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Grains and pulses in India: Diversity, socioeconomic significance, processing, pesticide management, preservation and shelf life-A narrative review

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ABSTRACT

Grains and pulses underpin India's food security, rural livelihoods, food-processing economy and dietary diversity. This narrative review examines the diversity of cereals, millets and pulses; official production trends; socioeconomic roles; the nutritional and technological consequences of milling, dehulling and polishing; stored-grain pest and pesticide management; preservation; and the determinants of shelf life. Government of India final estimates put 2024–25 foodgrain production at 357.73 million tonnes (Mt), 42% above 2015–16, with rice 150.18 Mt, wheat 117.94 Mt, pulses 25.68 Mt and millets (Shree Anna) 18.59 Mt; third advance estimates for 2025–26 indicate 376.56 Mt. Between 2015–16 and 2024–25 pulse output grew faster (5.2% per year, from a weather-depressed base) than rice (4.1%), wheat (2.8%) or millets (2.8%). Processing can improve cooking performance, texture and appearance, but removal of bran and germ lowers fibre and several micronutrients and phytochemicals. A national study estimated harvest and post-harvest losses at 4.65–5.99% for cereals and 6.36–8.41% for pulses, arising from insects, rodents, moisture and moulds. Drying, sanitation, monitoring, suitable packaging and hermetic storage can reduce losses and reliance on chemical treatments, whereas pesticides must be used only for approved uses and in accordance with labels, with worker protection and residue surveillance. Shelf life is condition-specific, not a fixed property of a crop. We provide five figures, seven tables and a reference list with DOIs where available, and identify research priorities.

Key words: Cereals; millets; pulses; India; rice polishing; pulse milling; stored-product insects; pesticide residues; hermetic storage; shelf life; post-harvest losses

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1. Introduction

Cereals, millets and pulses supply most of the energy and a large share of the protein in Indian diets and are the foundation of the country's public food-distribution and procurement systems. India is among the world's largest producers of rice, wheat and pulses, and official statistics record successive record outputs in recent years [1,2]. Yet the nutritional and economic value that reaches consumers and farmers depends on decisions made long after harvest: how grain is dried, stored, milled, polished, packaged and protected from insects and moulds. Post-harvest losses and quality deterioration remain substantial [3,4].

Three issues motivate this review. First, processing choices involve trade-offs between sensory quality, convenience and nutrient retention, and are often presented in simplified terms. Second, storage protection relies on a mixture of hygiene, physical methods and registered chemical treatments; the safe and lawful use of the latter is a public-health and occupational-safety concern. Third, "shelf life" is frequently quoted as a single number although it depends on moisture, temperature, packaging, composition and infestation. We aim to: (i). describe the diversity and official production trends of Indian grains and pulses; (ii). summarise their socioeconomic roles; (iii). evaluate nutritional effects of milling and polishing; (iv). outline integrated approaches to stored-grain pest and pesticide management; and (v). explain preservation methods and the determinants of shelf life. Chemical-specific treatment recipes are deliberately not provided.

2. Methods and scope

This is a narrative review and not a registered systematic review. It synthesises official Indian production statistics, government standards and regulations, peer-reviewed systematic reviews and mechanistic or technological studies, and established post-harvest principles. Evidence was selected non-systematically; no reproducible database search was performed, and some relevant studies may therefore be missing.

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Production data were taken from the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare: final estimates for 2015–16 to 2024–25 [1] and the third advance estimates for 2025–26 (as on 27 May 2026) [2]. DES reports production in lakh tonnes (1 lakh = 100,000); values were converted to million tonnes (Mt = lakh tonnes ÷ 10). Advance estimates are provisional and are revised before final estimates appear. Percentage changes and compound annual growth rates (CAGR) were calculated by the authors from published values between 2015–16 and 2024–25 (nine annual intervals) and are not official statistics. "Shree Anna" is the official term for millets; the official category "nutri/coarse cereals" also includes maize and barley, so millet totals are a subset of coarse cereals and the two must not be added. Official reports and regulations generally have no DOI and are cited by authoritative URL with access date.

3. Diversity of grains and pulses in India

Table 1 lists the principal cereals, millets, pseudocereals and pulses with their botanical names. Major cereals are rice, wheat, maize and barley. Sorghum (jowar) and pearl millet (bajra; *Cenchrus americanus*, formerly *Pennisetum glaucum*) are the large-seeded millets, while finger millet (ragi) and the small millets (foxtail, little, kodo, proso and barnyard millet) are important in dryland and hill systems. Buckwheat and amaranth are often discussed with grains but are botanically pseudocereals. Major pulses include chickpea, pigeon pea, mung bean, black gram, lentil and field pea, with regionally important cowpea, moth bean, horse gram, grass pea and kidney bean. Soybean and groundnut are legumes but are classified as oilseeds in Indian agricultural statistics.

