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Mapping the end-to-end processing workflow of corn hybrid seed: A case study of a commercial seed processing unit in Telangana

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ABSTRACT

Mapping the processing workflow of a commercial seed unit is a necessary first step toward evaluating its operational efficiency and identifying opportunities for improvement. The present study was conducted at the Commercial Seed Processing Unit (CSPU), Shamirpet, Medchal-Malkajgiri District, Telangana, a facility that processes corn hybrid seed under ISTA, FAO, and TSSOCA-aligned quality standards. Adopting a single-unit case study design during the Kharif pre-processing season (March-May 2026), the study mapped the complete end-to-end processing workflow through structured field observations at each stage and semi-structured interviews with departmental supervisors and the Plant Manager. The processing line comprised six interlinked in-house stages-ear corn receiving, weighing and unloading, pre-cleaning, drying, shelling, and grading-with seed treatment and packaging outsourced to third-party units after graded seed dispatch. During the study period, the unit processed 22,500 MT of ear corn, classified on arrival as Good Field (72%), Other Field (21%), or Return Field (7%) lots, reduced incoming moisture from a mean of 27.4% to a post-drying target of 9-11%, and yielded 17,360 MT of graded, certified seed. Pre-cleaning accounted for the largest material loss in the line (13.99%), followed by shelling (5.36%) and weighing/unloading (0.01%), each loss being structurally inherent to the respective stage rather than indicative of a process deficiency. The study recommends barcode-based lot tracking across stage transitions, buffer-stock monitoring at intake, and hybrid-specific screen and drum calibration protocols to further strengthen workflow traceability and consistency.

Keywords: Corn hybrid seed, Processing workflow, Seed processing unit, Stage-wise mapping, Moisture content, Telangana

Introduction

India's agricultural economy combines record crop production with a rapidly expanding commercial seed sector, within which maize has emerged as a critical crop underpinning the food, feed, starch and biofuel industries. As demand for high-quality certified corn hybrid seed has intensified, the efficiency of seed processing operations has become a decisive determinant of agribusiness competitiveness. Telangana, with its growing cluster of certified seed processing units in the Medchal and Warangal regions, sits at the centre of this transformation. The Commercial Seed Processing Unit (CSPU) at Shamirpet, Medchal-Malkajgiri district, is a modern commercial corn hybrid seed processing facility that operates under internationally benchmarked quality and efficiency standards set by ISTA, FAO and the Telangana State Seed and Organic Certification Authority (TSSOCA).

While seed processing units of this kind handle intake, drying, shelling and grading operations routinely, a documented, stage-wise mapping of the complete processing line for corn hybrid seed - from ear corn receiving through to graded seed dispatch - at a commercial unit in Telangana has not been reported in published literature. Without such a baseline map, subsequent efficiency evaluation and benchmarking exercises lack a clear operational reference. The present study addresses this gap by documenting the end-to-end processing workflow at the CSPU, Shamirpet, identifying the critical quality-control points at each stage and the benchmark standards against which each stage is assessed.

Materials and Methods

The study was conducted at the CSPU, Shamirpet, Medchal-Malkajgiri district, Telangana, during the Kharif pre-processing season from March to May 2026 - 80 days comprising the peak processing window in which all six processing stages operated simultaneously. A single-unit case study design was adopted, using a mixed-methods framework that combined quantitative operational data with qualitative process description. Respondents were purposively selected based on direct involvement in processing operations, comprising one departmental supervisor for each of the six processing stages and the Plant Manager ($n = 7$).

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Primary data on the sequence of operations, critical quality checkpoints and stage interlinkages were obtained through structured field observation at each of the six stages, supplemented by semi-structured interviews with the supervisors and Plant Manager. Secondary data were drawn from the plant's daily production shift logs, seed-quality release records, rejection registers and TSSOCA certification records. The workflow was analysed with reference to the quality benchmarks prescribed by [ISTA \(2023\)](#) ^[1], [FAO \(2023\)](#) ^[2] and [Harrington \(2023\)](#) ^[3], and the queue- and buffer-management principles described by [Berruto *et al.* \(2001\)](#) ^[4] and [Goldratt \(1984\)](#) ^[5].

