TIGR²ESS
Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies

2022

Best Practices in Sustainable Agriculture: Evidence from Punjab

UNIVERSITY OF CAMBRIDGE
GLOBAL FOOD SECURITY
GCRF Global Challenges Research Fund

Life of an Organic Farmer

Though mosquitoes suck my blood without my permission,
They rely after all on our blood donation.
The sharp sugar cane leaves do cut my flesh while weeding,
No pain no gain, plants will grow well, thanks to my bleeding.
Horse flies do harass me too, thinking I'm a donkey,
Or because I'm white , they assume I am a Yankee .
Ants hiding behind the leaves bite me mercilessly,
They save themselves, nothing against me personally.
While sweating like a horse, I think life is beautiful,
I don't have to go to the Turkish bath, and that's cool.
Like a soldier, a farmer has to shed sweat and blood.
He may harvest his crop after facing drought or flood .
The monsoon can bring hope, but also devastation,
He prays for it, rains guarantee food for the nation.
A farmer can sow seeds, work hard and hope for the best,
For it is through God's Grace, if one day he can harvest.
In Punjab, wheat and rice are the main cultivation,
The only crops favoured by the green revolution.
Punjabis don't relish rice , it's not their cup of tea,
To grow food we don't eat is a great absurdity.
Organic farmers don't believe in using pesticide ,
To work against nature is like committing suicide .
To pollute soil and water is not sustainable,
And produce pure and safe food, is only sensible.
Multi cropping combined with a wise crop rotation,
Can protect the soil from any deterioration.
Such farming does not rely on petrochemistry,
It provides healthy food for home and the country.
Such farmers who produce their food are self-reliant,
They won't make a fortune, but they are self-sufficient.
Hard work and organic food keep the farmer healthy,
If one stays in poor health, what's the point of being wealthy.
Farmers who feed the world are looked upon with contempt,
But when there is a lockdown, they are self-sufficient.
Do boost your immune system in time of pandemic,
Organic food will help you along with turmeric.

Darshan Singh Rudel
(Raza Farm, Nurpur Bedi)

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About TIGR^{2}ESS

Objectives and Outcomes Jointly Framed by the Consortium Partners

India's Green Revolution produced significant benefits. The greatest positive impact was felt in regions and on farmers who were able to harness benefits from the combination of new technologies, increased inputs and research-led innovation that have characterised agrarian transformation over the last fifty years. Despite these positive outcomes, there is widespread agreement that the 21st century demands new thinking to address new and emergent challenges, driven by changes in migration and settlement patterns, new forms of economic activity, changes in global commodity markets, and significant environmental challenges.

Objectives

1. To define the requirements and set the policy agenda for a second Green Revolution in India, framed by demographic changes affecting rural communities and feminisation of smallholder farming systems.
2. To develop and strengthen alliances across a carefully selected network of UK and Indian experts, to build a collaborative, long-term research partnership in sustainable agriculture that will set India on the path to a second Green Revolution.

Flagship Projects

Objectives were attained through fundamental research, structured into six Flagship Projects.

- **FP1** Sustainable and Transformative Agrarian and Rural Trajectories (START);
- **FP2** Crop Sciences: Water Use and Photosynthesis;
    - Improving Water Use and Yield Stability in Millet and Sorghum;
    - Crop Sciences: Enhancing Photosynthesis;
- **FP3** Heat and Drought Resilience in Wheat;
- **FP4** Water Use and Management in a Changing Monsoon Climate;
- **FP5** Supply Chains: Modelling Water Use for Sustainable Livelihoods;
- **FP6** Impacting Wellbeing in Rural and Urban Communities: Education, Empowerment and Entrepreneurship Leading to Improved Human Nutrition;
    - Education Food, Nutrition and Empowerment (EFNE);
    - Education, Employment, Empowerment and Entrepreneurship (4E);
    - Cross-Cutting FP6 Projects are the Mobile Teaching Kitchens and the Innovation Farm Model.

About the Research Team

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Cover Credits: Raza Farm, Nurpur Bedi captured by Prof. Suveera Gill (September 2021)

Contents

BOX

FIGURES

TABLES

Executive Summary

The impact of farming systems on the environment and biodiversity depends on the magnitude and intensity at which they are practised. Many alternate farming systems or approaches are characteristically more environment-friendly and support ecology. The underlying principle of these sustainable approaches is to preserve the environment and provide safe and healthy food for all. These systems characteristically require the application of natural processes to enhance diversity through farm inputs, outputs, as well as the use of natural resources across space and time.

The Government of India has taken several initiatives to address sustainability issues in agriculture. As a result, early evidence suggests that farmers are increasingly transitioning to more holistic farming systems. This report aims to demystify and compile sustainable farming best practices of progressive farmers in Punjab. The data was collected through questionnaires, in-depth interviews and stakeholder engagements. One hundred twenty-five farmers were interviewed from six districts and two cropping seasons. Fourteen approaches to sustainable agriculture formed the basis to delimit eight sustainable practice categories.

The findings highlight how farmers are working towards restoring soil fertility, conserving water, and improving crop resistance against pests and environmental stress by following conservation tillage, cover cropping and mulching, green manuring, crop diversification and mixed cropping, organic manuring and composting, rainwater harvesting, and micro-irrigation. A suitable cropping management system, pre- and post-harvest agricultural waste management systems, and an alternate energy source is being practised. Adopting a participatory and community-based approach has enabled knowledge sharing and joint marketing operations. Amongst several grassroots innovations, adopting experimental farming systems, improvising agricultural machinery/implements, water conservation, and mobile phone applications are the foremost.

An inductive research approach led to a framework expounding constraints, drivers, and outcomes underlying the ingenious and frugal solutions for on-farm sustainability. Farmers face resource, institutional, and marketing constraints. However, innovative solutions have not only alleviated resource-constrained conditions but are inclusive, scalable and sustainable. In the future, there is a need to leverage this compendium of solutions to be incorporated into a mainstream system. In addition, integrated policy support may create an enabling environment that addresses constraints and redefines priorities in the local context.

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We would like to acknowledge the unstinting guidance and expertise provided by Siva Muthuprakash K.M. (VikasAnvesh Foundation) in the development of quantitative-cum-qualitative Farm Assessment Index to better capture economic, social, and ecological dimensions of alternate agricultural systems. We are indebted to our colleagues at Panjab University, especially the Department of Public Administration, School of Communication Studies, University Institute of Applied Management Sciences, University Institute of Hotel and Tourism Management, and University Business School, in our pursuit of research across inter-disciplinary issues. Our sincere thanks to Prof. Shailaja Fennell (University of Cambridge), Prof. Sumantra (Shumone) Ray (NNEdPro Global Institute for Food, Nutrition and Health), Prof. Srijit Mishra (IGIDR), Prof. R. Padmaja (ICRISAT) and Dr. Vandana Shiva (Navdanya) for their expert insights and direction.

We have depended on support and advice from numerous stakeholders in each district and village, especially in the field. We are beholden to the wife-husband duo of Khaalis for unravelling the nuances of organics and ethos behind the farmers' collective. We are grateful to our technocrat farmer, Mr. C.S. Grewal (Grewal Farms) and engineer farmer, Mr. Tarjinder Singh (member of the organic grower's group of PAGREXCO), who provided us with a deep insight into farming practices and processes. Their knowledge of organic farming systems and clarity helped in the cost computations. A special thanks goes to our poet farmer, Mr. Darshan Singh Rudel (Raza Farm), who shared his precious and illuminating work titled 'Punjab Bachao (Save Punjab)' and 'Life of an Organic Farmer.' Our deepest thanks to all the farmers who came forth to respond and put forth their perspectives under challenging times of the pandemic and farmers' stir at Delhi borders.

Our young talented research team's consistent perseverance and efforts are highly appreciated. Their multitasking skills contributed to every aspect of research, from field surveys and data collection to analysis

support. It has been a great pleasure to work with them. Co-investigators and the team had the privilege of presenting and discussing their research findings with all our stakeholders at the Final Policy Dissemination Workshop, especially with Mr. Suresh Kumar (TIGR²ESS Policy Fellow). We are most grateful for their well-meaning engagement and thought-provoking suggestions for the way ahead. The creative help of Abhishek Kralia (Department of Geology, Panjab University) in producing maps is acknowledged. We also put on record the administrative support provided to us by the Department of Public Administration, Panjab University.

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Suveera Gill
29th July 2022

Abbreviations

APEDA	Agricultural and Processed Food Products Export Development Authority
CFAI	Comprehensive Farm Assessment Index
GHG	Greenhouse Gas
IUCN	International Union for Conservation of Nature
MoAFW	Ministry of Agriculture & Farmers Welfare
MoEFCC	Ministry of Environment, Forest and Climate Change
NAPCC	National Action Plan on Climate Change
NMSA	National Mission on Sustainable Agriculture
NPOP	National Programme for Organic Production
PAGREXCO	Punjab Agri-Export Corporation
PGS	Participatory Guarantee System
PIB	Press Information Bureau
PKVY	Paramparagat Krishi Vikas Yojana
PMFBY	Pradhan Mantri Fasal Bima Yojana
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
RADP	Rainfed Area Development Programme
SHC	Soil Health Card
SHM	Soil Health Management
SMAF	Sub-mission on Agroforestry

Conversion Table

Area

1 km^2 = 100 hectare (ha)

1 km^2 = 0.3861 square mile

1 km^2 = 247.105 acre

1 m^2 = 10.7639 square feet

1 ha = 10.000 m^2

1 ha = 2.4711 acres

1 square mile = 2.59 1 km^2

1 acre = 0.4047 ha

1 acre = 4046.86 m^2

1 acre = 4840 square yard

1 square yard = 9 square feet

1 square yard = 0.8361 m^2

1 square foot = 0.0929 m^2

Units

1 crore = 10 million

1 million = 10 lakh

1 lakh = 100000

1 billion = 1000 million

1 Sustainable Agriculture and Farming Practices

Sustainability is a dynamic concept and increasingly important in today's agricultural policy and practice. Conserving the environment and providing safe and healthy food are two concomitant priorities for any state. Beyond the state, the interdependence supporting agriculture and food systems assumes increasing importance in a globalised world. However, the global food system is the primary driver of agro-ecological and biodiversity loss, with agriculture alone threatening the risk of extinction of 86 per cent of species (Benton et al., 2021). Furthermore, unsustainable agriculture negatively impacts soil and water and contributes to climate change (Jia et al., 2019). Incongruously, policies and processes are structured around unsustainable agricultural practices leading to the production of 'cheaper' rather than 'quality' food. As a result, increasing consumption of cheaper and resource-intensive foods threatens the dietary health of the masses (Benton and Bailey, 2019).

The impact of farming systems and practices on the environment and biodiversity depends on the magnitude and intensity at which they are practised (Benton et al., 2003). For instance, conventional farming is concentrated around a limited set of crops grown using highly intensive methods, leading to negative consequences on the health and quality of soils, air, water sources and natural ecosystems (Foley et al., 2011). Furthermore, the use of chemical inputs, such as pesticides and nutrients, and the prevalence of monoculture cropping leads to the need to intensify agriculture further. On the other hand, many alternate farming systems or approaches are characteristically more environment-friendly and support biodiversity. These systems characteristically require the application of natural processes to enhance diversity through farm inputs (e.g., bio-nutrients), outputs (e.g., agroforestry), as well as the use of natural resources across space (e.g., biodiversity for nature's services) and time (e.g., crop rotations). While some approaches may increase agricultural productivity (Zaralis and Padel, 2019), environmentally-friendly farming is generally less productive than conventional farming (Seufert et al., 2012). However, farm-level incomes are enhanced through pricing premiums and value-added services.

There is a host of sustainable practices, processes and approaches, from substituting conventional inputs or practices for more sustainable alternatives to conversion to different sustainable agriculture systems that are more agro-ecological supporting modes of food production. Many environmentally friendly practices are similar across sustainable agriculture approaches. Many approaches share an all-compassing goal of striving for sustainability, including environmental aspects and socio-economic considerations. While sustainable

agriculture is subject to much deliberation, the underlying principle is preserving the environment and providing safe and healthy food for all. The three pillars of sustainable development, economic, social, and environmental sustainability, should be met concomitantly (World Commission on Environment and Development, 1987). Accordingly, the Food and Agriculture Organization (1988) defines sustainable agriculture as the "*management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such development .... conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable*". Thus, any agriculture system is sustainable if it hinges on renewable inputs and can steadily and certainly deliver desired outputs without causing adverse and irreversible environmental impacts.

Transitioning to an agricultural system that supports environmental and human health requires redesigning how production systems utilise natural resources. Reducing the conflict between food security and sustainable food production cannot be achieved by identifying a single approach to agro-ecological farming. A gradual transformative change is required, including a shift of the incentives that drive sustainable practices. Further, the entire food value chain beyond mere production must be considered. Thus, this research firstly seeks to identify sustainable farming best practices adopted by farmers in Punjab. In line with the definition proposed by the Food and Agriculture Organization (2003), good sustainable practices imply the management of soil, water, and food safety needs to meet high food production targets and concurrently promote food safety measures. Second, constraint-based creative solutions proposed in agriculture with sustainability insinuations were mapped through an immersive engagement with farmers. Thus, an attempt was made to unravel the constraints, drivers, and outcomes from the farmers' perspective using an inductive research approach.

