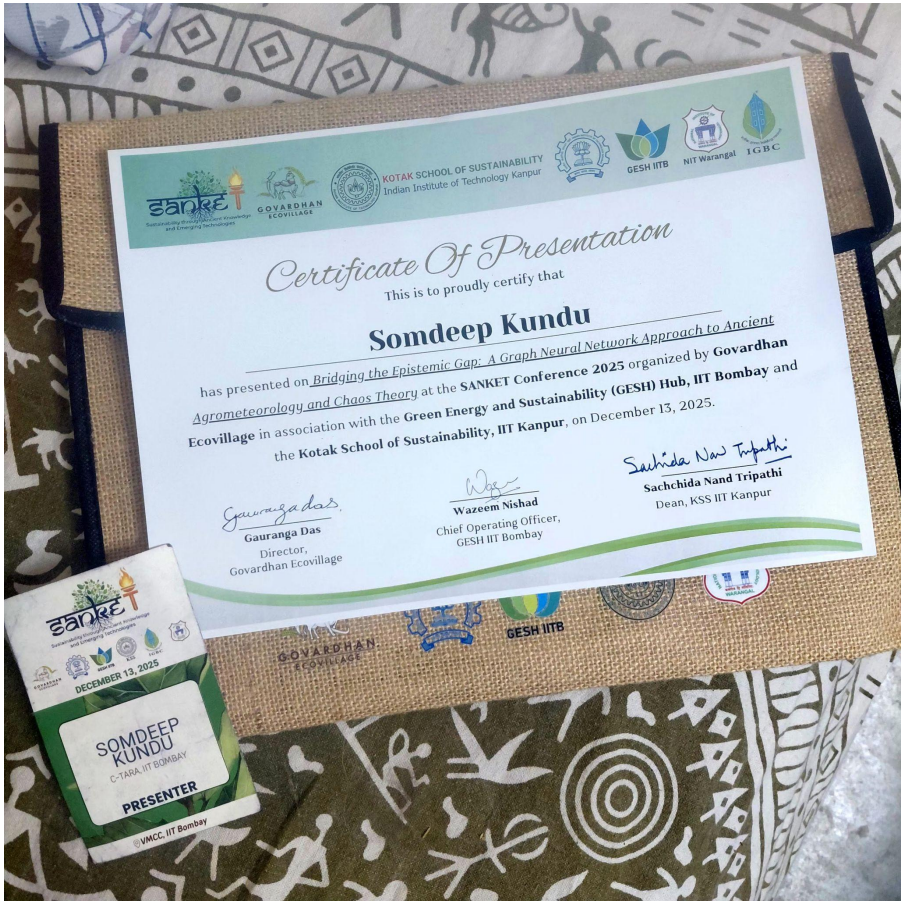

This presentation was delivered at SANKET - (Sustainability through Ancient Knowledge and Emerging Technologies) conference, held at IIT Bombay on 13th December

https://www.sanket.net.in/2025

Bridging the Epistemic Gap

A Graph Neural Network Approach to Ancient Agrometeorology and Chaos Theory

Youtube Recording

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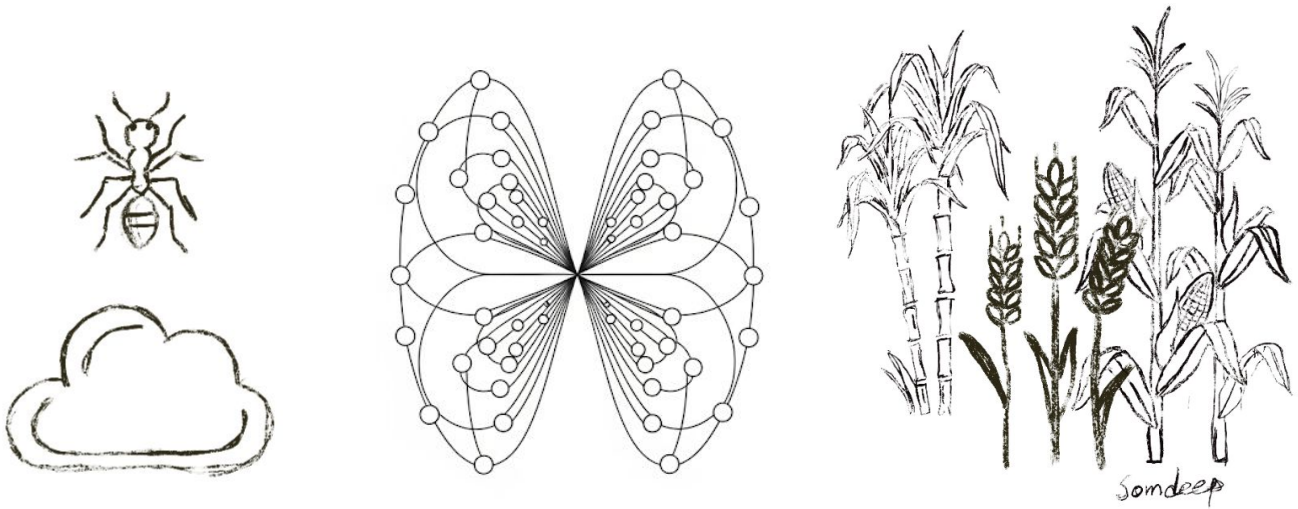