Results and Discussion

1.1 Overview of the processing line

The processing line at the CSPU comprised six interlinked in-house stages: ear corn receiving, weighing and unloading, pre-cleaning, drying, shelling and grading. Seed treatment and packaging were carried out at third-party units after graded seed was dispatched from the CSPU. Each in-house stage fed directly into the next, with quality checks conducted at critical transition points to ensure that only conforming seed lots progressed through the line. The stage-wise summary of the processing workflow is presented in [Table 1](#).

Table 1. Stage-wise summary of the corn hybrid seed processing workflow, CSPU, Shamirpet (March-May 2026)

Stage	Processing Stage	Key Operations	Critical Quality Parameter	Benchmark Standard
1	Ear Corn Receiving	Vehicle intake registration; lot numbering; moisture sampling; Corn Harvest Time Flag classification (GF/OF/RF)	Intake moisture content	≤ 30% MC (FAO, 2023)
2	Weighing and unloading	Calibrated platform-scale weighing of unloaded lots; receiving-bin allocation; conveyor transfer to pre-cleaner intake	Weight accuracy	± 0.5% (Company standard)
3	Pre-Cleaning	Air-screen cleaning using 6.4 mm and 7.0 mm hand screens; removal of trash, dust, leaf material and cob fragments before dryer intake	Seed loss in dryer trash; good-seed proportion in cleaned output	≤ 0.6 g good seed per 300 g dryer trash sample (ISTA, 2023)
4	Drying	Continuous-flow corn dryer operation; upward/downward airflow adjustment by bin moisture gradient; bin-wise moisture monitoring every 4 hours	Post-drying moisture content	9-11% MC (Harrington, 2023)
5	Shelling	Mechanical shelling with drum clearance and rotor speed calibrated to hybrid-specific settings; gravity-table separation of damaged/substandard kernels	Seed damage rate; cob residue in shelled output	≤ 1.5% seed damage (FAO, 2023)
6	Grading	Multi-deck flat-screen grading by hybrid-specific screen size; size and density uniformity check; lot clearance and dispatch to third-party treatment and packaging	Size uniformity index; screen calibration to hybrid-specific size requirements	≥ 95% size uniformity (ISTA, 2023)

Source: Primary observation, CSPU Shamirpet, 2026.

1.2 Ear corn receiving and weighing

Ear corn harvested from seed production plots across Telangana, Andhra Pradesh, *Karnataka* and Maharashtra was transported to the CSPU by vehicle. On arrival, each lot was registered with a unique lot number and sampled for moisture content; the mean moisture content of incoming lots during the study period was 27.4%, within the [FAO \(2023\)](#) ^[2] threshold of 30% for safe dryer intake. A Corn Harvest Time Flags system classified incoming lots as Good Field (72% of lots), Other Field (21%), or Return Field (7%), with OF and RF lots prioritised for early dryer intake to prevent quality deterioration. A token-based queuing system absorbed fluctuations in truck arrival rates without causing backlog at the intake yard, consistent with the queue-management strategies described by [Berruto *et al.* \(2001\)](#) ^[4]. Total intake during the study period was 22,500 MT.

At the subsequent Weighing and Unloading stage, each lot was weighed on a calibrated platform scale and unloaded into designated receiving bins, which served as the primary material-flow control point linking the receiving yard to the pre-cleaning and dryer-intake conveyors. Weight accuracy was maintained at ± 0.5%, with the maximum individual lot discrepancy recorded at 0.3%. A marginal material loss of 0.01% (3 MT) occurred at this stage through minor spillage during conveyor transfer and bin unloading - an incidental loss inherent to bulk material handling rather than a process deficiency. Buffer stock held in the receiving bins decoupled short-term intake irregularity from continuous processing, consistent with the buffering principle described by [Goldratt \(1984\)](#) ^[5].