Crop choice reflects rainfall, irrigation, soil, seed availability, food culture, procurement and market access. Rice and wheat are tied to procurement and public distribution in several regions. Millets can diversify diets and production in dryland areas, but uptake depends on convenient processing and stable markets [5]. Pulses supply plant protein, fibre, folate and minerals, and biological nitrogen fixation can benefit rotations when crop, rhizobia, soil and management are compatible [6].

Table 1. Major grain and pulse groups in India, botanical names and socioeconomic issues.

Group	Crops (common / Indian names; botanical name)	Food and agronomic role	Socioeconomic issue
Major cereals	Rice (*Oryza sativa*); wheat (*Triticum aestivum* and related species); maize (*Zea mays*); barley (*Hordeum vulgare*)	Staple energy foods; feed and industrial processing	Procurement, input and water costs, price transmission
Large-seeded millets	Sorghum/jowar (*Sorghum bicolor*); pearl millet/bajra (*Cenchrus americanus*)	Diet diversity; dryland and rainfed production	Processing convenience; market access; shelf life of flour
Small millets	Finger millet/ragi (*Eleusine coracana*); foxtail (*Setaria italica*); little (*Panicum sumatrense*); kodo (*Paspalum scrobiculatum*); proso (*Panicum miliaceum*); barnyard (*Echinochloa* spp.)	Nutrient-dense grains for marginal and hill areas	Dehulling technology, limited value chains
Major pulses	Chickpea/chana (*Cicer arietinum*); pigeon pea/tur/arhar (*Cajanus cajan*); mung bean/moong (*Vigna radiata*); black gram/urd (*Vigna mungo*); lentil/masur (*Lens culinaris*); field pea (*Pisum sativum*)	Protein, fibre, folate, minerals; rotation benefits	Yield and price volatility; storage and procurement
Regional pulses	Cowpea (*Vigna unguiculata*); moth bean (*V. aconitifolia*); horse gram (*Macrotyloma uniflorum*); grass pea (*Lathyrus sativus*); kidney bean/rajma (*Phaseolus vulgaris*)	Local nutrition and agroecological diversity	Small value chains; crop-specific safety issues (e.g. grass pea)
Pseudocereals and other legumes	Buckwheat (*Fagopyrum esculentum*); amaranth (*Amaranthus* spp.); soybean and groundnut (usually reported as oilseeds)	Diet diversification, niche markets	Classification differences; market volatility

Names follow common botanical usage. Soybean and groundnut are reported as oilseeds in official Indian statistics [1].

4. Production context

Final estimates report total foodgrain production of 357.73 Mt in 2024–25, up from 332.30 Mt in 2023–24 and 251.54 Mt in 2015–16 [1,7]. Selected outputs were rice 150.18 Mt, wheat 117.94 Mt, maize 43.41 Mt, pulses 25.68 Mt and Shree Anna (millets) 18.59 Mt (Figure 1a; Table 2). Within pulses, chickpea (11.11 Mt), moong (4.24 Mt) and tur (3.62 Mt) together contributed roughly three-quarters of

output (Figure 1b). The official nutri/coarse cereal category (63.92 Mt) includes maize and barley as well as millets [1,7].

Production rose steadily over the decade (Figure 2). Between 2015–16 and 2024–25 rice output increased by 44% (CAGR 4.1%), wheat by 28% (2.8%), millets by 28% (2.8%) and pulses by 57% (5.2%); total foodgrain production rose by 42% (4.0% per year). The pulse figure partly reflects a depressed 2015–16 base following weak monsoons, and year-to-year pulse output remained more variable than that of rice or wheat (for example, 27.30 Mt in 2021–22 versus 24.25 Mt in 2023–24). Third advance estimates for 2025–26 indicate 376.56 Mt of foodgrains, with rice at 154.02 Mt, wheat at 120.66 Mt and millets at 17.58 Mt; these are provisional [2]. National totals mask regional variation and are revised through the season, so publications should state estimate type, release date and category definitions.

Table 2. Official production of selected grain groups (million tonnes) and growth, 2015–16 to 2025–26.

Group	2015–16	2019–20	2023–24	2024–25 (final)	2025–26 (3rd AE)	Change 2015–16 to 2024–25	CAGR (%)
Rice	104.41	118.87	137.82	150.18	154.02	+43.8%	4.1
Wheat	92.29	107.86	113.29	117.95	120.66	+27.8%	2.8
Shree Anna (millets)	14.52	17.26	17.57	18.59	17.58	+28.1%	2.8
Total pulses	16.32	23.02	24.25	25.68	n.r.	+57.3%	5.2
Total foodgrains	251.54	n.r.	332.30	357.73	376.56	+42.2%	4.0

Source: DES final estimates [1]; 2025–26 third advance estimates (provisional) [2]; total-foodgrain values for 2015–16, 2023–24 and 2024–25 from the Government release [7]. Change and CAGR calculated by the authors from published values. n.r., not retrieved for this review (2025–26 pulse total; 2019–20 foodgrain total). Shree Anna is a subset of nutri/coarse cereals and is not additive with them.