Graphical Abstract

Introduction & Problem Statement

The Challenge

- Climate change renders traditional stats unreliable.
- Modern models lack hyper-local granularity for smallholders.

The Opportunity

Indian Knowledge Systems (IKS): A vast repository of localized observational data exists in regional calendars, proverbs, and bio-indicators.

The Gap

This wisdom currently exists as discrete linguistic units, disconnected from modern computational meteorology.

"Can we operationalize intangible heritage with Artifical Intelligence?"

Research Question

Can we operationalize intangible heritage into a predictive, socio-economically viable cropping model?

Hypothesis

Thinking dohas as Data

Folklore represents **semantic categories** of empirical observation and widespread wisdom from time immemorial.

Structural Isomorphism

Proverbs from Bengal & Maharashtra share **syntactic structures**, suggesting a pan-Indian system.

BioGeo-indicators as Initial Conditions

Flora/fauna behaviors act as sensitive initial conditions for chaotic weather systems.

Literature Summary

Agriculture 4.0

Folklore Mining

Previous studies view folklore as cultural artifacts. This study views them as spatio-temporally sparse data spaces.

Graph Neural Networks

GNNs are uniquely suited to handle non-Euclidean, relational data (unlike standard regression).

Chaos Theory (Lorenz)

Weather is a chaotic system. The "Lorenz Butterfly" paradigm helps model external drift variables.

