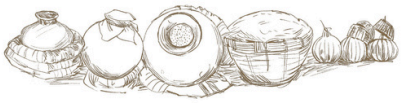
A WASSAN - RRA NETWORK PUBLICATION

THE LIVING HERITAGE OF SEEDS





Traditional Knowledge, Regional Practices and Traditional Seed Storage of India

An overview prepared for Civil Society Organisations, Government officers, policy makers, funders and researchers

NOVEMBER 2026

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Revitalising Rainfed Agriculture The RRA Network

ACKNOWLEDGEMENTS

Every seed carries a story, and every traditional practice holds generations of wisdom. This handbook is a humble attempt to bring those stories and insights to light. Above all, we are grateful to the women farmers and farming communities who generously shared their experiences, memories, and traditional seed-storage practices. Nurtured and preserved across generations, their knowledge is the foundation of this work. Without their trust, participation, and generosity, this handbook would not exist.

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This handbook is more than a compilation of information; it is a celebration of shared knowledge, collective effort, and community generosity. We hope it honors the custodians of these traditions and inspires future generations to protect, document, and carry forward the wisdom of traditional seed storage.

Bhagya Laxmi
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INDEX

About This Handbook 01
Regions Documented (Map) 02

Ch. 1 Historical Background of Traditional Seed and Grain Storage 03
1.1 Ancient and Classical Foundations 04
1.2 Gujarat 06
1.3 Himachal Pradesh 07
1.4 Eastern India 10
1.5 North-East India 11

PART I FOUNDATIONS 13

Ch. 2 Why Traditional Storage Matters 14
2.1 Viability Is Not Automatic 15
2.2 Genetic Integrity and the Landrace 16
2.3 Seed Sovereignty 17

Ch. 3 The Biology of Seed Storage 18
3.1 Dormancy and Respiration 19
3.2 Moisture Content and Harrington's Rule 19
3.3 Orthodox and Recalcitrant Seed 20
3.4 Purity, Viability and What a Good Seed Is 20

PART II MATERIALS AND STRUCTURES 22

Ch. 4 Storage Vessels and Materials 23
4.1 Clay and Earthenware 24
4.2 Bamboo Structures 24
4.3 Gourd Containers 25
4.4 Wooden Bins and Chests 25
4.5 Straw and Mud Silos 25

Ch. 5 Household and Community Structures 27
5.1 Integrated versus Free-Standing Storage 28
5.2 Granaries and Raised Platforms 28
5.3 Smoke-Curing Lofts 29
5.4 Community-Scale and State-Scale Structures 29

PART III PRACTICE AND TECHNIQUE 30

Ch. 6 Pre-Storage Processing 31
6.1 Threshing and Winnowing 32
6.2 Sun-Drying Protocols 33
6.3 Folk Moisture Tests 33
6.4 Sealing and Oxygen Exclusion 33

Ch. 7 Natural Pest and Pathogen Management 34
7.1 Botanical Repellents 35
7.2 Physical Desiccants and Barriers 36
7.3 Smoke and Heat Treatment 36
7.4 A Regional Comparison 36

Ch. 8 Seed Selection for Storage 37
8.1 Selection Criteria 38
8.2 Panicle and Plant-Level Selection 38
8.3 Naming, Memory and the Link to Landrace Heterogeneity 38
8.4 Seed Treatment Before Storage 39

PART IV SOCIAL ARCHITECTURE 40

Ch. 9 Women's Seed Authority 41
9.1 The Evidence Across Regions 42
9.2 Selection, Germination Testing and Intergenerational Transmission 42
9.3 Implications for Policy and Programme Design 43

Ch. 10 Community Seed Exchange Systems 44
10.1 Reciprocity and Informal Lending 45
10.2 Seed Festivals and Ritual Exchange 45
10.3 Institutionalised Exchange: The Chasi Swaraj Model 46
10.4 Why Exchange Systems Matter for This Handbook's Readers 46

PART V REGION-SPECIFIC PRACTICES 47

Ch. 11 Gujarat 48
11.1 The Household Storage Economy 49
11.2 Documented Pest Management Practice 49
11.3 From Household to State: The Darbari Kothar 49
11.4 Implications for Practice 50

Ch. 12 Himachal Pradesh 51
12.1 The Kath-Kuni House and the Integrated Store 52
12.2 Documented Storage Structure Types Recorded in the Field Inventory 53
12.3 Protectants and Ritual Practice 53

Ch. 13 Eastern India 54
13.1 Tribal Storage Practice in Odisha 55
13.2 Institutional Support: Bihana Maa, Chasi Swaraj and Seed Melas 55
13.3 Chhattisgarh and the Central Provinces Record 55
13.4 Bengal, Bihar and the Colonial Interface 56
13.5 Germination Testing in Chhattisgarh 56

Ch. 14 Assam and North-East India 58
14.1 The Bhoral and Assamese Wet Rice Economy 59
14.2 A Dense Vocabulary of Bamboo Forms 59
14.3 Ritual and Belief Systems Linked to Storage 59
14.4 Naga Hills and Khasi and Garo Hills 60

PART VI CONTEMPORARY INTERFACE 61

Ch. 15 Climate Change and Storage Resilience 62
15.1 Humidity, Temperature and the Biology in Chapter 3 63
15.2 Regional Exposure 63
15.3 Traditional Adaptive Capacity 63

Ch. 16 Why Documentation and Revival 65
16.1 A Documentation Methodology 66
16.2 Case Studies from the Foundation's Field Communities 66
16.3 From Documentation to Revival 67

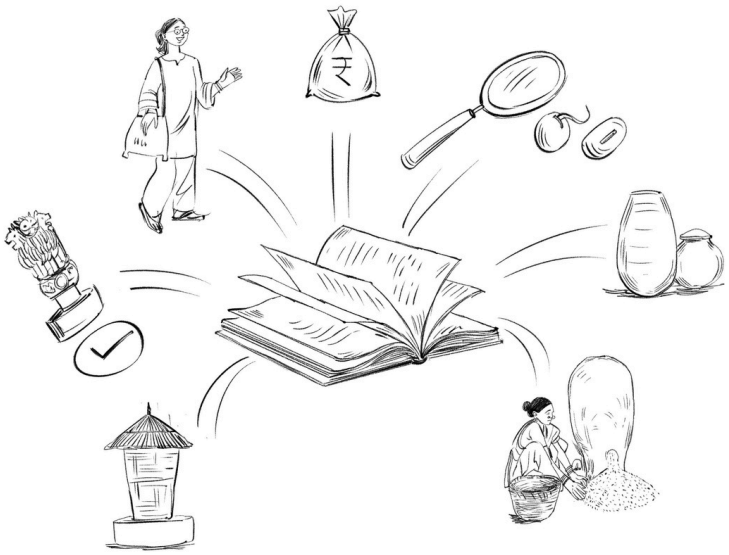
ANNEXURES SOURCE FIELD DOCUMENTATION 68
A. Gujarat: Documented Pest and Storage Practices 69
B. Himachal Pradesh: Master Inventory 73
C. North-East India: Master Inventory 75
D. Eastern India: Community-Wise Systems 78
E. Technical Reference: Seed Standards 82
E.1 What Is a Good Seed 83
E.2 Botanical and Mineral Protectants: Consolidated Reference Table 83
E.3 Community Seed Bank Maintenance 84

ABOUT THIS HANDBOOK

This Handbook brings together, in one place, what is known and documented about traditional seed and grain storage across four regions of India: Gujarat, Himachal Pradesh, Eastern India and North-East India. It is written for Civil Society Organisations, Government officers, policymakers, funders and researchers who need a working overview of traditional storage knowledge, not for practitioners looking for step-by-step construction instructions.

How This Handbook Is Organised

- **Part I** sets out why traditional storage matters and the biological principles that make it work.
- **Part II** describes the vessels, materials and structures that carry out storage at household and community scale.
- **Part III** covers the practice around storage: processing before the seed is put away, pest and pathogen management, and the selection decisions that determine what gets stored in the first place.



- **Part IV** examines the social architecture that sustains storage as a living system, principally the authority of women as seed custodians and the exchange networks that move seed between households.
- **Part V** gathers this material by region, giving Gujarat, Himachal Pradesh, Eastern India and Assam and North-East India each a dedicated chapter.
- **Part VI** turns to the contemporary interface: climate pressure on traditional methods, the gap between traditional practice and formal certification standards, and how this knowledge can be documented and revived before it is lost.

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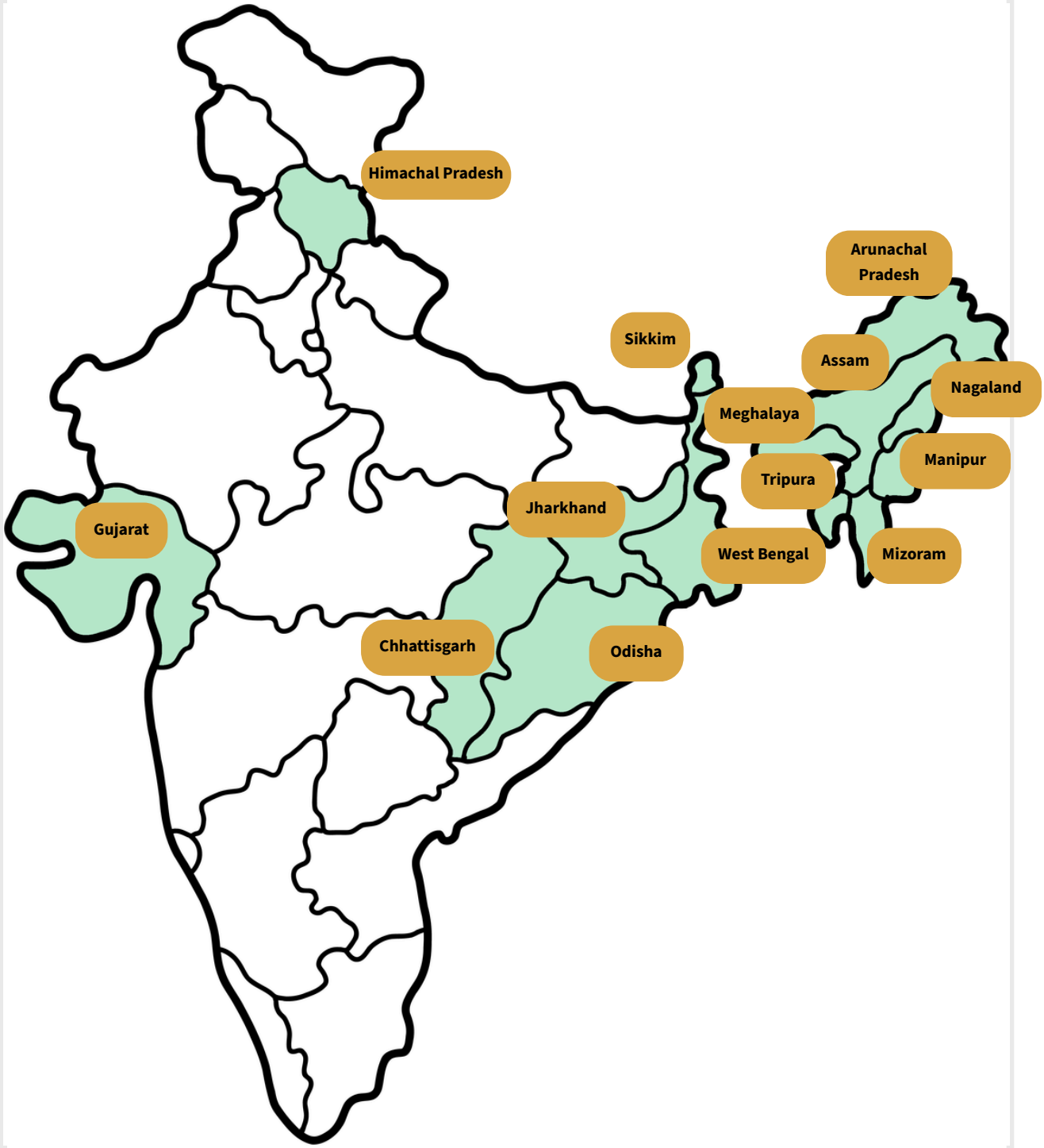


REGIONS DOCUMENTED ARE IN GREEN

CHAPTER 1

Historical Background of Traditional Seed and Grain Storage

Placing present-day traditional storage practice within a longer historical arc helps explain why it takes the form it does today. This chapter draws on reports of the colonial period, Sanskrit agricultural treatises, published research on vernacular architecture and ethnobotany, and field documentation, to trace the record for each of the four regions covered by this Handbook. Two threads run through the record and recur in every regional account below. The first is the persistence of the household or community grain store as the primary unit of food security, long before, and largely independent of, the state granary. The second is the periodic attempt by ruling powers, princely and colonial alike, to superimpose a centralised storage apparatus onto this decentralised base, usually in direct response to famine.

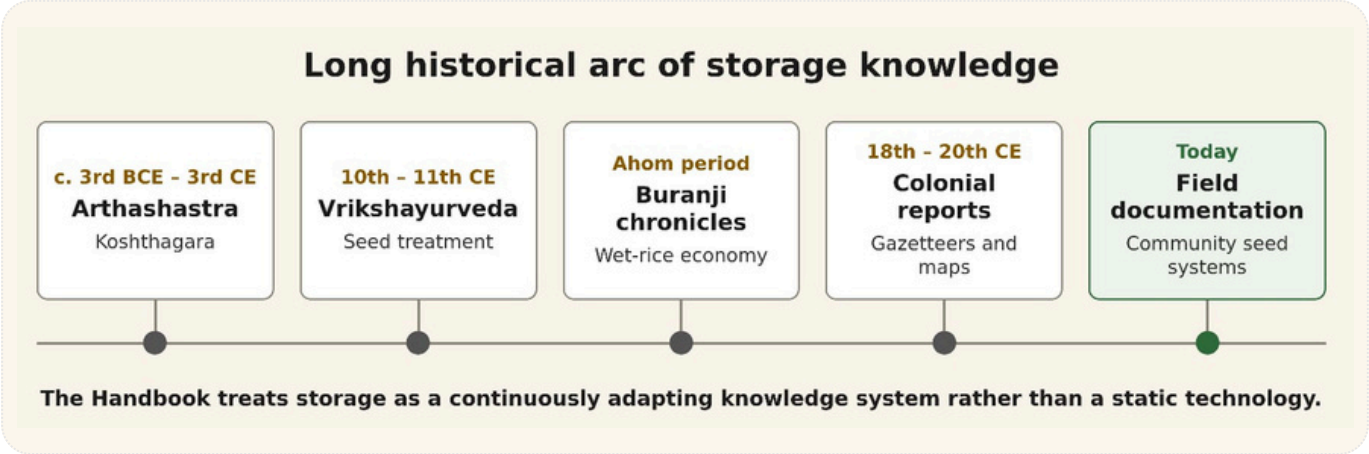


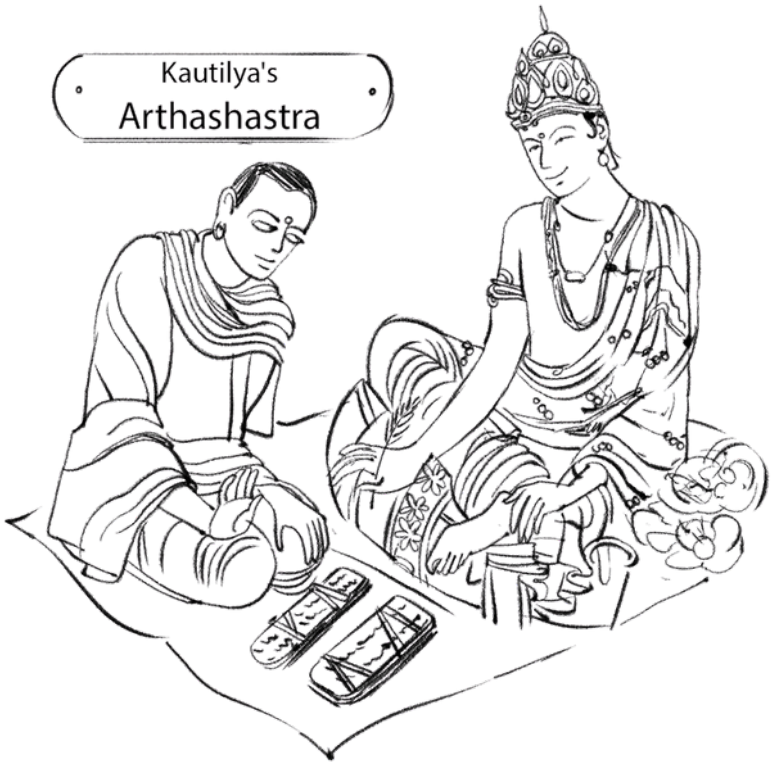
FIGURE - 1: HISTORICAL ARC: STORAGE KNOWLEDGE FROM CLASSICAL TEXTS, REGIONAL AGRARIAN TRADITIONS, COLONIAL DOCUMENTATION AND PRESENT FIELD RECORDS.

1.1 Ancient and Classical Foundations

One of the oldest textual reference to organised grain storage in the Indian subcontinent is the Koshthagara, the royal storehouse described in Kautilya's Arthashastra, a Sanskrit treatise on statecraft compiled between roughly the third century BCE and the third century CE. The text assigns a dedicated Superintendent of Storehouse the task of maintaining state reserves of grain, and it directs the officer in charge of trade, the Panyadhyaksha, to build up buffer stocks of grain and other essential commodities that could be released during emergencies. Early Bengal followed a comparable logic: the granary at Pundranagara, in the northern part of the region, was drawn upon for relief measures during periods of scarcity, showing that the Arthashastra's prescription for state buffer stocks found practical expression well beyond the text's own place of composition.

Alongside this administrative tradition sits a parallel body of agronomic knowledge concerned with the seed itself rather than with bulk grain. The Sanskrit treatise Vrikshayurveda, attributed to a scholar named Surapala and now dated to around the tenth or eleventh century CE, survived only as a manuscript in the Bodleian Library at Oxford until it was translated into English in the 1990s by the Asian Agri-History Foundation. Among its three hundred and twenty five verses, a distinct section is devoted to seed viability treatment: it recommends collecting seed between January and March, drying it thoroughly away from ant hills, cowsheds, food, ghee, oil, buttermilk, lamps and salt, and treating seed with combinations of dew, sun, honey, milk and cowdung before storage or sowing. Later compendia, including the Brahmasamhita and the Krishi-Parashara, repeat and extend these prescriptions, and add guidance on auspicious sowing dates tied to the lunar fortnight, indicating that seed treatment before storage was recognised as a distinct technical stage of agriculture well before the colonial period, circulating across regions rather than remaining local to any one of the four covered in this Handbook.




