An in-depth primary analysis on reviving the health of the soil: A case study on Soil Health, Farmer Awareness, Sustainable Agriculture, and Economic Viability in Bhurja Village, Haryana, India.

By

Yashveer Varun Tewatia

(The Doon School, India)

Abstract: This study explores the interplay between soil health, agricultural awareness, and sustainable practices in Bhurja village, Haryana, India, through a primary study which was conducted under an initiative known as "Soil to Soul." The research study analyses the extent of soil degradation, farmer awareness regarding government schemes and the potential capability of digital tools along with AI in promoting sustainability in agriculture. Using a mixed-method approach by combining primary data from 42 farmers with secondary data from ICAR, FAO, and government databases, the study showcases declining soil fertility rates, low soil testing awareness amongst farmers, and very limited adoption of sustainable practices. Despite these challenges, farmers display a willingness to adapt when informed. The paper concludes that interlinking traditional agricultural wisdom with modern awareness programs and youth-driven digital tools can revive both soil and spirit in India's farming ecosystem.

Keywords: *Soil health; Sustainable agriculture; Farmer awareness; Haryana; Youth in agriculture; Agri-tech.*

1. Introduction

For a state like Haryana, which has a rich historical background in the food production chain in India, the center of agricultural sustainability and rural livelihoods is soil health. However, in recent decades there has been growing evidence that this base is becoming increasingly strained. The results of various studies conducted in different districts of Haryana indicate that soil quality has been on a downward trend with some nutrient imbalances, decrease in organic matter and emerging soil problems like salinity. All these challenges are associated with high pressure production systems, high inputs of chemical fertilizers, and restricted diversification of farming practices, all favouring short-term production more than long-term rejuvenation of the soil. In districts like Hisar, Sonipat and Palwal, deficiencies of some essential nutrients are observed on a very large scale, especially in the levels of SOC, which is essential for maintaining soil structure and soil fertility. Meanwhile, land management practices like burning rice residues (which are still commonly applied for convenience and saving costs) have been found to impact soil health even more by causing a loss in soil organic matter and soil microbial processes. Scientific tools such as soil testing, geospatial soil mapping, and nutrient-based recommendations offer considerable solutions, their impact on the ground has been observed to be limited.There have been several such studies that have provided evidence on the behaviour of farmers in Haryana field and revealed a persistent gap in the use of soil health knowledge amongst farmers. Knowledge of soil health practices and soil health programme activities like soil testing, Soil Health Cards is uneven and many farmers receive inadequate soil health guidance or struggle to understand soil health technical guidance. This makes fertiliser use generally not soil specific and results in persistence of traditional cropping sequence in face of changing soil conditions. The translation of scientific knowledge into production decisions is also limited because of weak extension services and limited engagement at field level. This means a need for research at the village level in this context, which can focus on parameters like soil health, farming systems and people's knowledge about agricultural schemes and this will be done in the Bhurja Village in Haryana in this primary study. The study aims to bring the broad literature and concepts on soil health and sustainable agriculture to the village level and bridge the gap between research and soil health and sustainable agriculture policies in Haryana.

2. Research Gap

Modern agriculture in India faces a quiet crisis: primarily of soil degradation. Excessive use of fertilizers, shrinking biodiversity, urbanisation, and ignorance of natural farming practices are damaging the most essential layer of the Indian agricultural ecosystem. While large-scale solutions are being discussed globally, the absence of youth engagement in local soil awareness remains a critical gap. This paper analyses the (1) aspect of soil quality as perceived by the youth, (2) Awareness and knowledge of AI-based tools for soil testing, and (3) Reviving the emotional and moral connect to one's roots through storytelling and being guided by young adults.

The three main questions that are attempted to be addressed in this research are:

1. The condition of soil health, along with levels of agricultural awareness exists among small and marginal farmers in Haryana?

2. To what extent are farmers aware of the schemes designed by the government to improve soil quality and crop durability?

3. Upto what level can digital and AI-based tools effectively be used to improve knowledge about agricultural productivity among farmers and rural youth in Bhurja village, Haryana?

3. Methodology

The research design that was adopted consisted of a **mixed-method approach**. This combines both quantitative and qualitative data, to gain a thorough understanding of postulates such as ***soil's health***, ***farming practices***, ***awareness regarding government schemes*** and ***digital proactiveness among small farmers who are faced with limited opportunities***. Primary data was collected through structured interviews along with field observations from 42 farmers in Bhurja village situated in Haryana. Secondary data was analysed from multiple government sources, agricultural statistical reports and institutional datasets mainly from the following sites: (ICAR, FAO, PRS, and Ministry of Agriculture Portals or MAP). Both sets of data were compared and studied to understand the issues that were faced by these small farmers and reasons for the path adopted by them. The primary study area was in a village named Bhurja, in Haryana. This village was chosen as it is an apt representative of the agricultural community of Northern Indian farming systems. The sample size consisted of 42 farmers, where each farmer possessed landholdings that ranged from 1 to 3 acres (smallholdings). The age of the farmers tilling the soil was between 26 and 79 years. Most of these farmers had studied till only the secondary education level. Overall, the sample size recorded the direct relationship between small holdings and lack of education.

Data for the primary survey were collected in the following format:

- **Structured interviews** and **recorded conversations** were conducted with each farmer to gain information on several key factors, namely: *farm practices*, *soil testing behaviour*, *crop choices*, *fertiliser use*, *irrigation methods*, *scheme awareness*, and *other challenges* they face.

- **Field observations** were carried out to determine the soil type in the village, along with a comparison between verified indicators of land health, usual cropping trends, and infrastructural facilities that support irrigation.