2 Sustainable Agriculture and Policy Ecosystem in India

According to the Third Biennial Update Report (MoEFCC, 2021), the Indian agriculture sector contributed 14 per cent of the total greenhouse gas (GHG) emissions in 2016. The agriculture sector is the primary source of methane and nitrous oxide emissions. Further, within the sector, 54.6 per cent of GHG emissions were due to enteric fermentation, followed by 17.5 per cent from rice cultivation, 19.1 per cent from fertiliser applied to agricultural soils, 6.7 per cent from manure management, and 2.2 per cent due to field burning of agricultural residues. Though

there has been a fall of 2.25 per cent in GHG emissions since 2014, there is a lot to be done to mitigate the adverse implications of agriculture on climate change.

The Government of India has taken several initiatives to address sustainability issues in agriculture while securing the Sector's growth. The focus of state policy is to make Indian agriculture resilient and sustainable in the face of changing climate. In 2008 the flagship National Mission on Sustainable Agriculture (NMSA), under the National Action Plan on Climate Change (NAPCC), was proposed to make agriculture sustainable. From 2014-15, the NMSA aimed at *"making agriculture more productive, sustainable, and remunerative and climate resilient by promoting location specific integrated/composite farming systems; soil and moisture conservation measures; comprehensive soil health management; efficient water management practices and mainstreaming rainfed technologies"* (MoAFW, 2019: 101). The Mission encompasses sustainability dimensions of the ecological impact of agricultural practices, low farmer incomes, and the threat of climate change on crop yields (Bisht 2019).

The NMSA covers four sponsored schemes within its ambit – Rainfed Area Development Programme (RADP), Sub-mission on Agroforestry (SMAF), Soil Health Management (SHM), and Paramparagat Krishi Vikas Yojana (PKVY). To allay the effect of extreme weather events, the RADP was launched in 2011 to promote integrated farming systems in regions lacking suitable irrigation infrastructure. Overall, the programme has achieved about 75 per cent of its targets from 2014-15 to 2019-20. The SMAF, in line with the National Agroforestry Policy 2014, promotes an increase in tree plantation in an integrated manner with crop production (MoAFW, 2016). Such a practice improves soil health together with livelihood improvement for farmers. The interventions of the Sub-mission include nursery development, peripheral and boundary plantations, low-density farm plantations, high-density block plantations, capacity building and training, and demonstration of agroforestry models. The SHM was launched to encourage site- and crop-specific sustainable soil health management, create and link soil fertility maps with macro-micro nutrient management, judicious application of fertilisers and organic farming practices (MoAFW, 2017). The Soil Health Card (SHC) scheme was launched under its aegis in 2015 to apprise farmers about the status of soil nutrients, the appropriate choice of crops, and the correct nutrient dosage required to enhance soil fertility. Farmers have reported an increase in the crop yield of 5 to 6 per cent after applying the recommended doses of fertiliser and micronutrients (PIB, 2018).

To encourage commercial organic farming in India by creating an organic certification system, the PKVY was initiated in 2015 by the Ministry of Agriculture and Farmers'

Welfare through the National Centre of Organic Farming. To build mutual trust and local relevance in the certification process, the Participatory Guarantee System (PGS) involved the participation of producers and consumers (PKVY, 2017). The PGS has proved to be a workable alternative to third-party certification and effective in developing local organic produce markets. However, the organic production system uptake is not uniform across the country. Hence, the PKVY has not been able to engage small and marginal farmers. Further, most farmers practice conventional and organic agriculture in different farm plots (Reddy, 2017). An alternate programme, National Programme for Organic Production (NPOP), has been implemented by the Agricultural and Processed Food Products Export Development Authority (APEDA) under the Ministry of Commerce and Industries. While PGS-certified products are meant for the domestic market, NPOP-certified products can be exported.

The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was introduced in 2015 under the Ministries of Agriculture, Water Resources and Rural Development to expand the irrigation infrastructure and improve water-use efficiency in agriculture. At the launch of this scheme, 54 per cent of the agricultural land was unirrigated, and farmers depended on rainwater for irrigation. The scheme addresses specific issues related to water usage, such as fast completion of irrigation projects, promoting minor- and micro-irrigation, rain harvesting structures, watershed development, precision irrigation system, and other sustainable water conservation practices. Though prioritised projects under the Accelerated Irrigation Benefit Programme were lagging (NITI Aayog, 2019), there was a substantial increase in the area under micro-irrigation post 2015-2016 (PMKSY, 2020).

The Pradhan Mantri Fasal Bima Yojana (PMFBY) provides crop insurance cover to farmers. The risk coverage is for unavoidable natural risks and the coverage period extends from pre-sowing to the post-harvest period. PMFBY is supported by technological interventions, digitised land records linked to farmers' bank accounts, and purports to settle the claims better (Gulati et al., 2018). However, according to the Thirtieth Report of the Parliamentary Committee on Estimates (Lok Sabha Secretariat, 2018), since its inception in 2016, against the target of covering 40 per cent of India's gross cropped area, less than 24 per cent was covered. Many states opted out of the scheme due to high premiums, inadequate participation in the tendering process, and the limited underwriting capacity of insurers.

In line with India's commitment to the Paris Climate Agreement 2015, the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) was launched in 2019. The scheme aimed to address energy and water security, enhance farmers' income, de-dieselise

the farm sector and reduce environmental pollution. However, the Centre for Science and Environment (2019) reported that the large-scale solar pump deployment, without a comprehensive plan to monitor and control water usage, led to over-exploitation of groundwater. Thus, the scheme supported clean energy but was not green. Accordingly, as a follow-up to avoid disruption of the groundwater table, the government amended installation of new solar pumps as inadmissible in the dark zones notified by the Central Ground Water Board (PIB, 2022).

Among all Indian states, Punjab has the lowest number of farmers (262) practising organic farming under the PGS.[1] Further, only 367 were registered for the NPOP in TraceNet under the third-party certification. The PMKSY has been initiated; around 48,000 hectares of area are under the micro-irrigation system, which is only 0.5 per cent of the national uptake (Government of Punjab, 2022). The State has implemented the Paani Bachao Paise Kamao scheme to incentivise farmers who consume less than a fixed allocation of electricity consumption. In addition, a central government scheme for promoting agricultural mechanisation for in-situ crop residue management was implemented to contain the adverse ramifications of paddy stubble burning. Financial assistance of more than ₹850 crores was provided under the scheme to farmers, farmer groups, and co-operative societies from 2018-19 through 2021-22 (Government of Punjab, 2022), though the case of seasonal crop residue burning continues (Khaiwal et al., 2022). Furthermore, the state has not implemented a crop insurance scheme under the PMFBY to safeguard the farmer from the vagaries of climate change.

3 Materials and Methods

The research process of data collection through questionnaires, interviews and stakeholder engagements provided a holistic view of sustainable agricultural practices. The questionnaire was prepared in conjunction with delineating the conceptual framework based on a stock-and-flow approach and methodology using quantitative and qualitative elements to capture socio-economic as well as agronomic and environmental parameters of farm sustainability. Further, in-depth interviews with progressive farmers and consultations with related stakeholders enabled the selection of the best practices. Data collection was initiated; the selection of farmers was based on the spatial distribution of these practices. Several steps were taken to clean and validate the data using a software package.

[1] https://timesofindia.indiatimes.com/city/chandigarh/punjab-has-least-number-of-organic-farmers-in-the-country/articleshow/90553586.cms

3.1 Approaches and practices

There are numerous terminologies related to sustainable agriculture, making it difficult to differentiate between systems or approaches, practices and supporting activities. Oberč and Arroyo (2020) compiled the various terms related to sustainable agriculture, which included the key approaches with related practices that have been conceptualised and/or implemented around the world under the aegis of the International Union for Conservation of Nature (IUCN).[2] Each of these strives for sustainability, including environmental and socio-economic considerations. Although each approach may consider sustainable agriculture differently, they share more similarities than conventional agricultural systems.

In their study of sustainable agriculture, Gupta et al. (2021) assessed India's most promising sustainable agriculture practices and systems. Their study was referred to identify Indian indigenous or traditional agricultural systems and practices. It was observed that commonly cited Indian traditional farming methods, such as organic wastes, leguminous rotations, integrated farming, cover crops and no-till, find mentioned by Oberč and Arroyo (2020), thus making it exhaustive for identification of best sustainable practices. Furthermore, consultations were held with multiple stakeholders, including Krishi Vigyan Kendras[3] at S.A.S. Nagar (Mohali) and Patiala, Nabha Foundation[4] at Patiala, Baba Nanak Trust[5] at S.A.S. Nagar, Khaalis Collective[6] at S.A.S. Nagar, and Arms2Farms Technosolutions Pvt Ltd.[7] at S.A.S. Nagar, reinforced the choice of practices identified.

A total of fourteen approaches to sustainable agriculture, including agroecology, nature-inclusive agriculture, permaculture or natural farming, biodynamic agriculture, organic farming, conservation agriculture, regenerative agriculture, carbon farming, climate-smart agriculture, high nature value farming, low external input agriculture, circular agriculture,

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[2] IUCN is a membership Union uniquely composed of both government and civil society organisations. Created in 1948, it is the world's largest and most diverse environmental network, harnessing the knowledge, resources and reach of more than 1,400 member organisations and some 15,000 experts. Its broad membership enables its role of incubator and trusted repository of best practices, tools and international standards.

[3] Krishi Vigyan Kendras are the centres for agriculture extensions created by the Indian Council for Agricultural Research (ICAR) and its affiliated institutions at the district level (https://kvk.icar.gov.in/aboutkvk.aspx).

[4] The Nabha Foundation was established in 2003 as a response to a need for a holistic pattern of development and to act as a catalyst for the transformation of Nabha, Punjab. The Foundation has established a Sustainable Agriculture Program for small and landless farmers in Nabha (https://thenabhafoundation.org/about-us/).

[5] Baba Nanak Trust is a citizen-based group that is organised on the community level to serve specific local issues and endeavours to enagage in natural community farming.

[6] Khaalis Collective is a group of like-minded organic farmers of the region who combine their energies in bringing their produce directly to customers' doorstep. Their farms are certified organic and local (https://khaalis-organic-collective.business.site/).

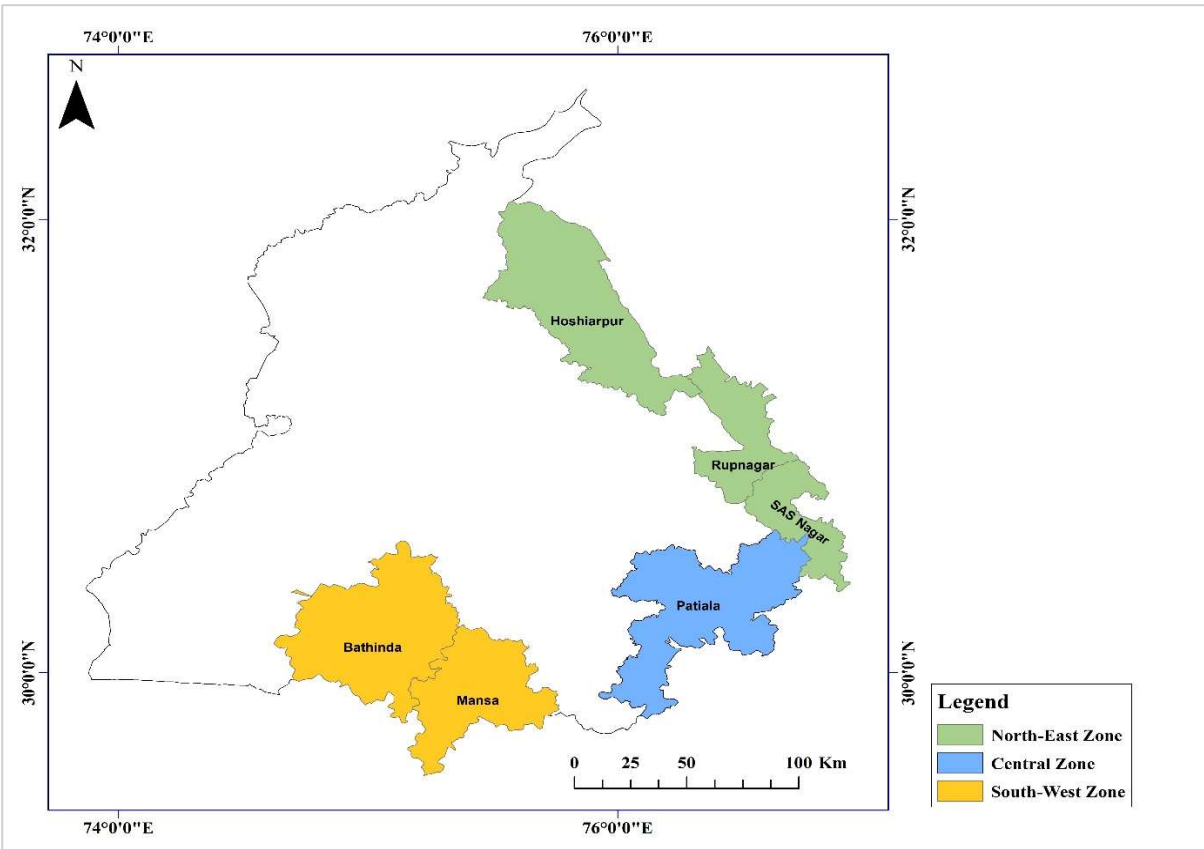
[7] Arms2Farms is a food processing start up based in Chandigarh, with the moto of empowering farmers and veterans. They process premium quality food products without using any artificial flavours or colours.

ecological intensification, and sustainable intensification were enumerated by Oberč and Arroyo (2020) based on the factual collection of information. Further, within each such approach, related sustainable agricultural practices were listed. It was observed that several approaches included similar environmentally responsive practices. Based on the approaches and the nature of associated practices, eight sustainable practice categories were identified, namely, agrobiodiversity and landscape management, soil health and nutrient management, water management, cropping management, weed, pest and disease management, waste and energy management, post-harvest management, and work integrity, health, and safety management.