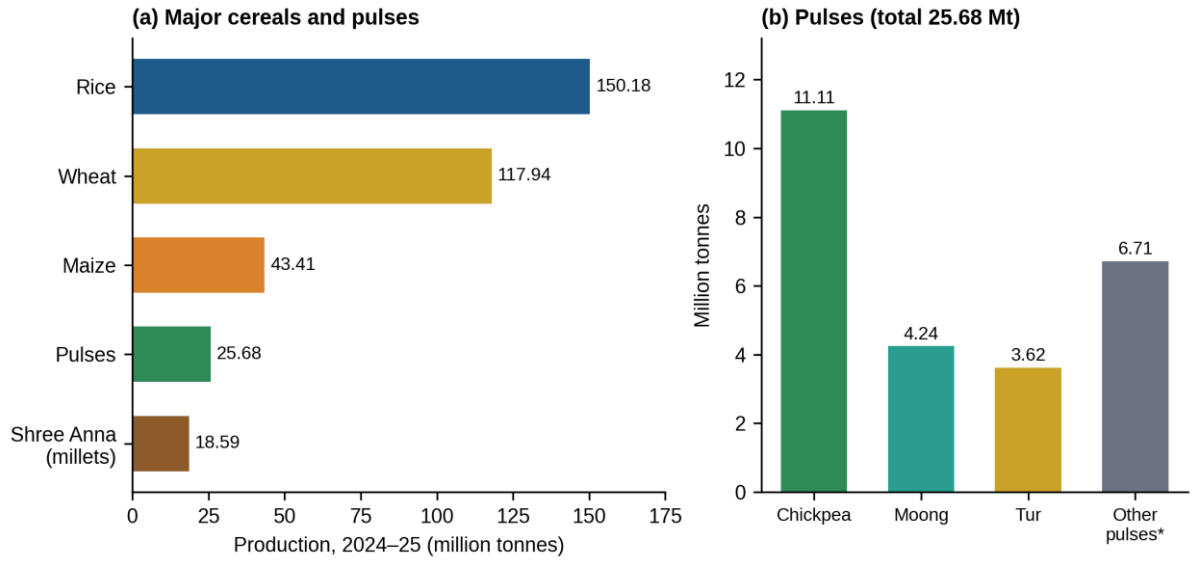


Figure 1. Production in 2024–25 (final estimates): (a). major cereals, pulses and millets; (b). pulse composition. *Other pulses obtained by difference (total pulses minus chickpea, moong and tur). Data: DES [1], PIB [7].

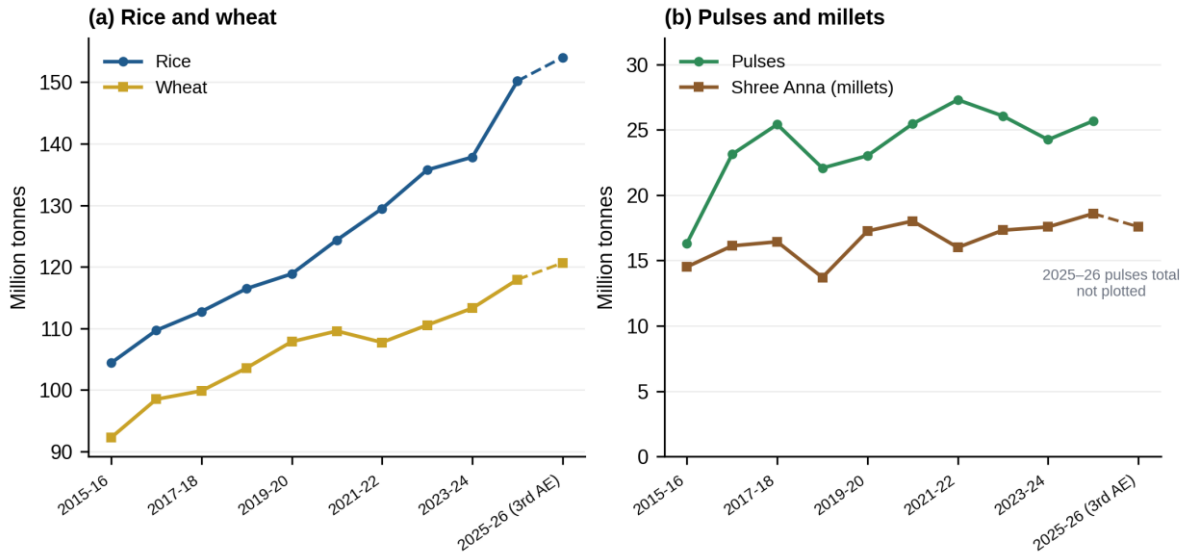


Figure 2. Production trends, 2015–16 to 2024–25 (final estimates, solid lines) and 2025–26 (third advance estimates, dashed): (a). rice and wheat; (b). pulses and Shree Anna (millets). The 2025–26 pulse total was not available. Data: DES [1,2].