- **Soil test summaries** were collected from farmers who had had their land's soil tested at least once through verified procedures, which included observations on the salinity of the soil, the soil's deficiency in nutrients (especially in nitrogen), and the level of porosity of the soil.

- **Secondary data** was obtained from authentic and official reports, along with several databases for carrying out both comparative and contextual analysis.

4. Literature Review

The data provided by the Food and Agriculture Organisation (FAO) in 2022 states that around 30% of arable land in India is observed to be suffering from moderate or, in some cases, severe degradation. Unbalanced application of fertilizers, monocropping and mismanaged cultivation, are mainly responsible for this. Moreover, Indian Council of Agricultural Research (ICAR, 2023) reported that long-term sustainability of the agriculture depends on the nutrient balance, organic carbon restoration process, and soil testing. Such steps, however, have not been successful in increasing the uptake of soil conserving practices by the small and marginal farmers especially in the more intensely farmed areas like Haryana.

These concerns are further supported by district level studies carried out in Haryana. Districts like Palwal have had soil fertility tests conducted which have shown that there are significant nutrient deficiency issues; nitrogen deficiency is a major constraint in most sampled soils. The geospatial mapping of soil fertility in Palwal district shows that although the level of phosphorous and potassium had spatial variation, the fertility level of nitrogen was very low in almost all the sites, which may be attributed to nutrient mining in the long run and lack of replenishment of soil organic matter. The study noted that a similar deficiency pattern of the micronutrients and secondary nutrient, with S and Zn deficiencies, resulted in further soil productivities and crop responses. These results indicated that degradation of soils in Haryana is not even but varies from place to place which makes the idea of site specific or localized soil management necessary instead of blanket soil recommendations for fertilizers.

In 2015, the government introduced a Soil Health Card to make soil information available to all. This was done by facilitating farmers with personalised reports once every two years, comprising detailed nutrient conditions and recommended balanced fertiliser usage.

5. An Analysis of Existing Schemes adopted by the Haryana Government with respect to farmer support

The implementation and extension of farmer-centric schemes have been uneven, with many of them either not receiving the cards or being unable to interpret the technical data without adequate institutional support. Experiments conducted in Haryana suggest that although soil health reports are produced, there is weak utilisation of these reports because of weak extension systems, low technical literacy to soil health reports, and less follow-up advisory service claims.

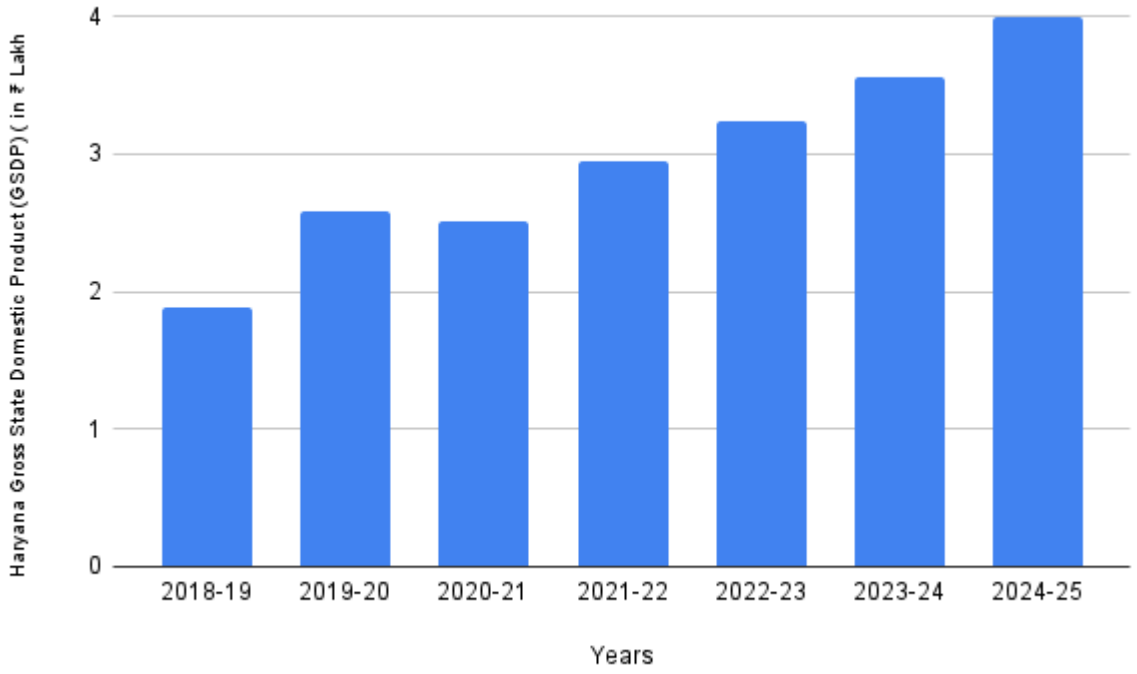
Haryana's Gross State Domestic Product (GSDP) reflects the growth of the economy in the region: From ₹1.89 lakh crore in 2018-19 to a reported ₹3.56 lakh crore in 2023-24, (Haryana Budget Documents; PRS, 2023). The agricultural contribution, however, showed a steady decrease during this time, falling from 17.6% in 2018–19 to an expected 15.9% in 2024–25. This declining share implies both structural economic changes and rising stress within the agricultural sector.