Kautilya's
Arthashastra



1.2 Gujarat

Rural Gujarat developed a distinct classification of household granaries, generally grouped as Kothi, Kothlo and Kabala, built from an admixture of mud, straw and cattle dung, hand sculpted mainly by women, with men assisting by supplying material. Documentation by the Design Innovation and Craft Resource Centre at CEPT University records that a cylindrical granary with sculptural curves, or a decorated rectangular form, is considered feminine and called a *Kothi*, while an unornamented rectangular granary is considered masculine and called a *Kothlo*. A smaller companion vessel, the *Kuthla*, was kept in the same room and refilled periodically from the larger Kothi, so that the household operated a two tier storage economy. Community-specific variants are recorded across Gujarat's diverse population: the Rebari of Kutch decorated their *Kothi* with mirror mosaic set into mud and donkey dung, the Meghwal of the Banni region used a reddish pigment derived from geru, Bhil potters in desert villages made unfired clay Kothi for Bajra, and communities in the Dangs made wicker granaries for storing paddy rice.

The Gazetteer of the Bombay Presidency, compiled under the general editorship of James Macnabb Campbell from the 1870s onward, situates this household practice within the wider agrarian economy of the Presidency. It records that the coarser grains, *Nachani* and *Kodra*, grown on the hill sides of Gujarat and the neighbouring Deccan, furnished the staple food of the *Koli, Bhil* and *Warli* communities the Gazetteer classed as aboriginal tribes, while wheat, grown chiefly in the northern part of the Presidency, was increasingly diverted to export. The clearest instance of the shift from household to state storage in Gujarat is the Darbari Kothar of Bhavnagar. Bhavnagar, founded in 1723, was prone to annual grain shortages arising from its arid climate. To break this cycle, Maharaja Takhatsinhji commissioned the British architect R.M. Simms to design a public granary explicitly named after, and drawing its inspiration from, the household *Kothi*. Built of brick, stone, steel and wood, it held enough reserve grain to meet the needs of the population for up to four consecutive years during drought, flood, famine or war, with grain collected monthly as tax and brought in by cattle through wide passageways.





PHOTO CREDIT: SATVIK PROMOTING ECOLOGICAL FARMING



1.3 Himachal Pradesh

The historical record for Himachal Pradesh is inseparable from the region's vernacular house form, since the grain store in the Himalayan hill house is typically not a free-standing structure, as it is on the plains, but a chamber integrated within the dwelling. Hill houses across Kangra, Mandi, Kullu and Shimla districts were traditionally built using the Kath-Kuni technique, alternating courses of dressed stone and deodar timber laid without cement, mortar or metal fastenings, a technique that proved markedly earthquake resistant during the severe 1905 Kangra earthquake. Within this structure, the household grain store, generally called a Kothar or Kothi, occupies a dedicated indoor room, often on a raised mud platform known locally as the Tallah. Field documentation across Hamirpur and Mandi districts records at least three distinct storage forms: the Bas Pedu, a cylindrical bamboo bin plastered with cowdung and soil and capped with a woven bamboo lid called a Changer; the Kothar proper, a closed wooden chest built from deodar, Raitosh and Kos timber, assembled without a single iron nail because community members hold that the scent of deodar itself repels storage pests; and the Dudlu and Gadlu, paired earthen pots wrapped in the bark fibre of the Shod plant, known as Bandhan, to extend the working life of the pot.







KOTHAR

Pest and moisture management practices draw on locally available material: Walnut leaves, the root of *Saussurea lappa*, known locally as Kuth, and an iron-rich mineral solution called Oose, obtained from hill sources. Several communities observe restrictions that mark the store as more than a purely functional space: the structure is oriented to face east or north, grain is not moved during solar or lunar eclipses, and in earlier practice only the head of the household was permitted to enter, with menstruating women excluded. The colonial Gazetteers of the Punjab Hill States, including the Kangra District volumes compiled in the early twentieth century, describe the same hill house economy chiefly in revenue and administrative terms, which means the ethnographic record of structures such as the Kothar survives today mainly through community memory and recent field documentation rather than through the colonial archive itself.



KOTHAR



DUDLU GADLU



DUDLU GADLU



DUDLU GADLU



SEED BIN SEALED BY CATTLE DUNG



MATURE FRUITS KEPT FOR SEEDS







BAS PEDU



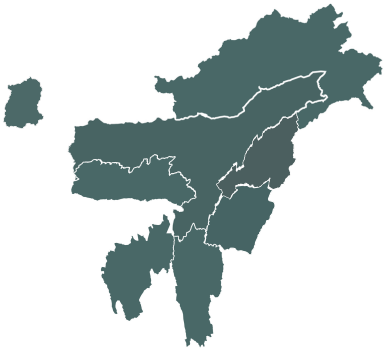
1.4 Eastern India

Present-day Chhattisgarh formed the Chhattisgarh Division of the Central Provinces under British administration, with agricultural production centred on rice alongside the hill millets and pulses that sustained Gond, Baiga, Kawar and Kol cultivators on land unsuited to paddy. Among Ho cultivators in Kendujhar district of Odisha, straw bins built by wrapping long indigenous paddy straw into a cylinder, bound with Kenaf fibre rope and raised on wooden platforms, were the dominant paddy store. Elsewhere in Odisha, seeds mixed with wood ash were stored in bottle gourd shells; grain was kept in earthen pots sealed with dung at the lid; maize cobs were hung whole from kitchen roofs, where smoke served as a pest deterrent; and pigeon pea and black gram were mixed with fine soil, or with the crushed seed of Bhelwa, the marking-nut tree, in a ratio of roughly one part Bhelwa to ten parts grain.

The institution of the Bihana Maa, or Seed Mother, recorded among communities working with the CSO- ORRISSA in Malkangiri and Kandhamal districts, formalised a role that appears informally across most communities surveyed: a knowledgeable woman responsible for maintaining awareness of local seed diversity and facilitating free exchange between households. Rural West Bengal's household grain store, the Dhaner Morai, a mud and bamboo silo built within the homestead, parallels the Kothi tradition of Gujarat in function though not in material. The Gazetteer of Bengal and North-East India situates this household economy within a Bengal repeatedly disrupted by famine, most catastrophically in 1770. It was this famine that prompted the most visible colonial response to grain storage failure anywhere in the four regions: the Golghar in Patna, commissioned by Governor-General Warren Hastings and built in 1786 under the engineer Captain John Garstin, a pillarless beehive-shaped brick dome designed to hold as much as one hundred and forty thousand tonnes of grain, though it appears never to have been filled to capacity or used as intended, since its single entrance opened inward and grain nominally held in reserve was in practice drawn upon by the British administration rather than reaching the population during subsequent famines.



POTOM SEED CONTAINERS MADE FROM GHUNGU (*BAUHINIA VAHLII*) PATTA



1.5 North-East India

North-East India's storage history is shaped less by state granaries than by the agro-ecology of Jhum, or shifting cultivation, and by a climate of high and sustained rainfall that makes elevation off the ground, rather than sealing against dryness, the primary design concern. The Bhoral, the traditional Assamese granary, is a raised structure of bamboo and thatch built within or adjoining the homestead, documented in the 1905 Gazetteer of Bengal and North-East India and situated within an Assamese agrarian tradition reaching back through the Ahom kingdom's court chronicles, the Buranjis, which record a settled wet rice economy along the Brahmaputra valley from at least the thirteenth century. In the Naga Hills, the most substantial nineteenth century ethnographic record was compiled retrospectively by Verrier Elwin in his 1969 anthology- The Nagas in the Nineteenth Century, bringing together colonial administrative reports, tour diaries and ethnographic notes. These accounts document a subsistence economy built around Jhum cultivation of Rice and Millet, with grain storage generally a household rather than communal responsibility, held in tightly woven, rat-proof bamboo baskets raised clear of the ground, a technique still visible today in villages such as Jakhama in Nagaland.

In the Khasi, Jaintia and Garo Hills of present-day Meghalaya, storage practice was, and in many villages remains, tied directly to the cycle of Jhum, locally termed Bun among the Khasi and Jaintia communities, with grain and seed held close to the current homestead and community norms of sharing acting as a buffer against an individual household's shortfall. The field inventory across Assam and Arunachal Pradesh records a dense vocabulary of small bamboo containers calibrated to different crops and different periods of use, including the Duli, Puru, Hoton, Sok Ingkro and Balak among Karbi communities, and the Apeh, Atutu, Boyo and Ahgra among Idu Mishmi communities of Dibang Valley, most raised on poles above the cooking hearth so that smoke from the Chullah doubles as a pest deterrent while the seed dries.

FIELD PHOTOGRAPH FROM ASSAM: HANGING STORAGE CONTAINERS WITHIN THE KITCHEN SPACE





FIELD PHOTOGRAPH FROM ASSAM: WOVEN BAMBOO STORAGE BASKET/CONTAINER



FIELD PHOTOGRAPH FROM ASSAM: BAMBOO BASKET/CONTAINER USED FOR HOUSEHOLD STORAGE

FIELD PHOTOGRAPH FROM ASSAM: RAISED HOUSEHOLD STORAGE/SHELVING.





FIELD PHOTOGRAPH FROM ASSAM: TRADITIONAL CROP/SEED MATERIAL IN THE FIELD. | LARGE EARTHEN STORAGE VESSELS WITHIN A HOUSEHOLD



FIELD PHOTOGRAPH FROM ASSAM: GOURDS USED AS SMALL-VOLUME STORAGE CONTAINERS.

PART - I

Foundations

CHAPTER 2

Why Traditional Storage Matters

Seed and grain are used as related but distinct categories in this Handbook. Here, seed storage refers specifically to material retained for future planting, while grain storage refers primarily to harvested produce retained for food, feed, processing or household consumption. Some traditional storage structures serve both purposes, and some practices are relevant to both. This distinction is important because drying requirements, quality criteria, pest-management treatments and the acceptability of particular storage materials may differ between planting seed and food grain.

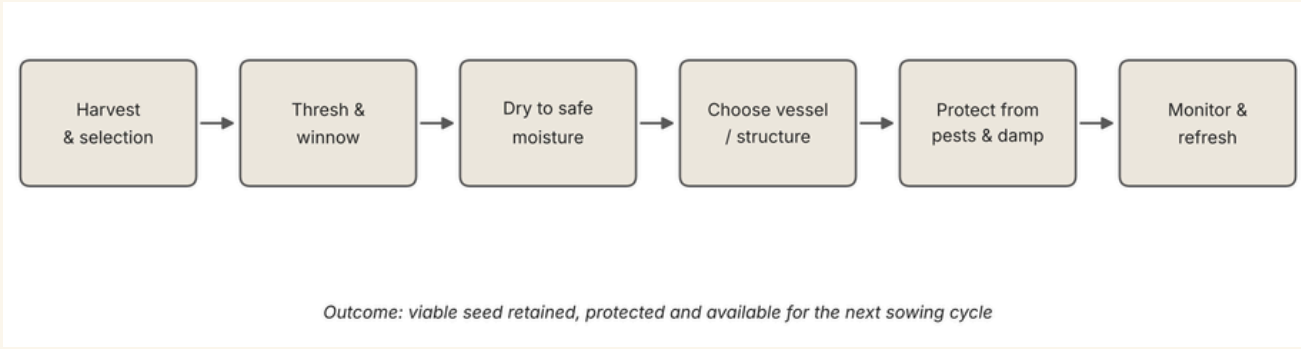
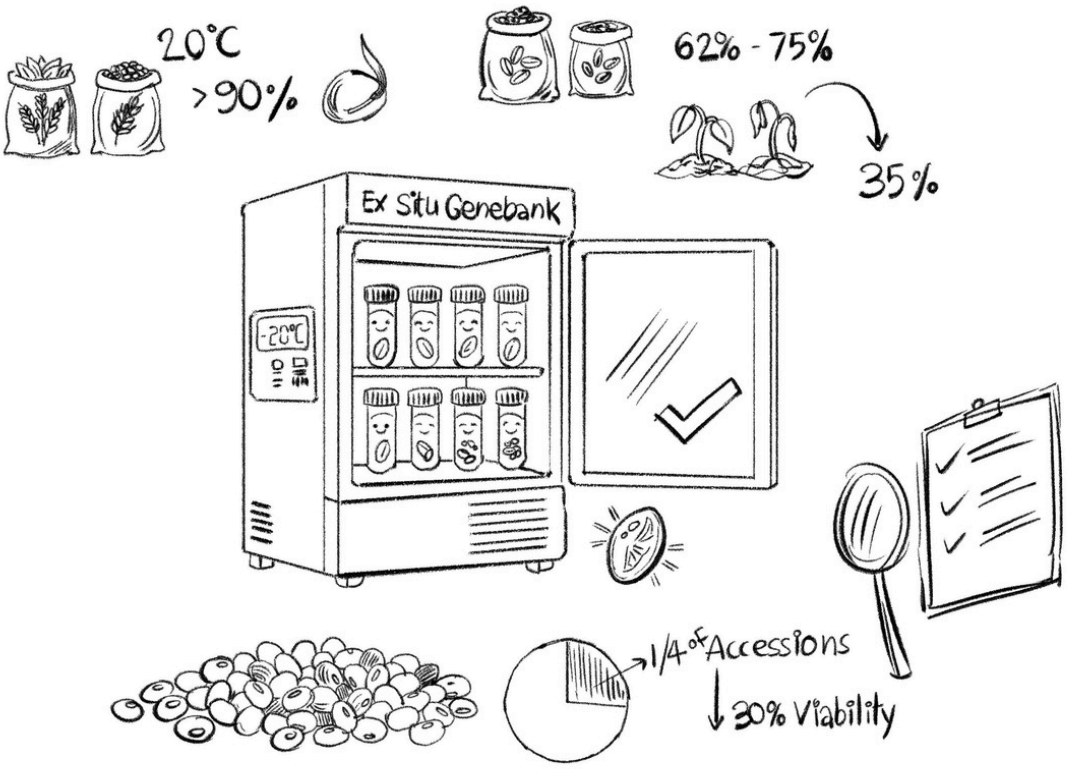


FIGURE - 2: TRADITIONAL STORAGE AS A LINKED MANAGEMENT SYSTEM: QUALITY BEGINS BEFORE THE SEED ENTERS THE STORE.

2.1 Viability Is Not Automatic

A stored seed is a living, respiring organism, and every storage decision either slows or accelerates its ageing. Ex-situ Genebanks, which store accessions at controlled low temperature and low moisture as a matter of institutional design, are often assumed to solve the viability problem definitively. The evidence does not support this assumption uniformly. A widely cited study of Wheat and Barley accessions held for twenty three to thirty three years found that samples stored at minus twenty degrees Celsius retained a mean germination above ninety percent, while comparable samples stored at four degrees Celsius had already fallen to sixty two and seventy five percent respectively, and a subset of the four degree wheat samples, retested six years later, had fallen further still to thirty five percent, with several accessions close to complete loss of viability. A separate monitoring exercise on Mungbean accessions held in an agricultural Genebank found that fully a quarter of the accessions tested had fallen below thirty percent viability. These are not failures of the Genebank concept as such, but they demonstrate that ex situ storage carries its own maintenance burden, cold-chain reliability, periodic regeneration, and monitoring capacity, that is neither automatic nor cost free, and that can and does fail in practice even where the institutional design is sound in principle.

Traditional storage carries a different risk profile. A community grain store is opened, inspected and replenished far more frequently than a Genebank accession is retrieved and regenerated, and the seed is grown out, and the store refilled with fresh seed, on an annual or near-annual cycle tied to the cropping calendar itself. This does not make traditional storage infallible, poor drying, inadequate sealing or an unusually damp season can and do cause loss, but it does mean that viability is continuously tested against the one condition that ultimately matters, whether the seed grows, rather than sampled periodically against a germination standard in a laboratory.



2.2 Genetic Integrity and the Landrace

A landrace is not a fixed genetic entity in the way a released variety is. It is a dynamic population, heterogeneous by design, that has been shaped over generations by the combined pressure of the local environment and the farmer's own selection choices, described further in ***Chapter 8***. This heterogeneity is the landrace's chief adaptive asset: within a single seed lot there is a spread of genotypes that respond differently to a dry year, a wet year, or a new pest, so the population as a whole is buffered against shocks that would be catastrophic for a genetically uniform crop. Formal conservation protocols built around genetic purity and rogueing, removing off-type plants to keep an accession uniform, are appropriate for improved varieties bred for uniformity, but they work against a landrace's own adaptive logic when applied without modification. On-farm and community storage, precisely because it keeps the landrace in active cultivation rather than in controlled ex-situ storage, allows this heterogeneity to keep responding to the environment each season rather than freezing it at the moment of collection.



2.3 Seed Sovereignty

Seed sovereignty describes a community's continuing ability to save, use, exchange and sell its own seed without needing permission, and without depending on a market or state supply chain that can fail, become unaffordable, or attach unwanted conditions. Traditional storage is the physical infrastructure that makes seed sovereignty possible in practice, not merely in principle. A household with a functioning Kothi, Kothar or Bhoral, and the seasonal know-how to keep it dry, cool and pest free, does not need to purchase seed each season, and is not exposed to the risk that a single bad harvest converts directly into a lost variety. Where this storage infrastructure and knowledge base has eroded, as the field documentation in Odisha records among Ho cultivators who have shifted to jute and polybag storage, dependence on external seed supply tends to follow quickly, and with it a narrowing of the varieties actually sown. The chapters that follow set out, region by region and practice by practice, what this storage infrastructure looks like and how it is maintained.



CHAPTER 3

The Biology of Seed Storage

Traditional storage practice, however local and however old, is working with the same underlying biology everywhere. Understanding that biology explains why particular materials, structures and treatments recur across regions that otherwise share very little else.

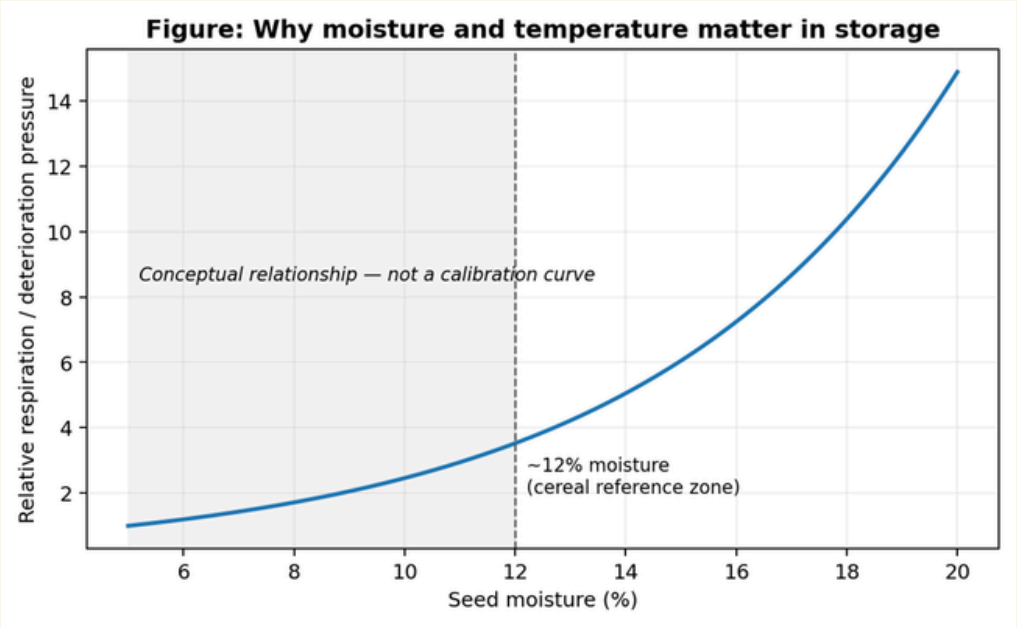


FIGURE - 3: CONCEPTUAL RELATIONSHIP BETWEEN SEED MOISTURE AND DETERIORATION PRESSURE; THE FIGURE IS EXPLANATORY RATHER THAN A CALIBRATION CURVE.