Phase 1: Data Curation

Cultural Zones

Maharashtra: Almanacs, Drik Panchang

Bengal: Khanar Bachan, Bangla Calendar

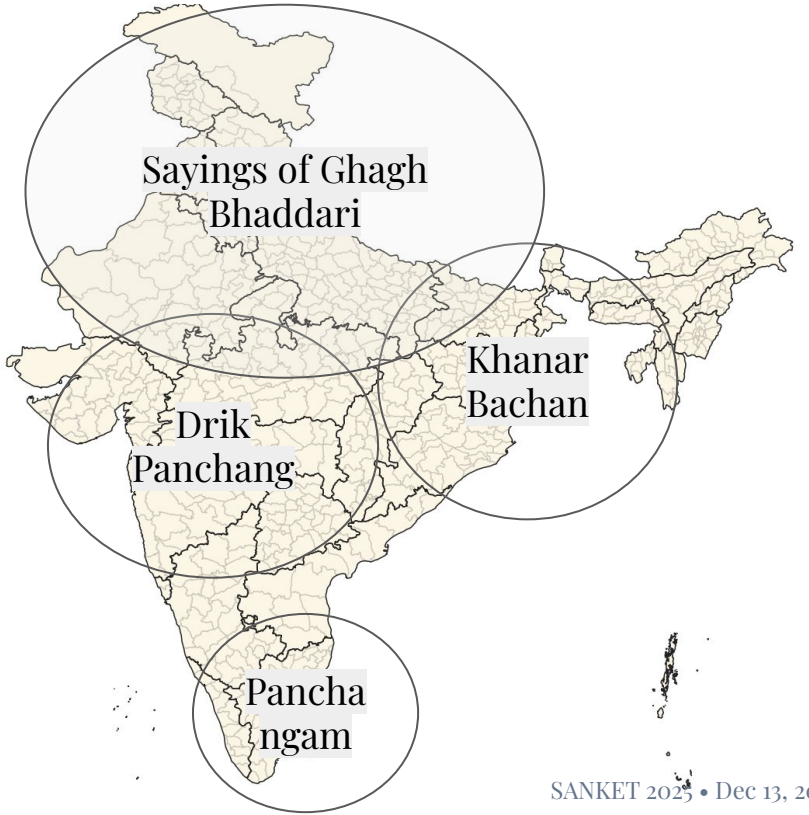
Tamil Nadu: Panchangam

Classification Strategy

Temporal: Solar/Lunar positions

Bio-indicators: Flora/Fauna behavior (proxies for humidity)

Linguistic: "If X, then Rain" logic structures

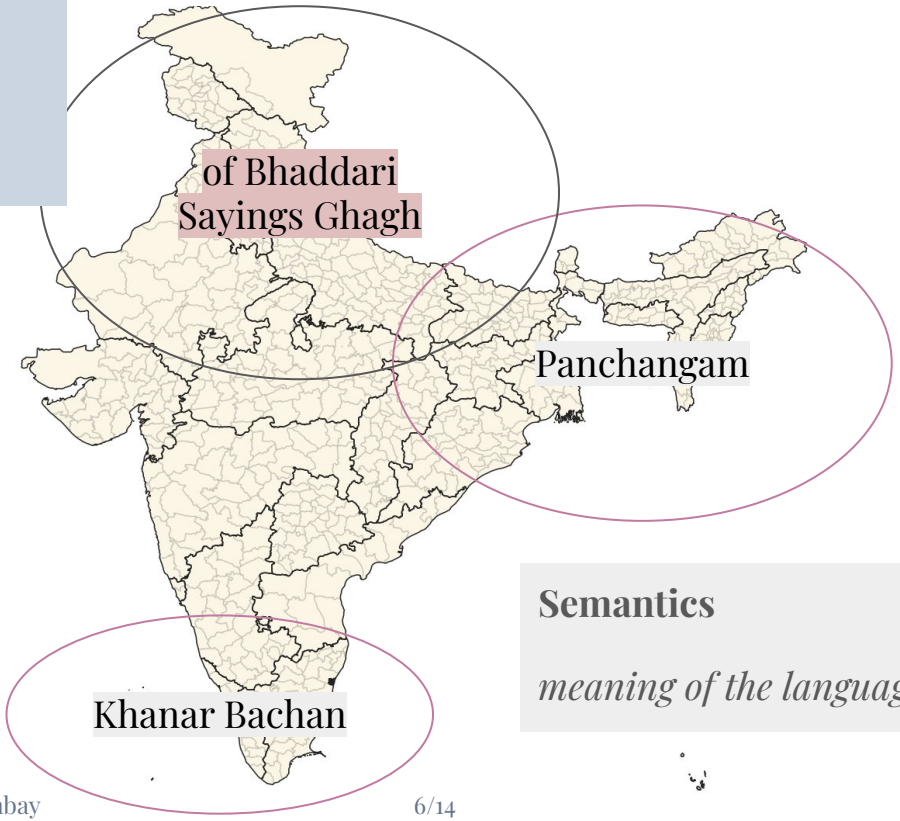


Language Space

Let's setup the coordinates

Syntactic

correct order of words or symbols



X

Semantics

meaning of the language or code

Phase 2: Knowledge Graph

Mapping qualitative folklore inputs **onto** a computational graph.

KHONAR BACHAN — Ashshin

"Ashshin-er jhor, fasol-er jwor."

Storms in Ashshin are like a fever for the crops (harmful).

KHONAR BACHAN — Ogrohaeon

"Agrahayan-er brishti, durbhikkher srishti."

Rain in Agrahayan destroys ripe crops and causes famine.