5. Socioeconomic significance

Grains and pulses support farmers, labourers, seed producers, input retailers, machinery-service providers, traders, transporters, warehouse operators, millers, packers, wholesalers and retailers (Table 3). Value is added through cleaning, grading, dehulling, splitting, milling, flour production and ready-to-cook foods. The share retained by farmers depends on bargaining power, storage access, transport costs, credit, market information, quality standards and buyer concentration. Pulse milling is a major agro-processing activity in its own right [8].

Rice and wheat benefit from relatively developed procurement and storage infrastructure in some states. Pulses face greater yield and price volatility [9]; farmers needing immediate cash may sell soon after harvest, and storage improves marketing flexibility only when drying, bags, finance, transport and testing are affordable. Farmer producer organisations, cooperatives, warehouse-receipt finance, transparent electronic markets and local pulse mills may help where governance and throughput are adequate. Women contribute substantially to sowing, weeding, harvesting, threshing, sorting and household processing, yet their unpaid labour and occupational exposure are often undercounted [10]. Mechanisation can reduce drudgery but may displace workers unless transitions are supported.

Table 3. Value-chain actors and principal socioeconomic issues for grains and pulses.

Actor / function	Role	Principal issues
Farmers and labourers	Cultivation, harvest, threshing, on-farm drying and storage	Price volatility, input and water costs, drying capacity, distress sales after harvest
Women workers	Weeding, harvesting, sorting, household processing	Unpaid and under-recorded labour; exposure to dust, pesticides and heavy loads; limited access to training and equipment [10]
Aggregators and traders	Collection, grading, transport, wholesale	Information asymmetry, quality grading, payment delays
Warehouses and storage operators	Stock holding, fumigation and monitoring	Infrastructure gaps; trained pest-control staff; finance linked to warehouse receipts
Millers and processors	Cleaning, dehulling, polishing, flour and dal production	Recovery and broken-grain losses, energy use, worker safety, nutrient trade-offs [8]
Regulators and extension	Standards, residue monitoring, advisory services	Surveillance capacity, farmer awareness of labels and pre-harvest intervals [11]

6. Milling, dehulling, polishing and refining

Grain kernels contain bran/pericarp, germ/embryo and starchy endosperm, with anatomy differing by species (Figure 3). Milling produces flour or grits; rice polishing removes bran layers from brown rice; pulse dehulling removes seed coats and splitting divides cotyledons into dal. These operations can shorten cooking time, alter texture and appearance, improve acceptance and remove some surface-associated contaminants. Intensive removal of bran and germ lowers dietary fibre and several B vitamins, minerals, phenolics and other compounds concentrated in outer layers [12].

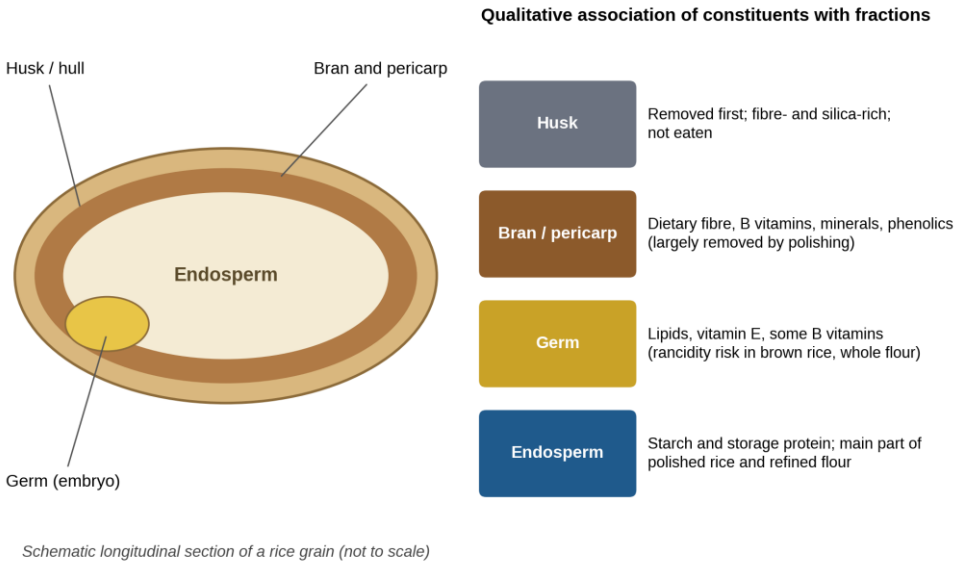


Figure 3. Schematic of a rice grain and the qualitative association of constituents with its fractions. Conceptual illustration; not measured data. See [12] for compositional data.