Year	Haryana Gross State Domestic Product (GSDP) (in ₹ Lakh crore)	Haryana's Agricultural and Allied Contribution (in % of GSVA/GSDP)
2018-19	₹1.89	18–19% (approx)
2019-20	₹2.58	18–19% (trend continuation)
2020-21	₹2.51	18.9%
2021-22	₹2.95	16.9%
2022-23	₹3.24	18%
2023-24	₹3.56	17–18%
2024-25	₹4.0 (approx)	15.9%

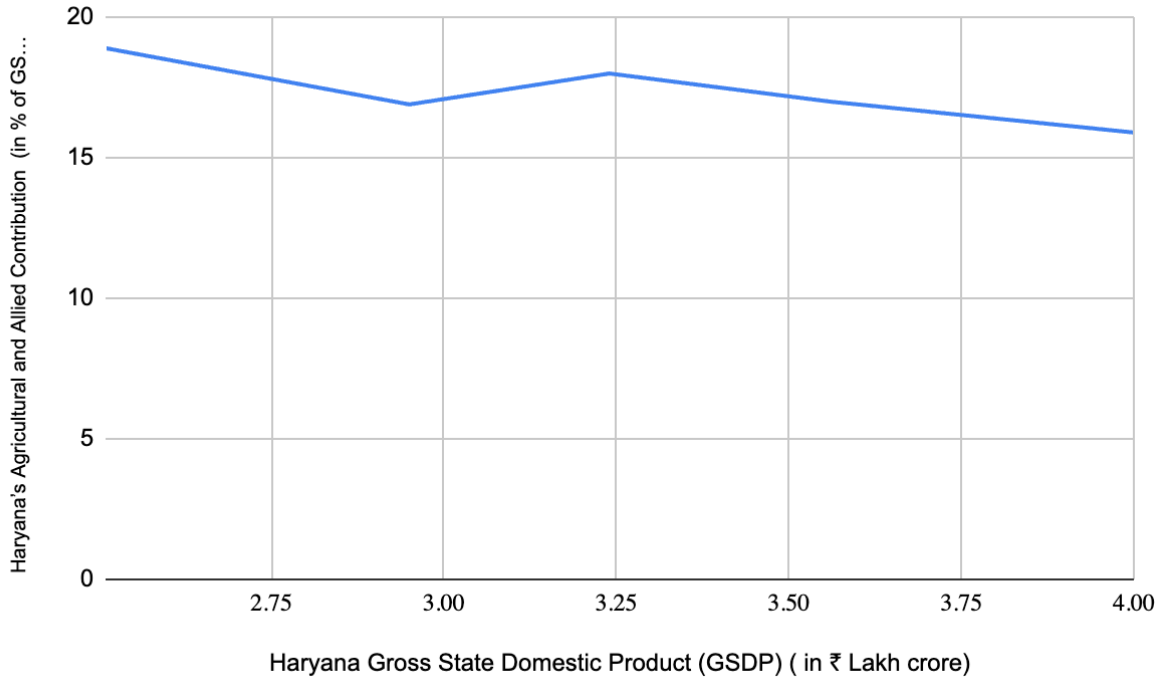
Table 1: Statement of Haryana's GSDP and contribution of Agriculture earnings from Haryana towards the economy.

Sources: Government of Haryana. (2024). *Haryana Economic Survey 2023–24*. Sectoral GSVA figures. Government of Haryana. (2025). *Haryana Economic Survey 2024–25: Full Summary*. GSDP and Agriculture & Allied share estimates. Department of Economic and Statistical Affairs, Haryana. (2025). *Economic Survey Highlights: GSVA sector share projections*. Reported in The Tribune. NABARD. (2023). *State Focus Paper 2019–20: Haryana*. Agriculture GSVA share. Drishti IAS. (2024). *Farmer Factor in Haryana*. Agriculture share context.

The above table has also been depicted in graphical form, indicating the growth of the state's GSDP and the contribution of farmers to the growth of the state. (indicated in graphs 1 and 2)



Graph 1



Graph 2: Contribution of Haryana's agricultural sector to the state's GDP

The importance of soil health and resources efficient utilization has increased with the decreasing proportion of agriculture where soil productivity on existing agricultural field is becoming increasingly important.

Previous studies have pointed to a gap between the adoption of farmers and technologies. The introduction of innovative technologies such as AI advisory tools, remote sensing, and precision agriculture machinery has occurred, but these small and marginal farmers may lack access to these technologies or experience limitations due to digital literacy, availability, and cost, or find that the technologies are not relevant to their specific context (FAO, 2022; ICAR, 2023). Using geospatial methods specifically for soil assessment has also been proved to be of very limited value if the direct communication at the village level is highly ineffective; consequently, it will cause the farmers' awareness to not develop, along with no institutional support.

This eventually resulted in emphasis on the importance of community level based interventions at the grassroots level for closing awareness and adoption gaps. However, the connection with youth-centered advocacy, traditional wisdom on the land related to soil health and novel visual tools that use digital and/or artificial intelligence to inform land stewardship decisions have not yet been much studied. This gap becomes more apparent at the village level where research is conducted to correlate scientific soil assessments and farmer perspectives, constraints, and policies. *The present study aims to bridge this gap* by combining primary field research with broader soil health literature to examine *soil degradation*, *farmer awareness*, and *sustainable agricultural practices* in Haryana.[1][2]

---

[1] **Soil Fertility Appraisal for Palwal District of Haryana Using Geospatial Tools**
(Indian Journal of Agricultural Sciences, ICAR)
[2] **Status of Secondary and Micronutrients of Block Hodal of District Palwal, Haryana**