1.3 Pre-cleaning and drying

Accepted ear corn lots were conveyed to air-screen pre-cleaners fitted with 6.4 mm and 7.0 mm hand screens, selected according to each variety's requirements, to remove trash, dust, leaf material, cob fragments and other extraneous material before dryer entry. Pre-cleaning performance, monitored through the good-seed proportion in dryer trash output, was consistently maintained below the [ISTA \(2023\)](#) ^[1] limit of 0.6 g per 300 g sample. Pre-cleaning accounted for the largest material loss in the processing line at 13.99%, an expected and structurally unavoidable outcome given the volume of cob fragments, pith, dust and leaf material removed at this stage.

The CSPU operated continuous-flow corn dryers configured in two rows of 16 bins each, with individual bin capacities of 25 MT and 50 MT. The target post-drying moisture content of 9-11%, consistent with [Harrington \(2023\)](#) ^[3], was achieved by adjusting airflow direction to each bin's moisture gradient and monitoring moisture every four hours. Drying was identified as the most technically critical stage in the line, since the Weighing and Unloading, Pre-Cleaning and Drying stages were physically interlinked by a continuous conveyor system, so that a stoppage at any one of the three halted material flow across the entire linked segment.

1.4 Shelling and grading

Following drying, ear corn was transferred to mechanical corn shellers, with drum clearance and rotor speed calibrated to hybrid-specific settings to minimise seed damage; a gravity table then separated damaged, undersized and cob-adhering kernels from the main seed flow. The shelling stage incurred a processing loss of 5.36%, principally through cob residue, fine removal and gravity-table reject

tion of sub-standard kernels. Shelling and Grading were connected by a single conveyor run with no intermediate buffering, so that a stoppage at either stage halted the linked pair as a whole. Shelled seed was passed through multi-deck flat-screen graders, with screen sizes matched to hybrid-specific specifications, to achieve the size and density uniformity required for consistent mechanical sowing performance. Post-grading, certified seed lots were dispatched to third-party units for seed processing line, from ear corn receiving treatment and packaging. Across the complete process from graded seed dispatch, the CSPU processed 22,500 MT of ear corn and yielded 17,360 MT of graded, certified seed during the 80-day study period, as summarised in Table 2.

Table 2. Stage-wise material loss along the processing line, CSPU, Shamirpet (March-May 2026)

Processing Stage	Material Loss (%)	Principal Cause
Weighing and unloading	0.01	Minor spillage during conveyor transfer and bin unloading
Pre-Cleaning	13.99	Removal of cob fragments, cob pith, dust and leaf material
Shelling	5.36	Cob residue, fine removal and gravity-table rejection of sub-standard kernels

Source: Primary observation and plant operational records, CSPU Shamirpet, 2026.

1.5 Key observations

- The processing line comprised six interlinked in-house stages, each with a defined critical quality parameter and benchmark standard, providing a documented operational baseline for the CSPU.
- Three stage pairs - Weighing/Unloading-Drying, and Shelling-Grading were physically interlinked through continuous conveyors, so that stoppages at any one stage in a linked segment affected the others jointly.
- Pre-cleaning was the single largest source of material loss (13.99%), an expected outcome of trash and extraneous-material removal rather than a process weakness.
- Incoming moisture content (27.4%) and Corn Harvest Time Flag classification (GF 72%, OF 21%, RF 7%) at intake governed the prioritisation of lots for early dryer processing.

Conclusion

The study successfully mapped the complete end-to-end processing workflow of corn hybrid seed at the CSPU, Shamirpet, establishing that the line comprises six interlinked in-house stages - ear corn receiving, weighing and unloading, pre-cleaning, drying, shelling and grading - with seed treatment and packaging outsourced to third-party units. The mapping exercise identified the critical quality parameter and benchmark standard governing each stage, the physical interlinkages that determine how downtime propagates along the line, and the points at which the bulk of material loss occurs. Pre-cleaning and shelling emerged as the principal loss-generating stages, both for structurally unavoidable reasons connected to trash removal and kernel separation rather than operational deficiency. This workflow map provides the operational baseline for the stage-wise efficiency evaluation reported separately. It offers a template that other commercial corn hybrid seed processing units in Telangana may adapt for their own operations. Strengthening lot-level traceability through barcode-based tracking at stage transitions, and formalising buffer-stock protocols at intake, are recommended as immediate next steps to consolidate the gains from a well-mapped processing line.

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