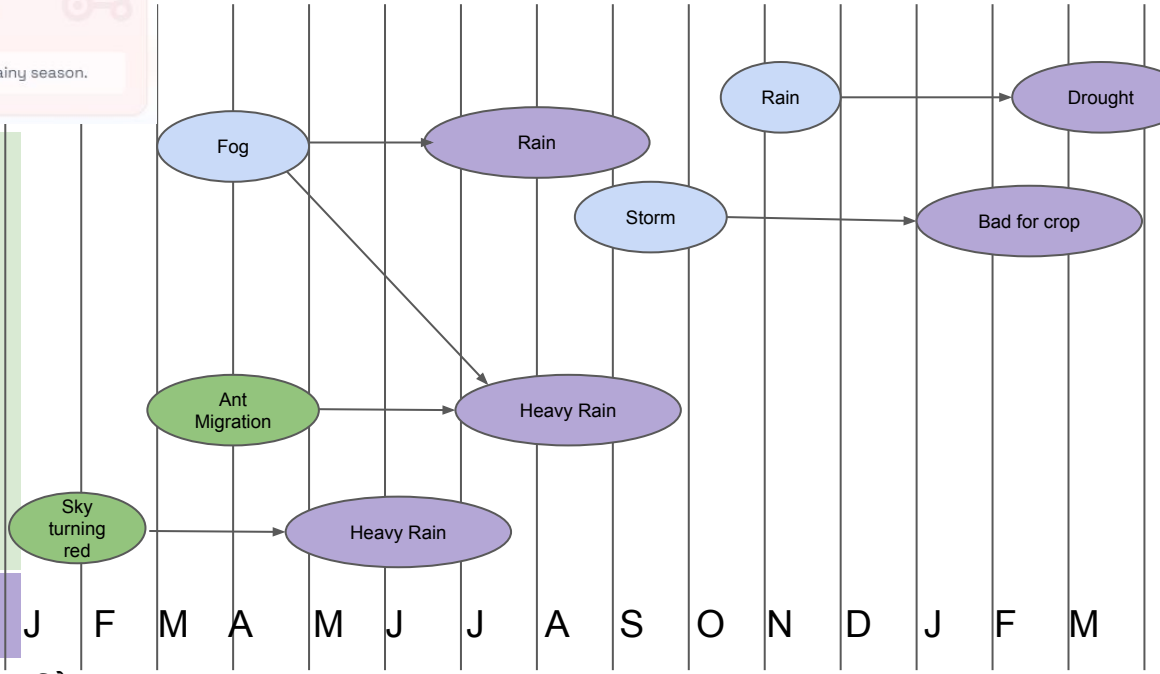
KHONAR BACHAN — Choitro

"Choitrer kuasha, borshar asha."

Fog in Chaitra gives hope for a good rainy season.

Mapping qualitative folklore inputs **onto (as a surjective function)** a computational graph.

- Bio/-indicator (Ants, Clouds..)
- Event (Rain..)
- Time (Month..)
- Effect



माघ में बादर लाल घिरै
तब जान्यो सांचो पथरा परै

Phase 3: Neuro-Symbolic Framework

Graph Neural Networks (GNN)

Learns latent relationships between discrete nodes (bird behavior, cloud patterns).