6. Primary Analysis of Bhurja Village, Palwal, Haryana

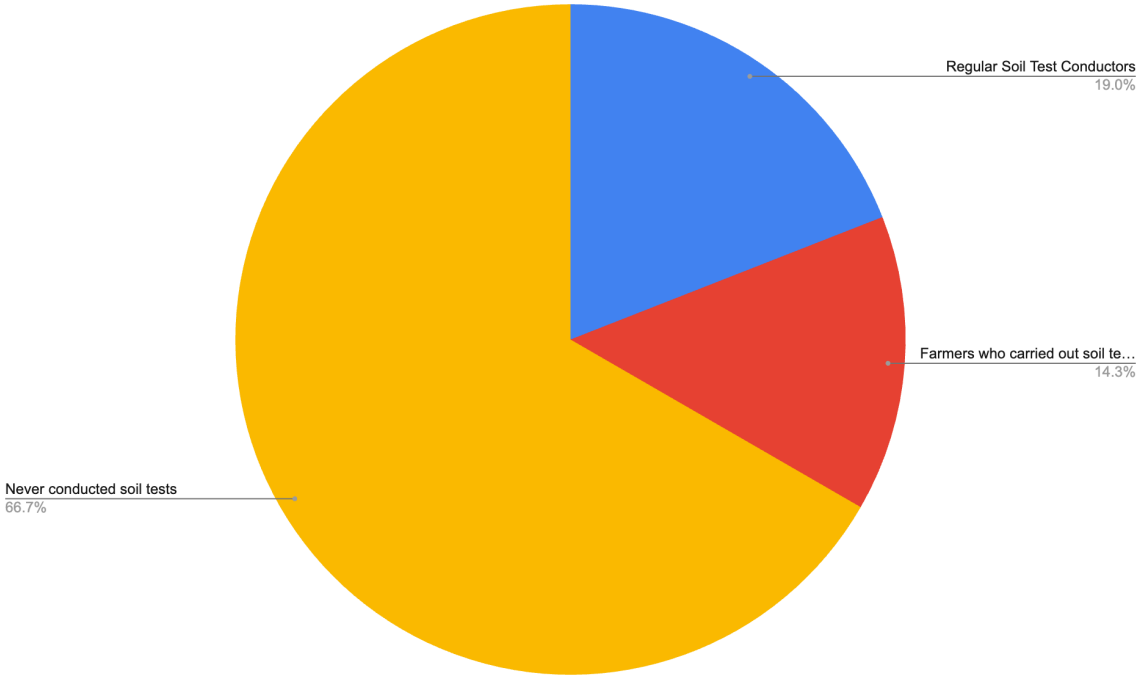
All the primary data was first accumulated and then combined into spreadsheets. Statistical tools like percentages, frequencies, etc., were then used to depict and summarise key trends. All the matters raised in interviews were qualitative and were coded for each major question, which were verified with quantitative findings. The merging of both types of data caused a systematic check of the results and was an intrinsic step in the robust interpretation of the primary data.

7. Ethical Considerations

In the study, none of the subjects were compelled to take part. Strict confidentiality was offered to the respondents and it was even stated that their information would be kept only for scholarly purposes and other related educational uses. In addition, there was no inclusion of any of the marginalised populations that need formal ethical board reviews.

8. Analysis of Primary Study

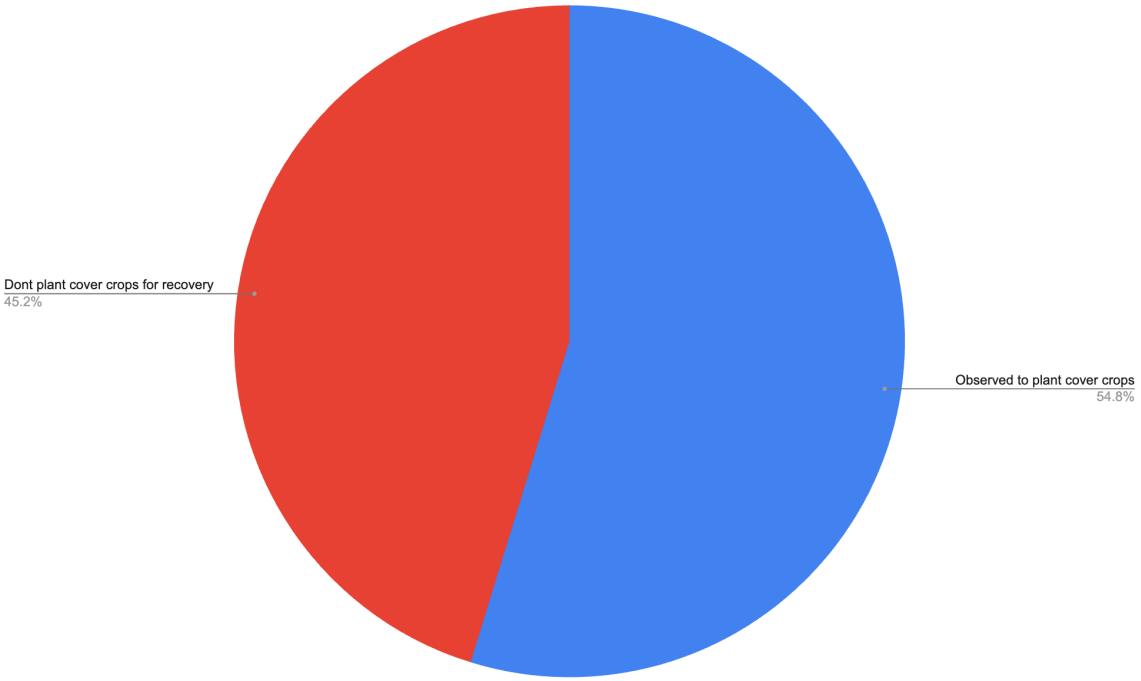
1. Soil Testing and Fertility



Pie Chart A: Indicates that, with respect to soil testing and fertility, among 42 farmers, only **14** had ever conducted testing on their land. Additionally, **8 farmers** did this on a regular basis.

