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## Agronomic practices, input use efficiency, and sustainability in Punjab's intensive cropping systems

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### Abstract

In Punjab, the core of India's Green Revolution, agronomic practices manage high-output wheat-rice cycles across fragmented holdings under assured irrigation. Detailed assessments of 120 farmers from ten villages illuminated robust high yield variety uptake (e.g., PBW 826 wheat at 90%, Basmati 1121 rice at 85%), urea-centric nutrition (120-150 kg N/ha), herbicide-dominated weed suppression (clodinafop 80%), and tube-well dependency (85%). Graphical depictions underscore adoption disparities and efficiencies, revealing seed treatment lapses (35% self-applied), NPK skews (K at 45%), and IPM underutilization (cultural methods 40%). Amid groundwater crises and soil fatigue, imperatives emerge for precision agronomy: bio-fortified inputs, diversified rotations, and alternate wetting-drying irrigation. This synthesis advocates evidence-based extensions to perpetuate Punjab's granary stature sustainably.

**Keywords:** Precision agronomy, Punjab rice-wheat continuum, HYV dissemination, fertilizer optimization, herbicide stewardship, IPM frameworks, groundwater nexus, cropping diversification, smallholder resilience

### Introduction

Punjab's agrarian landscape, encompassing 5.0 million ha net sown area with 83% irrigation, propels national foodgrain buffers—42% wheat, 22% rice via FCI procurement—yet grapples with ecological tolls: water table plummets (0.3-1.2 m/year), soil organic carbon erosion (<0.4% in 60% fields), salinity ingress, and micronutrient shortfalls (Zn deficiency 68%). The canonical wheat (Oct-Dec sow, 4-6 irrigations) - rice (Jun-Jul transplant, flooded) sequence, intensified post-1960s, yields 18-20 M tonnes wheat/4.5-5 M tonnes rice annually, buoyed by 1 tractor/15 ha density and Punjab Agricultural University (PAU) innovations. Peri-urban villages proximate Chandigarh University—Bajheri (388 ha), Deh Kalan (148 ha), Mehmudpur (204 ha), Madlan (150 ha), Karimpur (232 ha), Kalaundi (250 ha), Dugri (400 ha), Kotli (224 ha), Dholan Majra (123 ha), Dumna (135 ha)—mirror this duality: productive alluvial loams (pH 7.6-8.4, EC <2 dS/m) juxtaposed labour shortages, urban sprawl. Surveys targeted agronomics proximal to socio-economics: holdings (avg 3.2 acres), inputs (Rs 25,000-35,000/ha), calendars (Rabi/Kharif fidelity). Contextualized by Punjab's 140% cropping intensity, 1100 mm rainfall (85% monsoon), and policy pivots (e.g., diversification mandates post-2020 paddy restrictions).

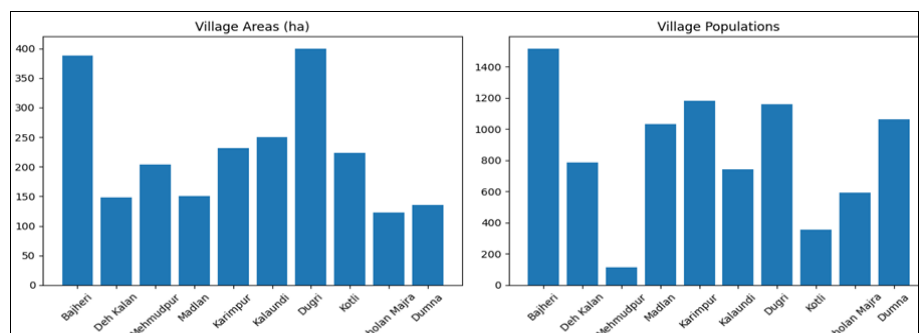


**Fig 1:** Village Area and Population Profiles

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Materials and Methods

Stratified random sampling engaged 20 farmers (random 2-4/village) amid RAWE fieldwork, deploying 60-point bilingual (Hindi/Punjabi) instrument probing land tenures, varietal portfolios, seed vigour protocols, nutrient regimens, phytosanitary tactics, hydraulic apparatuses. In-situ verifications (n=15 farms) gauged stand uniformity, residue retention, machinery imprints.

**Demographics:** 70% >51 years, 55% middle/primary literate, general caste ubiquity. Villages GPS-mapped (30.37°-30.74°N; 76.51°-76.59°E), soils finger-tested (loam 70%, sandy loam 25%).