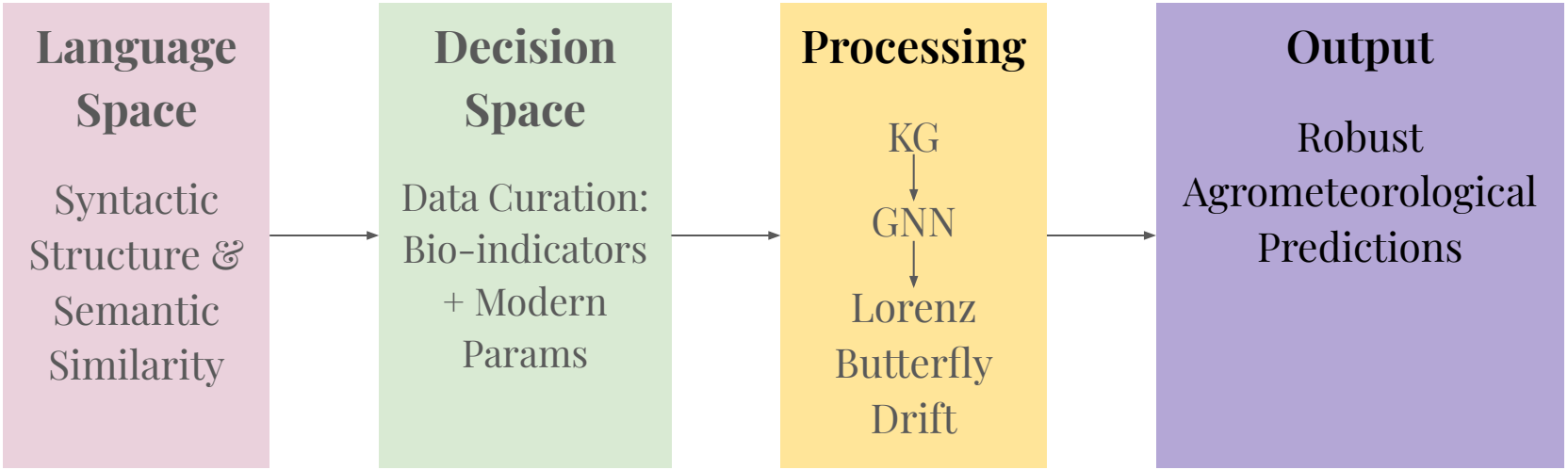
Lorenz Dynamics

Bio-indicators are modeled as observations of initial conditions.

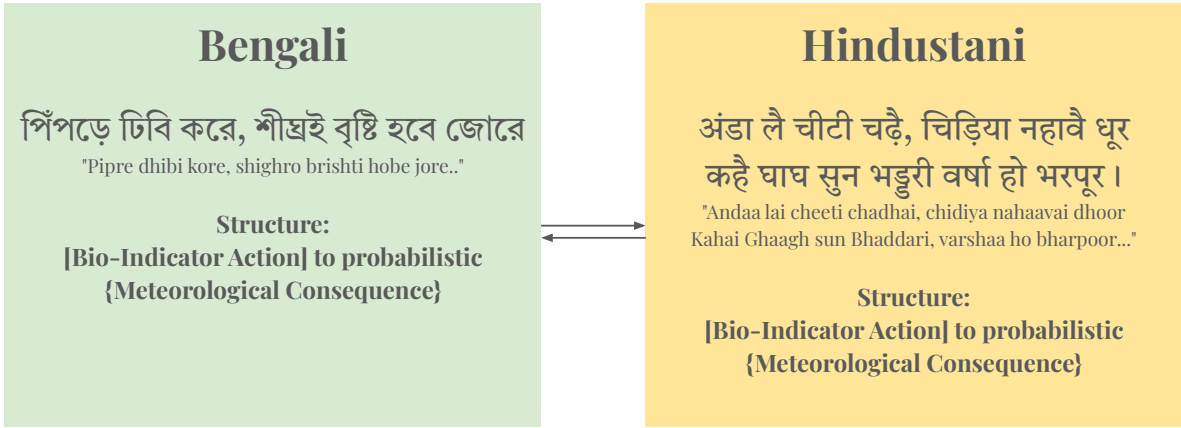
A sample trajectory through phase space is plotted near a Lorenz attractor (Wiki)

KG = Knowledge Graph,
GNN = Graph Neural Network

Literature Summary



Anticipated Outcome: Semantics Isomorphism



Implication: This consistency points toward a possible shared, pan-Indian system of empirical science rather than isolated regional wisdoms.

Theoretical Conclusion

Bridging the Epistemic Gap:

- This study successfully re-categorizes folklore not as cultural artifacts, but as **semantic categories of empirical observation**.
- We move beyond binary translation to a **Neuro-Symbolic Framework** where linguistic units (proverbs) are mapped onto a computational Knowledge Graph.

The Computational Breakthrough:

- **Graph Neural Networks (GNN):** Uniquely suited to process the non-Euclidean, relational nature of traditional knowledge, learning latent relationships between discrete nodes like bird behavior and cloud patterns.
- **The Lorenz Bridge:** By treating bio-indicators as sensitive "initial conditions" within a chaotic system, we mathematically validate the "Butterfly Effect" inherent in ancient wisdom, offering a method to model external drift variables.

Pan-Indian Structural Isomorphism:

- Preliminary mapping suggests a unified system of empirical observation; syntactic structures in Bengal (*Khanar Bachan*) and Maharashtra mirror one another, indicating a shared, scientific underlying logic rather than isolated regional beliefs.