3.1 Dormancy and Respiration

A mature seed is a dormant embryo, its metabolic activity slowed to a minimum but not stopped. Even in storage, a seed continues to respire, consuming stored carbohydrate and releasing carbon dioxide, water vapour and heat, at a rate that rises sharply with both temperature and moisture content. This respiration is the central fact that storage technique exists to manage: every traditional practice examined later in this Handbook, drying before storage, sealing a container, elevating a structure off damp ground, works either by lowering the moisture and temperature the seed experiences, or by lowering the oxygen available to the seed and to the pests and fungi that would otherwise multiply alongside it.

3.2 Moisture Content and Harrington's Rule

Seed moisture content is the single most important variable in storage outcomes, more important even than temperature, because respiration and fungal growth both accelerate sharply above a threshold that varies by crop but generally sits in the range of twelve to fourteen percent for cereals and closer to nine percent for pulses. This is why the folk moisture tests described in ***Chapter 6***, the crackling sound of a seed breaking between the teeth, or the seed no longer sticking to a hand pushed into the sack, remain functionally accurate even without instrumentation: both tests are informal proxies for crossing this same threshold. The relationship between moisture and storage life is captured formally in what seed technologists call Harrington's Rule, which holds, within the five to fourteen percent moisture range, that each one percentage point reduction in seed moisture roughly doubles potential storage life, and, independently, that each five degree Celsius reduction in storage temperature, within a zero to fifty degree range, also roughly doubles storage life. The two effects compound, which is why a traditional store that is both dry and cool, a raised bamboo loft above a smoky kitchen hearth, or an earthen pot sealed and kept in a shaded room, consistently outperforms one that is only dry or only cool.

3.3 Orthodox and Recalcitrant Seed

Not all seed behaves the same way in storage, and the distinction between orthodox and recalcitrant seed explains why. Orthodox seed, which includes the great majority of Cereals, Pulses, Millets and Oilseeds covered in this Handbook, tolerates drying to low moisture content and can be stored for extended periods once dried, precisely the behaviour that traditional dry storage in a Kothi, Kothar or Bhoral is built around. Recalcitrant seed, by contrast, cannot be dried below a relatively high moisture threshold without losing viability, and includes many tropical tree species, and certain fruit seed. This is one reason traditional systems do not store everything the same way: Turmeric and Ginger / Vegetative planting materials are commonly held in soil or replanted directly rather than dried and sealed, as the field documentation from Odisha and North-East India in ***Chapter 4*** records, and the same logic explains why vegetatively propagated material sits outside most seed storage protocols altogether, a gap in relation to formal certification standards.

3.4 Purity, Viability and What a Good Seed Is

Physical purity refers to the proportion of the seed lot that consists of the intended seed of the crop, expressed as a percentage by weight. In formal seed-quality analysis, the seed lot is assessed for several separate components, including pure seed, other crop seeds, weed seeds, inert matter, germination or viability, moisture content, and, where relevant, genetic or varietal purity.

A working value of 98% pure seed may be used as an indicative benchmark for some community seed lots, but it should not be treated as a universal standard. Acceptable limits vary according to crop, seed class and applicable seed-quality standards.

The presence of other crop or weed seeds should be recorded separately from inert matter such as soil particles, stones, chaff, broken plant material and other non-seed material. Where seed counts are recorded, the number and type of other seeds should be reported separately from the percentage of inert matter.

A Germination test measures how many (in %) of sampled seeds per batch germinate successfully after a reasonable time period; for most Cereals it should be above 80%. Lower Germination rates should be compensated by increasing seed rate or getting fresh samples if it’s too low.

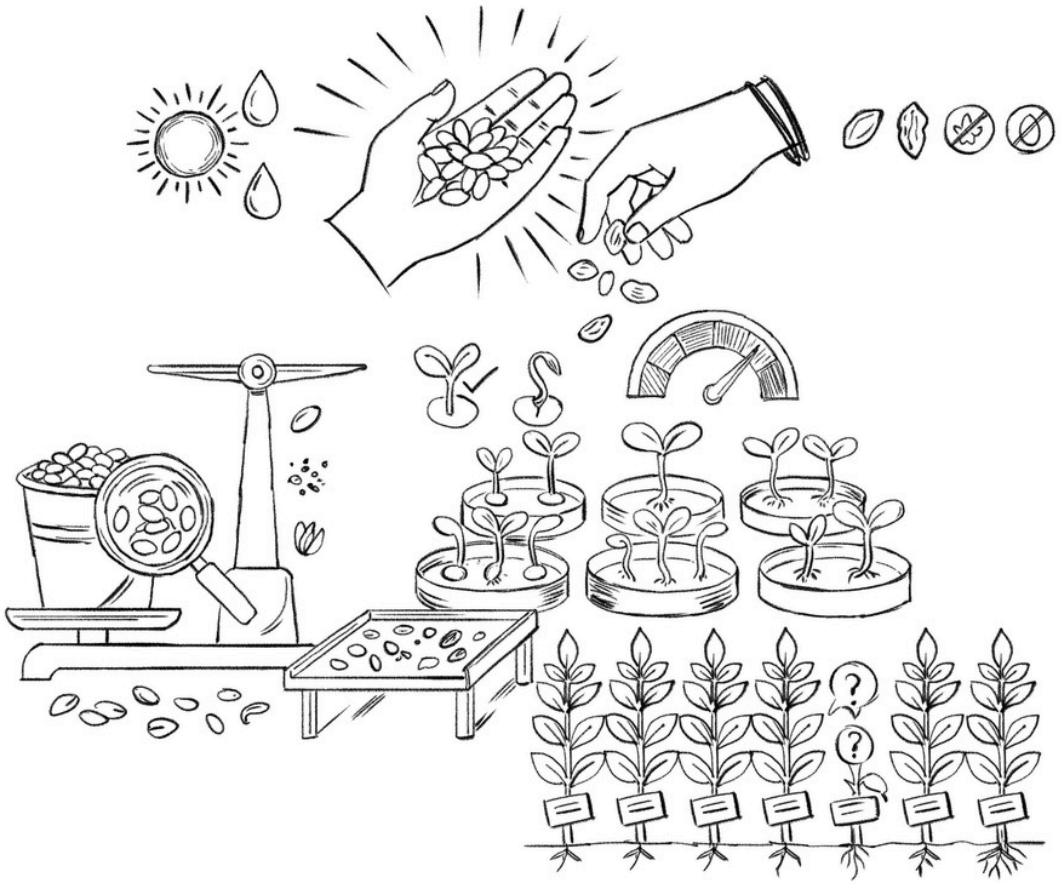
Genetic or varietal purity needs to be understood differently for formal varieties and for landraces or farmers' varieties.

For formal varieties, genetic or varietal purity generally refers to the degree to which the seed lot conforms to the identity and characteristic traits of the prescribed variety.

For landraces and farmers' varieties, genetic uniformity is not necessarily the objective. These populations may contain substantial genetic and phenotypic diversity that contributes to their adaptation to local environments. The objective is therefore better described as maintaining genetic identity and integrity while conserving the characteristic population structure, diversity and adaptive variation of the landrace or farmers' variety.

Seed selection and renewal should consequently avoid practices that unnecessarily eliminate desirable within-population diversity while still preventing unwanted admixture or replacement by unrelated varieties.

A well-formed, heavy seed, free of visible insect damage and fungal growth, is the working proxy farmers use for all three tests simultaneously, since a shrivelled, light or damaged seed usually signals reduced viability even before a formal germination test is run. Understanding these three tests, and the moisture and temperature relationships set out above, gives the material, structural and pest management chapters that follow a shared technical vocabulary, even where the specific practice described is entirely local.



PART - II

Materials and Structures

CHAPTER 4

Storage Vessels and Materials

The vessel a community chooses to store seed in is rarely arbitrary. It reflects what material is locally abundant, cheap and workable, the moisture regime of the agro-climatic zone, and the crop being stored, and the same underlying storage logic, exclude moisture, exclude pests, exclude oxygen where possible, recurs across a remarkable range of material choices.

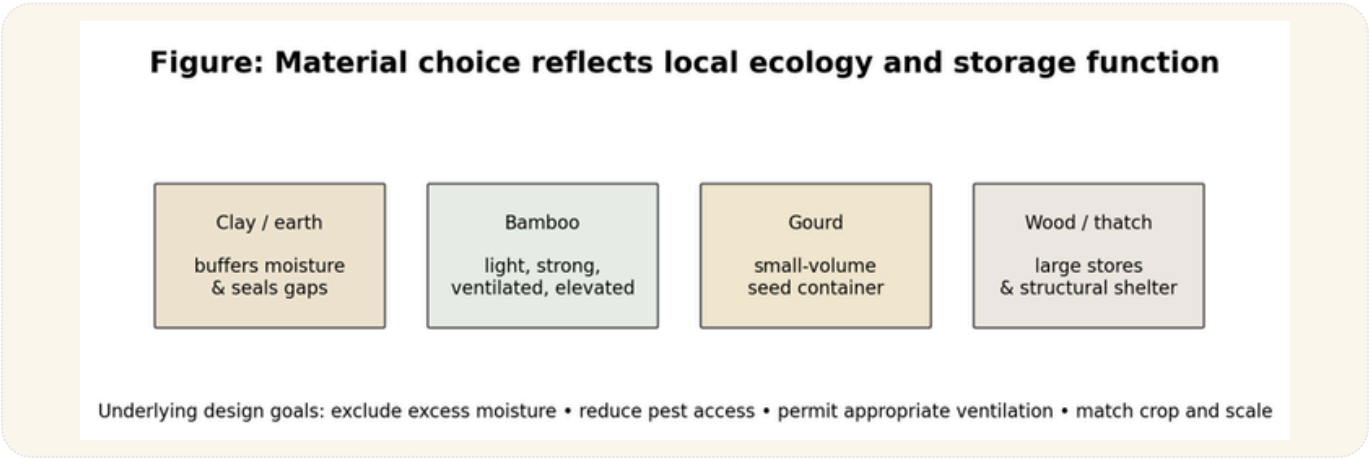


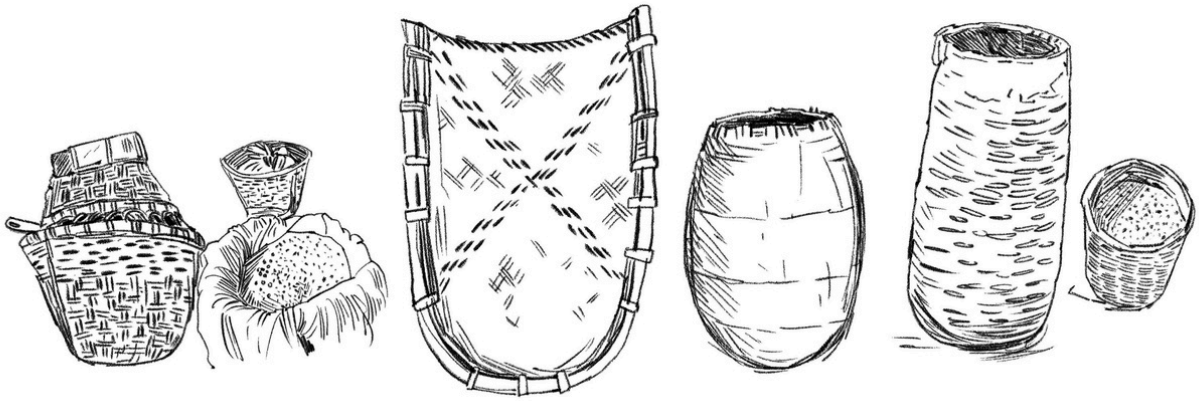
FIGURE - 4: MATERIAL CHOICE REFLECTS LOCAL AVAILABILITY, MOISTURE REGIME, CROP, SCALE AND THE DESIRED STORAGE FUNCTION.

4.1 Clay and Earthenware

Earthen and mud vessels are the most widespread storage material recorded across all four regions of this Handbook. In Gujarat, the Kothi and Kothlo are built from an admixture of mud, straw and cattle dung kneaded to a clay-like consistency and hand sculpted, generally by women, with community-specific variants including the mirror-decorated Rebari and Meghwal forms of Kutch. In Himachal Pradesh, the Dudlu and Gadlu are paired earthen pots wrapped in bark fibre to extend their working life. In Odisha, grain is kept in earthen pots sealed at the lid with dung, and the smaller Kuthla, a companion vessel refilled periodically from the main store, appears in both the Gujarat and Himachal Pradesh traditions independently. The shared principle across all these forms is that unfired or low-fired clay, plastered with dung and straw, breathes just enough to release excess humidity while excluding rain and standing damp, without the cracking that a fully sealed, hard-fired vessel would be prone to under repeated wetting and drying cycles.

4.2 Bamboo Structures

Bamboo dominates the storage vocabulary of North-East India and appears throughout Himachal Pradesh and Eastern India as well, chosen for its combination of tensile strength, rapid renewability and natural ventilation through the culm's hollow internode structure. The field inventory across Assam and Arunachal Pradesh records an unusually dense vocabulary of bamboo container forms calibrated to scale and crop: the Duli, a small bamboo bin coated with cowdung and clay for paddy; the Puru, a large elevated wooden and bamboo bin holding up to two and a half tonnes of paddy and sticky rice; the Hoton, a woven bamboo plank structure called Rh-ap, hung above the kitchen hearth for smaller quantities of mixed vegetable seed; and the Sok Ingkro, a paddy-specific bamboo structure of some one hundred and fifty kilogram capacity. In Himachal Pradesh, the Bas Pedu is a cylindrical bamboo bin plastered with cowdung and soil and capped with a woven bamboo lid, the Changer. In Odisha, bamboo storage bins are recorded alongside straw bins bound with Kenaf fibre rope for paddy among Ho cultivators.



4.3 Gourd Containers

The dried bottle gourd shell is among the most distinctive storage vessels recorded in Eastern India material, used across Odisha for seed of pulses, oilseeds, small millets and vegetables. The gourd is allowed to fully ripen on the vine, then soaked in water for about a week to loosen the internal pulp, dried thoroughly, and the top removed to hollow out a rigid, naturally sealed container. Seed is commonly mixed with wood ash before being placed inside, and the shell sealed at the neck with Siali leaf. The same pitcher-shaped gourd form recurs, functionally if not materially, in the gourd-shaped clay Kothi of Gujarat's tribal households, suggesting that the vessel shape itself, a narrow neck over a wide body, is doing independent work in excluding pests regardless of what material it is built from.

4.4 Wooden Bins and Chests

Solid timber storage, less common than clay or bamboo because it demands more material and skilled joinery, is concentrated in Himachal Pradesh's Kothar, a closed chest built from Deodar, Raitosh and Kos timber and assembled without metal fastenings, in the belief that the scent of Deodar itself deters storage pests. A comparable large wooden bin, the Puru, recurs among Karbi communities in Assam, there built from wood and cowdung rather than Deodar alone, and reaching a far larger capacity of roughly two and a half tonnes, since it functions as a household's primary annual paddy reserve rather than a supplementary store.

4.5 Straw and Mud Silos

Straw-bound and mud-plastered silo forms appear wherever cereal straw is abundant and long enough to bind into a coherent structure. In Bengal, the Dhaner Morai is a mud and bamboo silo built within the homestead specifically for Paddy. Among Ho cultivators in Odisha's Kendujhar district, a straw bin is built by tightly wrapping long indigenous paddy straw into a cylinder held together with rope made from Kenaf fibre, and raised on a wooden platform. The ancient Sanskrit record of underground grain pits, plastered with mud or cowdung and layered with straw before the grain itself is added, described in the classical texts, indicates that the straw-and-mud silo principle, insulation and moisture exclusion through a fibrous, breathable plaster, has a documented lineage stretching back well before the regional structures recorded in the field inventories that inform this Handbook.

TABLE- 2: ILLUSTRATIVE VESSEL FORMS BY PRINCIPAL MATERIAL (SEE REGIONAL CHAPTERS FOR THE FULLER INVENTORY)

Material	Representative Forms	Region	Typical Contents
Clay and earthenware	*Kothi, Kothlo, Kuthla, Dudlu, Gadlu*	Gujarat, Himachal Pradesh, Eastern India	Cereals, Pulses, Oilseeds
Bamboo	*Duli, Puru, Hoton, Sok Ingkro, Bas Pedu*	North-East India, Himachal Pradesh	Paddy, Maize, mixed Vegetable seed
Gourd shell	*Bottle gourd (pitcher form)*	Eastern India	Millets, Pulses, Oilseeds
Timber	*Kothar, Puru (wood and dung)*	Himachal Pradesh, Assam	Paddy, Wheat, Maize
Straw and mud	*Dhaner Morai, straw bin with Kenaf rope*	West Bengal, Odisha	Paddy



KHOCHOR SANTHAL PARGANAS - JHARKHAND

CHAPTER 5

Household and Community Structures

Much of the evidence in this chapter concerns household grain storage rather than storage of planting seed. Where the same structure is documented as being used for both purposes, the distinction is noted.

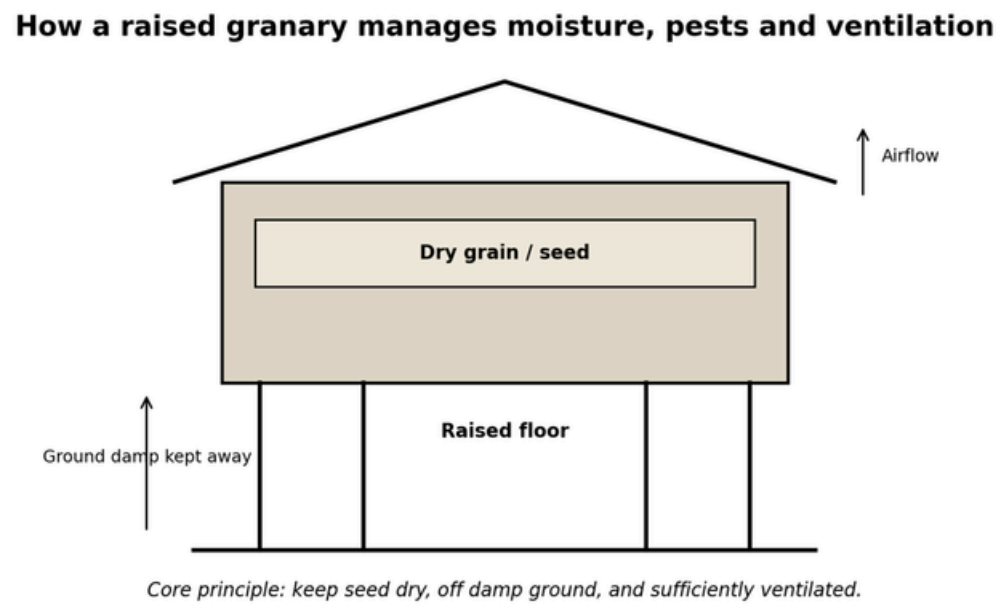


FIGURE - 5: RAISED STORAGE MANAGES MOISTURE AND PESTS THROUGH ELEVATION, VENTILATION AND SEPARATION FROM DAMP GROUND.