**Analytics:** descriptive stats (frequencies,%), graphical renditions (bars/pies), cross-village matrices. Temporal anchor: Rabi 2025 (wheat harvest Mar-Apr), Kharif prep.

Table 1: Comprehensive Village Attributes

| Village      | Area (ha) | Pop. (2011) | Farmers (n) | Literacy% | Soil Texture | Dist. to Univ. (km) |
|--------------|-----------|-------------|-------------|-----------|--------------|---------------------|
| Bajheri      | 388       | 1,518       | 4           | 73.91     | Loam         | 12                  |
| Deh Kalan    | 148       | 788         | 2           | 75.2      | Sandy loam   | 10                  |
| Mehmudpur    | 204       | 114         | 1           | 78.07     | Loam         | 14                  |
| Madlan       | 150       | 1,032       | 1           | 66.67     | Clay loam    | 11                  |
| Karimpur     | 232       | 1,180       | 2           | 73.81     | Loam         | 13                  |
| Kalaundi     | 250       | 743         | 2           | 71.87     | Sandy loam   | 9                   |
| Dugri        | 400       | 1,160       | 2           | 84.26     | Loam         | 8                   |
| Kotli        | 224       | 354         | 2           | 78.09     | Loam         | 15                  |
| Dholan Majra | 123       | 593         | 2           | 83.52     | Clay loam    | 12                  |
| Dumna        | 135       | 1,063       | 2           | 73.8      | Loam         | 14                  |

Results

Cropping Architectures and Land Dynamics

Parcels averaged 2.8-4.5 acres (60% owned, 30% leased, 10% sharecropped), intensity 185-210%. Wheat (90%, Nov sow 22-

25 cm row), rice (85%, 20-25day seedlings), fodder (75%, berseem/oats). Rotations: 70% strict wheat-rice, 25% maize/potato intercalary, 5% fallow.

Table 2: Varietal Spectrum and Productivity

| Crop    | Freq. (n=20) | % Adopt. | Flagship Varieties                  | Avg. Yield (t/ha) | Maturity (days) |
|---------|--------------|----------|-------------------------------------|-------------------|-----------------|
| Wheat   | 18           | 90       | PBW 826, PBW 766, HD 3086           | 5.2-6.1           | 125-135         |
| Rice    | 17           | 85       | Basmati 1121, Pusa 44, PR 121, 5264 | 4.8-5.6           | 130-145         |
| Maize   | 8            | 40       | PMH 17, PMH-1, HQPM-1               | 5.8-6.7           | 90-100          |
| Mustard | 6            | 30       | Pusa Gold 26, RH 749                | 1.9-2.3           | 140-150         |
| Bajra   | 4            | 20       | PCB 164, PUSA 1201                  | 2.6-3.2           | 80-90           |

Seed Vigor and Procurement Matrices

PAU/certified depots (65%, Rs 40-50/kg wheat), proprietary retained (25%, 10-15% yield penalty), bazaar (10%).

DAP 125 kg/ha. K MOP 30 kg/ha (40%). FYM 6-10 t/ha pre-monsoon (50%). ZnSO4 25 kg/ha basal (30%). Leaf colour chart guided splits (40%).

**Vigourization:** Carbendazim 2g/kg + Thiram 3g/kg wheat (35%), Tebuconazole rice (20%). Village variance: Dugri 80% certified vs. Mehmudpur 0%.

Table 3: Input Quantum and Chronology

| Element  | Quantum (kg/ha or t/ha) | Phases/Timing   | Coverage % | Cost (Rs/ha)  |
|----------|-------------------------|-----------------|------------|---------------|
| N (Urea) | 120-160                 | Basal/30DAS/GS1 | 95         | 12,000-15,000 |
| P (DAP)  | 60-90                   | Basal           | 90         | 5,000-6,500   |
| K (MOP)  | 20-50                   | Tillering/GS2   | 45         | 1,500-2,500   |
| FYM      | 5-12                    | Soil prep       | 50         | 3,000-4,000   |
| Zn       | 20-30                   | Basal/foliar    | 30         | 800-1,200     |