3.2 Description of the location and cropping seasons

Punjab is traditionally classified into three agro-climatic zones primarily based on homogeneity of factors like climatic conditions, precipitation distribution, soil type, and cropping pattern (World Bank, 2003). A total of 178 farm plots across three agro-climatic zones – the North-East (Districts of S.A.S. Nagar, Rupnagar, and Hoshiarpur), Central (Patiala District) and South-West (Districts of Mansa and Bhatinda) – were assessed, as depicted in Figure 1. The northeast zone is a sub-mountainous region called the Kandi or wheat-maize belt, covering

Figure 1 Sample Agro-Climatic Zones under Study



Source: Depiction by Kralia (Department of Geology, Panjab University).

around 19 per cent of the state's geographical area, with relatively high rainfall (950 mm) and low groundwater levels. The central or wheat-paddy zone covers 47 per cent area with 650 mm rainfall and a depleting groundwater level. The South-West Zone or wheat-cotton region accounts for 34 per cent area with 400 mm of rain and faces waterlogging problems. Thus, the research provides an opportunity to capture the spatial variations in agriculture.

The two cropping seasons, i.e., Rabi 2020-2021 and Kharif 2021, were taken for analysis. According to the Punjab Economic Survey (2021-2022), approximately 40 per cent of Punjab's total cultivated land is used to grow paddy, an area of 31.42 lakh hectares. Other major Kharif crops include cotton (3.2%), followed by maize (1.5%) and sugarcane (1.2%). Approximately 45 per cent of the total cultivated land or 35.21 lakh hectares is utilised to cultivate wheat, a Rabi crop. Accordingly, wheat, rice and cotton are the major crops of interest in this study.

3.3 Sample profile

A total of 125 farmers were interviewed from 68 villages across six districts. The overall sample has only two per cent women farmers, and that too concentrated in only one district, i.e., Patiala, as shown in Table 1. The average age of the respondents is 47 years, ranging from

Table 1 Demographic Profile of the Farmers

		Number	Percentage
Gender	Male	122	98
	Female	3	2
Age (in years)	Less than 30	13	10
	30-39	27	22
	40-49	28	22
	50-59	29	23
	60-69	22	18
	Above 70	6	5
Education	No formal education	5	4
	Primary	6	5
	Secondary	35	28
	Higher-Secondary	33	26
	Graduate	30	24
	Post-graduate	16	13
Farming experience (in years)	Less than 10	16	13
	11-19	21	17
	20-29	34	27
	30-39	27	22
	40-49	19	15
	Above 50	8	6

Note: $n = 125$.
Source: Compilation by Gill and Sharma.

23 years to 72 years. Further, 46 per cent of farmers are 50 years and above. The participation of the youth (< 30 years) in farming is a dismal ten per cent. The education-wise distribution of farmers shows that 63 per cent are higher-secondary and above. The average farming experience is 25 years; 70 per cent of the farmers have an experience of 20 years and more.

With 100 per cent irrigated land, around 83 per cent of the organic farmers plough their own owned land compared to 67 per cent of the conventional ones. The average size of organic and conventional plots are 2.56 and 11.16 acres, respectively. Thus, organic farmers are primarily practising on small and marginal farm plots. Amongst organic farmers, 49 per cent are certified, with 43 per cent having a second source of income. Around 84 per cent of farming households own livestock, primarily buffaloes and cows.

3.4 Preparation, administration and validation of the survey instrument

The survey instrument used is an extended version of the farm assessment index proposed by Muthuprakash (2018). Accordingly, an extensive validated questionnaire was used to collect all the quantitative details of farm inputs (Annexure A). In addition, qualitative parameters were built into the questionnaire to measure the contextual aspects of farming in the national indicator framework of sustainable agriculture (Muthuprakash and Damani, 2019). Each bilingual (English and Punjabi) questionnaire had three parts. In the first section (questions 1 and 2), respondent farmers provided their personal and asset details. The second section (questions 3-12) pertained to soliciting data going into the construction of a quantitative Comprehensive Farm Assessment Index (CFAI). This was followed by questions (13-18) on getting details about farmers' other sources of income, debt position, and agricultural insurance or subsidies. Finally, the third section (questions 19-22) is related to the general perception of the respondents' on-farm management resources, social interface and extension activities, as well as experiences, challenges and suggestions. This section was framed around one proposed by Muthuprakash and Damani (2019) and Muthuprakash et al. (2020).

The social sciences have been paying increasing attention to the issue of research ethics (e.g., Finch, 1984; Borland, 1991; Hornsby-Smith, 1993; Gilhooly, 2002). Therefore, informed consent was secured from the respondents at the outset after sufficiently informing them about the research objectives and stated outcomes. In addition, a common problem in participative research is that respondents often over-report desirable activities and under-report undesirable ones (Krumpal, 2013). As a result, researchers gather situation-specific information that cannot be generalised. The questionnaire's cover page assured that anonymity would be observed to abate any such problem. Further, the respondents were gently reminded of the value they were

potentially bringing to the research. The questionnaires were personally administered and completed on the field by trained facilitators over six months.[8]

As specified earlier, the present work draws from the research work of Muthuprakash (2018), who conducted both the validity and sensitivity analysis of the FAI tool indicators. The current composite index added thirteen additional qualitative indicators based on past research. The validation of the indicators used in developing the index has been carried out through the Delphi technique. As a first step, a focused group discussion cum workshop on *'Exploring Sustainable Farming and Innovative Marketing Practices'* was held in collaboration with Krishi Vigyan Kendra, S.A.S Nagar (Mohali). The discussion cum workshop with farmers and other stakeholders provided insight regarding various indicators and their weightage to different index dimensions. Since the Delphi technique does not call the expert panels representative samples for statistical purposes (Powell, 2003; Thangaratinam and Redman, 2005), three experts were chosen based on their knowledge and experience as a second step in sustainable farming practices and processes. At the end of two rounds, the indicator set and its hierarchy were agreed upon by participating experts.

3.5 In-depth interviews

Based on the field observations of best practices, farmers were identified for conducting in-depth interviews. Prior permission was sought for conducting the interview and recording on-farm practices. All relevant questionnaire responses were reviewed before the interviews to form an agenda for the interviews. At the start of each interview, the objective underlying the conduct of the study was elucidated. There were no fixed series of interview questions as the issues arising in each case differed depending on the agro-ecological practice es. Consistent with the recommendations of Brown (1992), the interviews employed neutral, conversational prompts and a laddering technique. Where appropriate, reference was made to the farmers' survey response to confirm the reliability of the evidence collected, as proposed by Yin (2003). All the interviews were recorded and fully transcribed and lasted between two and three hours.

3.6 Data analyses

The main quantitative characteristics of the sample were explored by applying descriptive statistics. A descriptive analysis unravelled the relevant, sustainable practices and systems in the context of the region and the ecosystem under study. Thus, as the data were generated, the

[8] A PU-TIGR^{2}ESS workshop on *'Survey Field Work and Data Collection'* was held on Tuesday 31 August, 2021, for the facilitators by the resource person Dr. Amandeep Singh Sidhu, Agronomist, School of Organic Farming, Punjab Agricultural University, Ludhiana.

interviews and supporting documentation of the sustainability practices (e.g., organic farming certificates, soil test reports[9]) were analysed based on the pre-defined filters for identification.

4 Results and Discussion

4.1 Best Practices

Best farming practices are key to ensuring safe food and non-food agricultural products with a minimum impact on the environment and health of all stakeholders. A combination of sustainable on-farm and post-production processes is a practical approach to deliver a genuine assurance of food safety and quality together with food security.

4.1.1 Agro-biodiversity and landscape management

Historically, varied forms of agro-biodiversity have developed across the world. Agro-biodiversity includes all aspects of biodiversity that are quintessential in producing food and maintaining the agro-ecosystem. It is thus an interface between the environment, genetic resources, species, ecosystem diversity of animals, plants, and microorganisms, as well as socio-economic and cultural impacts (Food and Agriculture Organization, 1999). Holistic landscape management aims to increase synergies and reduce trade-offs between agricultural production and ecosystem conservation.

Table 2 and Figure 2 present the best agrobiodiversity and landscape management practices observed in the field. Practices fostering the natural ecosystem that makes up the landscape with associated ecological properties and processes together with cultivation has a positive impact on biodiversity, water resources, and soil fertility. Agroforestry improves soil fertility and structure by providing a conducive microclimate for crops, such as pollinators and nitrogen-fixers. Using the natural landscape, including natural ponds and moats, creates a habitat where it becomes difficult for natural predators, pests, and diseases to thrive. Awareness about the local ecosystem enables adapting crop selection and cropping patterns supporting soil health, water, and other resources. Planting a variety of trees, plants and shrubs across the field contributes to plant diversity and associated improvement in ground and surface water levels. Prudent tree planting and canopy management can provide suitable habitats for flora and fauna. Plantations around the field are living fences that provide windbreaks, are a source of organic matter, and bind the soil.

[9] Soil samples were collected from all 178 farm plots to test parameters like nutrient content, soil pH, soil salinity and soil organic carbon required soil sample analysis.

Table 2 Best Agrobiodiversity and Landscape Management Practices

Practice	Sustainability Upshot	Associated Sustainable Approach	Location (Village/District)
Protecting biodiversity and natural habitats	Maintains and improves natural soil fertility and structure, natural disease and pest control pollination, water supply and treatment	• Agroecology • Nature-inclusive agriculture • Permaculture • Biodynamic agriculture • Organic farming • Regenerative agriculture • Climate-smart agriculture • High nature value farming • Sustainable intensification	• Dadiana (S.A.S. Nagar) • Kishanpur (S.A.S. Nagar) • Mothapur (Rupnagar) • Mullanpur (S.A.S. Nagar) • Nurpur Bedi (Rupnagar)
Assessing topography and soil for optimal selection of crops	Adapt crop production to terrain and climate change	• Climate-smart agriculture	• Gajewas (Patiala) • Kishanpur (S.A.S. Nagar) • Meemsa (Patiala) • Mullanpur (S.A.S. Nagar) • Saidpura (S.A.S. Nagar)
Canopy management	Maximises the use of sunlight and other resources	• Agroecology • Permaculture	• Bhattlan (Patiala) • Mothapur (Rupnagar) • Saidpura (S.A.S. Nagar)
Trees, plants and shrubs on farmland	Improves the soil productivity, groundwater table and the ecosystem	• Agroecology • Carbon farming	• Gunike (Patiala) • Kishanpur (S.A.S. Nagar) • Mullanpur (S.A.S. Nagar) • Saidpura (S.A.S. Nagar)
Boundary/border planting	Serve as windbreaks, source of organic matter, shade and soil binder	• Agroecology • Regenerative agriculture	• Gunike (Patiala) • Kakut (Rupnagar) • Mullanpur (S.A.S. Nagar) • Saidpura (S.A.S. Nagar)

Source: Compilation from survey, interviews, and stakeholder consultations.

Figure 2 Select Agrobiodiversity and Landscape Management Practices

Note: Clockwise from top left: Maintaining natural habitat; Protecting biodiversity; Canopy management; Border tree planting.
Source: Compilation from field visits to Nurpur Bedi (Rupnagar), Kakut (Rupnagar), and Saidpura (S.A.S. Nagar).