5.1 Integrated versus Free-Standing Storage

In the cold, comparatively dry climate of Himachal Pradesh, the grain store is generally integrated within the dwelling itself, a dedicated indoor room called the Tallah, raised on a mud platform, inside the Kath-Kuni timber and stone house. Keeping the store indoors and close to the living space serves both a practical purpose, protecting stock from the cold and from damp ground, and, as ***Chapter 1*** records, a ritual one, with access to the room restricted by gender, timing and lunar calendar in ways that mark it as more than a purely functional space. In Gujarat's warmer and more variable climate, the Kothi is typically a free-standing or semi-attached structure within the household courtyard, allowing air to circulate around all sides of the vessel. In the high-rainfall climate of North-East India, storage structures are consistently raised on stilts or hung well above the ground, whether the large wooden Puru in the courtyard, or the smaller bamboo baskets suspended above the kitchen hearth, since the dominant threat in this climate is ground damp and flooding rather than cold.

5.2 Granaries and Raised Platforms

The raised platform is the single most consistent structural response to moisture across all four regions, though the material and scale vary. In Himachal Pradesh, both the Bas Pedu and the Kothar sit on a raised mud platform inside the house. In Odisha, straw bins built by Ho cultivators are stored over wooden platforms. In North-East India, the Puru sits in the courtyard on its own raised base, and the research records granary forms among the Mising tribe of Assam reaching a capacity of some two tonnes, combining jute sacking, mud pots, bamboo compartments and a wooden lid within a single structure placed on a wooden floor, field hut, kitchen or elevated loft five to eight feet above a cooking hearth.

5.3 Smoke-Curing Lofts

Positioning the store directly above or adjacent to the cooking hearth, so that daily cooking smoke passes through or around it, is recorded independently across Odisha, Himachal Pradesh, Assam and Arunachal Pradesh, and represents one of the clearest examples of a single design principle arrived at separately by communities with no direct contact. Maize cobs hung whole from kitchen roofs in Odisha, the Hoton basket hung above the Chullah among Karbi communities in Assam, and grain stored in lofts above kitchen fires described in the review of classical and folk practice, all use the same mechanism: smoke both continues the drying process begun at harvest and physically deters storage insects, while the elevated position keeps the store warm and dry relative to ground level. Several field records note this explicitly, for instance the observation from Karbi communities that smoke from the Chullah prevents insect infestation in the Hoton basket.

5.4 Community-Scale and State-Scale Structures

Where household structures are extended to community or state scale, the underlying design logic does not change, only the material and the institutional purpose behind it. ***Chapter 1*** records how Gujarat's princely Darbari Kothar in Bhavnagar and colonial Bihar's Golghar in Patna both scaled up, explicitly or implicitly, the household granary form into a monumental structure intended to buffer an entire population against famine rather than a single household against a lean season. Both examples illustrate a durable tension in storage design: the structural features that make a household granary work well, ventilation, accessibility, frequent turnover, become harder to sustain at very large scale, and the Golghar's inward-opening door, which appears to have prevented the structure from ever being filled or emptied efficiently, is a cautionary instance of this tension resolved badly. Contemporary community seed bank design, inherits the same tension between scale and accessibility.



KORAPUTI - ODISHA



BIRNI, SANTHAL PARGANAS - JHARKHAND

PART - III

Practice and Technique

CHAPTER 6

Pre-Storage Processing

No vessel or structure, however well designed, compensates for seed that goes into storage wet, dirty or poorly selected. Pre-storage processing, threshing, winnowing, drying and moisture testing, is where most of the controllable variation in storage outcome is actually determined, and traditional practice across all four regions treats this stage with as much attention as the storage structure itself.

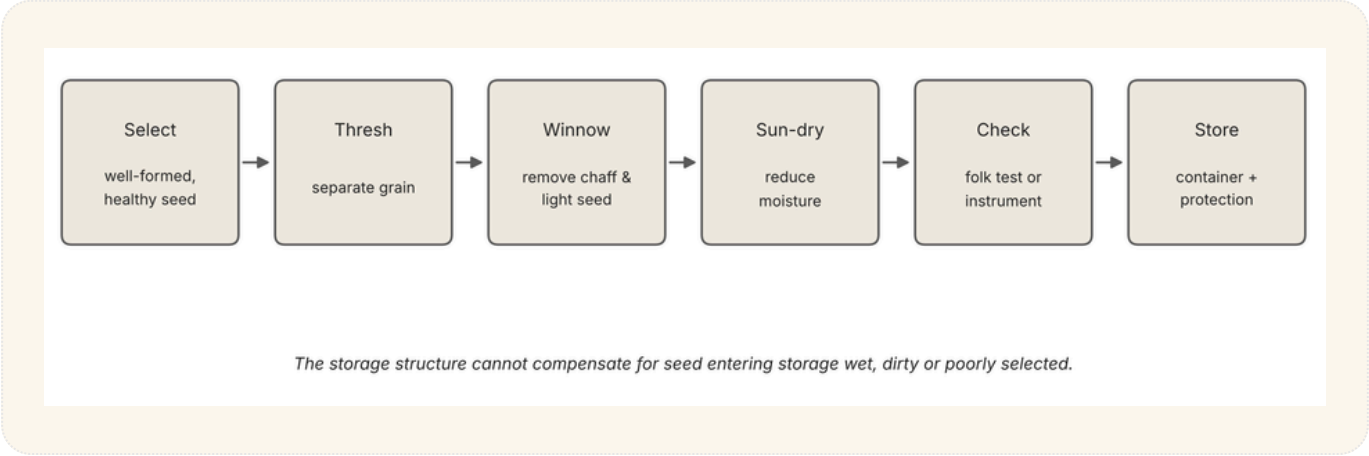


FIGURE - 6: PRE-STORAGE SEQUENCE: SELECTION → THRESHING → WINNOWING → DRYING → MOISTURE CHECK → STORAGE.

6.1 Threshing and Winnowing

Threshing separates grain or seed from the stalk and husk, and winnowing, tossing threshed grain or seed in a shallow basket or against the wind, removes lighter chaff, broken grain and light-weight, poorly filled seed, leaving behind the denser, better-formed seed that traditional practice identifies as the working definition of good seed: well formed, heavy, free of insects, free of fungus, good in appearance and pure. This is functionally identical to the physical purity standard used in formal seed technology, generally expressed as a target of ninety eight percent pure seed, arrived at through manual technique rather than mechanical grading.

The field documentation records separate practices for planting seed and for household grain. These are presented together where they share storage structures, but the intended use is retained in the description.



6.2 Sun-Drying Protocols

Sun-drying is the single most important step in the entire storage sequence, since seed moisture content, more than any other variable, determines storage life once the seed is sealed away. Traditional protocols recorded across the regions in this Handbook specify a target moisture range of roughly twelve to thirteen percent for cereals, around nine percent for pulses, and seven to nine percent for oilseeds intended for open, non-airtight storage, ranges that align closely with formal agricultural extension standards. Drying is typically staged and periodic rather than a single event: grain is spread in the sun for one or more days immediately after threshing, as recorded among Karbi paddy growers in Assam, and many communities repeat sun-drying at intervals through the storage season, particularly for pulses, which the Odisha field documentation identifies as more prone to pest infestation than cereals unless dried and monitored periodically (indicative moisture targets for open/short-to-medium-term community storage).

6.3 Folk Moisture Tests

Where no instrument is available, farmers rely on two folk tests that function as accurate, if informal, proxies for the same moisture thresholds seed technologists measure directly. The first is the chewing or tooth test: a properly dried seed produces an audible crackling sound when bitten, indicating it has crossed below the moisture threshold at which respiration and fungal risk rise sharply. The second is the hand or palm test: a hand pushed into a sack of properly dried grain should come out clean, with no seed sticking to the palm; sticking indicates residual surface moisture that will accelerate spoilage.

Both tests are consistent with what seed technologists term Harrington's Rule, described in *Chapter 3*, which holds that within the five to fourteen percent moisture range, each one percentage point reduction in moisture roughly doubles potential storage life, meaning that the difference between a seed that passes and fails these simple folk tests can translate into a doubling or halving of realistic storage duration. Where instruments are available, community seed banks increasingly supplement these folk tests with a thermo-hygrometer for ambient monitoring and a grain moisture metre for direct seed readings, without displacing the folk tests, which remain faster and require no equipment in the field.

6.4 Sealing and Oxygen Exclusion

A final processing step, recorded in the classical Sanskrit textual tradition and still practised in parts of Gujarat, is deliberate oxygen exclusion at the point of sealing. A small oil lamp is lit inside the filled storage bin immediately before the lid is closed; the lamp consumes the available oxygen and extinguishes itself, leaving the sealed container in a low-oxygen state that inhibits the survival and development of storage insects without any added chemical. This technique depends on an airtight container, generally an earthen Kothi or Kothlo rather than a ventilated bamboo structure, and represents one of the more technically sophisticated pieces of traditional storage knowledge documented in this Handbook, since it anticipates by many centuries the hermetic and modified-atmosphere storage principles used in some contemporary grain storage technology.

CHAPTER 7

Natural Pest and Pathogen Management

Once seed is dried and stored, the ongoing risk is biological: storage insects, principally weevils and bruchids, and the fungi that develop wherever residual moisture allows. Traditional pest management across the four regions in this Handbook draws on an unusually wide botanical and mineral pharmacopoeia, and while the underlying mechanisms vary, most fall into a small number of recurring categories: repellent volatile compounds, physical desiccants, and airtight or low-oxygen sealing.

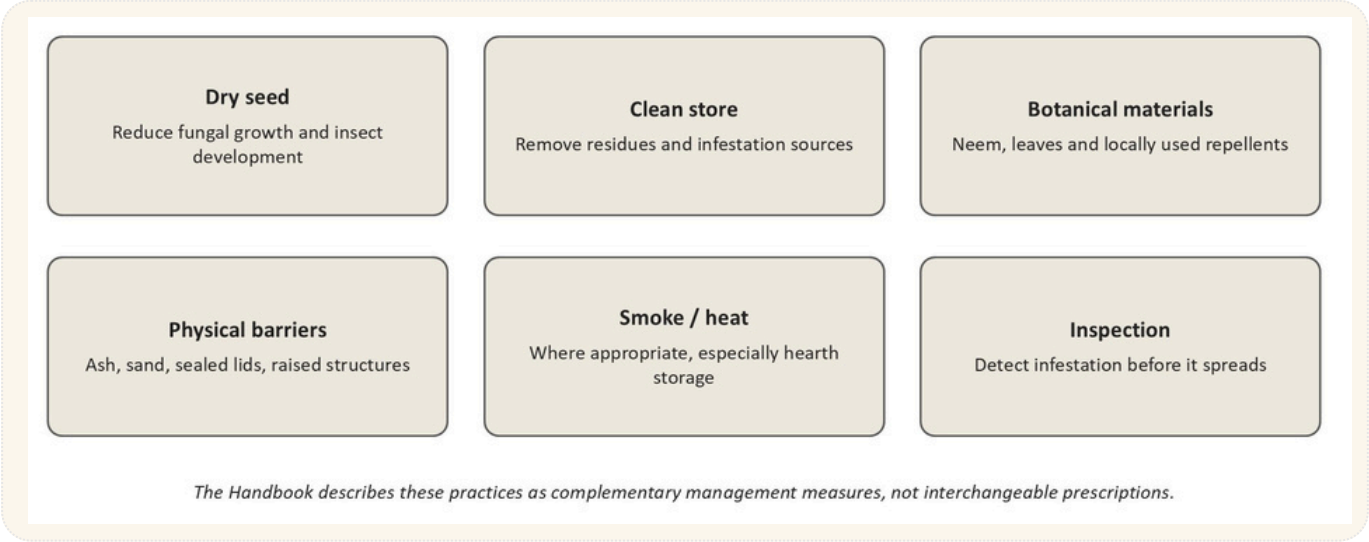
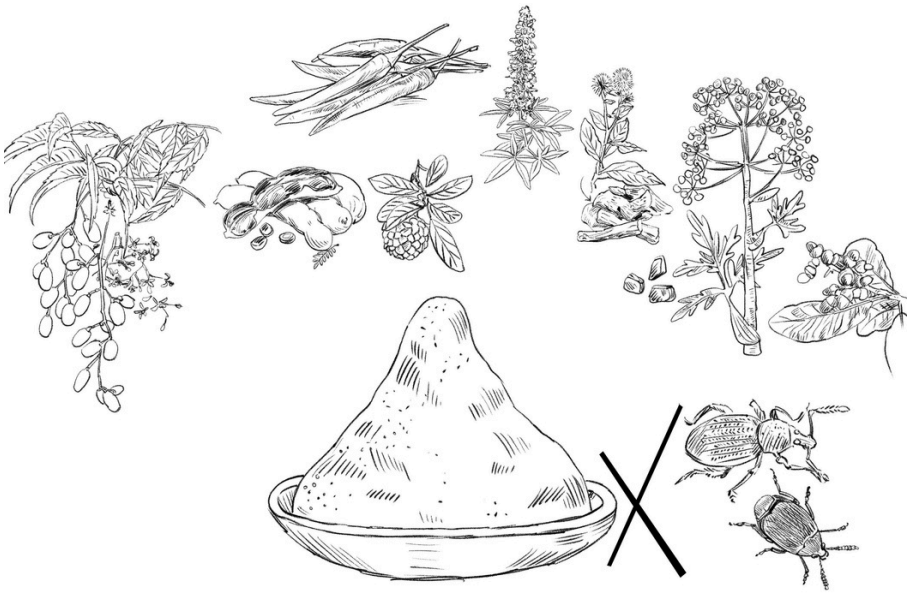


FIGURE - 7: PEST MANAGEMENT IS LAYERED: DRYING, HYGIENE, BOTANICAL MATERIALS, PHYSICAL BARRIERS, SMOKE AND INSPECTION.

7.1 Botanical Repellents

Neem, *Azadirachta indica*, is the single most widely recorded botanical protectant across every region in this Handbook, used as dried leaf layered through stored grain, as a seed-derived powder mixed directly with grain at roughly ten to twenty grams per kilogram of Wheat for season-long weevil protection, and as an oil, two to three millilitres mixed thoroughly into a kilogram of stored beans, protecting against Bruchid infestation for around six months. Gujarat's documented pest management practice extends well beyond Neem alone: tamarind and custard apple leaf, crushed custard apple seed, Nagod or *Vitex negundo* ash, dried whole or crushed chilli exploiting the repellent effect of Capsaicin, Turmeric powder for its antifungal Curcumin content, and Asafoetida are all recorded as household-level protectants, generally mixed directly with grain or packed into cloth sachets distributed through the stored lot. Himachal Pradesh relies principally on Walnut leaf and the root of *Saussurea lappa*, locally Kuth. Odisha's field documentation records wood ash as the single most consistently used protectant, alongside the crushed seed of Bhelwa, the marking-nut tree, mixed with Pigeon Pea in a ratio of roughly one part Bhelwa to ten parts grain. North-East India's field inventory records *Vitex negundo* and Neem leaf used together in Assamese granary structures.



7.2 Physical Desiccants and Barriers

Wood ash, fine sand and dry soil are used across all four regions as physical rather than chemical protectants, working by two related mechanisms: they reduce the air space between individual grains, restricting the movement of insects through the stored lot, and their abrasive, desiccant particles damage the waterproofing layer of an insect's exoskeleton, leading to death through water loss rather than through any toxic action. This is one of the clearest instances in this Handbook of a traditional mechanism that has been independently confirmed by modern entomology, and it explains why the same materials, ash and sand, recur as protectants across communities and crops with otherwise very little else in common.

7.3 Smoke and Heat Treatment

Positioning stored seed above a cooking hearth, discussed in ***Chapter 5*** as a structural design choice, is simultaneously a pest management technique, since the smoke itself, and the low, sustained heat, deters insect activity in a way that is documented from Odisha through Himachal Pradesh to Assam. A more active heat treatment is recorded in Gujarat for green gram, where seed tied in a cloth bag is dipped briefly in boiling water two to three times and then thoroughly sun-dried before storage, a method that works by killing insect eggs and larvae present on the grain surface, and which requires more active intervention than passive smoke exposure but achieves a comparably strong effect against surface-borne pests.

7.4 A Regional Comparison

TABLE- 3: SELECTED BOTANICAL AND MINERAL PROTECTANTS BY REGION

Region	Principal Protectants Recorded	Documented Mechanism
Gujarat	Neem, Tamarind, Custard Apple leaf and seed, Chilli, Turmeric, Asafoetida, Nagod ash, Camphor, Castor seed	Volatile repellent compounds; antimicrobial and antifungal action; physical barrier from ash
Himachal Pradesh	Walnut leaf, *Saussurea lappa (Kuth)* root, Oose mineral solution	Repellent and, for Oose, a mineral desiccant and moisture-conditioning action
Eastern India	Wood ash, *Bhelwa* (marking-nut) seed, Siali leaf sealing, smoke from kitchen hearth	Desiccant abrasion of insect exoskeleton; sealed leaf packaging; smoke deterrence
North-East India	*Vitex negundo,* Neem leaf, smoke from the Chullah	Volatile repellent compounds; smoke deterrence and continued drying

Read across the table, the regional differences are differences of available flora rather than of underlying principle. Every region combines at least one volatile botanical repellent with at least one physical or thermal method, ash, smoke or heat treatment, suggesting that traditional pest management, wherever it developed, converged independently on a layered defence rather than relying on any single technique.

CHAPTER 8

Seed Selection for Storage

What gets stored is decided before storage begins, at the point of harvest selection, and this decision is where traditional practice does its most consequential work for long-term genetic diversity. Seed selection is also the point at which the three farmer roles this Handbook returns to repeatedly, plant breeder, conserver and consumer, are exercised simultaneously in a single act.

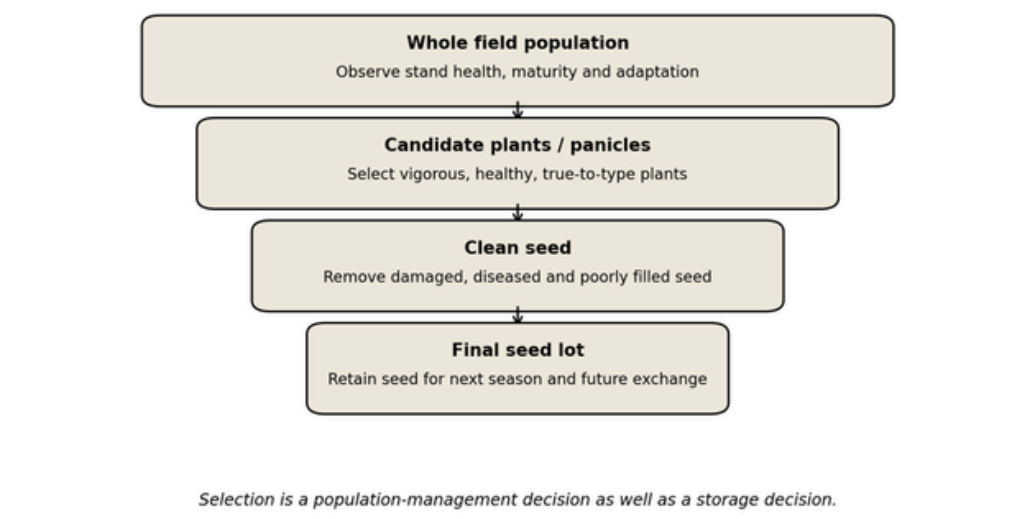


FIGURE - 8: TRADITIONAL SEED SELECTION NARROWS A FIELD POPULATION INTO A DELIBERATELY CHOSEN SEED LOT.