Impact & Future Scope

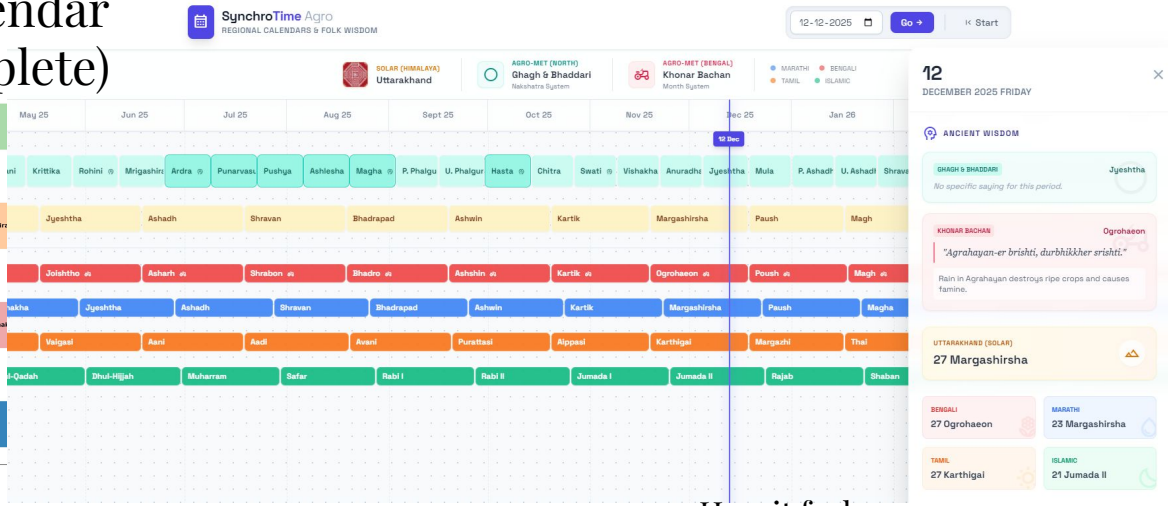
Hyper-Local Precision for Smallholders:

- While modern satellites observe macro-systems, bio-indicators function as **high-sensitivity ground sensors**.
- This hybrid model addresses the granularity gap in modern forecasting, providing actionable, hyper-local climate data essential for crop water optimization.

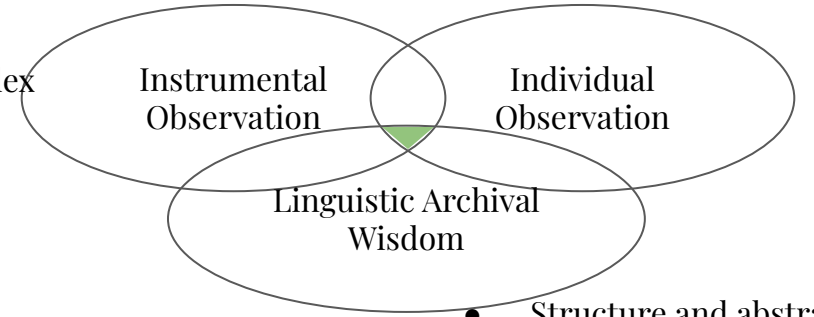
Operationalizing Intangible Heritage:

- We are answering the critical research question: *Can we operationalize intangible heritage into a predictive model?*.
- The result is a scalable, mathematically rigorous tool that preserves cultural wisdom by transforming it into precise data for climate resilience.

A Harmonised Calendar (incomplete)