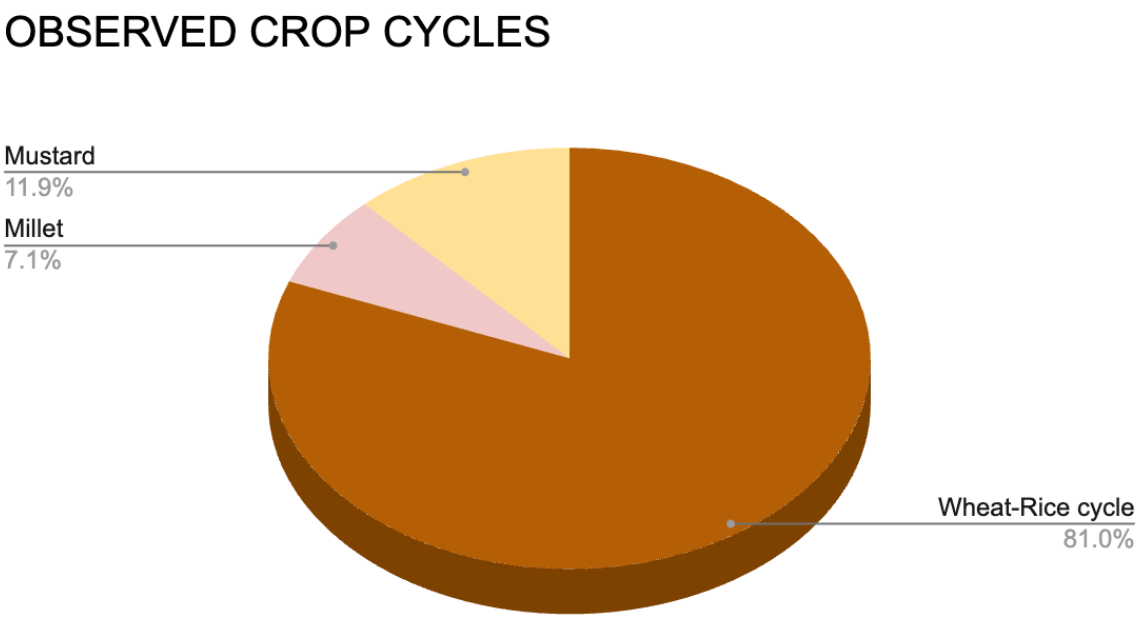
- The two most common soils observed in the region were **mixed and sandy**.
- Among the farmers who carried out soil tests for their land, the most frequently mentioned problems were **high levels of salinity of the soil**, **blocked pores throughout the soil that prevented percolation of water**, and a **lack of nitrogen**.
- Over **80% of the farmers** had a perception that the fertility rates of the soil have been continuously declining over the years.

2] Cropping Pattern and Practices



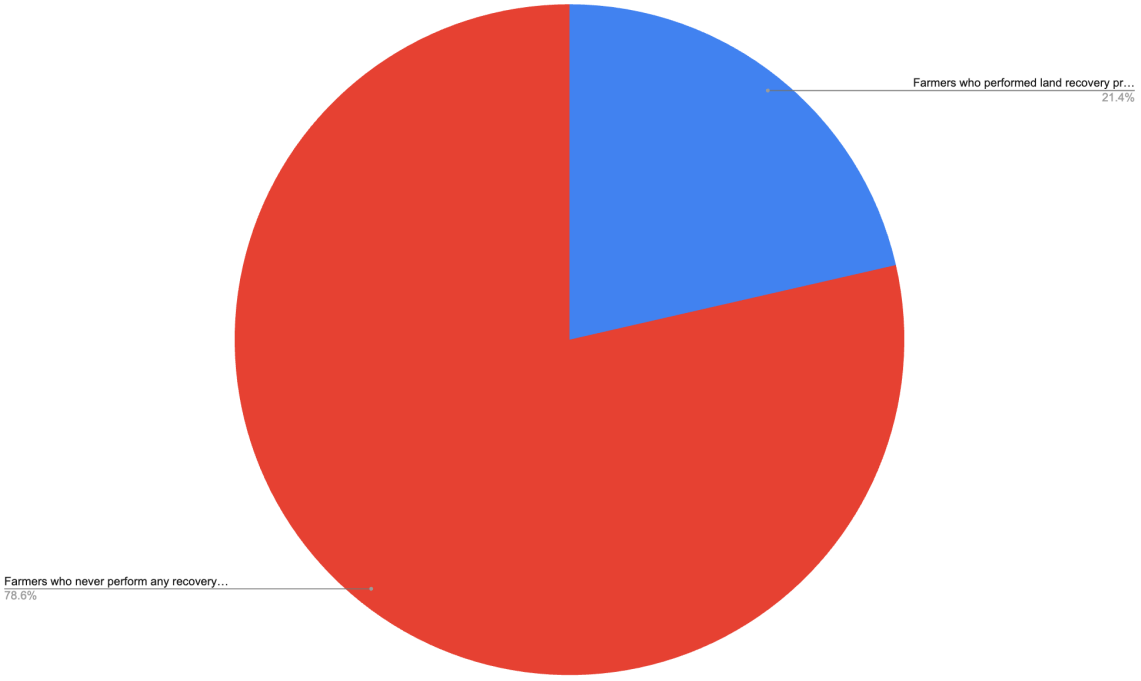
Pie Chart B: Cropping Pattern

In the above diagram, **23 farmers out of 42** were observed to have planted nutrient-replenishing crops (like moong). A **Large number of farmers** were **reluctant to experiment with nutrient-replenishing crops (cover crops)** due to the fear of loss of revenue. Most of the farmers were poor and were concerned with the stability of revenue, which they obtained from ***wheat and rice***.