4.1.2 Soil health and nutrient management

The soil composition includes mineral particles (sand, silt, and clay), organic matter, air and water. Soil aids ecosystem function, but much cannot be done about its texture since it is region specific. However, since healthy soil sustains biological productivity, maintains air and water quality, and promotes plant, animal and human health, efforts should be made to increase soil quality. Thus, healthy soil is the foundation for profitable, productive, and sustainable agricultural systems. Nutrients are essential for plant growth and are available in the soil (e.g., nitrogen, phosphorus, and potassium) in air and water (carbon, hydrogen, oxygen). Nutrient management involves balancing soil nutrients consistent with crop requirements.

Select soil health and nutrient management practices are presented in Table 3 and Figure 3. Progressive farmers are aware of how overworking soil with aggressive machinery can degrade soil structure and aggregation. Hence, leaving fields fallow or following no or minimum tillage restores soil fertility and water infiltration, improves crop resistance against pests and environmental stress, and carbon sequestration. Growing cover crops (e.g., rye, oats, millets, alfalfa, barley) and mulching keep the ground covered to protect soil from erosion and

Table 3 Soil Health and Nutrient Management Best Practices

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
Leaving fields fallow for one crop cycle	Restores soil fertility and interrupts the lifecycle of weeds, pests, and diseases	• Agroecology • High nature value farming	• Bhattlan (Patiala) • Mullanpur (S.A.S. Nagar)
Minimum or conservation tillage practice	Improves soil structure, water infiltration and retention, and carbon sequestration	• Agroecology • Nature-inclusive agriculture • Permaculture • Organic farming • Conservation agriculture • Regenerative agriculture • Carbon farming • Ecological intensification • Sustainable intensification	• Kishanpur (S.A.S. Nagar) • Makran (S.A.S. Nagar) • Mullanpur (S.A.S. Nagar) • Saidpura (S.A.S. Nagar)
Cover crop and mulching*	Reduces soil erosion and provides nutrients	• Agroecology • Permaculture • Organic farming • Conservation agriculture • Regenerative agriculture • Sustainable intensification	• Bhajo Majri (Patiala) • Dalanpur (Patiala) • Duan Kalan (Patiala) • Kishanpur (S.A.S. Nagar) • Madu (Patiala) • Mullanpur (S.A.S. Nagar) • Patialan (Rupnagar) • Saidpura (S.A.S. Nagar)
Nitrogen-fixing cropping	Boosts soil fertility naturally	• Agroecology • Organic farming	• Bhawalpur (Patiala) • Kishanpur (S.A.S. Nagar)

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
		• Low external input agriculture • Sustainable intensification	• Mehandli Khurd (Rupnagar) • Mullanpur (S.A.S. Nagar) • Nurpur Bedi (Rupnagar) • Saidpura (S.A.S. Nagar)
Green manure	Improves soil structure, increases water holding capacity and decreases soil loss by erosion	• Organic farming • Low external input agriculture • Sustainable intensification	• Bhawalpur (Patiala) • Gunike (Patiala) • Kalyan (Patiala) • Nasirpur (Patiala) • Nurpur Bedi (Rupnagar)
Forage and biomass planting	Improves soil health, water quality and improves organic matter	• Carbon farming • Circular agriculture	• Nasirpur (Patiala) • Saidpura (S.A.S. Nagar)
Crop diversification and rotation	Conserves soil nutrients and interrupts lifecycle of weeds, pests, and diseases	• Agroecology • Biodynamic agriculture • Organic farming • Conservation agriculture • Regenerative agriculture • Low external input agriculture • Circular agriculture • Ecological intensification • Sustainable intensification	• Kakut (Rupnagar) • Kuttiwal Khurd (Bathinda) • Nabha (Patiala)
Crop residue retention (e.g., use of elevated crop straw mulch over a waterway)	Source of organic matter that leads to soil health, water conservation, nutrient recycling, and decreases the trends of residue burning	• Conservation agriculture • Carbon farming • Circular agriculture	• Kishanpur (S.A.S. Nagar) • Pandori Phangura (Hoshiarpur) • Saidpura (S.A.S. Nagar)
Farmyard manure application*	Keeps the soil productivity longer	• Agroecology • Circular agriculture	• Kishanpur (S.A.S. Nagar) • Makran (S.A.S. Nagar) • Mullanpur (S.A.S. Nagar) • Nasirpur (Patiala) • Nurpur Bedi (Rupnagar) • Saidpura (S.A.S. Nagar)
Organic manure and bio-fertilisers	Reduces or eliminates the use of chemical fertilisers	• Agroecology • Nature-inclusive agriculture • Biodynamic agriculture • Organic farming • Regenerative agriculture • Carbon farming • Climate-smart agriculture • High nature value farming • Low external input agriculture • Ecological intensification • Sustainable intensification	• Balahar (Bathinda) • Bassi Ballo (Hoshiarpur) • Bhattlan (Patiala) • Dalanpur (Patiala) • Dulewal (Bathinda) • Makran (S.A.S. Nagar) • Meemsa (Patiala) • Mehma (Bathinda) • Moosa (Mansa) • Nasirpur (Patiala) • Saidpura (S.A.S. Nagar)

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
Composting and vermicomposting*	Enhances plant growth, reduces disease, increases soil porosity and microbial activity, and improves water retention and aeration	• Agroecology • Permaculture • Biodynamic agriculture • Organic farming • Regenerative agriculture • Carbon farming • Sustainable intensification	• Nohra (Patiala) • Kuttiwal Khurd (Bathinda) • Lubana Teku (Patiala) • Pandori Khangura (Hoshiarpur) • Saidpura (S.A.S. Nagar)
Algae and other aquatic biomass (e.g., Azzola)	Makes a natural fertiliser and an ideal feed for animals due to its high nitrogen content	• Circular agriculture	• Kuttiwal Khurd (Bathinda) • Makran (S.A.S. Nagar) • Saidpura (S.A.S. Nagar)

Note: *Select villages (districts) listed.
Source: Compilation from survey, interviews, and stakeholder consultations.

Figure 3 Select Soil Health and Nutrient Management Best Practices

Note: Clockwise from top left: Straw mulching; Green manure cropping; Farmyard manure; Bio-fertilisers; NDAEP composting; Azolla cultivation.

Source: Compilation from field visits to Patialan (Rupnagar); Nasirpur (Patiala), Kuttiwal Khurd (Bathinda), Moosa (Mansa); and Saidpura (S.A.S. Nagar).

runoff. Further, cover crops add carbon-based organic matter to the soil to match the timing of crop nutrient needs due to their slow decomposition, which is far more beneficial than fertilisers. Some cover crops proliferate and keep weeds at bay. Above the ground cover crops attract farmer-friendly insects; below the ground, they decrease the number of harmful nematodes in the soil. Organisms, like ants, earthworms and beetles, contribute to the change and maintenance of soil structure. Legume plants (e.g., lentils, peas, peanuts, clover) boost soil fertility naturally as they help in nitrogen-fixation in the roots of plants.

Box 1 Nurturing the Food Chain

Many microbes, insects and birds that we think of as pests are nurturers of the organic food chain. Mr. Ramnik believes that organic systems strengthen natural disease resistance and pest predation. The preservation of natural areas of vegetation adjacent to crops and plants provide alternative food and sanctuary to many insect predators, wild flora, birds and other wildlife. Planting large trees on the periphery of the farmland provides a natural shield against hazardous drifts. They also provide important nesting, feeding and sheltering sites for birds, thus enhancing farmland birds that pick on insects and worms in the field. Growing legumes on a rotation basis fix atmospheric nitrogen and improve soil health while increasing biodiversity as pollinators. Many bees, beetle, and butterfly species are pollinators that are crucial in natural plant communities. The fodder crops and grains grown as livestock and poultry feed change the soil food web composition, augmenting the earthworm population. Earthworms work as soil biotechnologists and solid waste managers leading to improved soil fertility. Further, the animal and bird feed waste and excreta are excellent farmyard manure as they supply plant nutrients, including micronutrients. Organic farms are thus an intricate web of life.

Source: Excerpts from the blog by Gill and Kaur (2021), Growing Organics 'Organically': A Reality Check. https://greenerrevolution.wordpress.com/2021/09/04/growing-organics-organically-a-reality-check/

Besides the use of cover crops, crop rotation, crop residue management, and the use of nutrients like compost and manure increase the soil's organic matter. Crop rotations help break up soil-borne pest and disease life cycles besides managing weeds. Diversification of crops helps reduce nutrient excesses. Instead of burning stubble, maintaining residue on the soil surface helps to suppress weeds, conserve moisture, and provide a habitat for insect predators. Further, the recycling of biomass optimises organic matter decomposition and nutrient cycling. Adding inputs like compost, farm yard manure and bio-fertilisers at the right time, quantity, and manner increases soil porosity and microbial activity and improves water retention and aeration. Azolla and other aquatic biomass contribute to the recycling of nutrients.

4.1.3 Water management

Water is a critical input for agricultural production. Irrigated agriculture is, on average, at least twice as productive per unit of land as rainfed agriculture.[10] Climate change and the resultant changing rainfall patterns are a major concern to farmers. Agricultural management practices that improve water retention and percolation at the field level result in more soil moisture for plant growth, leading to increased productivity and groundwater recharge. Further, optimising irrigation scheduling and more efficient irrigation systems, such as drip irrigation, can result in water conservation.

Around 85 per cent of the water resources in Punjab are consumed for irrigation purposes, drawn primarily from underground through a diesel-powered pump irrigation system. Since 2017, there has been overexploitation of groundwater to meet the agricultural requirement pushing the net annual groundwater availability for irrigation to zero (Government of Punjab, 2022). Irrigated crop production costs are strongly affected by diesel prices, which have been on an upward trajectory. In the face of depleting water resources, many farmers have adopted best-fit agricultural water management practices (Table 4 and Figure 4). The choice of crops should depend much on local contexts and specific priorities. A number of organic farmers have opted out of rice cultivation and thus avoided flooded paddy fields and associated greenhouse gas effects.

Diversified agricultural systems make more productive use of water. For example, cover cropping and mulching retain or increase soil organic matter, increasing the soil's capacity to hold water and decreasing evaporation, facilitating groundwater recharge. Similarly, raised bed and furrow cropping offer more effective control over irrigation and

[10] https://www.worldbank.org/en/topic/water-in-agriculture

drainage as well as conveyance of nutrients and rainwater management. The practice also allows for diversified and mixed cropping.

Table 4 Water Management Best Practices

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
Choice of crops (e.g., avoid paddy rice system to avoid flood irrigation)	Use crop production for mitigation of methane emissions	• Climate-smart agriculture	• Gharuan (S.A.S. Nagar) • Saidpura (S.A.S. Nagar)
Raised bed and furrow cropping	Conserves water, better drainage of excess water, and proper aeration in the seedbed and root zone	• Climate-smart agriculture	• Bhattlan (Patiala) • Dulewal (Bathinda) • Makran (S.A.S. Nagar) • Makran (S.A.S. Nagar) • Nasirpur (Patiala) • Nurpur Bedi (Rupnagar)
Cover cropping and mulching*	Reduces water evaporation and runoff	• Climate-smart agriculture • Low external input agriculture • Ecological intensification	• Barwa (Rupnagar) • Dabrikhana (Bathinda) • Fatehgarh Nouabad (Bathinda) • Kakut (Rupnagar) • Kishanpur (S.A.S. Nagar) • Nabha (Patiala) • Patialan (Rupnagar) • Saidpura (S.A.S. Nagar)
Rainwater harvesting (e.g., farm ponds)	Reduces the need for irrigation	• Agroecology • Permaculture	• Basiballo (Hoshiarpur) • Nurpur Bedi (Rupnagar) • Saidpura (S.A.S. Nagar)
Water recharging (e.g., termite foraging activity)	Strengthens water supply through recharge; and resilience to drought	• Climate-smart agriculture	• Saidpura (S.A.S. Nagar)
Micro-irrigation systems (e.g., drip irrigation and sprinklers	Decrease water, fertiliser and labour requirements	• Climate-smart agriculture	• Bhattlan (Patiala) • Kakut (Rupnagar) • Saidpura (S.A.S. Nagar)

Note: *Select villages (districts) listed.
Source: Compilation from surveys, interviews, and stakeholder consultations.

Many water and irrigation management practices improve nutrient absorption and the amount of carbon sequestered in the soil. Water recharging through percolation tanks and tubewells are common water harvesting structures. Fertigation, which is administering fertilisers into the irrigation system, primarily through micro irrigation systems, results in a better and controlled application. Supplemental irrigation with rainwater harvesting in aquifers as well as drip and sprinkler irrigation results in greater crop and water productivity. These

practices also reduce soil erosion and the cost of pumping groundwater. An added benefit of micro-irrigation methods is that they deliver water slowly and directly to the plant root systems without much evaporation.