Refining is a trade-off rather than a simple distinction between safe and unsafe food (Table 4). Removing lipid-rich fractions can improve storage stability by reducing rancidity, whereas whole-grain flours and brown rice retain more fibre and micronutrients but need stronger control of oxygen, heat and storage time [12,13]. Fortification can restore selected nutrients but does not recreate the full food matrix. Pulse-milling performance depends on crop, seed-coat adhesion, moisture conditioning, equipment and abrasion; optimisation should consider recovery, broken fraction, cooking time, nutrient composition, energy use and acceptance [8].

Table 4. Processing operations: Benefits, costs and good practice.

Operation	Potential benefits	Potential costs	Good practice
Cleaning and grading	Removes stones, dust and damaged seed; improves uniformity	Poor calibration can reject edible grain	Suitable screens and aspiration; clear criteria
Pulse dehulling and splitting	Desired dal texture; shorter cooking; consumer acceptance	Seed-coat fibre and phytochemicals reduced; broken grain [8]	Optimise conditioning and abrasion; recover by-products
Rice polishing	White appearance; faster cooking; lower bran-lipid rancidity	Lower fibre and some micronutrients than brown rice [12]	Offer less-polished options; fortify where appropriate
Whole-grain milling	Retains bran and germ fractions	Lipid oxidation and shorter flour shelf life [13]	Barrier packaging; small batches; stock rotation
Fortification	Can address selected nutrient gaps	Needs dosing accuracy and quality control	Follow current national standards and labelling

7. Health and nutrition

Whole grains and pulses contribute fibre, plant protein, resistant starch, minerals and bioactive compounds. In prospective studies, higher whole-grain intake was associated with lower risk of cardiovascular disease and mortality [14], and higher white-rice intake with increased risk of type 2 diabetes, particularly in Asian populations [15]; these are observational associations whose size depends on overall diet and the foods replaced. Clinical trials show that pulse intake modestly lowers LDL cholesterol [16]. Polishing is therefore important when habitual intake shifts away from whole grains without adequate dietary diversity or fortification, but it should not be described as the sole cause of any disease. Table 5 summarises the evidence and cautions.

Pulses contain crop-specific amounts of phytate, tannins and enzyme inhibitors; soaking, germination, fermentation and adequate cooking can reduce some of these and improve mineral availability [17]. Grass pea contains the neurotoxin β-ODAP, and heavy reliance on it during severe food scarcity has been associated with neurolathyrism [18]. Wheat and barley contain gluten and are unsuitable for people with coeliac disease, which occurs in India, especially in the wheat-eating north [19]; rice, maize and most millets are naturally gluten-free but can be cross-contaminated during processing. Other hazards include mycotoxins, pesticide residues, foreign matter, microbial contamination and adulteration (Section 8; Table 6).

Table 5. Nutrition and health evidence for grains and pulses: Constituents, evidence and cautions.

Topic	Key constituents / mechanism	Evidence	Caution
Whole grains	Fibre, minerals, phenolics, lipids in bran and germ	Prospective cohorts and dose-response meta-analysis show lower cardiovascular and mortality risk with higher intake [14]	Observational; confounding possible
White (polished) rice	Rapidly digestible starch; bran removed	Higher intake associated with higher type 2 diabetes risk, stronger in Asian cohorts [15]	Depends on portion size and overall diet
Pulses	Plant protein, fibre, folate, minerals, resistant starch	Meta-analysis of trials: Modest LDL-cholesterol lowering [16]	Anti-nutrients reduced by soaking, germination, cooking [17]
Millets	Fibre, minerals, polyphenols	Reviews describe nutritional promise and agronomic resilience [5]	Processing convenience and flour shelf life limit uptake
Grass pea	β-ODAP neurotoxin	Neurolathyrism associated with heavy reliance during food scarcity [18]	Avoid as sole staple; detoxification practices exist
Gluten-containing cereals	Gluten proteins in wheat, barley	Coeliac disease present in India, with regional variation [19]	Strict avoidance in coeliac disease; cross-contamination risk for other grains
Mycotoxin-contaminated grain	Aflatoxins, ochratoxin A and others	Detectable contamination is common globally, though most samples are below regulatory limits [20,21]	Visible mould is not a reliable indicator; cooking may not destroy toxins

8. Insecticides and pesticide management

Field pesticide use and post-harvest storage treatments are different exposure scenarios. Residues depend on active ingredient, crop, dose, timing, weather, pre-harvest interval and handling. Pesticide choice must comply with current Indian registration and labelling under the Insecticides Act and associated rules [22], with approved crop or commodity uses, and with applicable maximum residue limits set under food-safety regulations [11,23]; international reference limits are set by Codex [24]. Because these instruments are amended periodically, the current consolidated texts must be consulted. This review does not provide chemical-specific treatment recipes.