Pie Chart C:

The above chart indicates that the most prevalent type of crop rotation cycle was **Gehu-Chawal (Wheat-Rice),** but crops like **Mustard (Sarso)** and **Millet (Bajra)** were also observed to be grown.



Pie Chart D indicates that there were only **9 farmers** out of **42** who performed practices like leaving the land idle and uncultivated for short periods of time, which would help in replenishing necessary nutrients in the soil.

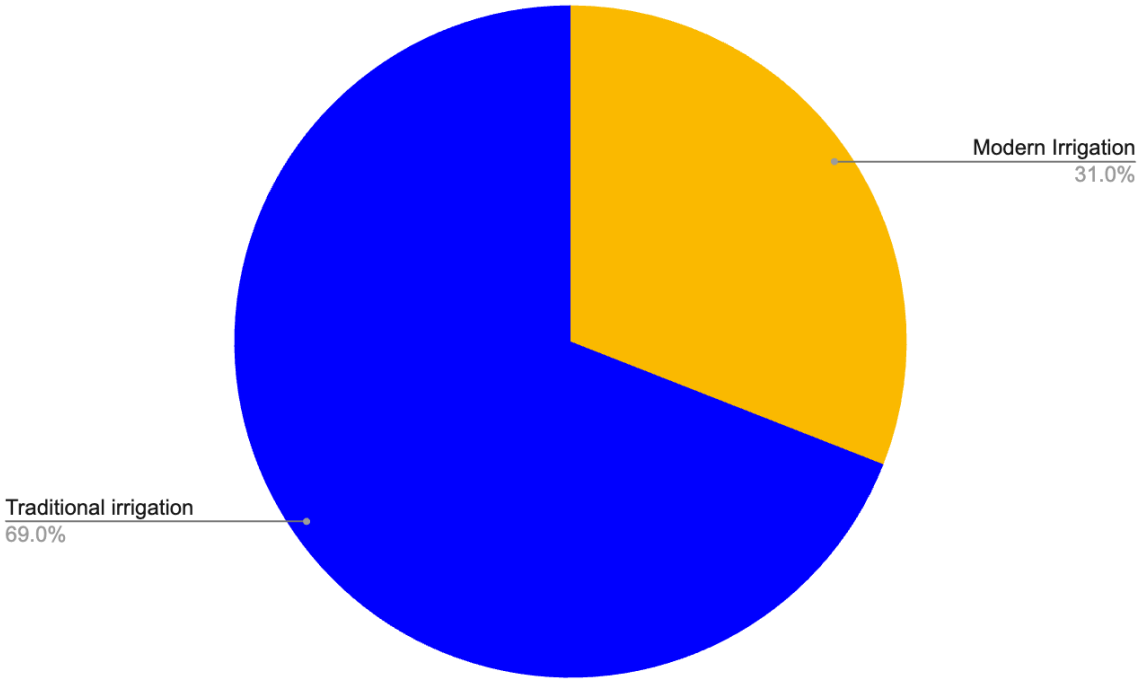
3] Fertiliser and Input Use

- In the survey, use of **natural fertilisers** (cow dung) was noticeably missing from current farming practices.

- **All farmers** who were surveyed used artificial chemical-based fertilisers like **DAP and Urea**.

- The overall average expenditure on inputs by the farmers was about **₹30,000 to ₹35,000 per acre**.