8.1 Selection Criteria

Farmers selecting seed for storage and future sowing weigh a wide set of criteria well beyond yield alone: vigour of the parent plant, palatability, colour, texture, flavour and cooking time, nutritional value, adaptation to local soil and climate, disease and pest resistance, medicinal or fodder value, and cultural or ritual use. Research on community seed banks in Andhra Pradesh, found that nutritional and cultural value were the primary reasons farmers gave for preferring traditional seed over improved alternatives, ahead of adaptation, fodder value and taste. This breadth of criteria is itself a form of conservation practice, since a selection process optimising for yield alone would tend to narrow a landrace population over successive generations, while a selection process weighing many criteria simultaneously tends to preserve a wider range of trait combinations within the population.

8.2 Panicle and Plant-Level Selection

Selection is generally carried out at the level of the individual plant or panicle rather than the bulk harvest. Among Dongaria Kondh communities in Odisha's Niyamgiri hills, core samples, the best individual fruits or panicles, are selected and dried separately before storage, a practice that concentrates the following season's seed stock on plants that performed well under that year's specific conditions rather than diluting it across the average of the whole field. This plant-level selection is functionally close to what formal plant breeding calls mass selection, though carried out without record-keeping or statistical control, repeated every season by the same knowledgeable individuals, generally women, discussed further in ***Chapter 9***.

8.3 Naming, Memory and the Link to Landrace Heterogeneity

Traditional seed selection is supported by an equally traditional system of naming: seed is named for its characteristics, appearance, region of origin and use, and this naming system functions as a living catalogue that aids selection decisions across generations even where no written record exists. A landrace population held under this kind of naming and selection regime over many decades accumulates the heterogeneity described in ***Chapter 2*** as its central adaptive asset, a spread of genotypes within a single named seed lot, each favoured under slightly different conditions, none eliminated by a rogueing protocol built for a genetically uniform variety.

This is the direct, practical link between an everyday harvest-time selection decision and the population genetics that make landrace conservation valuable, and it is the reason, that genetic purity standards drawn from formal variety release systems are poorly suited to community seed bank material of this kind.

8.4 Seed Treatment Before Storage

Selection is generally followed by a treatment step before the seed is placed in storage. The Sanskrit textual tradition traced in ***Chapter 1***, the *Arthashastra, Brahmasamhita* and *Vrikshayurveda*, prescribes soaking seed in dew overnight and drying it in the sun by day, for seven days for cereals and three nights for pulses and stalks, treatment with honey and ghee for bulbous roots, and smearing with cowdung for hard-coated seed. Regional germination testing traditions recorded in this Handbook's field material function as a final check on selection quality before full-scale sowing: in Karnataka, seed is sown in a flat clay pot filled with wet field soil during the Ugadi festival and observed over nine days, with poor germination triggering exchange or borrowing from other farmers rather than use of the doubtful lot; in Chhattisgarh, women farmers tie twenty one seeds into a small cloth bundle and bury it in soil for three days, adjusting the sowing rate if one or two seeds fail and rejecting the batch outright if more than three fail. Both traditions anticipate the logic of a modern germination test using a small representative sample rather than the full seed lot, arrived at independently of any formal seed testing standard.



PART - IV

Social Architecture

CHAPTER 9

Women's Seed Authority

Across every region covered by this Handbook, the historical and field record converges on a single, consistent pattern: women build, maintain, select for and control access to the household seed store, and this authority is neither incidental nor recent, but is documented as a stable feature of the storage system across all four regions and across the entire period this Handbook's sources cover.

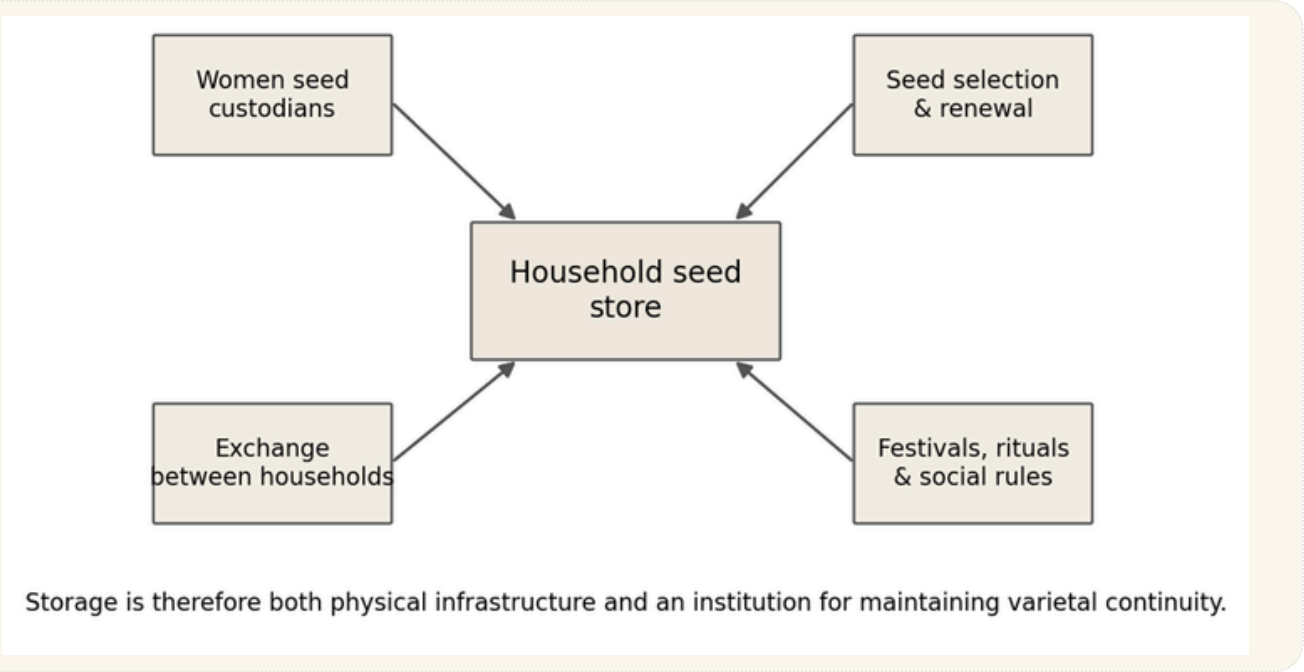


FIGURE - 9: SOCIAL ARCHITECTURE AROUND STORAGE: CUSTODIANSHIP, RENEWAL, EXCHANGE AND SOCIAL RULES REINFORCE THE PHYSICAL STORE.

9.1 The Evidence Across Regions

In Gujarat, household *Kothi* and *Kothlo* granaries are built by women, with men assisting mainly by supplying material, and the gendered form language of the vessel itself, feminine curved forms against masculine rectangular ones, encodes this authority directly into the object. In Odisha, the institution of the Bihana Maa, or Seed Mother, formalises a role that recurs informally across the wider field record: a knowledgeable woman responsible for maintaining community awareness of varietal characteristics, agronomic performance and storage method, and for facilitating free seed exchange between households. Odisha's field documentation notes explicitly that traditional storage systems empowered women as the key agent in storage and sowing decisions, in contrast to introduced varieties, where men more often hold the say. In Himachal Pradesh, women share responsibility for the household grain store within the *Kath-Kuni* house, though ritual restrictions recorded there, excluding menstruating women from the storage chamber in earlier practice, sit in some tension with the broader pattern of female authority and are worth reading as a locally specific constraint rather than as evidence against the wider pattern.

9.2 Selection, Germination Testing and Intergenerational Transmission

Women's authority over storage is inseparable from their authority over the selection and testing decisions described in ***Chapter 8***. Women farmers are custodians of seed, select seed from storage and harvest and carry out germination tests as a cultural and ritualistic dimension of farming rather than a purely technical one, and the regional germination traditions recorded in Karnataka and Chhattisgarh are themselves carried out by women. This combination, physical custody of the store, selection authority over what enters it, and testing authority over what leaves it for sowing, gives women a role that runs the full length of the seed cycle rather than being confined to any single stage.



Intergenerational transmission of this knowledge has historically occurred through direct mother-to-daughter and elder-to-younger observation and practice within the household, rather than through written instruction, which is part of why this Handbook's authors treat the erosion of women's storage authority, wherever it is occurring, as a knowledge loss risk of the first order, addressed further in ***Chapter 16***.

9.3 Implications for Policy and Programme Design

For the Government officers, funders and researchers this Handbook is written for, the practical implication is direct: any programme intervention in traditional seed systems, whether a community seed bank, a documentation exercise or a revival initiative, that does not actively engage the women who hold this authority is working against the grain of the system it is trying to strengthen. Programmes reviewed elsewhere in this Handbook, including the Chasi Swaraj programme and the Bihana Maa institution described in ***Chapter 10***, succeed in part because they formalise and support an authority structure that already existed, rather than attempting to introduce a new one.

CHAPTER 10

Community Seed Exchange Systems

A household grain store is rarely a closed system. Seed moves between households, and between villages, along channels governed by reciprocity norms, seasonal festivals and, increasingly, formal programme structures that have grown up around and alongside the older informal networks.

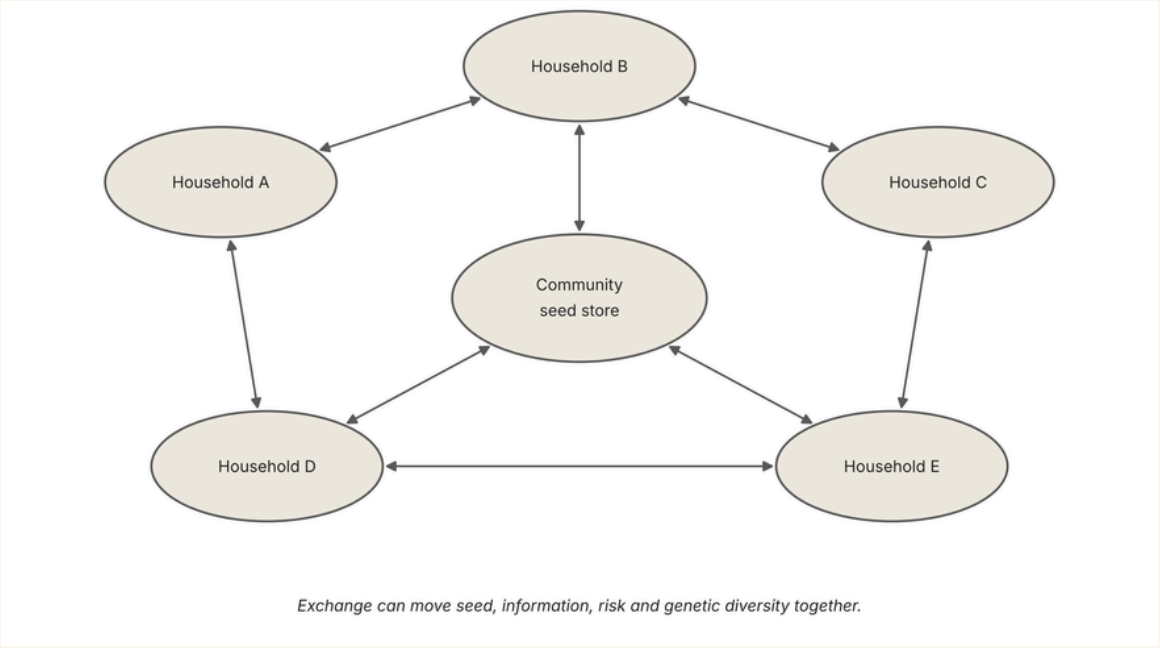


FIGURE - 10: SEED EXCHANGE AS A NETWORK LINKING HOUSEHOLDS AND COMMUNITY-LEVEL STORES.

10.1 Reciprocity and Informal Lending

The baseline exchange norm recorded across the field material in this Handbook is straightforward reciprocity: a household short of a particular variety borrows or receives seed from a neighbour or relative, with the expectation, rarely written down but consistently understood, that the borrowed quantity, or an equivalent, will be returned after the next harvest. This informal lending network functions as a distributed backup system for the individual household store: a poor storage outcome, a damp season, a pest outbreak, a lost harvest, does not necessarily mean the loss of a variety, provided the same variety survives in a neighbour's store and the reciprocity norm holds. Odisha's field documentation records this exchange as common both within a village and between villages, extending the effective resilience of any single household's storage well beyond what that household's own structures could guarantee alone.

10.2 Seed Festivals and Ritual Exchange

Formal, calendared exchange events recur across the regions covered by this Handbook, generally timed to the agricultural calendar and combining practical seed distribution with ritual observance. In Odisha, the Bija Sopan festival, held in May, brings seed from every household in a village together for a blessing by the village priest before the seed is returned to households for a separate germination trial sowing ahead of the main planting season, effectively combining ***Chapter 8***'s germination testing with a community-wide seed exchange event in a single occasion. Annual food festivals and seed melas, seed fairs, recorded by NGOs including ORRISSA and NIRMAN working across Odisha, extend this exchange function beyond a single village, bringing farmers from a wider area together specifically to trade, gift and compare varieties.



10.3 Institutionalised Exchange: The Chasi Swaraj Model

The Chasi Swaraj programme, run by ORRISSA in Malkangiri and Kandhamal districts since 1989, offers a documented example of formalising informal exchange without displacing it. Under the programme, community members jointly carry out seed mapping, listing the indigenous varieties present in an area and matching them against the seed needs of each participating household. Aggregated demand is then used to plan exchange within the village, and, where a variety is not locally available, to make requests to other farmer organisations beyond it. This model works because it builds directly on the existing authority of the Bihana Maa, discussed in ***Chapter 9***, and on the existing reciprocity norm described above, adding coordination and record-keeping capacity rather than introducing an unfamiliar institutional structure.

10.4 Why Exchange Systems Matter for This Handbook's Readers

For funders and policy makers, community seed exchange systems are worth understanding as existing social infrastructure rather than as a gap to be filled. A funded intervention that tries to build a new seed distribution channel from scratch, without first mapping the reciprocity networks, festival calendar and existing knowledge-holder roles already active in an area, risks duplicating capacity that already exists while failing to engage the people, generally women, who hold the actual authority over what gets exchanged and with whom. The documentation methodology set out in ***Chapter 1*** is written in part to help programme designers map this existing infrastructure before attempting to extend or formalise it.

PART - V

Region - Specific Practices



CHAPTER 11

Gujarat

Gujarat brings together, more completely than any of the other three regions in this Handbook, the full sequence from household vessel to princely state granary, and an exceptionally well documented body of botanical pest management practice gathered at village level across multiple districts.

Region	Dominant setting	Representative storage logic
Gujarat	Dry / semi-arid	Earthen, mud–straw–dung structures; emphasis on sealing and buffering
Himachal Pradesh	Mountain / cool	Bamboo, wood and earthen stores; elevation and protection
Eastern India	Mixed humid plains / hills	Earthen pots, gourds, bamboo and household-scale systems
Assam & North-East	High rainfall / jhum	Raised bamboo structures, smoke exposure and off-ground storage

FIGURE - 11: REGIONAL ADAPTATION LOGIC USED IN THE HANDBOOK; THE FOUR REGIONS DIFFER IN CLIMATE AND MATERIAL EMPHASIS WHILE SHARING CORE STORAGE PRINCIPLES.

11.1 The Household Storage Economy

The *Kothi, Kothlo* and *Kuthla*, described in ***Chapters 1 and 4***, remain in active use across the Banni grasslands of Kutch, the farming villages of Saurashtra and the Adivasi tracts of eastern and southern Gujarat, and are still built predominantly by women using mud, straw and cattle dung. The classification of forms by gender, curved and decorated Kothi as feminine, plain rectangular Kothlo as masculine, and the community-specific decorative traditions of the Rebari, Meghwal, Bhil and Dangi communities, are treated in this Handbook as evidence that the vessel itself carries social meaning well beyond its storage function.

11.2 Documented Pest Management Practice

Gujarat's field-level documentation of botanical and mineral pest protectants, gathered village by village across districts including Sabarkantha, Panchmahal, Dangs, Vadodara, Junagadh, Navsari, Valsad, Dahod, Mehsana, Bhavnagar, Surendranagar and Ahmedabad, is the most granular of any region in this Handbook, recording specific plant material, dosage per unit weight of grain, and the named knowledge holder and compiling field worker behind each entry. Recorded protectants span Neem leaf, seed and oil, Tamarind leaf, Custard Apple leaf and seed, Nagod or *Vitex negundo* ash, Kanthi leaf, whole and crushed dried chilli, Turmeric, holy Basil, Mint and Camphor for Rice, Teak leaf and seed, Chickpea husk, Arni leaf, Mamejvo leaf, Asafoetida, and, for Pulses specifically, Castor seed and coarse sand for Garlic. Two techniques recorded specifically in Gujarat stand out as more elaborate than simple admixture: a layered Pulse storage method using a straw-rope container lined with Teak leaf and packed with a mixed layer of Chickpea husk, nightshade, Neem leaf and ash, and the oxygen-depletion method described in ***Chapter 6***, in which a small lamp burned inside a sealed Kothi consumes available oxygen before extinguishing itself.

11.3 From Household to State: The Darbari Kothar

Bhavnagar's Darbari Kothar, described fully in ***Chapter 1***, remains Gujarat's clearest illustration of the transition this Handbook traces from household to state-scale storage. Commissioned explicitly to break the cycle of annual grain shortage in an arid climate, and consciously modelled on and named after the household *Kothi*, the structure illustrates a



principle worth carrying into contemporary community seed bank design, scaling up a storage form that works at household level does not guarantee it will work at population level without deliberate attention to throughput, access and turnover.

11.4 Implications for Practice

Gujarat's documented practice offers this Handbook's Government officer and funder readers an unusually specific evidence base for cost-effective, locally sourced pest management that could inform state-level agricultural extension guidance, since nearly every protectant recorded is a low-cost, locally available plant or mineral material rather than a purchased input, and each entry in the underlying field record specifies the district and knowledge holder, offering a directly traceable path back to the source community for any programme wishing to verify, scale or formally document the practice further.