Integrated pest management (IPM) prioritises prevention (Figure 4): clean stores and equipment; remove old residues and infested material; dry grain appropriately; repair leaks; use suitable packaging; monitor moisture, temperature and insects; rotate stocks; and consider hermetic storage where suitable

[4,25]. Chemical interventions should be targeted, lawful and performed by trained personnel. Unlabelled household insecticides must never be applied to food grain, and fumigation, where permitted, is a high-risk professional operation that requires exposure control, aeration and worker protection. Reliance on a single fumigant has contributed to resistance in stored-product insects worldwide, which makes monitoring, correct sealing and non-chemical measures essential [26].

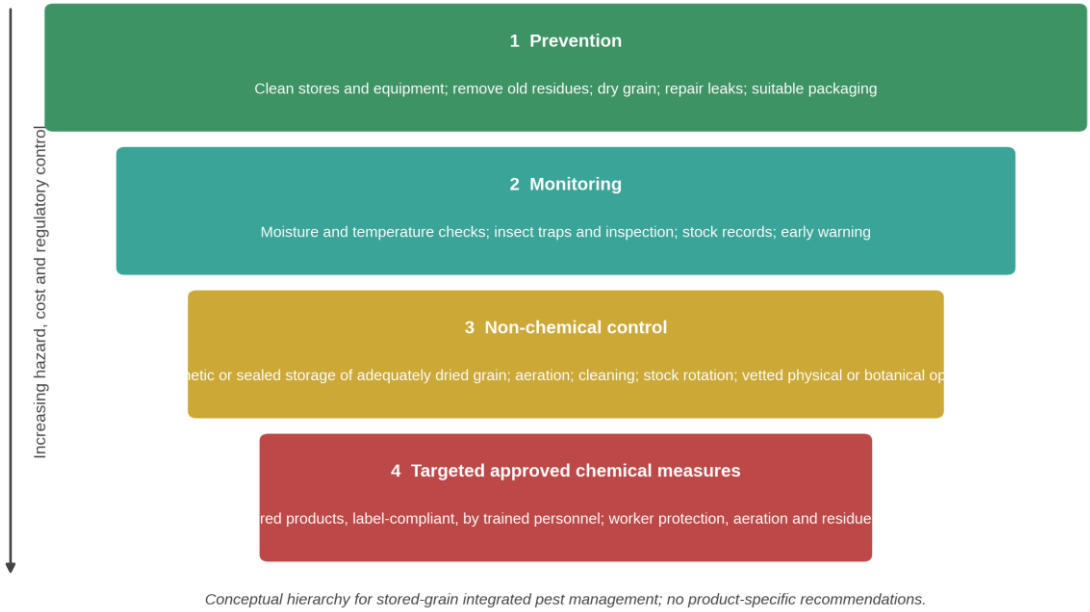


Figure 4. Hierarchy of stored-grain integrated pest management measures, from prevention to targeted approved chemical measures [4,26].

Risk depends on the substance, residue level, toxicology and dietary exposure; appearance and odour cannot establish that grain is residue-free. Risk-based surveillance, traceability, accredited testing and farmer training are therefore essential. Table 6 summarises the main hazards in stored grain and pulses, their indicators and controls.

Table 6. Principal hazards in stored grains and pulses, indicators and controls.

Hazard	Typical drivers	Indicators	Controls
Stored-product insects (e.g. beetles, moths, bruchids)	Warm, humid storage; infested residues; grain with high moisture [4]	Holes, webbing, dust, heating, live insects	Sanitation, drying, sealed or hermetic storage, monitoring [25]; targeted approved treatment where needed
Rodents and birds	Open stores, damaged bags, food residues	Droppings, gnawed bags	Proofing, pallets, trapping, regular inspection
Moulds and mycotoxins	Moisture above safe levels; temperature fluctuations; delayed drying [20]	Musty odour, discoloration, caking; absence of visible mould is not proof of safety	Rapid drying, moisture meters, ventilation, testing [21]
Pesticide residues	Misuse, wrong product or timing, ignoring pre-harvest or aeration intervals	Not detectable by sight or smell	Label compliance, trained applicators, residue testing [11]
Fumigant resistance	Repeated under-dosed or poorly sealed fumigation	Survivors after treatment	Resistance monitoring; good sealing; non-chemical options [26]
Adulteration and foreign matter	Economic motivation; poor grading	Mixed varieties or old stock, artificial colour or polish, stones	Sampling, grading, traceability [23]

9. Preservation, post-harvest losses and shelf life

A national study by ICAR–CIPHET (2012–2015) estimated cumulative harvest and post-harvest losses of 4.65–5.99% for cereals and 6.36–8.41% for pulses, with the stage at which losses occur differing by crop and chain [3]. These figures predate the latest production levels, and absolute tonnages of loss are therefore larger today; losses should be re-estimated with current methods. Figure 5 maps the main stages at which losses and quality problems arise and the corresponding controls.