Box 2 Ground Water Harvesters

As an engineer, Mr. Singh had a fair idea of his farmland's contours. The region receives around 600 mm of annual rainfall that saturates about ten feet of the soil layer. Instead of using a field leveller, he used this knowledge to conserve water and protect the soil. Once, while watering a plant, he was struck by the quick absorption of water in the ground where dry mulching was carried out and termitaria were present as termite feed on dead organic matter. So, he experimented with the termites. Termites live in colonies, tunnelling to 100 feet below the ground. He stacked the farm biomass on the berms at the lower elevations, where termites started building termitaries. Again, termite foraging activity led to below-ground tunnels, which increased soil microporosity, increasing water infiltration in soil. This circumvented farm flooding and rainwater runoff, resulting in water recharging and a resultant increase in the water table. The small hand water pump on his farm that had dried out earlier started running water within four years. It began to discharge sufficient water that ideally met the farm requirement. With the improved saturation of the soil, drip irrigation was feasible, which could not be thought of before. Thus, termite foraging management led to water availability and the creation of fertility hotspots.

Source: Excerpts from the blog by Gill et al. (2022), Fertility Hotspots: Using Termite Activity in Agro-Ecosystems. https://greenerrevolution.wordpress.com/2022/01/05/fertility-hotspots-using-termite-activity-in-agro-ecosystems/

Figure 4 Select Water Management Best Practices

Note: Clockwise from top left: Raised bed and furrow cropping; Elevated mulch crop bed on a waterway; Farm pond; Drip irrigation.
Source: Compilation from field visits to Dulewal (Bathinda), Kishanpur (S.A.S. Nagar), Basiballo (Hoshiarpur), Saidpura (S.A.S. Nagar).

4.1.4 Cropping management

Proper management of crops is vital to increasing agricultural productivity and improving food and nutrition security. In addition, there is increasing awareness about the spatial and temporal ramifications of agricultural systems on sustainability. Cropping management includes making the right choice of crop type, crop sequences and techniques in a manner that augments the utilisation of land, water and nutrients, thus positively affecting the environment.

Table 5 and Figure 5 present the best farm crop management practices. Growing and saving the seed of diverse species and varieties, especially traditional ones, is vital to creating resilient and diverse agriculture. Further, a few framers have also successfully tried self-seeded cropping by not tilling and allowing crops to mature and shed their seeds. Moving to polyculture systems by rotating crops and planting a diverse selection of crops leads to improve nutrient cycling and to ward off pests and diseases. Practices such as intercropping and mixed cropping improve soil moisture content and retention, enhance water infiltration, boost the diversity of soil biota, and decrease soil erosion. An innovative farmer is also practising relay

Table 5 Cropping Management Best Practices

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
Farm-saved seeds and self-seeded cropping	Adapts to local conditions and resistant to pests and diseases	• Agroecology • Biodynamic agriculture • Organic farming	• Ajroor (Patiala) • Dulewal (Bathinda) • Kishanpur (S.A.S. Nagar)
Crop diversification	Increases soil fertility and controls pest incidences	• Organic farming • Conservation agriculture • Regenerative agriculture • Low external input agriculture • Circular agriculture • Ecological intensification • Sustainable intensification	• Kakut (Rupnagar) • Kuttiwal Khurd (Bathinda) • Makran (S.A.S. Nagar) • Nabha (Patiala) • Nilanaloya (Hoshiarpur) • Saidpura (S.A.S. Nagar)
Intercropping/mixed/ relay cropping	Improves nutrient and input efficiency, space usage and pest regulation	• Agroecology • Regenerative agriculture • High nature value farming • Low external input agriculture • Circular agriculture • Ecological intensification • Sustainable intensification	• Ajjowal (Hoshiarpur) • Bassi Jalal (Hoshiarpur) • Kakut (Rupnagar) • Kuttiwal Khurd (Bathinda) • Makran (S.A.S. Nagar) • Nabha (Patiala) • Nilanaloya (Hoshiarpur) • Patialan (Rupnagar) • Saidpura (S.A.S. Nagar)
Crop rotation	Conserves nutrients and interrupts lifecycle of weeds, pests, and diseases	• Agroecology • Biodynamic agriculture • Organic farming • Conservation agriculture • Regenerative agriculture • Low external input agriculture • Circular agriculture • Ecological intensification • Sustainable intensification	• Kakut (Rupnagar) • Kuttiwal Khurd (Bathinda) • Nabha (Patiala)
Crop-livestock integration*	Allows optimal nutrient recycling	• Agroecology • Biodynamic agriculture • Organic farming • Climate-smart agriculture • Circular agriculture • Sustainable intensification	• Bassiballo (Hoshiarpur) • Bhagiwander (Bhatinda) • Duan Kalan (Patiala) • Kakut (Rupnagar) • Makran (S.A.S. Nagar) • Raipur (Mansa) • Saidpura (S.A.S. Nagar)

Note: *Select villages (districts) listed.
Source: Compilation from surveys, interviews, and stakeholder consultations.

farming by sowing one vegetable into a standing second vegetable well before harvesting the latter. To reinforce critical agro-ecosystem processes, integrated crop-livestock systems rely on synergistic relationships between plants and animals. For example, manure from livestock is used as a nutrient source for crops, and crop residues are used as feed for livestock.

Figure 5 Select Cropping Management Best Practices

Note: Clockwise from top left: Seed bank; Intercropping, Mixed cropping; Crop-livestock farming.
Source: Compilation from field visits to Kishanpur (S.A.S. Nagar), Patialan (Rupnagar), Ajjowal (Hoshiarpur), and Duan Kalan (Patiala).

farming by sowing one vegetable into a standing second vegetable well before harvesting the latter. To reinforce critical agro-ecosystem processes, integrated crop-livestock systems rely on synergistic relationships between plants and animals. For example, manure from livestock is used as a nutrient source for crops, and crop residues are used as feed for livestock.

4.1.5 Weed, pest and disease management

There is considerable loss in crop yield due to weeds, pests and diseases. Weed management focuses on controlling weeds that vie with crops for sunlight, moisture, and soil nutrients. Weeds are sometimes also a primary cause of insects and other pests attacking the plants and causing diseases. The increased use of chemicals to control weeds and pests has generally led to an initial increase in crop productivity and farm labour efficiency. However, over the long-

term, it forces the usage of more extensive prevention practices, thereby increasing production costs. The most successful weed, pests and diseases management programs have been the ones that have their foundations in preserving agro-ecosystems.

Restoring and maintaining natural balance within the farm ecosystem is one of the best ways to contain weeds, pests and diseases. Table 6 and Figure 6 explicate some of the ecologically friendly practices farmers adopt in Punjab. The ecological practices common in controlling weeds are conservation tillage, growing cover crops, mulching, crop rotation, multiple and relay planting, and drip irrigation. Organic farmers plant companion planting to draw pests away from crops. They also develop insectaries to attract beneficial insects and birds, biologically controlling pests. The grazing by livestock also helps in the natural clearing of the fields. Using natural herbicides and pesticides from fruits and plant extracts are inexpensive and effective tools in managing weeds and pests. Further, pest monitoring and control can be done through insect traps (with and without baits) and fruit bagging.

Table 6 Weed, Pest and Disease Management Best Practices

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
Cover crops	Enhances biological control of weeds and pests	• Agroecology • Low external input agriculture • Circular agriculture • Ecological intensification	• Kishanpur (S.A.S. Nagar) • Mothapur (Rupnagar) • Mullanpur (S.A.S. Nagar) • Nurpur Bedi (Rupnagar) • Saidpura (S.A.S. Nagar)
Companion planting of marigold and other bright yellow-coloured planters	Helps to keep pests away	• Biodynamic agriculture	• Kakut (Rupnagar) • Kishanpur (S.A.S. Nagar) • Kuttiwal Khurd (Bathinda) • Nasirpur (Patiala) • Nurpur Bedi (Rupnagar) • Saidpura (S.A.S. Nagar)
Biological control through beneficial insects and birds	Decreases long-term incidence of pests and reduces environmental and health hazards	• Agroecology • Biodynamic agriculture • Organic farming • Ecological intensification • Sustainable intensification	• Kishanpur (S.A.S. Nagar) • Makran (S.A.S. Nagar) • Mothapur (Rupnagar) • Mullanpur (S.A.S. Nagar) • Saidpura (S.A.S. Nagar) • Shatabgarh (S.A.S. Nagar) • Tangori (S.A.S. Nagar)
No or natural herbicides*	Reduces environmental and health hazards	• Agroecology • Organic farming • High nature value farming • Low external input agriculture	• Balahar (Bathinda) • Bassi Ballo (Hoshiarpur) • Bhattlan (Patiala) • Dalanpur (Patiala) • Meemsa (Patiala) • Mehma (Bathinda) • Moosa (Mansa) • Nasirpur (Patiala) • Rolumajra (Rupnagar) • Saidpura (S.A.S. Nagar)

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
No or natural pesticides*	Reduces environmental and health hazards	• Agroecology • Nature-inclusive agriculture • Permaculture • Organic farming • Regenerative agriculture • High nature value farming • Low external input agriculture • Sustainable intensification	• Moosa (Mansa) • Bassi Ballo (Hoshiarpur) • Dalanpur (Patiala) • Balahar (Bathinda) • Bhattlan (Patiala) • Mehma (Bathinda) • Meemsa (Patiala) • Nasirpur (Patiala) • Saidpura (S.A.S. Nagar) • Rollumajra (Rupnagar)
Insect traps	Minimises ecological disturbance and impact	• Ecological intensification	• Balahar Mehma (Bathinda) • Bhattlan (Patiala) • Dabrikhana (Bathinda) • Fatehgarh (Bathinda)
Fruit bagging	Reduces the use of pesticides, natural pests and disease control	• Ecological intensification	• Dabrikhana (Bathinda) • Fatehgarh (Bathinda) • Mehandli Khurd (Rupnagar)

Note: *Select villages (districts) listed.
Source: Compilation from surveys, interviews, and stakeholder consultations.

Figure 6 Select Weed, Pest and Disease Management Best Practices

Note: Clockwise from top left: Companion planting; Bevy of peacocks; Insect trap; Fruit bagging.
Source: Compilation from field visits to Nasirpur (Patiala), Kishanpur (S.A.S. Nagar), Bhattlan (Patiala), Fatehgarh (Bathinda).

Box 3 DIY Sustainable Farm Hacks to Control Weeds, Pests and Diseases

- **Neem extract or oil** is highly potent against insect and mite pathogens as it works as an antifeedant. It is also a natural fungicide.
- **Vetiver oil** is an effective insect repellent and has a larvicidal activity. It also possesses herbicidal and termiticide properties.
- **Garlic extract** has pungent repellent properties and is used as insecticide, fungicide, and nematicide.
- **Onion extract** has a bioinsecticidal impact. It improves the quality and growing patterns of plants.
- **Chilli pepper** has a strong odour as well as taste and is an excellent homemade natural antifeedant and insect repellent.
- **Datura stramonium seeds** have insecticidal and repellent properties. It can be used for biopesticide application and post-harvest loss control of insects
- **Turmeric powder** has natural bactericidal as well as antifungal properties and can be used with irrigation water to control pests.
- **Fermented fruit juice** is used as bait to attract fruit flies that enter the trap bottle and get stuck.
- **Sour buttermilk** stored with a copper strip for a week makes an effective fungicide and pesticide.
- **Cow urine,** when fermented, has nitrogen that aids the growth of crops. It is also an effective insect repellant.
- **Ash** from wood contains silica that hinders insect feeding and is an effective repellant.
- **Cow dung cake water** has gibberellic acid, a plant growth hormone that helps ward off diseases.
- **A mix of cow dung and urine** best controls pests, besides being a good source of plant nutrients.
- **A mix of cow urine and chillies** is an effective organic fertiliser and helps control pests.
- **A mix of cow urine, chillies, garlic and neem** is an insect repellant and pesticide. It also controls for the common viral diseases of vegetables and fruits.
- **A mix of cow dung, gram flour, and jaggery** helps decompose organic matter and repels insects.
- **A mix of leaves (neem, aak, datura, aonla, jamun, tulsi, jatropha), onion bulbs, ginger and turmeric rhizomes** possess excellent fungicidal properties.

Source: Field survey inputs shared by farmers with Sharma, Kukreja, and Chaddha (2021-22).

4.1.6 Waste and energy management

Like any sector, agriculture also generates waste depending on the type of cultivated produce and the farming approach adopted. Every stage of cultivation, from land preparation to harvest, results in the generation of agricultural waste. Post-harvest activities, like storage and transport, especially perishable food, can lead to spoilage and waste. Further, livestock farming results in greenhouse gas emissions, besides the generation of solid waste. To make matters worse, indiscriminate burning of agricultural stubble, weeds, and waste emits toxic pollutants and adversely affects soil fertility. Using fossil fuels for energy negatively affects the environment and health. This calls for prudent agricultural waste management that sustains the quality of soil, water, air, plant, animal, and energy resources.