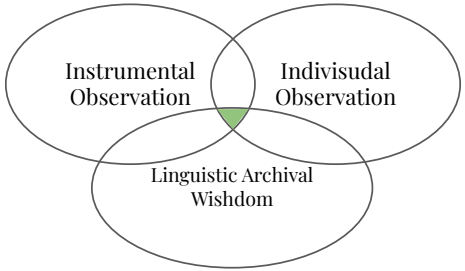


- Rainfall
- Soil Moisture Index
- Land Surface Temperature
- …



- How it feels
- Knowledge-Based Decision
- Technological reachability
- …

- Structure and abstract form
- …



Thank You

Sustainability through Ancient Knowledge and Emerging Technologies

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Portfolio

Used Proverbs

Season / Event	Ghagh & Bhaddari (North India)(Hindi/Braj)	Khana (Bengal)(Bengali)	Scientific Logic & Temporal Lag
1. Pre-Monsoon Heat *(Prediction)*	**"Rohini tape, Mrigshira tape..."** *(Heat in late May/Early June brings abundance).*	**"Joisthite shukaye kathi, Ashare hobe mathi."** *(If Joistho/May is dry as a stick, Ashadh/June rains will be muddy/heavy).*	**Logic:** Low pressure formation. **Alignment:** Both identify intense heating in May (Rohini/Joistho) as the precursor to a strong monsoon vacuum.
2. Bio-Indicator: Ants *(Rain Forecast)*	**"Anda lai cheeti chadhe..."** *(Ants carrying eggs up walls signals rain).*	**"Pipre dhibi kore, shighro brishti jore."** *(Ants building mounds signals heavy rain).*	**Logic:** Barometric pressure sensitivity. **Alignment:** Identical bio-indicator usage across regions regardless of geography.
3. Monsoon Onset *(Sowing Window)*	**"Adra gela teen..."** *(If Adra/mid-June passes without rain, 3 crops fail).*	**"Ashare poncho dine, ropon koro dhane."** *(Transplant paddy within the first 5 days of Ashadh/mid-June).*	**Lag:** Bengal (Khana) advises *transplanting* in mid-June (earlier moisture), while North India (Ghagh) is still hoping for the *first rains* of Adra to start sowing.
4. Cloud Shapes *(Short-term Forecast)*	**"Teetar pankhi badli..."** *(Clouds like partridge wings = rain).*	**"Kodale kurule megh..."** *(Clouds like spades/axes = rain).*	**Logic: Cirrocumulus clouds** (Mackerel sky). **Alignment:** Both describe the same distinct cloud pattern that precedes Western Disturbances or depression systems.
5. Peak Sowing *(Paddy/Rice)*	**"Dhan pandrah..."** *(Paddy requires heavy water/attention).*	**"Shrabone puro, Bhadre baro."** *(Full Shravan is best; up to 12th Bhadra is the limit).*	**Lag:** Khana gives a strict deadline (late Aug) because the monsoon recedes earlier in the North; Bengal has a slightly wider buffer but still warns against late planting.
6. Drought Signs *(Wind Direction)*	**"Sawan maas bahe purvaiya..."** *(Easterly in Sawan? [Nuance: Usually bad if it stops]).*	**"Pubali batas..."** *(Easterly wind brings rain).*	**Logic:** In Bengal, the Easterly wind is the moisture-bearing monsoon current directly from the Bay. In UP/North, the relationship with wind direction is more complex due to landlocked geography.
7. Late Rain Value *(Grain Filling)*	**"Kanagat mein jo barse bam..."** *(Rain in Sep/Pitru Paksha doubles yield).*	**"Ashwine brishti, raja... Kartike, duno dhan."** *(Rain in Ashwin is kingly; Scanty rain in Kartik doubles paddy).*	**Logic: Grain Filling Stage.** Both agree that late rain (Sept/Oct) is critical for "swelling" the grain, though Khana warns against *heavy* rain in Kartik (Nov) which causes lodging.
8. Crop Destruction *(Heavy Late Rain)*	**"Chitra barse matti maare."** *(Rain in Chitra/Oct kills the soil/crop).*	**"Kartic er jole, dhaan moray."** *(Excess rain in Kartik/Oct-Nov kills the paddy).*	**Alignment:** Rain during harvest time (Oct/Nov) causes fungal attacks and rotting. Both traditions fear rain during this specific window.
9. Wheat Sowing *(Temperature)*	**"Gehun wahi jo Aghan pawa."** *(Wheat is that which is sown in Aghan/Nov).*	**"Oghrane gom, Poushe jom."** *(Wheat in Aghan/Nov; In Poush/Dec it is death/failure).*	**Logic: Vernalization.** Wheat needs specific cold hours. Sowing late (Dec) significantly reduces tillering. The advice is identical despite the location difference.
10. Farming vs Trade *(Socio-Economic)*	**"Uttam kheti, madhyam baan..."** *(Farming is best, trade medium, service lowest).*	**"Khatbe khate, labh pabe mate."** *(Work hard in the soil/field, find profit in the land).*	**Ethos:** Both traditions prioritize agrarian self-reliance over servitude, reflecting the socio-economic structure of pre-modern India.

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