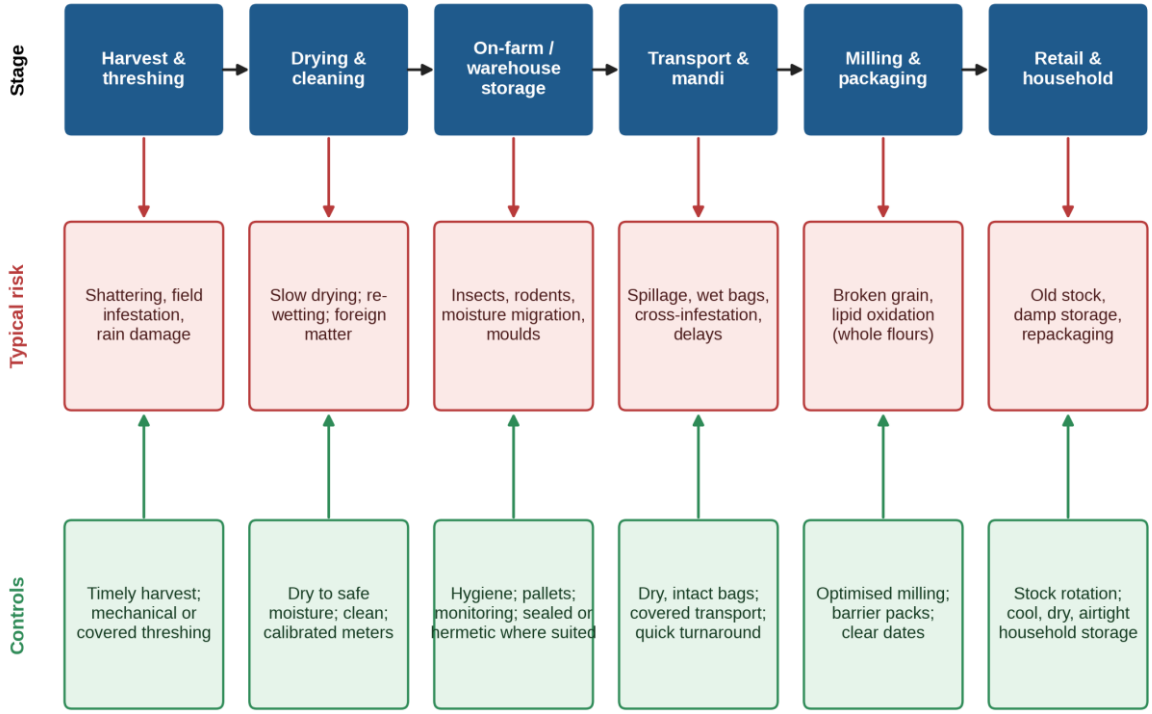


Figure 5. Post-harvest chain for grains and pulses showing typical risks and controls at each stage. Conceptual diagram; losses vary by crop, region and season [3,4].

Shelf life is the period during which a product remains safe and acceptably fit for use under defined storage and packaging conditions; it is not a single fixed number for a crop. Initial quality, moisture or water activity, temperature, relative humidity, oxygen, insect load, fungal contamination, package integrity, kernel damage and fat content all influence stability. Whole-grain flour often oxidises faster than refined flour because it retains lipid-rich bran and germ [13]. Dry pulses can remain physically stable for long periods when properly stored, but prolonged storage may cause hard-to-cook defects, colour changes and reduced germination.

Prompt drying after harvest is foundational: grain should be dried to a commodity- and climate-appropriate moisture, cooled before long-term storage and protected from rewetting [4,27]. A universal moisture threshold should not be applied to every grain, pulse, climate and duration. Use calibrated moisture meters, keep bags on pallets and away from leaks, and inspect stores. Hermetic bags or sealed systems limit gas exchange; respiration and insect activity lower oxygen and raise carbon dioxide, suppressing many storage insects when the system remains sealed [25]. Hermetic storage is not a substitute for drying: sealing wet grain can encourage mould and mycotoxin formation [4]. Traditional botanicals and inert dusts should be assessed for efficacy, contamination, safety and local approval. Table 7 gives indicative storage guidance by commodity.

Table 7. Indicative storage guidance by commodity (not a guaranteed shelf-life claim).