There are sustainable options for handling agricultural wastes and meeting energy needs, as shown in Table 7 and Figure 7. As far as possible, initiatives taken to contain in-situ waste management benefit farmers and the environment. Using agricultural by-products and residue in fodder or feed preparation has been practised long as an indigenous alternative. Furthermore, these natural plant and animal wastes are important for composting due to their high organic matter content and nutrients. Rice straw has been successfully used for mulching and applied with compost as a substrate to grow vegetables on an elevated waterway to recycle straw and conserve water. Using fortified soil (e.g., farmyard manure, coco peat, and river sand) in sustainably prepared pots (clayey soil, cow manure, and wheat chaff) dug in the earth

Table 7 Waste and Energy Management Best Practices

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
Composting (e.g., agricultural and livestock waste)	Enhances plant growth, reduces disease, increases soil porosity and microbial activity, and improves water retention and aeration	• Agroecology • Permaculture • Biodynamic agriculture • Organic farming • Regenerative agriculture • Carbon farming • Sustainable intensification	• Avtaar Singh (Patiala) • Kuttiwal Khurd (Bathinda) • Lubana Teku (Patiala) • Pandori Khangura (Hoshiarpur) • Saidpura (S.A.S. Nagar)
Waste recycling (e.g., animal fodder, straw mulching, termite foraging activity)	Reduces the use of some external inputs	• Agroecology	• Kuttiwal Khurd (Bathinda) • Nurpur Bedi (Rupnagar)
Biomass, biogas and solar energy	Increases energy efficiency of farming practices and minimises the use of non-renewable energy sources	• Climate-smart agriculture • Sustainable intensification	• Anandpur Sahib (Rupnagar) • Dabrikhana (Bathinda) • Jai Singhwala (Bathinda)

Note: *Select villages (districts) listed.
Source: Compilation from surveys, interviews, and stakeholder consultations.

Figure 7 Select Waste and Energy Management Best Practices

Note: Clockwise from top left: Vegetable and fruit waste; making sunken pots out of a mixture of clayey soil, sand, cow dung, and wheat chaff; Biogas plant; Agrivoltaics through solar panels.
Source: Compilation from field visits to Kuttiwal Khurd (Bathinda), Kishanpur (S.A.S. Nagar), Anandpur Sahib (Rupnagar), Jai Singhwala (Bathinda).

enables the growth of varied vegetables and fruits. Biomass has been used for termite foraging and sold to local cement and fertiliser manufacturing companies for a good price. Besides, agricultural and animal waste is being used to produce biogas. Shifting to more eco-friendly and renewable energy sources, such as solar, was observed only on one farm in Bathinda. The State has taken no initiatives to encourage renewable energy for agricultural purposes nor availed of the central government scheme[11] to reduce its agricultural subsidy bill.

4.1.7 Post-harvest management

Sustainable post-harvest management is systematically handling, storing, transporting and carrying out any value-addition activities on agricultural produce and products after harvest while reducing the carbon footprint. The pre-harvest cultivation practices and soil as well as climatic conditions affect post-harvest quality. Temperature is the most crucial factor in maintaining quality after harvest, especially for perishable crops. Proper handling, sorting and

[11] The PM-KUSUM Scheme launched in 2019 is aimed at ensuring energy security for farmers in India.

cleaning as well as packaging extends the shelf life, preserving the freshness and quality of the produce. Storage in the value chain is required to ensure uninterrupted supplies and can be carried out in-situ or ex-situ in commercial storage or cold chains. Affordability or safety is a significant trade-off that needs to be considered in transportation from production to marketing sites. Processing is an essential value-added activity that stabilises food supplies and makes them available beyond their harvesting period. Post-harvest technologies can contribute to food security as well as create better employment and income earning opportunities.

The climatic conditions of Punjab with extreme summer and winter periods pose a major post-harvest challenge. Therefore, it is not difficult to comprehend why farmers prefer to follow the wheat-paddy cycle, where procurement happens at the market price within a short period immediately post-harvest. For organic farmers, however, this is not a marketing option; therefore, they sell their seasonal produce at the farm gate or organic farmers' markets. However, certain post-harvest prevention and reduction practices taken up by progressive farmers have been presented in Table 8 and Figure 8.

Table 8 Post-Harvest Management Best Practices

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
In-situ crop storage (e.g., multi-tier zero energy storage, zero energy cool storage chamber)	Increases shelf-life and nutritional value and reduces spoilage	• Climate-smart agriculture	• Kishanpur (S.A.S. Nagar) • Makran (S.A.S. Nagar) • Nilanaloya (Hoshiarpur)
Food processing*	Reduces food loss, waste and adverse environmental impact	• Climate-smart agriculture	• Ajjowal (Hoshiarpur) • Gajewas (Patiala) • Gharuan (S.A.S. Nagar) • Kalyan (Patiala) • Kishanpur (S.A.S. Nagar) • Kuttiwal Khurd (Bathinda) • Meemsa (S.A.S. Nagar) • Mullanpur (S.A.S. Nagar) • Patialan (Rupnagar)
Retail market outlets	Reduces nutrient loss	• Biodynamic agriculture	• Mullanpur (S.A.S. Nagar) • Patialan (Rupnagar)
Agri-marketing app using service-oriented architecture	Reduces nutrient loss and leads to transparent pricing information, as well as saves cost, time and effort for the producer and consumer	• Circular agriculture • Sustainable intensification	• Patialan (Rupnagar) • Gharuan (S.A.S. Nagar)

Note: *Select villages (districts) listed.
Source: Compilation from surveys, interviews, and stakeholder consultations.

Figure 8 Select Post-Harvest Management Best Practices

Note: Clockwise from top left: Multi-tier zero energy storage; Zero energy cool storage chamber; Khaalis Organic Collective retail outlet; Processed vinegar, pickles, and jams sold in organic farmers' market.
Source: Compilation from field visits to Kishanpur (S.A.S. Nagar), Makran (S.A.S. Nagar), Mullanpur (S.A.S. Nagar), Gajewas (Patiala).

Innovative farmers have created low-cost ecologically sound structures for in-situ crop storage. Multi-tier zero energy storage optimises the use of storage resources and saves costs for crops like onions, garlic, and fennel. Zero energy cool storage chamber enables short-term storage of vegetables and fruits on-field before sale. Many organic producers have taken up food processing for increased income and food safety. From basic processing, like wheat flour, wheat porridge, gram flour, turmeric powder, and chilli powder, to tertiary processing, like edible oils, vinegar, jaggery, preserved and dehydrated fruits and vegetables, jams, candies, ketchup and chutneys, farmers have a wide range of processed products to offer. Some also undertake festival and special occasion orders for sweets and savouries. One organic farmer has opened a roadside Dhaba (eatery) and is in the catering business. With a strong bent toward responsible and sustainable consumerism, a group of organic farmers of the region formed a collective to open a retail outlet that sells only certified organic and local products. Since they have no intermediary, it is a 'farm to plate' model. Using new-media marketing tools, young farmers promote sales of fruits and vegetables through Instagram or Facebook to become more resource efficient and temporally and spatially precise.

Box 4 Disrupting Gendered Status Quo

Interacting with the women active in various agricultural activities unfolds what motivated them to break down the gender challenge. Harjeet Kaur, a middle-aged woman, surprised us when she mentioned that she looks after each farm operation, from tilling the land to buying farm inputs and supervising the labour. She revealed that agriculture always interested her, and she was encouraged by her father to drive a tractor. After marriage, Harjeet pursued her interest and had the full backing of her husband. She has gone ahead to teach operating the tractor to village women and participated actively in the tractor rally during the farmers' protests in Delhi in 2020-21. Another woman agriculturist, Sandeep Kaur, is a processor, trainer, and shareholder in Green Focus Farmer Producer Company. She trains women in food packaging and labelling. Her organic products, including spices, mustard oil, jaggery sweets, wheat porridge, multigrain wheat flour, maize porridge, and pickles, are in great demand and are sold through Kisan Huts. When Gurpreet Kaur walked us through her kitchen, it seemed more like a food laboratory! Through processing and dairy operations, she engages in diverse agricultural activities. She sells her products under the label 'K.S. Agro Products.' Her organic milk and milk products, like ghee, are popular with customers. We witnessed Navreet Kaur actively engaging with customers selling fresh organic vegetables and pulses besides homemade processed items during our visits to one of the weekly organic farmers' markets in Patiala. She said that though she does not participate in field operations, food processing and value addition help showcase her culinary skills. Navreet promptly added that pursuing such ventures involves investment, but it helps if you have a steady income to fall back on.

Source: Excerpts from the blog by Gill et al. (2022), Women in Agriculture: Marginalised or on the Margins? https://greenerrevolution.wordpress.com/2022/01/20/women-in-agriculture-marginalised-or-on-the-margins/

4.1.8 Work integrity, health, and safety management

Upholding the integrity of organic produce, normally requires the farmers to comply with the stated norms along the entire value chain, from farm to market. In India, organic products are certified under the NPOP Standard[12], PGS for India[13], and Food Safety and Standards (Organic Foods) Regulations, 2017[14]. Through Punjab Agri-Export Corporation (PAGREXCO), the Government of Punjab is implementing the organic programme by providing institutional support to the state's organic farmers under various Government of India schemes.[15] From a socio-economic angle, strengthening local communities through collectivism, women's engagement, and innovations can support sustainable agriculture.

Table 9 and Figure 9 present best practices of work integrity, health, and safety management in Punjab. It has been observed that the actual standards and control may vary considerably between organic certifiers and producers, which could risk undermining the veracity of organic farming. Much cannot be said about the uncertified farmers, who comprise more than half of the organic farmers in Punjab. Nonetheless, most organic farmers and processors are driven by an intrinsic motivation to offer authentic, high-quality products. Similarly, most consumers buy organic products based on their trust in farmers and their practices. Some farmers have been recognised and awarded for their sustainable and progressive practices.

Sustainable agriculture involves a participatory approach aiming to empower the community through networking. Regular interactions, exchange of farm inputs, including preservation of seeds, sharing of knowledge and expertise, and joint marketing are the important activities of these organic communities. There are alternative forms of farmers' collectivisation or cooperation models. Traditionally, co-operatives have been structured based on user-ownership, -control, and -benefit principle. Lately, the model of farmer producer

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[12] The NPOP grants organic farming certification through a process of third-party certification carried out by an independent body. The certified products can be traded both in foreign and domestic markets under the tag '. TRACENET is an on-line application tool managed by the APEDA under NPOP for management of entire organic certification system in the country (http://apeda.gov.in/apedawebsite/organic/Organic_Products.htm).

[13] PGS-India programme is a farmer group centric certification system, which was launched by the Ministry of Agriculture and Farmers Welfare. This is applicable to organic products made available in the local and domestic markets (https://pgsindia-ncof.gov.in/). Kheti Virasat Mission is the authorised regional council in Punjab to provide organic certification under the PGS (https://www.agrifarming.in/organic-farming-in-punjab-how-to-start).

[14] The 2017 Regulations are based on the standards of NPOP and PGS-India. The unified logo is an identity mark to distinguish organic products from non-organic ones supported with the tagline '*Jaivik Bharat'* (https://jaivikbharat.fssai.gov.in/).

[15] PAGREXO has partnered with CropIn to ensure the traceability and transparency of its organic produce using artificial intelligence and machine learning technology (https://www.cropin.com/news/government-of-punjabs-pagrexco-scales-up-partnership-with-cropin-and-the-subheading-will-be-march-2020).

organisations or companies is an emerging hybrid legal form of collaboration.[16] Further, the model of engaging consumer families who contribute towards the growth of vegetables on the farm and receive their supply of fresh vegetables at home through shared farmland is a unique experiment carried out by establishing direct engagement with no intermediaries.

The health and safety of food are not only a priority for consumers but farmers and farm labour as well. Practising sustainably, sans harmful fertilisers, pesticides, and insecticides save farm workers from exposure to toxic chemicals and related health hazards. However, due to the increased mechanisation of farm processes, working on farms exposes the operators to accidents and injuries. On the contrary, in labour-intensive processes fatigue, monotony and hardship experienced while working with hand implements commonly lead to drudgery. Left unattended, such activities and exposure can lead to psycho-physiological stress and occupational diseases. Keeping in mind safety and health concerns, farmers have made improvisations in

Table 9 Work Integrity, Health, and Safety Management Best Practices

Practice	Sustainability Upshot	Associated Sustainable Approach	Village (District)
Upholding agricultural integrity with certification*	Provides an excellent local and global market for products	• Organic farming • Biodynamic agriculture	• Bhagiwander (Bathinda) • Bhajo Majri (Patiala) • Kishanpur (S.A.S. Nagar) • Makran (S.A.S. Nagar) • Mothapur (Rupnagar) • Nila Niloya (Hoshiarpur) • Raipur (Mansa) • Saidpura (S.A.S. Nagar)
Participatory (community-supported) and responsible way of farming	Contributes to the ecological, economic, social, cultural, and spiritual resilience of the community	• Organic farming • Biodynamic agriculture	• Makran (S.A.S. Nagar) • Mullanpur (S.A.S. Nagar) • Patialan (Rupnagar)
Reducing in-situ health externalities (e.g., motorised operated chaff cutter machine was customised with a safety feature)	Provide a safe and conducive environment to the farm workers	• Agro-ecological • Organic farming • Biodynamic agriculture • Circular agriculture • Ecological intensification	• Khangar (Rupnagar) • Meemsa (S.A.S. Nagar) • Saidpura (S.A.S. Nagar)
Drudgery reduction (e.g., customised stand-up manual weeder and stick planter) and equivalent pay for similar tasks to workers (e.g., gender parity)	Promote sustained, inclusive and productive employment and decent work for all	• Biodynamic agriculture	• Kuttiwal Khurd (Bathinda) • Meemsa (S.A.S. Nagar) • Kakut (Rupnagar) • Gajewas (Patiala) • Bhattlan (Patiala)

Note: *Select villages (districts) listed.
Source: Compilation from surveys, interviews, and stakeholder consultations.