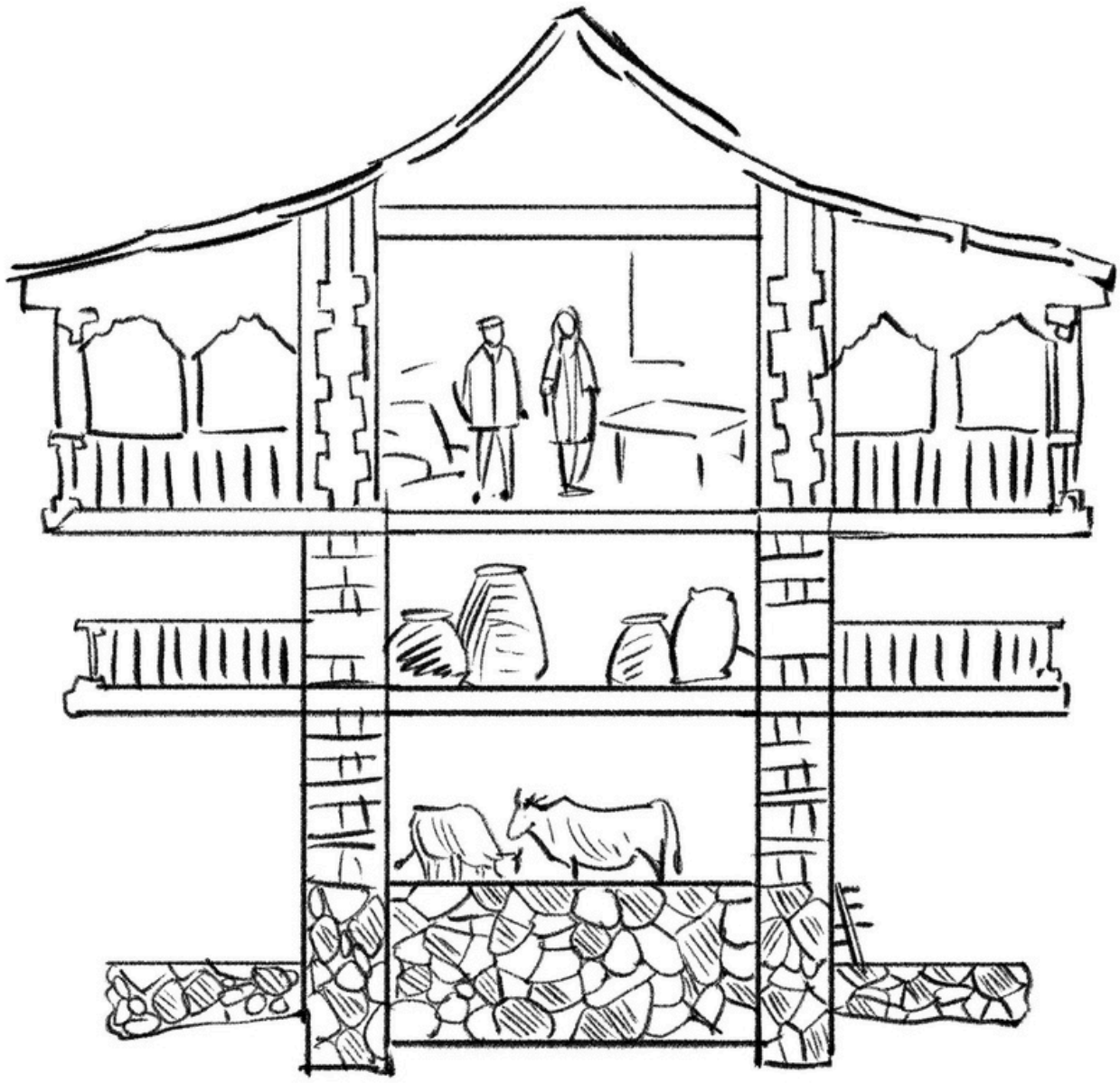
CHAPTER 12

Himachal Pradesh

Himachal Pradesh's storage tradition is inseparable from its house form, and this chapter should be read alongside Chapter 5's discussion of integrated, indoor storage, since almost nothing in the Himachal Pradesh material can be understood as a free-standing structure in the way Gujarat's or Eastern India's storage vessels generally can.

12.1 The *Kath-Kuni* House and the Integrated Store

The *Kath-Kuni* construction technique, alternating stone and Deodar timber without cement, mortar or metal fastening, produces houses that proved markedly earthquake resistant during the 1905 Kangra earthquake, and within this structure the grain store, generally called Kothar or Kothi, occupies a dedicated raised room known locally as the Tallah. This integration is a direct climatic adaptation: in a cold, high-altitude environment, keeping the grain store indoors protects it from freezing damp and extreme cold in a way a free-standing granary could not, at the cost of the ventilation that warmer-climate structures prioritise.



12.2 Documented Storage Structure Types Recorded in the Field Inventory

The master inventory for Himachal Pradesh, covering Hamirpur and Mandi districts, records at least seven distinct structure types. The Bas Pedu is a cylindrical bamboo structure plastered with cowdung and soil, capped with a woven bamboo lid called a Changer, built by the Tarkhan community and traditionally paid for in grain rather than cash, with payment scaled to the capacity built, roughly one Bati, about two kilograms, of grain per one Man, about sixteen kilograms, of storage capacity. The Kothar is a closed wooden chest built from Deodar, Raitosh and Kos timber without any iron nail, in the belief that Deodar's scent itself repels pests. The Dudlu and Gadlu are earthen pots wrapped in Shod bark fibre, known as Bandhan, to extend their working life. Simpler forms recorded include the Khadda, a dug pit used for tuber crops, a cowdung-embedded bamboo structure also for tuber crops, and a horizontal hanging bamboo structure for Cucurbit crops. Recorded capacities range from small household quantities up to roughly seven to eight quintals for the larger Kothar structures, with most forms achieving a documented storage life of around two years for cereals under good management.

12.3 Protectants and Ritual Practice

Walnut leaf and the root of *Saussurea lappa*, Kuth, recur across nearly every structure type in the Himachal Pradesh inventory, alongside a distinctive mineral treatment, an iron-rich, brownish-yellow solution obtained from hill sources and known locally as Oose, not recorded elsewhere in this Handbook's regional material. The ritual practices associated with these structures, described fully in ***Chapter 1***, orientation to the east or north, avoidance of grain movement during solar and lunar eclipses, and historical restriction of entry by gender and timing, are recorded by the field teams as still remembered even where no longer strictly observed, and are treated in this Handbook as evidence of the store's sacral as well as functional status within the household.



CHAPTER 13

Eastern India

The field documentation records separate practices for planting seed and for household grain. These are presented together where they share storage structures, but the intended use is retained in the description.

13.1 Tribal Storage Practice in Odisha

Among Ho cultivators in Kendujhar district, most traditional technique has been substantially lost in favour of jute and HDPE sacking, with the notable exception of a straw bin for paddy, built by wrapping long indigenous paddy straw into a cylinder bound with Kenaf fibre rope and raised on a wooden platform. Elsewhere, seed is commonly mixed with wood ash and stored in bottle gourd shells; grain is kept in earthen pots sealed at the lid with dung; Maize cobs are hung whole from kitchen roofs where smoke deters pests; and Pulses, particularly Pigeon Pea and Black Gram, are mixed with fine soil or with crushed Bhelwa seed at roughly a one to ten ratio.



MAIZE COBS HUNG FROM THE ROOF FOR DRYING AND STORAGE.

Among Dongaria Kondh communities in the Niyamgiri hills, almost no market-purchased seed is used, core samples of the best fruit or panicle are selected and dried before storage, and Millets are kept in stacked earthen pots. Among Bonda communities of the Bonda hills, seed is kept within the living area itself, moved to alternative containers if pests are detected, and cats are kept specifically to control rodents.

13.2 Institutional Support: Bihana Maa, Chasi Swaraj and Seed Melas

The institution of the Bihana Maa, or Seed Mother, recorded through NGO ORRISSA's work in Malkangiri and Kandhamal districts, and the Chasi Swaraj seed-mapping and exchange programme described fully in ***Chapter 10***, together with the NGO NIRMAN's work supporting seed banks, multiplication, value addition and marketing elsewhere in Odisha, represent an unusually well institutionalised layer of support for traditional practice, built directly on top of the existing knowledge and authority structures documented in the field study rather than replacing them.

13.3 Chhattisgarh and the Central Provinces Record

Present-day Chhattisgarh's historical record, traced in ***Chapter 1*** through the Central Provinces District Gazetteers and the Chhattisgarh Feudatory States volume of 1906, centres on a Gondwana agrarian base sustaining Gond, Baiga, Kawar and Kol cultivation of Rice, hill Millet and Pulses.



13.4 Bengal, Bihar and the Colonial Interface

Rural West Bengal's Dhaner Morai, a mud and bamboo silo built within the homestead for paddy, remains in everyday use and is documented in this Handbook, as ***Chapter 1*** sets out, engaged more with Bengal's famine history and administrative structure than with household storage technique. That famine history nonetheless produced the region's most visible historical storage structure, the Golghar in Patna, built in 1786 following the Bengal famine of 1770, and discussed fully in ***Chapter 1*** as this Handbook's clearest single example of a colonial administration attempting, and largely failing, to substitute a monumental state structure for the distributed household and community storage that had until then carried the primary burden of regional food security.

13.5 Germination Testing in Chhattisgarh

Chhattisgarh contributes one of this Handbook's clearest examples of folk statistical method: women farmers tying twenty one seeds into a small cloth bundle, burying it in soil for three days, and adjusting the sowing rate, or rejecting the batch, based on how many seeds fail to germinate, described fully in ***Chapter 8***. This practice, carried out independently of any formal seed testing protocol, is treated in this Handbook as evidence that traditional seed knowledge in Eastern India extends well beyond storage technique into the statistical logic of quality control itself.

BAMBOO STORAGE BINS USED FOR HOUSEHOLD SEED AND GRAIN STORAGE.





BOTTLE GOURD SHELL USED AS A SEED-STORAGE VESSEL.

COWPEA PODS BUNDLED FOR SEEDS





DRYING JOWAR PANICLES FOR SEEDS

KHOCHAR – STRAW BIN TO KEEP SEEDS/GRAIN ; GOURD SHELLS TO KEEP SEEDS







HANGING MAIZE COBS OVER WOOD STOVE FOR SEEDS/GRAINS

CHAPTER 14

Assam and North-East India

North-East India's storage tradition is shaped by two forces largely absent, or much weaker, elsewhere in this Handbook: the agro-ecology of Jhum, shifting cultivation, and a climate of sustained high rainfall that makes elevation off the ground the dominant design concern across nearly every structure recorded.

14.1 The Bhoral and the Assamese Wet Rice Economy

The Bhoral, a raised bamboo and thatch granary built within or adjoining the Assamese homestead, sits within an agrarian tradition traced in ***Chapter 1*** back through the Ahom kingdom's Buranji chronicles to at least the thirteenth century, and remains, unlike some structures recorded elsewhere in this Handbook, an actively used and culturally celebrated symbol of agricultural abundance in Assam today rather than a structure surviving only in memory or as a historical curiosity.

14.2 A Dense Vocabulary of Bamboo Forms

The master inventory across Assam and Arunachal Pradesh records an unusually granular vocabulary of small bamboo storage forms, generally calibrated to a specific crop and a specific period of use rather than serving as general-purpose containers. Among Karbi communities in Karbi Anglong, recorded forms include the Duli, coated in cowdung and clay for paddy; the Gaiko Gotha, hung in the ceiling of the cowshed for Maize, doubling as cattle feed storage; the Hoton, a bamboo plank structure hung above the kitchen hearth for mixed vegetable seed; the Puru, a large wood and cowdung bin reaching roughly two and a half tonnes capacity for Paddy and sticky rice; the Balak, a small basket for Corn and Bottle Gourd, associated with a pre-sowing ritual called Rit Anglong As; and the Longle, a clay and cowdung structure for taro. Among Idu Mishmi communities in Arunachal Pradesh's Dibang Valley, recorded forms include the Apeh, Atutu, Boyo and Ahgra, bamboo baskets of varying capacity for Beans, Mustard, Paddy, Pumpkin, Brinjal, Millet and Buckwheat, several linked to a community festival called Keh-meh Haa tied to the storage calendar. Among Singpho and other communities of the state tea garden population, an even finer-grained set of small open bamboo boxes and baskets, Karan, Kho-un, Luphun, Singoli and Kinsang among them, each hold small quantities, ten grams to one kilogram, of specific vegetable seed, hung above the hearth on bamboo poles.

14.3 Ritual and Belief Systems Linked to Storage

Storage among the Mising tribe of Assam is recorded together with an explicit ritual calendar: the Ali Aye Ligang seed-sowing festival, the Laxmi Ona ritual performed before storage, and Ruwa Jatra marking the first Rice sowing of the season, alongside sacred objects, Betel leaf and nut, yam plant and fern, associated with the storage structure itself. A specific mantra recorded in the field inventory, recited before storage, expresses an intention to share the harvest with seekers, beggars, and with birds and animals alongside the household, along-side a wish for abundance, indicating that, as in Himachal Pradesh, the act of sealing grain away is treated as a moment carrying social and spiritual obligation rather than as a purely technical act.



14.4 The Naga Hills and Khasi and Garo Hills

The nineteenth-century ethnographic record for the Naga Hills, compiled by Verrier Elwin and discussed in ***Chapter 1***, documents household rather than communal grain storage organised around Jhum cultivation of Rice and Millet, held in tightly woven, rat-proof bamboo baskets raised off the ground, a technique still visible in villages such as Jakhama in Nagaland today. In the Khasi, Jaintia and Garo Hills of Meghalaya, storage is tied directly to the shorter planning horizon of the Jhum, or locally Bun, cycle, with community sharing norms acting as the primary buffer against an individual household's shortfall rather than large individual reserves, a pattern that contrasts with the multi-year reserve logic of the lowland Kothar and Kothi traditions described in ***Chapters 11 and 12***.



EAST GARO HILLS - MEGHALAYA

PART - VI

Contemporary Interface

CHAPTER 15

Climate Change and Storage Resilience

Every traditional storage practice described in this Handbook was developed against a historical climate baseline that is now shifting, and this chapter sets out, briefly, where that shift is likely to put the greatest pressure on traditional technique, and where traditional technique already contains an adaptive response worth building on rather than replacing.

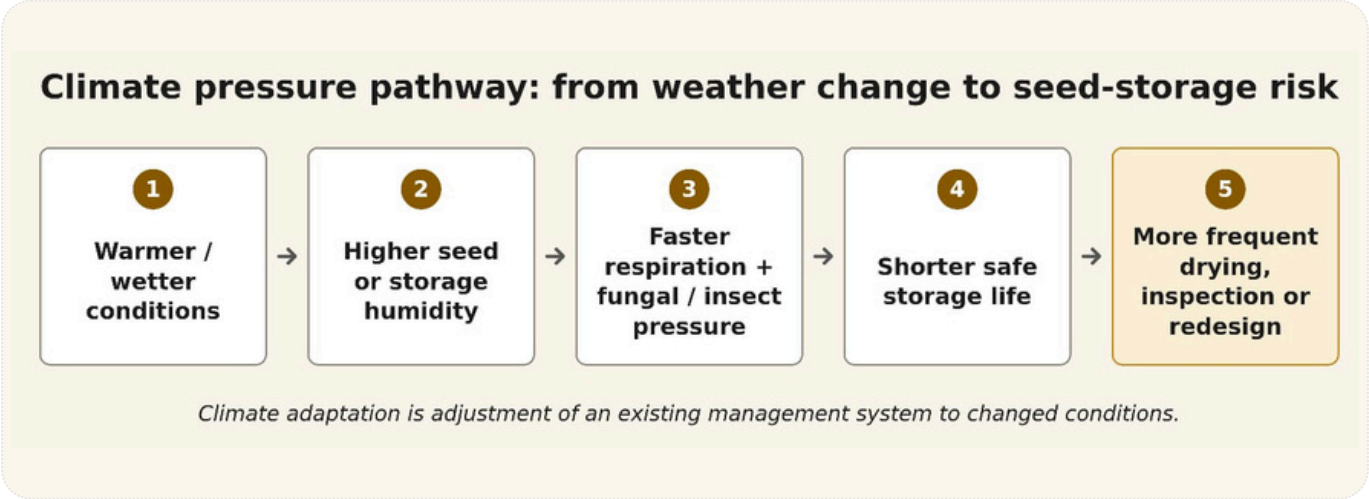


FIGURE - 12: REGIONAL ADAPTATION LOGIC USED IN THE HANDBOOK.

15.1 Humidity, Temperature and the Biology in Chapter 3

Chapter 3 set out Harrington's Rule, the empirical relationship by which each one percentage point rise in seed moisture, and each five degree Celsius rise in storage temperature, roughly halves potential storage life within the normal working range. A warming, and in many parts of eastern and north-eastern India, wetter climate therefore does not threaten traditional storage abstractly; it threatens it through this specific, quantifiable mechanism, by pushing ambient humidity and temperature further from the dry, cool conditions every structure examined in Part II is designed to approximate. Structures that rely on passive ventilation and periodic sun-drying, rather than sealed, airtight storage, are likely to see this pressure first, since their internal moisture control depends directly on ambient conditions rather than on a sealed barrier.

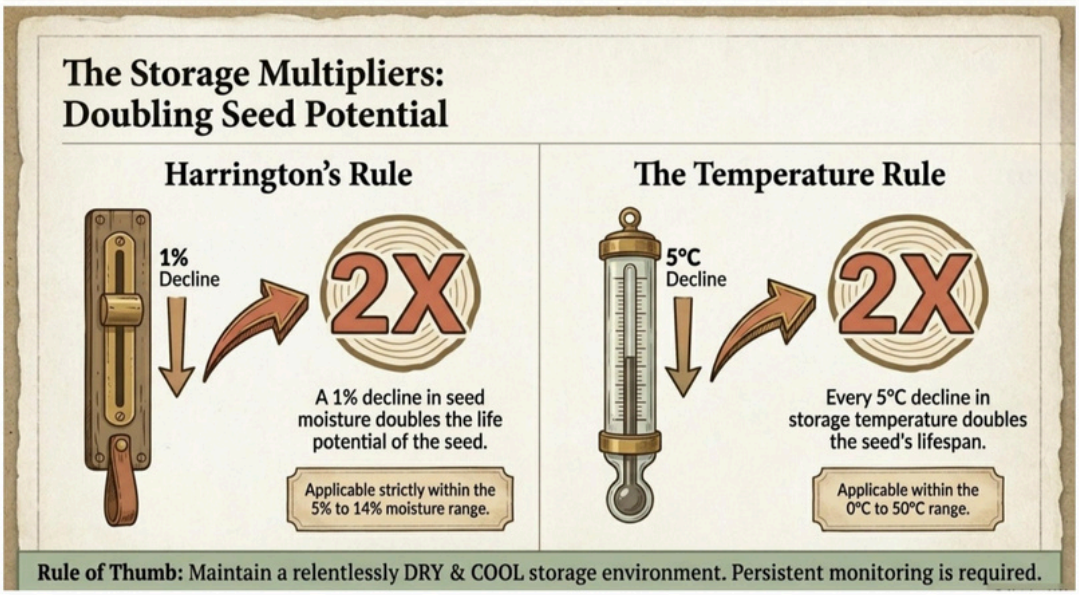
15.2 Regional Exposure

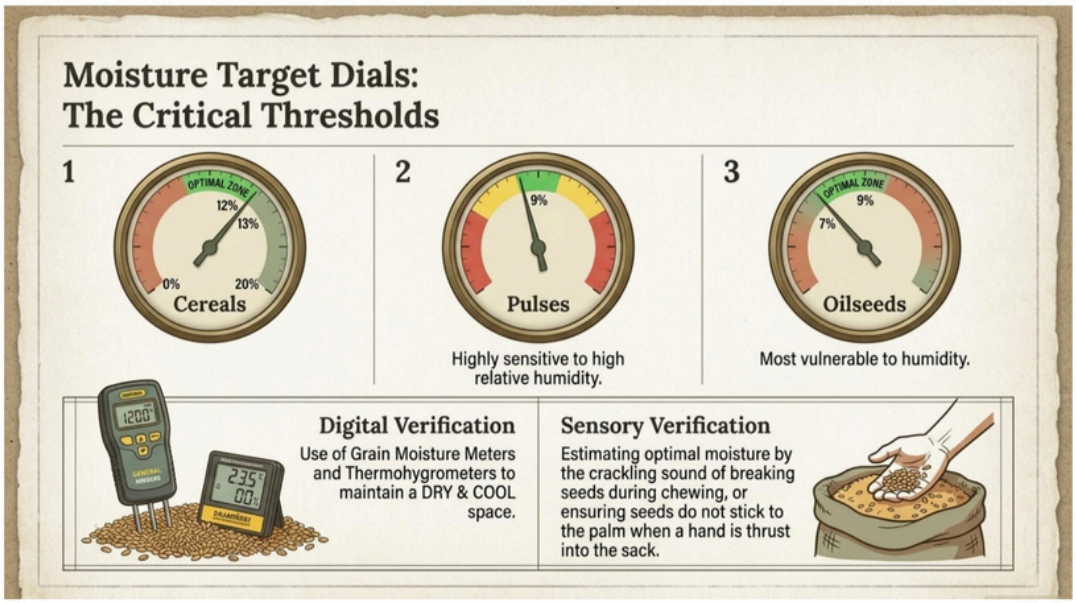
The four regions covered by this Handbook face this pressure differently. North-East India, already operating at the high end of the rainfall and humidity range that traditional bamboo and thatch structures were designed for, has the least buffer against further increases in rainfall intensity and humidity, and the raised, ventilated design already in near-universal use there, described in ***Chapters 5 and 14***, is likely to need to move further toward sealed or semi-sealed variants rather than relying on ventilation alone as extreme rainfall events increase in frequency. Gujarat and parts of Eastern India, by contrast, face growing exposure to heat and to more erratic monsoon timing that shortens or disrupts the sun-drying window described in ***Chapter 6***, since a delayed or interrupted drying period leaves seed going into storage at a higher starting moisture content than traditional protocols assume. Himachal Pradesh's integrated, indoor Kothar system, evolved for a stable cold climate, is exposed differently again, to a warming trend that may erode the passive cooling the Kath-Kuni house currently provides.