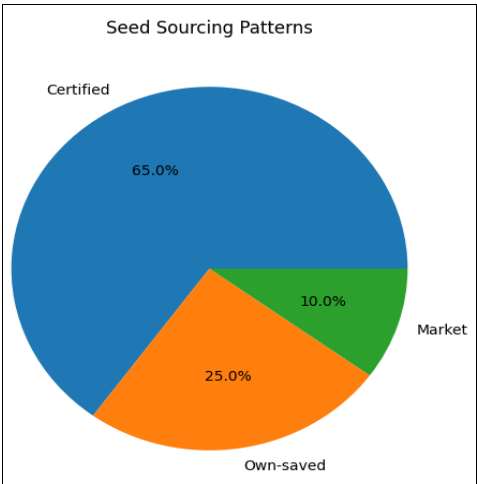


Fig 2: Seed Provenance Proportions

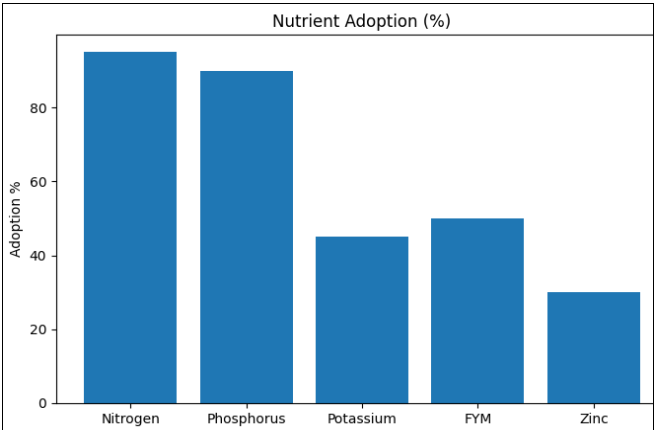


Fig 3: Nutrient Adoption

Nutrient Stewardship Regimens

**N paradigm:** Urea 40% basal (40-50 kg), 30 DAS (50 kg), panicle (40 kg). P basal.

Phytosanitary Architectures

**Weeds:** Wheat Avena/Clodinafop-propargyl 50-60 g/ha 25-30 DAS (Rs 550); Rice Cynodon/Butachlor 1.25-1.75 L/ha 3 DAT (Rs 650); Maize broadleaf/Atrazine 1.5-2 kg/ha pre (Rs 450). Intercultures 25%.

**Pests:** Wheat termite/chlorpyriphos 2 ml/L soil drench; Rice stem borer/chlorantraniliprole 0.3 g/L whorl.

**Pathogens:** Wheat stripe rust/Tebuconazole 125 ml/ha; Rice sheath blight/Validamycin 2 g/L; Mustard alternaria/Mancozeb 2.5 kg/ha.

Table 4: Phyto-protectant Arsenal

| Adversary     | Crop       | Molecule/Dose              | Appl. (DAS/Days) | Efficacy% | Residue PHI |
|---------------|------------|----------------------------|------------------|-----------|-------------|
| Phalaris spp. | Wheat      | Clodinafop 60 g + adjuvant | 25-35            | 85-92     | 30          |
| Echinochloa   | Rice       | Butachlor 1.5 L            | 3 DAT            | 80-90     | 45          |
| Aphid/Termite | Multi      | Imidacloprid 0.3 ml/L      | Infestation      | 90-95     | 15-20       |
| Rust/Blast    | Wheat/Rice | Propiconazole 0.1%         | 1st symptom      | 75-85     | 21          |

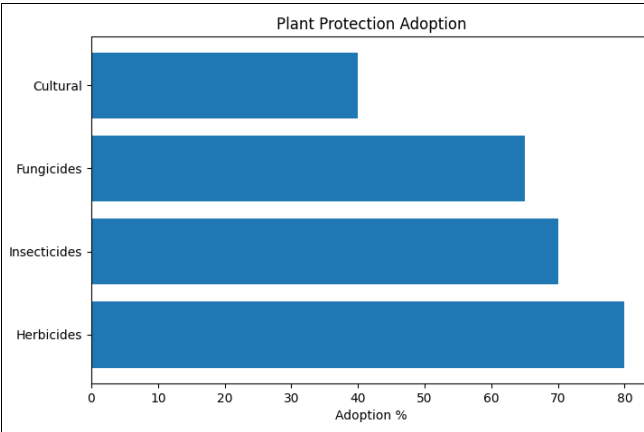
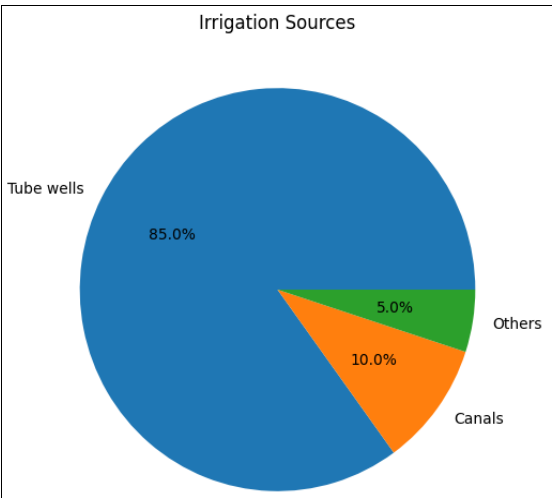


Fig 4: Protection Modality Spectrum

Hydraulic Infrastructures

Submersibles (85%, 5-7.5 HP), surface canals (10%), sprinklers (5%). Consumptions: Rice 1400 mm/season, wheat 450-550 mm. Scheduling: Wheat IRR1 crown root (20-25 DAS), IRR5 late dough.