[16] The Government of India introduced a pilot scheme, Farmer Producer Organisations during 2011-12 through Small Farmers' Agribusiness Consortium (https://sfacindia.com/FPOS.aspx).

farm equipment, like adding a safety feature in the motor-operated chaff cutter machine. Farm implements such as manual weeder and stick planter have been ergo-designed to minimise drudgery. The novel practice of rotating job functions on the farm reduces monotony, and 'equal pay for equal work' promote gender parity, which is an added incentive.

Figure 9 Select Work Integrity, Health, and Safety Management Best Practices

Note: Clockwise from top left: Award for outstanding farmer adopting organic farming; Community-supported family farming; Safety feature in chaff cutter machine; Customised stand-up manual weeder and stick planter.
Source: Compilation from field visits to Nila Naloya (Hoshiarpur), Makran (S.A.S. Nagar), Saidpura (S.A.S. Nagar), Kuttiwal Khurd (Bathinda).

4.2 Ingenious and frugal solutions for on-farm sustainability

An immersive engagement with the farmers enabled mapping constraint-based indigenous, creative and frugal solutions proposed in agriculture with sustainability implications as in Table 10. These most relevant grassroots innovations ranged from adopting experimental farming systems, improvising agricultural machinery/implements, water conservation, and using mobile phone applications. These are sometimes creative and at other times, a novel twist on an old idea. Further, some reflect the farmer's creativity, such as elevated horizontal mulch crop bed on a waterway or termite foraging for biomass management and water recharging, to look for newer ways of farming. While in the case of others, a solution, such as collective crop

Table 10 Alleviating Constraints by Improvising Ingenious and Frugal Solutions for On-Farm Sustainability

Ingenious Solution	Description	Trigger/ Constraint	Outcome	Value Proposition
Cover cropping and canopy management blueprint	The system of planting orchard trees according to their canopy height with a 24 square feet grid of mango trees, by plantations done alternately and guavas grown at their diagonal centre and peaches on four sides.	• Innovative mindset • Resource constraint	• Optimum land utilisation • Increased fruit yield	**Impactful**: Robust and affordable **Inclusive**: Applicable to all sites both at an individual- and the community-level **Scalable**: Extendible **Sustainable**: Resilient use of space and water conservation
Elevated horizontal mulch crop bed on a waterway	A system to grow vegetables (e.g., spinach, fenugreek, coriander and onions) on an elevated platform of mulch over a waterway instead of using the conventional method of planting them in the soil	• Innovative mindset • Environmental concern • Scale-up constraint • Resource constraint	• Increased productivity per acre • Reduced water evaporation • Sustainable use of crop straw • Improved eco-efficiency	**Impactful**: Robust and affordable **Inclusive:** Applicable to all sites both at an individual- and the community-level **Scalable**: Ease of use and extendible **Sustainable**: Resilient production, water conservation, and reduction in carbon footprints
Termite foraging management	Due to termite foraging activity, the system led to below-ground tunnels, increasing soil microporosity and water infiltration resulting in water recharging and a resultant increase in the water table.	• Innovative mindset • Environmental concern	• Sustainable use of biomass • Increased water table • Increased soil microporosity and fertility • Improved biodiversity	**Impactful**: Robust and affordable **Inclusive**: Applicable to all sites both at an individual- and the community-level **Scalable**: Extendible **Sustainable**: Resilient use of biomass and water conservation at zero cost
Modified trench method	A system of sugarcane planting with the depth of the trench is 26 inches, and line-to-line space is kept at one foot. However, the cropping is skipped after planting two consecutive rows.	• Innovative mindset • Resource constraint	• High input use efficiency • Intercropping possible • Enhanced water efficiency • Low weeding cost	**Impactful:** Robust and affordable **Inclusive:** Applicable at an individual- and the community-level **Scalable:** Ease of use and extendible **Sustainable:** Resilient and conserves soil and water
High-value vegetable relay cropping	A system of high-value vegetable relay protected cropping with emphasis on quality rather than yield over short-period (e.g., one capsicum cycle from September-December) targeting early harvesting with high margins	• Innovative mindset • Resource constraint	• High-quality produce • Negligible use of insecticides • Four to five times increased price realisation	**Impactful:** Robust **Inclusive:** Applicable at the community-level **Scalable:** Extendible **Sustainable:** Resilient

Ingenious Solution	Description	Trigger/ Constraint	Outcome	Value Proposition
Farming with controlled and fortified soil conditions	A system to grow vegetables and fruits (e.g., Indian squash and muskmelon) using fortified soil (e.g., farmyard manure, coco peat, and river sand) in sustainably prepared pots (using clayey soil, cow manure, and wheat chaff) dug in the earth. The pots will eventually merge into the ground, leaving the sand in place for the plants to grow in.	• Innovative mindset • Environmental concern	• Diversified production • Sustainable and optimal resource usage • Improved eco-efficiency	**Impactful**: Robust and affordable **Inclusive**: Applicable to all sites both at an individual- and the community-level **Scalable**: Ease of use and extendible **Sustainable**: Resilient and diversified production
Multi-tier zero energy storage	A system to store crops (like onions, garlic, and fennel) on an elevated two-tier mesh hung from the roof girder ensures air circulation and a longer shelf-life.	• Innovative mindset • Environmental concern • Resource constraint	• Sustainable and optimal resource usage • Improved eco-efficiency	**Impactful**: Robust and affordable **Inclusive**: Applicable to all sites both at an individual- and the community-level **Scalable**: Ease of use and extendible **Sustainable**: Resilient and reduces food wastage
Zero energy cool storage chamber	The double brick-walled structure with wet sand filled in between and covered by straw for short-term storage of vegetables and fruits on-field before sales were improvised to two-thirds below the ground	• Innovative mindset • Resource constraint • Scale-up constraint	• Better marketability of vegetables and fruits • Retain nutritive value • Improved eco-efficiency	**Impactful:** Robust and affordable **Inclusive:** Applicable to all sites both at an individual- and the community-level **Scalable:** Ease of use and extendible **Sustainable:** Resilient and reduces produce perishability and wastage
Customised agricultural plough	An agricultural plough customised with bolts and nuts to adjust the distance between two blades depending on the bed plantation.	• Innovative mindset • Resource constraint	• Flexible usage • Reduced investment in machinery	**Impactful**: Robust and affordable **Inclusive**: Applicable to all sites both at an individual- and the community-level **Scalable**: Ease of use and extendible **Sustainable**: Resilient
Collective crop planning and marketing	A system of cropping and marketing is done through a collective so that the consumer gets a choice of a diversified food basket from a single sale point, and the producers get a guaranteed market and good price	• Marketing constraint • Resource constraint • Scale-up constraint • Institutional constraint	• Guaranteed market • Increased income • Collective seed bank	**Impactful:** Robust **Inclusive:** Applicable at the community-level **Scalable:** Extendible **Sustainable:** Resilient

Ingenious Solution	Description	Trigger/ Constraint	Outcome	Value Proposition
Using an app for agri-marketing	An app service that provides up-to-date market prices of vegetables and architecture that better matches the supply with demand	• Innovative mindset • Resource constraint • Marketing constraint	• Transparent pricing information • Low-cost marketing • Saves time and effort for the producer and consumer • Engagement of youth in farming through the use of technology	**Impactful:** Robust and affordable **Inclusive:** Applicable at the community-level **Scalable:** Ease of use and extendible **Sustainable:** Resilient and supply of fresh vegetables
Community-supported family farming	A group of twenty-five families contribute towards the growth of vegetables on the farm and receive their supply of fresh vegetables at home through common farmland.	• Marketing constraint • Resource constraint • Scale-up constraint	• Ensures production marketability and revenues • Builds trust between producer and consumer	**Impactful:** Robust and affordable **Inclusive:** Applicable to all sites at the community-level **Scalable:** Ease of use and extendible **Sustainable:** Resilient
Motorised chaff cutter machine	A motorised chaff cutter machine was customised with a safety feature	• Innovative mindset • Avoiding machine-operating injuries	• Increased machine safety	**Impactful**: Robust and affordable **Inclusive**: Applicable to all sites both at an individual- and the community-level **Scalable**: Ease of use and extendible **Sustainable**: Resilient and safe
Customised stand-up manual weeder and stick planter	A stand-up manual weeder and manual stick planter customised to be user friendly	• Innovative mindset • Health constraint	• Less strenuous and comfortable to use • Reduces drudgery of work • Low cost and efficient	**Impactful**: Robust and affordable **Inclusive**: Applicable to all sites both at an individual- and the community-level **Scalable**: Ease of use and extendible **Sustainable**: Resilient

Note: The table presents select but most relevant sustainable grassroot farm-based solutions.

Source: Compiled by Gill based on inputs from surveys, interviews, and stakeholder consultations.

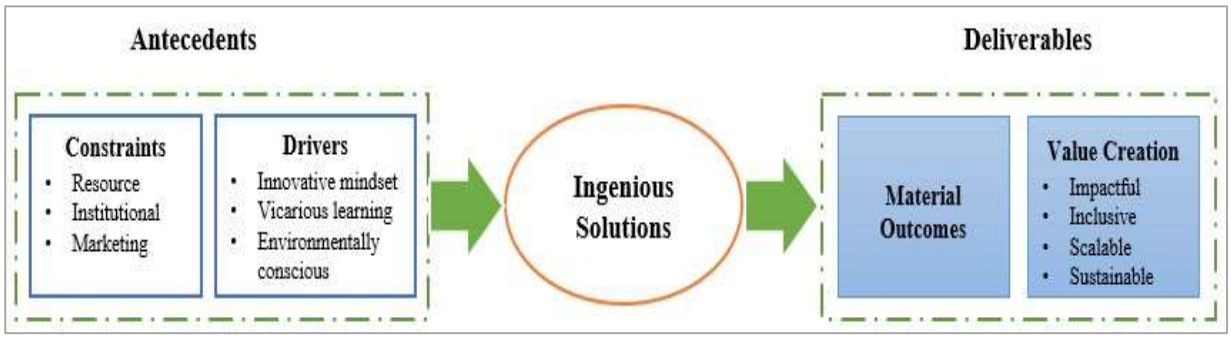
planning and marketing or using an app for agri-marketing, alleviates challenges at hand given the constraint on resources or scaling up to tap emerging opportunities. Besides, the solution should target the sustainable well-being of the consumer and farming community, especially small and marginal farmers as well as women, while reducing drudgery and being cost-effective. Resource constraints range from the availability of inputs, labour, finance, and marketing to institutional void.

There is a three-fold outcome, in economic, environmental and social terms, of such solutions provided by the farmers. First, in economic terms, better land utilisation has increased the yield and quality of produce at a lower cost. The farmers have a more diversified production, better access to information, and marketing avenues resulting in cost savings and improved safety. Second, on the environmental front, not applying pesticides and insecticides favours soil fertility, water use and biodiversity. Further, the optimal usage of resources results in being more eco-efficient. Last, from a social perspective, more transparency and quality products build trust between producers and consumers. Low-cost improvisations in machinery as well as ergonomic hand tools and implements promote safety and reduce work drudgery. Further engagement of women and empowering of youth creates an inclusive community.

As a value proposition, the indigenous solutions devised by the farmers are robust and affordable. The capacity to adapt in the face of limits in the availability of critical resources or changes is likely to affect their long-term resilience and viability. Their purpose is focused on alleviating the challenge at hand and delivering value to customers and a broader set of impacts on society. For a few, their creative solutions are acknowledged by the public and media, building their image amongst their fellow farmers and consumers. Though local resources ease local problems, most solutions have wider applicability and recyclability. These can be replicated at a reasonable price, cost, and level of performance with positive ramifications on the environment.

The inductive framework provides unique insight into value creation in an agricultural context and its impact on sustainable development in the backdrop of the farming heartland of India, as shown in Figure 10. The framework explicates the exposition of antecedents (i.e., constraints and drivers) and deliverables (i.e., material outcomes and value creation) of sustainably indigenous and ingenious solutions at a low cost. Farmers face three significant constraints – resource, institutional, and marketing. The drivers to overcome these constraints include an innovative mindset, vicarious learning and environmental consciousness. The ingenious solutions provide material outcomes in terms of inclusive and sustainable growth in production and performance and create long-term value.