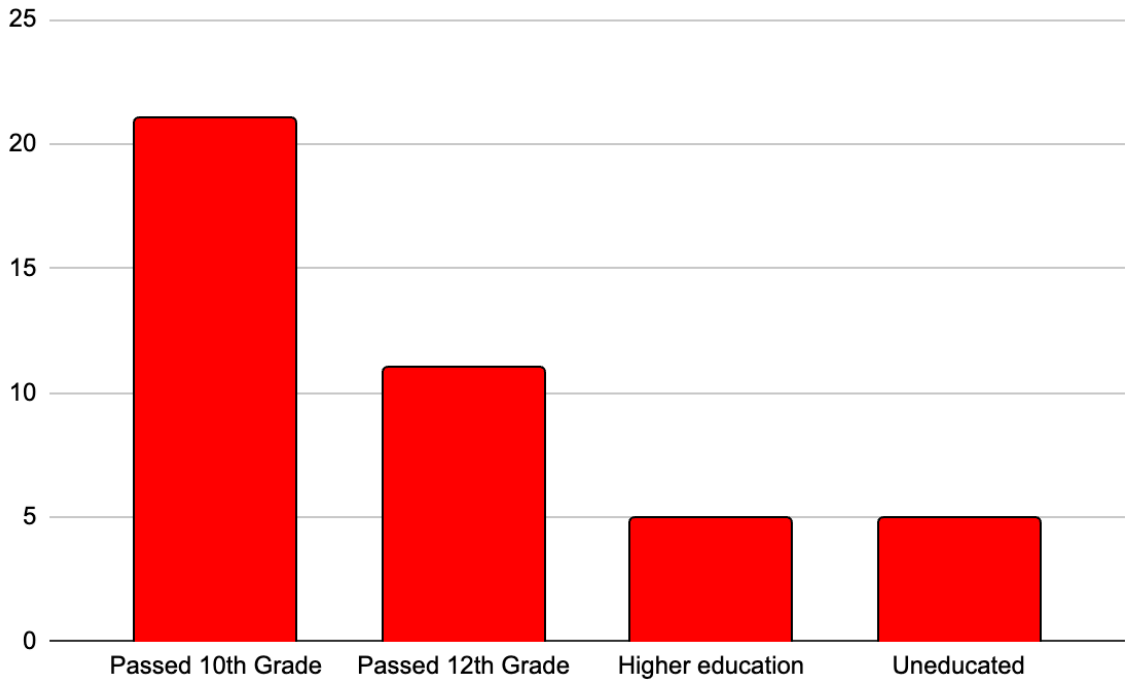
4] Irrigation and Water Use



Pie Chart E:
The above indicates that the majority of the respondents relied on water supply from **canals, borewell, and tubewell systems**. **Only 31%** of the farmers claimed to use smart and modern methods of irrigation like sprinklers. The greater use of these methods (like sprinklers) would lead to efficient use of limited resources like water.

- All farmers expressed the challenges they faced due to the **scarcity of water during cultivation**. This becomes more acute during power cuts and other electrical shortages that limit borewell use.

5] Education Levels



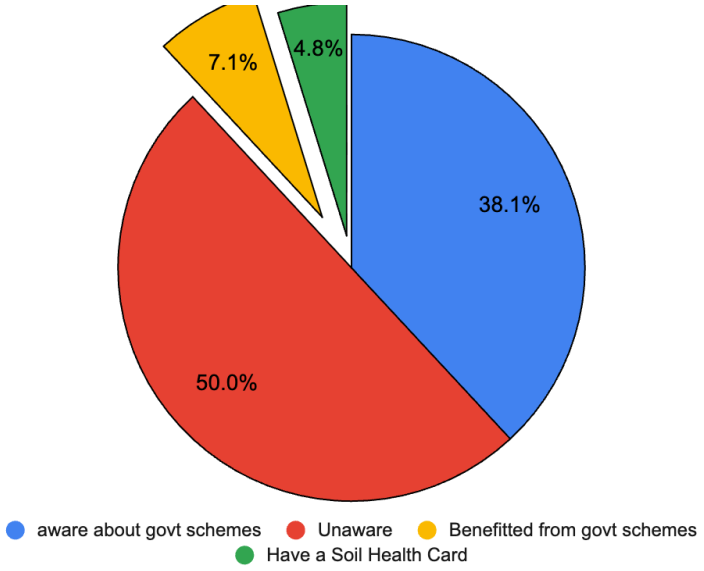
The above graph indicates that the majority of the farmers had only passed their 10th Grade. Very few of them continued beyond the 12th grade. The survey indicated a small number of uneducated farmers. This points to the fact that they did not get employment outside the agricultural sector and thus came back to their villages.

6] Land Profile



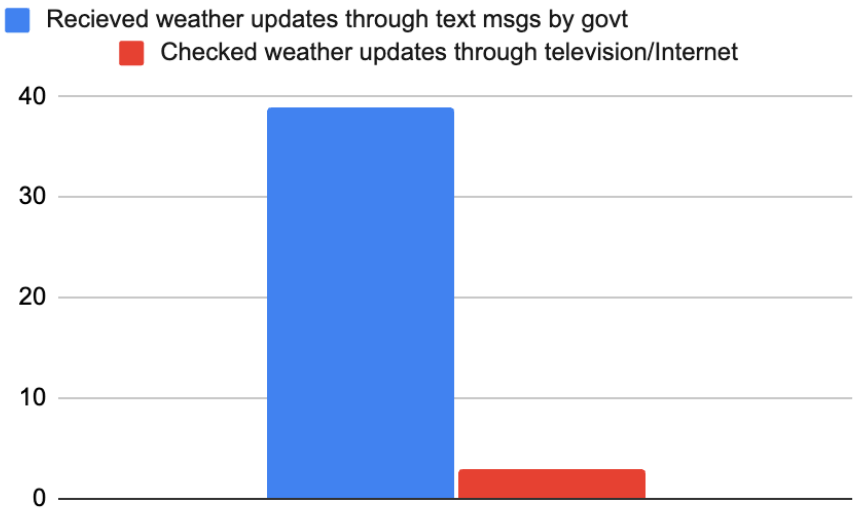
The above graph indicates that the majority of the respondents were on rent.

7] Awareness and Use of Government Schemes



In Pie chart F, less than **50% of the respondents** were aware of government incentive schemes for farmers like PM-KISAN, PMFBY, Soil Health Card, and KCC. Only **7% of the farmers successfully benefited from government schemes, 5%** had their **Soil Health Cards**. The primary reason for this was the infrequent visits of Health card officials, resulting in most of the farmers relying on their **own experience and that of their peers**. Lack of education may be considered as one of the reasons for small numbers joining these schemes.

8] Digital Information Access



In the above graph, the majority of the farmers checked weather updates through text messages that the government periodically sent to them. This clearly indicates the widespread use of digitalisation and affordable smartphones. However, the awareness of AI-based tools and services among the respondents was close to being negligible.

9. Summary of Primary Findings

All the above primary research findings depict a gap among advisory systems regarding soil health and their acknowledgement by farmers in Bhurja Village, Palwal, Haryana. Despite the apparent reduction in the fertility of soil, the use of natural nutrients was not being adopted; it is the dominance of chemical-based fertilisers that seems to be responsible for this situation. The only important postulate under consideration is the maximum yield earned from the farm.