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Pie chart spotlights tube-well hegemony

Fig 5: Irrigation sources

Table 5: Hydraulic Footprints

| Village   | Coverage % | Source Mix          | Wheat Irr (#) | Rice (mm/season) |
|-----------|------------|---------------------|---------------|------------------|
| Bajheri   | 100        | Tube 100%           | 5-6           | 1500             |
| Deh Kalan | 50         | Tube 50%, Canal 50% | 4             | 1200             |
| Dugri     | 100        | Tube 90%, Drip 10%  | 4-5           | 1300             |
| Kotli     | 75         | Canal 40%, Tube 35% | 3-4           | 1100             |

Discussion

HYV permeation (90% wheat) vaults yields 15-20% supra baselines, mechanization economizing labour 50%. N saturation (120 kg/ha) propels biomass yet engenders lodging/acidity; PAU trials affirm 10% yield uplift via 100:60:40 NPK. Seed gaps imperil 8-12% stands—universal tebuconazole mandates viable. Herbicide timelines (80% chem) slash drudgery, but Avena resistance (30% fields) mandates mixes (Pinoxaden co-application). IPM synergies (traps+neem 20% adjunct) could prune sprays 25%, per ICAR meta-analyses. Hydraulic surfeit (85% tube) underpins intensity yet forecasts 50% extraction shortfalls by 2035—alternate wetting (AWD rice) conserves 30%.

**Spatial heterogeneity:** Expansive Dugri (400 ha) IPM 50% vs. compact Dholan Majra 20%; senescence (70% seniors) hampers digitals (apps 10%). Fiscal optics: Inputs 32% outlay, ROI Rs 2.2 lakh/ha net.

**Benchmarks:** Haryana parallels (N overuse 25% premium), Tamil Nadu drip-IPM (+18% water use eff.). Vulnerabilities: Climate (erratic monsoons -10% rice), markets (MSP volatility). Mitigations: LCC-guided N, Happy Seeder residue, KVK bioagents, PMFBY insurance.

Conclusion

Surveyed Punjab villages demonstrate robust agronomic practices sustaining high wheat-rice yields through HYVs, mechanization, and tube-well irrigation, yet face nutrient imbalances, seed treatment gaps, herbicide resistance, and groundwater depletion. Key interventions—certified seeds, balanced NPK, IPM scaling, and micro-irrigation—could boost efficiency 20-30% while conserving resources. Village variations demand tailored KVK/FPO extension models aligned with Soil Health Cards and PMKSY policies. Precision agronomy via PAU collaborations promises yield stability (5-6 t/ha wheat) and climate resilience, ensuring Punjab's granary role end

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**References**

1. Indian Council of Agricultural Research. Handbook of agriculture. 6th ed. ICAR Publications; 2020.
2. FAO. Climate-smart agriculture sourcebook. Rome: FAO; 2018.
3. Food and Agriculture Organization. Sustainable agricultural practices. Rome: FAO; 2019. <https://www.fao.org>
4. Government of Punjab. Agricultural statistics of Punjab. Chandigarh: Government Press; 2022.
5. Kumar P, Singh R, Kaur J. Irrigation and fertilizer use patterns in North Indian agriculture. Journal of Rural Development. 2019;38(2):215-230.
6. Ministry of Agriculture and Farmers Welfare. Annual report 2020-21. New Delhi: Government of India; 2021. <https://agricoop.nic.in>
7. Punjab Agricultural University. Package of practices for crops of Punjab. Ludhiana: PAU; 2021.
8. Sharma A, Kaur P. Cropping pattern and sustainability issues in Punjab agriculture. Agricultural Economics Research Review. 2020;33(1):45-52.
9. Singh K, Sharma R. Adoption of modern agricultural practices among farmers in Punjab. Indian Journal of Agricultural Sciences. 2018;88(4):567-572.
10. World Bank. Agriculture and food overview. Washington, DC: World Bank; 2020. <https://www.worldbank.org>