15.3 Traditional Adaptive Capacity

Traditional storage is not a static technology, and the historical record traced in ***Chapter 1*** shows communities already adapting structure and material to local conditions over long timescales, the shift from ground-level to raised storage across the wetter parts of Eastern and North-East India being one clear example.

This adaptive capacity is a genuine asset that formal climate resilience programming should draw on rather than override: farmers and Seed Mothers already read local moisture and pest signals, described in ***Chapters 6 and 7***, as part of ordinary storage practice, and are consequently well placed to detect and respond to a shifting baseline earlier than a centralised monitoring system reliant on periodic external assessment would. Programme design that supports faster iteration on existing structures, more frequent drying and monitoring where seasons demand it, incremental improvement to sealing and ventilation, rather than programme design that proposes to replace traditional structures wholesale with standardised alternatives, is more likely to build durable resilience, because it works with rather than against the knowledge and authority structures documented throughout Parts III and IV of this Handbook.





CHAPTER 16

Why Documentation and Revival

The Odisha field study is direct on this point: among Ho cultivators in Kendujhar district, most traditional storage technique has already been lost in favour of jute and HDPE sacking, and the study's authors describe the loss of this knowledge among the newer generation as alarming, since without viable traditionally stored seed, communities remain dependent on external seed supply, and vulnerable in exactly the way Chapter 2 describes. This pattern, erosion of technique tracking the shift to purchased inputs and synthetic protectants such as Aluminium Phosphide tablets, recurs wherever this Handbook's regional chapters touch on present-day practice, and it is generational rather than gradual: the knowledge holders interviewed across the field studies are consistently the older generation, and the specific ritual and access restrictions recorded in Himachal Pradesh, for instance, are already described by field teams as remembered rather than practised.

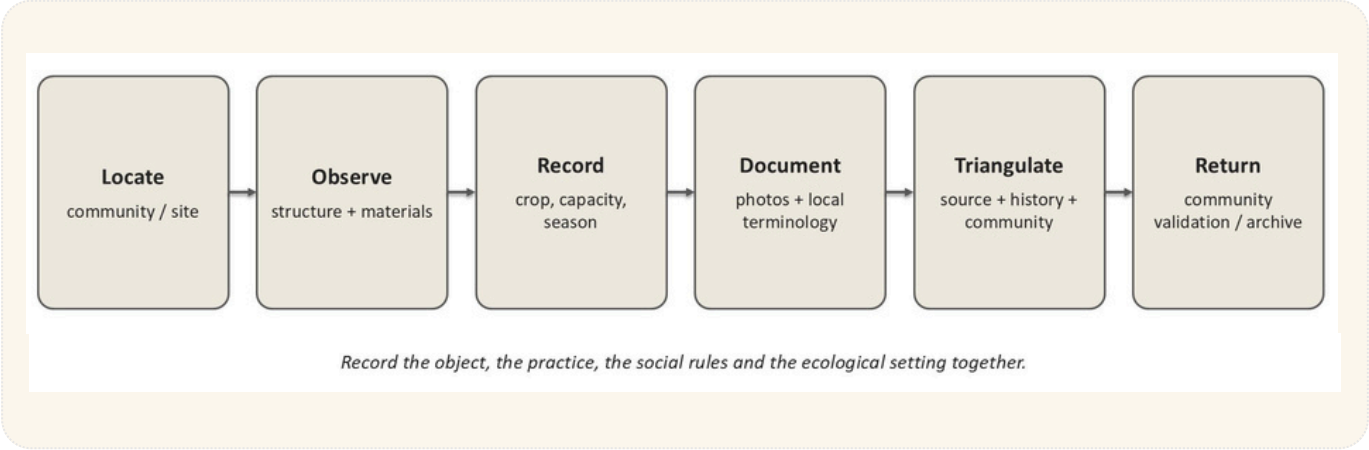


FIGURE - 13: FIELD DOCUMENTATION WORKFLOW: RECORDING THE OBJECT, PRACTICE, SOCIAL RULES AND ECOLOGICAL SETTING TOGETHER.

16.1 A Documentation Methodology

The master inventory format, used across the Himachal Pradesh and North-East India field studies, structures documentation around two linked components: a master inventory table, recording one row per distinct structure type with material, capacity, crops stored, protectants used, storage life achieved and community or site location, and a fuller structure profile card for each distinct type, capturing construction method and preparation, form and dimensions, placement within or around the dwelling, associated knowledge and belief, and current condition and status. This two-tier structure allows a field team to record breadth quickly, through the master inventory, while still capturing the depth of practice, construction technique, ritual association, oral history, that a single summary table would lose. Photograph or sketch reference fields on every profile card, and consistent recording of the specific knowledge holder and compiling field worker behind each entry, as practised particularly thoroughly in the Gujarat pest management documentation referenced in ***Chapter 11***, keep the record traceable back to its source community, which matters both for verification and for any future benefit-sharing or acknowledgement obligation.

16.2 Case Studies from the Foundation's Field Communities

Three examples from this Handbook's own source material illustrate what documentation can achieve beyond the record itself. The Odisha study's identification and naming of the Bihana Maa institution gave an informal, previously unlabelled social role a name and a documented function, which in turn made it possible for NGO programmes such as Chasi Swaraj to build formal support structures around an authority that communities already recognised, rather than inventing a new one.

The Himachal Pradesh inventory's recording of payment-in-grain arrangements for the Tarkhan community building the Bas Pedu preserves an economic detail, a craft economy running on grain rather than currency, that would otherwise have left no trace once the practice itself lapsed.

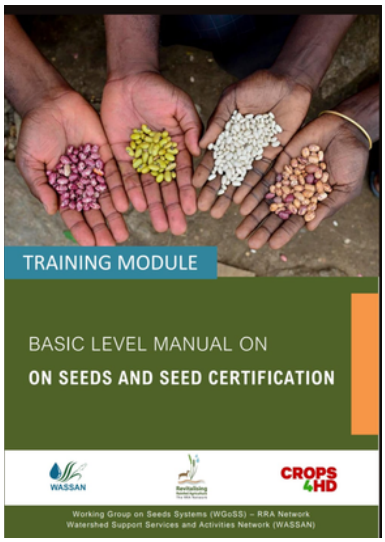
The North-East India inventory's village-by-village recording of bamboo container vocabulary, Duli, Puru, Hoton, Apeh, Atutu and the rest, captures a granularity of local variation that a single generalised entry for the region would have flattened entirely, and that granularity is itself evidence of how localised and how recently active this knowledge base still is.

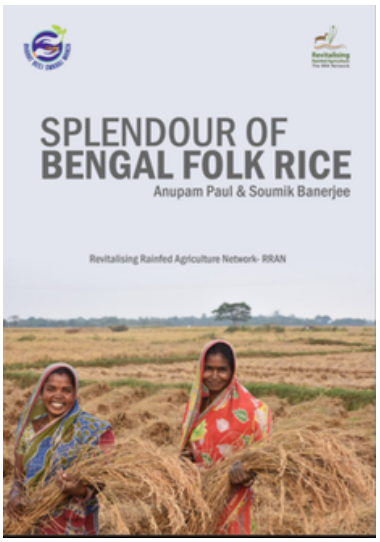
16.3 From Documentation to Revival

Documentation on its own preserves a record but does not, by itself, keep a practice alive. Revival, returning a documented practice to active use, works best where it follows the pattern this Handbook has identified repeatedly across Parts III and IV: building on existing authority structures, principally the women described in ***Chapter 9***, existing exchange networks described in ***Chapter 10***, and existing ritual and festival calendars described throughout Part V, rather than introducing a parallel structure.

Programmes that have succeeded in this Handbook's own source material, the Bihana Maa-anchored work of ORRISSA, the Seed Mela and food festival model recorded in Odisha, and NIRMAN's combination of seed banking with multiplication and value addition, share this feature: they formalise, resource and extend a system that was already functioning at reduced scale, rather than attempting to replace it.

For the Government officers, funders and policy makers this Handbook is written for, that is the single most actionable conclusion across all sixteen chapters: the most effective, and the most cost-effective, intervention in traditional seed storage is support for what a community is already doing, delivered through the people who already hold the authority to do it.

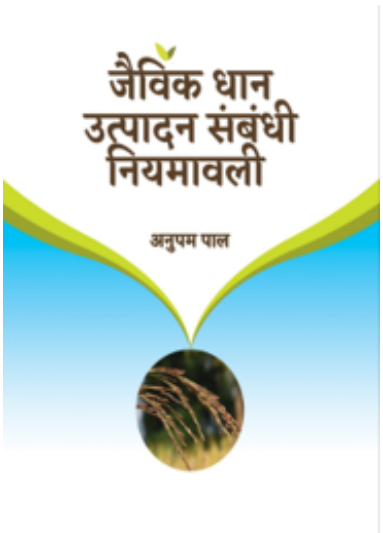












ANNEXURES

Source Field Documentation

*The **four annexures** below reproduce, in structured reference form, the underlying field documentation that **Chapters 4, 7, 11, 12, 13 and 14** draw on and summarise in prose. They are included for readers, researchers, Government officers and programme designers in particular, who need the granular, village and knowledge-holder level detail behind this Handbook's regional narrative, rather than the synthesised account alone. Each annexure follows the recording format used by the underlying field study or inventory it is drawn from, and community and place names are given as recorded in the field, which means spelling sometimes varies between entries describing the same community.*

ANNEXURE - A

Gujarat, Documented Pest and Storage Practices

*The following entries are drawn from village-level field documentation of storage practice across Gujarat, each recorded against a named knowledge holder and compiling field worker. They are summarised in **Chapter 7 and Chapter 11**; the table below gives the fuller detail.*

TABLE - A1: GUJARAT PEST AND STORAGE PRACTICES BY CROP AND DISTRICT

Crop / Commodity	Plant or Material Used	District	Method and Knowledge Holder
Grain (general)	Neem, Kanaji, Eucalyptus leaves	Vadodara	Dried leaves of all three mixed uniformly with grain, 100 g each per 20 kg. Knowledge holder: Bhantiben Surtanbhai Rathwa, Village Raipur, Kavant.
Grain (general)	Sour Tamarind leaves	Sabarkantha	100 g powdered dried leaves per 20 kg grain. Knowledge holder: Navinbhai Jagdishbhai Chauhan, Village Vatrakgadh, Bayad.
Seed and Grain	Tendu and Custard Apple leaves	Dangs	1 kg each, dried and crushed, per 100 kg grain; storage life 2 to 3 years. Knowledge holder: Vestabhai Devjibhai Gamit, Village Jambal, Ahwa.
Dried Mahua flowers	Tendu (Diospyros melanoxylon) leaves	Dangs	Bamboo bin lined and layered with Tendu leaves, sealed; storage up to 2 years. Knowledge holder: Sudirbhai Pashliyabhai Bhilar, Village Liliamba, Ahwa.
Grain (general)	Nagod (*Vitex negundo*) ash and sand	Sabarkantha	500 g ash with 1.5 kg sand per 100 kg grain, spread at container base. Knowledge holder: Nagjibhai Jagabhai Bharwad, Village Sagva, Modasa.
Grain (general)	Kanthi leaves	Sabarkantha	500 g powdered leaves per 100 kg grain. Knowledge holder: Devabhai Bhikhabhai Vankar, Village Rampur, Modasa.
Grain (general)	Whole dried chillies	Surendranagar	250 g slightly crushed chillies in cloth sachets per 20 kg grain. Knowledge holder: Mokuben Gelabhai Koli, Village Kalasar, Chotila.
Rice	Holy Basil, Mint, Camphor	Ahmedabad	100 g each dried mint and basil leaf with 10 camphor tablets, 10 to 12 cloth sachets per 20 kg rice. Knowledge holder: Ramabahen Arvindbhai Patel, Village Rupgarh, Dholka.
Maize	Neem leaf, ash and salt	Anand and Sabarkantha	300 g dried neem leaf, 150 g ash, 500 g whole salt per 20 kg maize. Knowledge holders: Kantaben Govindbhai Patel; Santokben Baldevbhai Patel.
Maize	Rujda leaves	Sabarkantha	500 g dried leaves per 20 kg maize.

TABLE - A1: GUJARAT PEST AND STORAGE PRACTICES BY CROP AND DISTRICT (CONTD.)

Crop / Commodity	Plant or Material Used	District	Method and Knowledge Holder
Little Millet (Varai)	Mixed storage with pigeon pea, beans or black gram	Dangs	10 kg of the companion pulse per 20 kg Varai, stored together airtight. Knowledge holder: Kashiram Lasubhai Hilim, Village Gavdahad, Ahwa.
Grain (general)	Orange peel	Not specified	30 to 50 g dried peel per kg grain; storage one year or longer. Knowledge holder: Dr. G.M. Patel, retired entomologist.
Grain (general)	Custard apple seeds, crushed	Not specified	100 g coarsely crushed seed per 10 kg grain; long-term storage. Knowledge holder: Dr. G.M. Patel.
Sesame	Castor seeds	Junagadh	2 kg castor seed per 100 kg sesame. Knowledge holder: Gobarbhai Bhovanbhai Rupareliya, Village Makhiyala.
Sesame	Dried chillies and castor seeds	Junagadh	100 g each per 20 kg sesame.
Sesame	Kachka seeds	Mehsana	250 g per 10 kg sesame. Knowledge holder: Vasantiben Popatlal Raval, Village Ijipura (Jethaji).
Garlic	Coarse sand (Vekaro)	Junagadh	Bulbs mixed with sand, topped with coarse sand layer.
Grain (general)	Arni leaves	Panchmahal	500 g dried, powdered leaf in 50 g cloth pouches per 100 kg grain; leaves reported toxic, pouches removed before use. Knowledge holder: Ratnabhai Thavrabhai Charpot, Village Motanatva.
Grain (maize, wheat, sorghum)	Mamejvo (*Enicostema littorale*) leaves	Vadodara	500 g dried leaf per 20 kg grain.
Pulses (chickpea, pigeon pea, beans, peas, cowpea)	Teak leaf, chickpea husk, nightshade, neem leaf, ash	Valsad	Straw-rope container lined with teak leaf, layered with the mixture and sealed. Knowledge holder: Bapjibhai Bhayalbhai Ganvit, Village Bilpudi, Dharampur.

TABLE - A1: GUJARAT PEST AND STORAGE PRACTICES BY CROP AND DISTRICT (CONTD.)

Crop / Commodity	Plant or Material Used	District	Method and Knowledge Holder
Pulses	Chickpea husk, ash, paddy straw	Navsari	Layered at base and top, sealed airtight. Knowledge holder: Govindbhai Shobhanbhai, Village Dholumbar, Vansda.
Grain and Pulses	Teak seeds	Dahod	Roughly 500 g per layer, layered through the stored grain.
Green Gram	Salt	Bhavnagar	500 g salt per 20 kg green gram. Knowledge holder: Lakhubhai Medhabhai Sanga, Village Kamlej.
Green Gram	Salt coating	Junagadh	Moistened powdered salt coating, sun-dried before storage; several years' storage life. Knowledge holder: Manglaben Savjibhai Vadhwana, Village Dadar (Gir).
Green Gram	Boiling water treatment	Rajkot	Grain in cloth bag dipped 2 to 3 times in boiling water, then sun-dried; up to one year storage.
Green Gram	Turmeric sachets	Navsari	8 to 10 sachets per 20 kg green gram. Knowledge holder: Kamlaben Harkisanbhai Patel, Village Kandolpala.
Grain (general)	Neem and sweet Dodi	Panchmahal	500 g each per 20 kg grain, layered with the grain in two stages. Knowledge holder: Lakshmansinh Fatesinh Thakor, Village Kadachhla, Lunawada.
All grains and pulses	Asafoetida (Hing)	Dahod	100 g applied inside the container before filling. Knowledge holder: Parvatbhai Dhirabhai Baria, Village Jambusar, Devgadh Baria.
Grain (general)	Oxygen depletion (lamp in sealed Kothi)	Surendranagar	A lit lamp placed inside the filled bin consumes available oxygen and self-extinguishes before sealing. Knowledge holder: Iqbalbhai Baudinbhai Thiba, Village Mevasa, Chotila.