Commodity	Main deterioration drivers	Storage approach	Interpretation
Dry whole rice	Insects, moisture, odours; lipid oxidation in brown rice [12]	Clean, dry, sealed moisture barrier; cool and dark	Long storage possible under controlled conditions; brown rice often has a shorter quality life
Wheat grain	Insects, moisture, moulds, hot spots [4]	Dry, clean, monitored storage; prevent leaks	Months to years depending on conditions and use
Whole-wheat flour	Lipid oxidation, insects, moisture, flavour loss [13]	Small batches, airtight packaging, cool storage	Shorter quality life than intact grain
Millets and millet flour	Insects, moisture; rancidity in milled fractions [5]	Dry whole grain; barrier packaging for flour	Whole grain generally lasts longer than flour
Dry pulses	Bruchids, moisture, hard-to-cook defects	Thorough drying; clean sealed or hermetic storage [25]	Many months or longer when dry; cooking quality can decline with age
Milled dal	Insects, moisture, odour, oxidation	Clean, dry, airtight package; stock rotation	Varies with processing and package barrier
Cooked grains and pulses	Microbial growth if temperature-abused	Cool promptly and refrigerate	Perishable; dry-grain guidance does not apply

Commercial shelf-life claims should be validated under defined conditions, including packaging, microbiological and chemical quality where relevant, sensory acceptance and pest resistance. Consumers should follow package dates and storage instructions and discard damp, musty, mouldy or chemically contaminated grain.

10. Adulteration and quality assurance

Potential problems include substitution with lower-value commodities, mixing of old and new stock, foreign matter, artificial colour or polish, undeclared blending, and insect- or moisture-damaged lots. Checks may include representative sampling, visual inspection, moisture measurement, foreign-matter screening, microscopy or DNA-based identity methods, and laboratory tests for pesticide residues and mycotoxins where indicated [11,23]. Claims such as “organic” or “residue-free” require certification or analytical evidence and cannot be established by appearance. Traceability should link lot identity, drying records, storage history, treatment records, test results and dispatch; transparent grading and prompt payment can reward quality, and shared dryers, moisture meters, hermetic systems and accessible accredited testing can lower compliance costs for smallholders.

11. Recommendations for India

1. Promote locally appropriate crop diversity, including millets and pulses, rather than assuming one crop suits every agroecological zone [5,6].
2. Make whole-grain and less-polished options affordable and available, and explain polishing trade-offs without alarmism [12,14].
3. Improve drying, moisture measurement, sanitation, packaging and pest monitoring at farm, mandi, mill and household levels [4,27].
4. Train farmers and handlers on pesticide labels, approved uses, pre-harvest intervals, worker protection and fumigation safety [22,26].
5. Support smallholder access to hermetic systems while ensuring grain is adequately dried before sealing [4,25].
6. Optimise pulse milling for recovery, energy, water, nutrient retention, cooking quality and worker safety [8].
7. Improve market transparency, farmer aggregation, warehouse finance, procurement reach and women’s access to training and equipment [9,10].

8. Use validated local shelf-life trials that report temperature, humidity, moisture, packaging and quality endpoints.
9. Strengthen pesticide-residue, mycotoxin and adulteration surveillance with transparent reporting [11,20].

12. Research priorities

Priority areas include multi-season storage-life datasets for Indian cultivars across hot, humid and dry zones; cost and life-cycle comparisons of conventional bags, improved warehouses and hermetic systems; residue monitoring linked to active ingredient and application history; nutrient retention across measured degrees of rice polishing and pulse dehulling; hard-to-cook defects in aged pulses; economics of decentralised pulse mills; updated, crop-specific loss estimates that supersede the 2012–2015 survey [3]; and gender-disaggregated studies of post-harvest labour and pesticide exposure. Studies should report uncertainty and distinguish empirical results from illustrative diagrams.

13. Limitations

This review is narrative and non-systematic, so some studies may have been omitted. Production values for 2025–26 are provisional advance estimates. Growth rates were calculated from published rounded values and depend on the base year; the 2015–16 pulse base was low. Post-harvest loss figures come from a 2012–2015 national survey and may not reflect current practice. Several statements about regulation, practice and shelf life are qualitative because India-specific quantitative data are limited, and regulatory instruments are amended frequently and should be checked at the time of use.

14. Conclusions

Grains and pulses underpin food security, rural employment, dietary quality and regional food cultures in India, and official estimates show sustained growth, with 357.73 Mt of foodgrains in 2024–25 and a provisional 376.56 Mt in 2025–26. Their benefits depend on decisions across the chain, from crop selection and field pest management to drying, milling, polishing, packaging, storage and cooking. Intensive polishing can improve sensory and processing properties but commonly removes bran-associated nutrients, and whole-grain products require control of oxidation and moisture. Shelf life is conditional, not universal. Drying, hygiene, moisture control, hermetic storage where appropriate, stock rotation and monitored integrated pest management can reduce losses and chemical reliance, and pesticides should be used only within current legal approvals and label requirements, with trained handling and residue oversight.

Declarations

Author contributions: Conceptualisation, drafting, reviewing and editing.

Funding: This research received no external funding.

Conflict of interest: The author declares no conflict of interest.

Data availability: Production data are publicly available from the Directorate of Economics and Statistics [1,2]; the values analysed are tabulated in Table 2. No new primary data were generated.

Use of generative AI: During preparation of this narrative review the author used AI tools to assist with language revision, figure-generation code and reference checking. The author has reviewed and edited the output and the content.

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