpening/maintenance of cutting sections.

- Rotary/disc mowers, while less prone to clogging, generally require higher power (PTO HP) to operate.

- Cutting height must be properly set — too low risks soil contamination of forage and blade damage from stones; too high leaves excessive stubble and reduces yield recovery.

- Requires timely operation to catch the crop at the optimum stage for forage quality (e.g., pre-bloom stage for many legumes).