The GDSP of Haryana has been observed to be growing steadily from 2018-19 to the current time period (2024–25), but the **agricultural sector's contribution has declined** from 17.6% to 15.9%. This trend suggests that there is a structural shift in their contribution to the **state's GDP**.

The awareness of certain government schemes, such as PM-KISAN, PMFBY, Soil Health Cards, and KCC, is seen to be negligible despite the potential benefits of such programs. This gap is possibly due to the **lack of communication, complications regarding enrollment, and the lack of government implementation**. The absence, along with the of lack of interaction of Kheti officers with farmers, led to the respondents relying on peer suggestions. This indicates a concerted effort to spread awareness amongst the farmers of various schemes that are intrinsically beneficial to them.

The Digital penetration that occurs via SMS alerts is astonishingly high, but given the respondents' awareness, it points towards a capability that is not being efficiently utilised. In addition, what is essential is the introduction of certain user-friendly and localised agricultural advisory tools, potentially modified with AI visualisation. These steps would definitely improve decision-making, while reducing the reliance on traditional schemes or practices that may not be sustainable in the long run.

10. Conclusion

Soil is a lot more than just its physical form; it is the very basis which connects the economy with ecology and the community. The above primary study from Bhurja Village presents a unique and vivid pattern. Its main aim was to understand the respondents' awareness about various schemes, along with the realisation of the problems faced by the farmers. The study concluded that most of the farmers who had small landholdings were unaware of these schemes. If the awareness increased, it would lead to better utilisation of their limited holdings.

The findings indicated the diminishing nature of soil health, along with significantly challenging environmental and economic pressures that were perceived by all farmers. Many government-run schemes do exist; however, their benefits are unrealised by them, largely due to huge gaps in information and constant impediments in the implementation of these schemes and other policies in the rural areas.

The combination of traditional and cultural farming wisdom passed on through generations, along with newer advanced technology and motivated programs through digital platforms, would be a positive path in bridging these gaps. The "Soil to Soul" approach ideates that **reviving the health of our soil demands more than just mere technology; it requires deep-rooted education in communities, accessibility of information to all, and local support systems that are responsive.**

11. The Way Forward

To increase literacy and productivity among marginal farmers in Bhurja Village, it is suggested to implement the following steps:

1. **School-Level Soil Literacy Programs**
   Introduce soil health and sustainable farming workshops across rural schools to cultivate early environmental and agronomic literacy.

2. **AI-Driven Awareness Tools**
   Used for developing mobile-based dashboards and visualisation tools that simplify soil data, fertiliser guidance, and scheme access for farmers in local languages.

3. **Strengthening Existing Schemes' Adoption**
   This could be achieved by ensuring regular field visits by agricultural officers and proactive awareness sessions in villages to educate farmers about government benefits.

4. **Increase Awareness Of Cover Crop Adoption**
   This would provide incentives or subsidies for cover crops and soil-enhancing practices to reduce reliance on chemical fertilizers and improve soil organic content.

5. **Youth-Farmer Exchange Programs**
   Establish fellowship programs connecting agricultural students and youth volunteers with farmers for mutual knowledge exchange and technical support.

12. Bibliography

Data.gov.in. (n.d.). Agriculture data. (n.d.). *Data.gov.in*. https://data.gov.in/sector/Agriculture

Department of Economic and Statistical Analysis, Haryana. (n.d.). Agriculture statistics. (n.d.). *Department of Economic and Statistical Analysis, Haryana.* https://desagri.gov.in/document-report-category/agriculture-statistics

Food and Agriculture Organisation. (2022). State of the world's soil resources. (n.d.). Food and Agriculture Organisation.

Government of India, Ministry of Agriculture & Farmers' Welfare. (2023). (n.d.). *Government of India, Ministry of Agriculture & Farmers' Welfare*. https://agriwelfare.gov.in/en/Agricultural_Statistics_at_a_Glance

Haryana Budget Documents. (2018–2025). (n.d.). PRS Legislative Research.

Indian Council of Agricultural Research. (2023). Soil Health Reports. (2020). Indian Council of Agricultural Research.

PRS Legislative Research. (2023). Agriculture and farmers' welfare report. (n.d.). *PRS Legislative Research*.

13. REFERENCES

[1] Kumar, R., Meena, B. S., & Singh, R. (2023). A study on farmers' knowledge and use of soil health practices for crop production in Hisar district of Haryana, India. International Journal of Plant & Soil Science.

[2] Sharma, P., Singh, A., & Yadav, R. (2021). Soil health status of select village of district Sonipat, Haryana and way forward. International Journal of Advances in Agricultural Science and Technology.

[3] Yadav, M., Singh, S. K., & Kumar, S. (2024). Soil fertility appraisal for Palwal district of Haryana using geospatial tools. Indian Journal of Agricultural Sciences. Indian Council of Agricultural Research.

[4] Understanding the Persistence of Rice Residue Burning in Northwestern India: A Mixed Methods Approach Author list: Divya Solomona, Andrew McDonaldb, Chris Barrettac, Prakashan Chellattan Veettild, Buta Singh Dhillone Corresponding author: Divya Solomon. Email: dss356@cornell.edu Phone: +1 434 554 1722 Address: 8310 Reed Ct Sacramento, California 95826, USA. (n.d.). *Cornell University*.

14. Appendix

Pilot Study:

https://docs.google.com/spreadsheets/d/1n0HAPVnGDkVU8zv6u-ytgeeTg82HrMUxWsPAG9gNrn8/edit?usp=sharing