ANNEXURE - B

Himachal Pradesh, Master Inventory of Storage Structures

The following is the master inventory of traditional seed and grain storage structures recorded across Hamirpur and Mandi districts, Himachal Pradesh, summarised in ***Chapter 4, Chapter 7 and Chapter 12.***

TABLE - B1: INVENTORY OF STORAGE STRUCTURES OF HIMACHAL PRADESH

Structure	Material(s)	Capacity	Crops Stored	Storage Life	Site
Bas Pedu	Bamboo, cowdung and soil coating, Changer lid	600 kg	Paddy, wheat, maize	12 to 14 months	Village Dar, Block Hamirpur, District Hamirpur
Khadda (pit) method	Dug pit, spade-worked	Not recorded	Tuber crops	3 to 6 months	Village Panjali, Block and District Hamirpur
Cowdung-embedded bin	Bamboo and cowdung	Not recorded	Tuber crops	3 to 6 months	Village Harner, Block and District Hamirpur
Hang method	Bamboo placed horizontally above ground, thin rope	Not recorded	Cucurbit crops	1 year	Village Harner, Block and District Hamirpur
Kothar	Deodar (Kelo), Raitosh and Kos timber, no iron nails	7 to 8 quintal	Ragi, maize, wheat	2 years	Village Nog, Block Padhar, District Mandi
Dudlu and Gadlu	Earthen pot wrapped in Shod bark fibre (Bandhan)	50 to 60 kg	Ragi, maize, Amaranthus	2 years	Village Nog, Block Padhar, District Mandi

B.1 Supplementary Profile Notes

- Bas Pedu and Pedu are built by the Tarkhan community and paid for in grain rather than cash: a structure of one Man (about 16 kg) capacity is charged at roughly one Bati (about 2 kg) of grain.
- Kothar is assembled without any iron nail; the community holds that deodar's scent itself repels storage pests.
- Pest and moisture management across Bas Pedu, Pedu, Kothar and Dudlu/Gadlu draws on walnut leaf, the root of *Saussurea lappa* (Kuth), and Oose, an iron-rich mineral solution obtained from hill sources.
- Associated belief and access restriction, recorded against Pedu, Kothar and Dudlu/Gadlu alike: the structure should face east or north; grain is not moved during solar or lunar eclipses; historically only the head of household entered the store, and menstruating women were excluded.
- Condition and status of all seven structure types is recorded as good, still in active use, with the exception of the cowdung-embedded tuber bin, recorded as declining.

ANNEXURE - C

North-East India, Master Inventory of Storage Structures

The following is the master inventory of traditional seed and grain storage structures recorded across Assam and Arunachal Pradesh, summarised in ***Chapter 4, Chapter 7 and Chapter 14.***

TABLE - C1: INVENTORY OF STORAGE STRUCTURES OF NORTH-EAST INDIA

Structure	Material(s)	Capacity	Crops stored	Storage Life	Site / Community
Cotton cloth store	Cotton cloth	2 to 3 kg per crop bundle	Brinjal, papaya, cauliflower, paddy, tomato	3 to 8 months by crop	Village Suradi, District Nalbari, Assam
Dark room storage (unnamed)	Dedicated dark room, no structure	5 to 6 kg by crop	Turmeric, Kosu (Colocasia), Simolu Alu	1 to 6 months by crop	Adivasi Gaon, Block Bokajan, Karbi Anglong, Assam
Duli	Bamboo, cowdung and clay coating	10 to 12 kg	Paddy	12 months	Karbi Anglong, Assam
Gaiko Gotha	Bamboo, hung in cowshed ceiling	10 to 12 kg	Maize (also cattle feed)	12 months	Village Nepal Gaon, Bokajan, Karbi Anglong
Hoton	Bamboo plank (Rh-ap), hung above Chullah	4 to 5 kg	Roselle, corn, okra, longbean, black sesame	12 months	Rongkimi, Bormanthi, Karbi Anglong
Puru (small)	Bamboo	200 to 400 kg	Cereals	12 months	Rongkimi, Bormanthi, Karbi Anglong
Buruk	Bamboo basket	2 to 3 kg	Vegetables	12 months	Rongkimi, Bormanthi, Karbi Anglong
RH AP	Bamboo, elevated exterior placement	3 to 4 kg	Vegetables	12 months	Rongkimi, Bormanthi, Karbi Anglong
Sok Ingkro	Bamboo	150 kg	Paddy	8 to 12 months	Rongkimi, Bormanthi, Karbi Anglong
Balak	Bamboo	1 to 3 kg	Corn, bottle gourd	6 months	Village Baliram Terange, Lumbajong, Karbi Anglong
Puru (large)	Wood and cowdung, elevated courtyard bin	2,500 kg	Sticky rice and paddy	12 months	Village Dalamara, Karbi Anglong
Longle	Clay and cowdung	20 kg	Taro	12 months	Dalamara and Bapuram Tokbi, Karbi Anglong
Apeh	Bamboo	8 kg	Bean, mustard, paddy, pumpkin, brinjal	7 to 8 months	Village Prabeya, Anini, Dibang Valley, Arunachal Pradesh
Atutu	Bamboo	8 kg	Maize, millet, bean, mustard, pumpkin	4 months	Village Prabeya, Anini, Dibang Valley
Boyo	Bamboo	20 kg	Bean, mustard, paddy, pumpkin, brinjal, chilli, millet, foxtail, ragi, amaranthus, buckwheat	1 year	Village Prabeya, Anini, Dibang Valley
Ahgra	Bamboo	50 kg	Bottle gourd, beans, mustard, maize, dal	7 to 8 months	Village Prabeya, Anini, Dibang Valley

TABLE - C1: NORTH-EAST INDIA MASTER INVENTORY (CONTD).

Structure	Material(s)	Capacity	Crops stored	Storage Life	Site / Community
Granary (Mising tribe)	Bamboo, clay and wood; jute bags, mud pot, Toomb and Sepit compart-ments	2 tonnes	Rice, black gram, mustard, daikon, gourds, garlic, coriander, potato, onion, yam	7 to 8 months	Block Bokakhat, District Golaghat, Assam
Atutu, Ahgra	Bamboo	8 kg	Ash gourd, bottle gourd, brinjal, buckwheat, pumpkin, rice	7 to 8 months	Idu Mishmi community, Arunachal Pradesh
Kuwa Ndum, Luphun, Chran	Bamboo (box, basket and sieve forms)	10 g to 1 kg	Long bean, green peas, pumpkin, cucumber, coriander, mustard	6 to 12 months by crop	Khang Na and Enthem Nagapather, Margherita, Tinsukia
Singoi, Chran, Luphun	Bamboo	10 g to 1 kg	Long bean, potato, pumpkin, cucumber, tomato, papaya, mustard, chilli, coriander	6 to 12 months by crop	Khang Na and Enthem Nagapather, Margherita, Tinsukia
Karan and Kho-un, Luphun, Tougong, Singoli, Kinsang	Bamboo	10 g to 1 kg	Long bean, potato, pumpkin, cucumber, gourds, onion, ginger, yam, mustard, coriander, chilli, corn, sesame, garlic	6 to 12 months by crop	Dubung and Duwaramara, Kakopather, Tinsukia; Singpho community

C.1 Supplementary Profile Notes

- The Balak basket is associated with Rit Anglong As, a ritual performed before sowing, among Karbi communities.
- The large Puru and Atutu forms in Arunachal Pradesh's Dibang Valley are associated with Keh-meh Haa, a community festival linked to the storage calendar; one field note records that harvesting and sowing should begin from the bottom of the structure.
- The Mising tribe granary of Golaghat district is protected using *Vitex negundo* and neem leaf, and its use is bound to a specific ritual calendar: Ali Aye Ligang, the seed-sowing festival; Laxmi Ona, performed before storage; and Ruwa Jatra, marking the first rice sowing of the season. Betel leaf and nut, yam plant and fern are kept as sacred objects with the structure, and a mantra is recited before storage expressing the intention to share the harvest with those in need and with birds and animals, alongside a wish for abundance.
- The Duli, Gaiko Gotha, Hoton, Puru (small), Sok Ingkro forms are dried in the sun for one to two days immediately before storage to remove surface moisture; the Hoton in particular is recorded as protected by smoke from the Chullah, positioned directly above it.

ANNEXURE - D

Eastern India, Community-Wise Storage Systems (Odisha)

The following tables reproduce, community by community, the crop and storage system detail recorded in the field study across five sites in Odisha: Kodoribadi village, Banspal block, Kendujhar district (Ho community); Dupi village, Thumribandh block, Kandhamal district (Kutia Kondh community); Kirda village, Bissamcuttack block, Rayagada district (Dongaria Kondh community); Gutalpara village, Lamtaput block, Koraput district (Gadaba community); and Dumripada Madiguda village, Kairput block, Malkangiri district (Bonda mixed community). This detail underlies the synthesis given in ***Chapter 4, Chapter 7 and Chapter 13****.*

D.1 Ho Community, Kendujhar District

Most traditional storage technique has been substantially lost in favour of jute and HDPE sacking, with the notable exception of paddy storage. A straw bin is built by tightly wrapping long indigenous paddy straw into a cylinder, held together with Kenaf (*Hibiscus sabdariffa*) fibre rope, and stored over a wooden platform inside the house.

D.2 Kutia Kondh Community, Kandhamal District

TABLE - D1: KUTIA KONDH CROP STORAGE SYSTEMS

Food Group	Crops	Seed Storage System
Cereals	Paddy, maize, finger millet, little millet, foxtail millet, sorghum, pearl millet, Sokra and Dhulia	Paddy in jute sacks; millets in jute sacks, earthen pots or bottle gourd shells; maize cobs hung from the kitchen roof
Pulses	Rice bean, pigeon pea, black gram, cowpea	Pigeon pea and black gram in jute sacks mixed with fine soil, dried monthly in sun; cowpea and rice bean as dried pods hung in bundles from the kitchen roof
Oilseeds	Niger, mustard, castor	All kept in jute sacks
Vegetables and tubers	Pumpkin, bottle gourd, cucumber, Indian bean	Pumpkin and bottle gourd as dried ripe fruit; Indian bean as dried pods; cucumber seed kept inside bottle gourd shells
Spices and condiments	Turmeric, ginger	Tubers planted into soil for transplantation during rains

Seeds are stored in a cleaned, plastered section of the living quarters, raised above the floor on paddy straw stools. The Bija Sopan festival, held in May, brings seed from every household for a blessing by the village priest before a separate germination trial sowing.

D.3 Dongaria Kondh Community, Rayagada District

TABLE - D2: DONGARIA KONDH CROP STORAGE SYSTEMS

Food Group	Crops	Seed Storage System
Cereals	Maize, finger millet, little millet, foxtail millet, sorghum, pearl millet, barnyard millet	Millets in earthen pots with lid, stacked in series; maize cobs hung from the kitchen roof
Pulses	Rice bean, pigeon pea, black gram, cowpea	Pigeon pea dried and stored with crushed Bhelwa (*Semecarpus anacardium*) seed at roughly 1 to 10 ratio; rice bean and black gram mixed with wood ash and stored in earthen pots; cowpea as dried pods hung in bundles

TABLE - D2: DONGARIA KONDH CROP STORAGE SYSTEMS (CONTD.)

Food Group	Crops	Seed Storage System
Oilseeds	Castor	Covered earthen pot with lid, or sealed with straw
Vegetables and tubers	Chilli, tomato, ridge gourd, okra, pumpkin, bitter gourd, bottle gourd, cucumber, Indian bean, Colocasia	Ripe fruit stored whole for ridge gourd, pumpkin, okra and bottle gourd; chilli dried over the oven; Colocasia tubers spread and kept in shade; remaining seed dried and kept in cloth bags stored on an earthen pot
Spices and condiments	Turmeric, ginger	Tubers spread over the floor in shade

Almost no market-purchased seed is used. Core samples, the best fruit or panicle from the harvest, are selected and dried before storage. Seed is kept within the living area, with kitchen smoke acting as a pest deterrent, and a cat is kept specifically to control rodents.

D.4 Gadaba Community, Koraput District

TABLE - D3: GADABA CROP STORAGE SYSTEMS

Food Group	Crops	Seed Storage System
Cereals	Paddy, maize, finger millet, barnyard millet, foxtail millet, sorghum	Paddy and millets in bamboo bins, jute sacks or bottle gourd shells; maize cobs hung from the kitchen roof
Pulses	Cowpea	Dried pods hung in bundles from the kitchen roof
Oilseeds	Mustard, linseed	Jute sacks or straw bins
Vegetables and tubers	Amaranthus, chilli, brinjal, tomato, ridge gourd, snake gourd, okra, pumpkin, bitter gourd, bottle gourd, cucumber, Indian bean, radish, onion, garlic, potato, sweet potato, Colocasia	Seed mixed with wood ash and kept in bottle gourd shells; onion and garlic bundled and hung; Colocasia and sweet potato buried underground until transplant; potato spread on the floor
Spices and condiments	Turmeric, ginger	Tubers kept in bamboo baskets for up to a year after drying

Gadaba women judge dryness by the tinkling sound seed makes during sorting. Seed is kept inside the house, with rodenticides from weekly haats used against rats where needed.

D.5 Bonda Mixed Community, Malkangiri District

TABLE - D4: BONDA CROP STORAGE SYSTEMS

Food Group	Crops	Seed Storage System
Cereals	Paddy, maize, finger millet, barnyard millet, foxtail millet, pearl millet	Paddy in bamboo bins or jute sacks; millets in earthen pot or bottle gourd shell sealed with Siali (*Bauhinia vahlii*) leaf; maize cobs hung from the kitchen roof
Pulses	Cowpea, black gram, rice bean	Cowpea and rice bean as dried pods hung in bundles; black gram in bottle gourd shells or plastic bottles, cleaned and sun-dried periodically
Oilseeds	Niger	Bottle gourd shells
Vegetables and tubers	Brinjal, tomato, pumpkin, bottle gourd, yard-long bean, bitter gourd, cucumber, Indian bean, chilli	Bitter gourd, cucumber, brinjal and tomato seed mixed with ash and kept in bottle gourd shells sealed with Siali leaf; pumpkin and bottle gourd kept as ripe fruit; yard-long bean and Indian bean pods bundled and hung; chilli kept dried
Spices and condiments	Turmeric	Tubers planted underground until transplanting

Seed is kept in the household's living room; where pest damage is detected, seed is shifted to alternative containers. Rodenticides from weekly haats are used against rats where necessary. Bottle gourd containers across all five Odisha communities are prepared the same way: the gourd is allowed to fully ripen on the vine, soaked in water for about a week, dried thoroughly, and the top removed to hollow out the vessel.

D.6 Institutional Support Referenced Across the Odisha Sites

- Bihana Maa (Seed Mother): a knowledgeable woman recognised by the community, responsible for building awareness of varietal characteristics, agronomic performance and storage method, and for facilitating free seed exchange, recorded through ORRISSA's work in Malkangiri and Kandhamal districts.
- Chasi Swaraj programme: community-led seed mapping, matching aggregated household seed needs against available local supply, and coordinating exchange within and beyond the village, run by ORRISSA since 1989.
- NIRMAN: an NGO supporting indigenous seed conservation elsewhere in Odisha through seed banks, multiplication, seed fairs, value addition and marketing.

ANNEXURE - E

Technical Reference, Seed and Community Seed Bank Standards

The following technical reference material, drawn from the Foundation's own Community Seed Bank Maintenance note, underlies the biological and quality-standard discussion in ***Chapter 3 and Chapter 6****.*

E.1 What Is a Good Seed

The three primary standards for a good seed are germination, physical purity and genetic purity. A good seed should be well formed, heavy, free of insects, free of fungus, good in appearance, and pure, and should germinate well.

- Physical purity is expressed as the percentage by weight of pure seed in the total sample (usually taken as 98%). The proportion of other crop seeds, weed seeds and inert matter should be recorded separately.
- Optimal moisture for open storage: cereals 12 to 13 percent; pulses approximately 9 percent; oilseeds 7 to 9 percent (Indicative moisture targets for open/short-to-medium-term community storage).
- Harrington's Rule: within the 5 to 14 percent moisture range, each 1 percentage point decline in seed moisture roughly doubles potential storage life.
- Temperature rule: seed life roughly doubles with every 5 degree Celsius decline in storage temperature, within a 0 to 50 degree Celsius range.
- Pulses and oilseeds are affected by high relative humidity more readily than cereals.
- Recommended monitoring equipment: a thermo-hygrometer for ambient conditions and a grain moisture metre for direct seed readings, alongside persistent manual monitoring.
- Reference germination rate cited for cowpea: 75 percent.
- Folk moisture indicators: a crackling sound when the seed is broken between the teeth; a hand pushed into the sack of grain coming out clean, with no seed sticking to the palm.

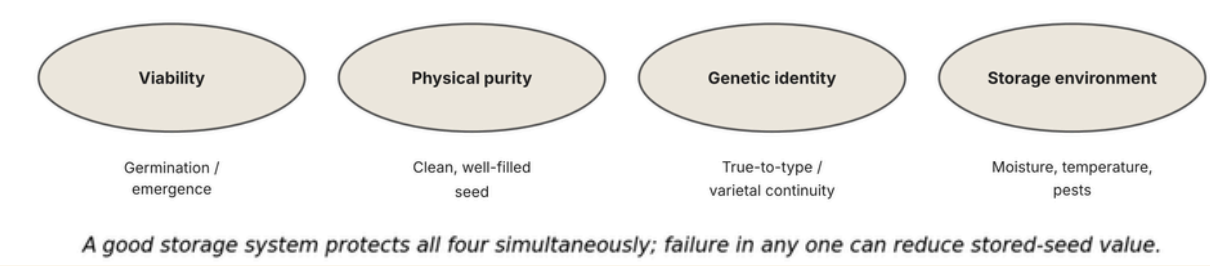


FIGURE - 14: FOUR DIMENSIONS OF SEED-STORAGE QUALITY USED IN THE TECHNICAL REFERENCE.

E.2 Botanical and Mineral Protectants: Consolidated Reference Table

TABLE - E1: TRADITIONAL PLANT AND MINERAL PROTECTANTS AND THEIR RECORDED USE

Material	Recorded Use
Black pepper	5 percent by weight protects wheat against weevils
Cinnamon bark	Raw bark placed in a sack of polished rice attracts weevils away from the grain
Eucalyptus bark	Used in the same way as cinnamon bark
Fenugreek	Mixed directly with grain in storage sacks
Vitex negundo	Leaves used to protect sorghum and pulses
Neem	Leaves, fruit and seed all used; 5 to 7 layers spread through large grain quantities; seed-derived powder mixed with wheat at 10 to 20 g per kg gives year-long weevil protection; 2 to 3 ml neem oil per kg of beans, mixed thoroughly, protects against bruchid infestation for about 6 months

Material	Recorded Use
Red chillies	Protects rice against weevils; burnt seed historically used to protect maize seed
Mint leaves	Powdered leaves mixed at 5 percent give good control of rice weevils
Turmeric	Powder mixed with rice, wheat and some pulses at 2 percent
Wild tobacco	Dried, chopped leaf laid over pulses protects against bean weevil
Other materials	Ash of Acacia, Casuarina, cowdung, mango bark and leaf, rice husk and tamarind seed are all mixed with grain to form a protective covering

E.3 Community Seed Bank Maintenance: Working Principles

- Selecting pure, healthy, quality indigenous seed is the first and most important step in good storage outcomes.
- Maintaining a dry and cool storage space is more effective than relying on any single protectant material.
- Persistent monitoring, rather than a one-time quality check at the point of storage, is necessary to catch and correct moisture or pest problems before they cause significant loss.
- Grain moisture metres and thermo-hygrometers, where available, supplement rather than replace the folk moisture tests described in ***Chapter 6***, since the folk tests remain faster and require no equipment in the field.



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THE LIVING HERITAGE OF SEEDS

Traditional Knowledge, Regional Practices and Traditional Seed Storage of India

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