Figure 10 Ingenious Solutions Framework to Alleviate Constraints



Source: Depiction by Gill.

5 Conclusion and Recommendations

Agriculture and farmers are cardinal associates for making the food system more secure and sustainable. However, conserving the environment and concomitantly providing safe and healthy food is challenging. The magnitude and intensity of farming systems and practices determine their impact on the agro-ecosystem. While sustainable agriculture is subject to much deliberation, the underlying principle is preserving the environment while considering the socio-economic imperatives. Many alternate farming systems or approaches are more environment-friendly and support biodiversity. Such holistic approaches propagate similar sustainable agricultural practices.

Punjab has been a laggard in implementing initiatives to make agriculture resilient and sustainable in the face of depleting natural resources and climate change. However, early evidence highlights that select progressive farmers are transitioning to more holistic farming systems. This report aims to demystify and compile sustainable farming best practices of these farmers in the state of Punjab, India. The data was collected through questionnaires, in-depth interviews and stakeholder engagements. A total of 125 farmers were interviewed across 68 villages from six districts and two cropping seasons. Fourteen approaches to sustainable agriculture enumerated by Oberč and Arroyo (2020) formed the basis to delimit eight sustainable practice categories.

Farmers are practising agrobiodiversity landscape management to increase synergies and reduce trade-offs between agricultural production and ecosystem conservation. Concerted efforts are being made to restore soil fertility, conserve water, and improve crop resistance against pests and environmental stress by following conservation tillage, cover cropping and mulching, green manuring, crop diversification and mixed cropping, organic manuring and composting, rainwater harvesting, and micro-irrigation. Further, a proper cropping

management system of moving to polyculture, saving seeds, and integrating crop-livestock has been implemented. The farmers are conscious of reducing pre- and post-harvest agricultural waste management systems and use an alternate source of energy, i.e., biogas and solar power. They systematically handle, store, transport and carry out any value-addition activities on agricultural produce and products after harvest, creating better employment and income earning opportunities in rural Punjab. From a socio-economic angle, a participatory and community-based approach has enabled sharing of knowledge, expertise, and joint marketing operations.

An immersive engagement with the farmers enabled mapping constraint-based indigenous, creative and frugal solutions proposed in agriculture with sustainability insinuations. These most relevant grassroots innovations ranged from adopting experimental farming systems, improvising agricultural machinery/implements, water conservation, and using mobile phone applications. An inductive research approach led to a framework expounding constraints, drivers, and outcomes underlying the ingenious and frugal solutions for on-farm sustainability. Farmers face resource, institutional, and marketing constraints, though they are driven by an innovative mindset, vicarious learning and environmental consciousness. The ingenious solutions lead to inclusive and sustainable growth in production and performance that create long-term value.

The present research findings highlight how ingenious frugal solutions can alleviate resource-constrained conditions and still be inclusive, scalable, and sustainable. In the future, there is a need to leverage this compendium of solutions to be incorporated into a mainstream system. In addition, integrated policy support may ensure nurturing these hotspots of green shoots. Unfortunately, some such progress is being made at the central level only. The challenge is to gear the state policymaking to create an enabling environment that addresses constraints and redefines priorities in the local context while engaging with farmers and stakeholders. As a way ahead, it is vital to identify critical underlying resources required to replicate successes in different contexts. Further, determining the implication of sustainable farming practices on women's empowerment would bring added insights.

References

Benton, T. G & Bailey, R. (2019). The paradox of productivity: agricultural productivity promotes food system inefficiency. *Global Sustainability*, *2*, E6. http://10.1017/sus.2019.3

Benton, T. G., Bieg, C., Harwatt, H., Pudasaini, R., & Wellesley, L. (2021). *Food system impacts on biodiversity loss*. United Nations Environment Programme (UNEP), Chatham House. https://www.chathamhouse.org/sites/default/files/2021-02/2021-02-03-food-system-biodiversity-loss-benton-et-al_0.pdf

Benton, T. G., Vickery, J. A. & Wilson, J. D. (2003). Farmland biodiversity: is habitat heterogeneity the key? *Trends in Ecology & Evolution*, *18*(4), 182–188, http://10.1016/S0169-5347(03)00011-9

Bisht, J. (2019). *Indian agriculture: the transition to sustainability.* Social and Political Research Foundation, New Delhi. https://www.sprf.in/post/indian-agriculture-the-transition-to-sustainability

Borland, K. (1991). That's not what I said: interpretive conflict in oral narrative research. In Gluck, S. & Patai, D. (Eds.) *Women's Words: The Feminist Practice of Oral History*, 63–74. New York: Routledge.

Brown, S. M. (1992). Cognitive mapping and repertory grids for qualitative survey research: Some comparative observations, *Journal of Management Studies*, *29*(3), 287–307. https://doi.org/10.1111/j.1467-6486.1992.tb00666.x

Centre for Science and Environment (2019). *Silver bullet: Are solar pumps a panacea for irrigation, farmer distress and discom losses?* https://www.cseindia.org/cse-releases-its-new-report-on-use-of-solar-powered-water-pumps-in-agriculture-9644

Finch, J. (1984). It's, great to have someone to talk to: ethics and politics of interviewing women. In Bell, C. & Roberts, H. (Eds.) *Social Researching: Politics, Problems, Practice*, 70–87. London: Routledge.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., O'Connell, C., Ray, D. K., West, P. C., Balzer, C., Bennett, E. M., Carpenter, S. R., Hill, J., Monfreda, C., Polasky, S., Rockstrom, J., Sheehan, J., Siebert, S., Tilman, D. & Zaks, D. P. M. (2011). Solutions for a cultivated planet. *Nature*, *478*, 337–342, http://10.1038/nature10452

Food and Agriculture Organization (1988). United Nations. *Report of the FAO Council, 94th Session, 1988*. Rome.

Food and Agriculture Organization (1999). *Agricultural biodiversity*. Multifunctional character of agriculture and land. Background Paper 1. Maastricht, Netherlands. September 1999. http://www.fao.org/mfcal/pdf/bp_1_agb.pdf

Food and Agriculture Organization (2003). *Development of framework for good agricultural practices*. Committee on Agriculture, Seventeenth Session Food and Agriculture organisation, Rome. https://www.indiawaterportal.org/sites/default/files/iwp2/development_ofa_framework_for_good_agricultural_practices_FAO_2003.pdf

Gilhooly, M. (2002). Ethical issues in researching later life. In Jamieson, A. & Victor, C.R. (Eds.), *Researching Ageing and Later Life*, 211–225. Buckingham: Open University Press.

Government of Punjab (2022). *Punjab economic survey 2021-22*. https://esopb.gov.in/Static/PDF/EconomicSurvey-2021-22.pdf

Gulati, A., Terway, P., & Hussain, S. (2018). *Crop insurance in India: key issues and way forward*. Working Paper No. 352. ICRIER: New Delhi. http://icrier.org/pdf/Working_Paper_352.pdf

Gupta, N., Pradhan, S., Jain, A., & Patel, N. (2021). *Sustainable agriculture in India 2021*. CEEW Report, New Delhi. https://www.ceew.in/sites/default/files/CEEW-Sustainable-Agricultre-in-India-2021-ES-21May21.pdf

Hornsby-Smith, M. (1993). Gaining Access. In Gilbert, N. (Eds.) *Researching Social Life*, 52–67. London: Sage.

Jia, G., Shevliakova, E., Artaxo, P., Noblet-Ducoudré, N. D., Houghton, R., House, J., Kitajima, K., Lennard, C., Popp, A., Sirin, A., Sukumar, R., & Verchot, L. (2019). Land-climate interactions. In Shukla, P. R., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H.-O., Roberts, D. C., Zhai, P., Slade, R., Connors, S., van Diemen, R., Ferrat, M., Haughey, E., Luz, S., Neogi, S., Pathak, M., Petzold, J., Portugal Pereira, J., Vyas, P., Huntley, E., Kissick, K., Belkacemi, M., Malley, J. (Eds.), *Climate Change and Land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, IPCC. https://www.ipcc.ch/site/assets/uploads/2019/11/05_Chapter-2.pdf

Khaiwal, R., Singh, T., & Mor, S. (2022). COVID-19 pandemic and sudden rise in crop residue burning in India: issues and prospects for sustainable crop residue management. *Environmental Science and Pollution Research*, *29*(2), 3155–3161. http://10.1007/s11356-021-17550-y.

Krumpal, I. (2013). Determinants of social desirability bias in sensitive surveys: a literature review. *Quality & Quantity, 47*(4), 2025–2047. https://doi.org/10.1007/s11135-011-9640-9

Lok Sabha Secretariat (2018). *Committee on estimates 2018-19 thirtieth report: performance of the national action plan on climate change.* Sixteenth Lok Sabha. https://eparlib.nic.in/bitstream/123456789/783946/1/16_Estimates_30.pdf#search=null%20Estimates%20 Committee

MoAFW (2016). *Sub-mission on agroforestry: operational guidelines.* The Ministry of Agriculture & Farmers Welfare, Government of India. https://nmsa.dac.gov.in/pdfdoc/Agroforestory_Guidelines_English.pdf

MoAFW (2017). *National mission for sustainable agriculture: operational guidelines.* The Ministry of Agriculture & Farmers Welfare, Government of India. http://agricoop.nic.in/sites/default/files/NMSA%20-%20Guidelines%20updated%20on%2009.02.2017%20 %20.pdf

MoAFW (2019). *Annual report 2018-19*. The Ministry of Agriculture & Farmers Welfare, Government of India. http://agricoop.nic.in/sites/default/files/AR_2018-19_Final_for_Print.pdf

MoEFCC (2021). *India: third biennial update report to the United Nations framework convention on climate change*. Ministry of Environment, Forest and Climate Change, Government of India. https://unfccc.int/sites/default/files/resource/INDIA_%20BUR-3_20.02.2021_High.pdf

Muthuprakash, K. M. S. & Damani, O. P. (2019). A stock and flow based framework for indicator identification for evaluation of crop production system. *Agricultural Research, 6*(1-2), 248–258. https://www.cse.iitb.ac.in/~damani/papers/sd14.pdf

Muthuprakash, K. M. S. (2018). Development and Field Application of the Farm Assessment Index (FAI) for Evaluation of Farming System. PhD Thesis, IIT Bombay. https://www.cse.iitb.ac.in/~damani/FAI/fai.html

Muthuprakash, K. M. S., Pawar, V., Deora, S., Gupta, A., Kumar, G., Rabha, M., Serupally, R., Gevariya, R. & Sridhar, S. (2020). *Sustainable agriculture in India: why does it not scale up? studies in development process*, Issue 10, Pune: VikasAnvesh Foundation. https://www.vikasanvesh.in/studies-in-development-processes/sustainable-agriculture-in-india-why-does-it-not-scale-up/

NITI Aayog (2019). *Sustainable development and climate change*. https://www.indiabudget.gov.in/economicsurvey/doc/eschapter/echap06.pdf

Oberč, B. P. & Arroyo Schnell, A. (2020). *Approaches to sustainable agriculture. Exploring the pathways towards the future of farming*. Brussels, Belgium: IUCN EURO. https://doi.org/10.2305/IUCN.CH.2020.07.en

PIB (2018). *Decline in agriculture cost.* Press Information Bureau, Government of India. http://pib.nic.in/newsite/PrintRelease.aspx?relid=181606

PIB (2022). *Objectives of PM-KUSUM.* Press Information Bureau, Government of India.https://pib.gov.in/PressReleseDetail.aspx?PRID=1843536

PKVY (2017). *Paramparagat Krishi Vikas Yojana: manual for district-level functionaries.* Government of India. https://darpg.gov.in/sites/default/files/Paramparagat%20Krishi%20Vikas%20Yojana.pdf

PMKSY (2020). *Per Drop More Crop - Micro Irrigation*. Pradhan Mantri Krishi Sinchayee Yojana, Government of India. https://pmksy.gov.in/mis/frmDashboard.aspx

Powell, C. (2003). The Delphi technique: myths and realities. *Journal of Advanced Nursing. 41*(4), 376–382. https://doi.org/10.1046/j.1365-2648.2003.02537.x

Reddy, A. A. (2017). *Impact study of Paramparagat Krishi Vikas Yojana*, National Institute of Agricultural Extension Management (MANAGE), Hyderabad. https://www.manage.gov.in/publications/reports/pkvy.pdf

Seufert, V., Ramankutty, N. & Foley, J. (2012). Comparing the yields of organic and conventional agriculture. *Nature, 485*, 229–232. https://doi.org/10.1038/nature11069.

Thangaratinam, S. & Redman, C. W. E. (2005). The Delphi technique. *The Obstetrician & Gynaecologist, 7*(2), 120–125. https://doi.org/10.1576/toag.7.2.120.27071

World Bank (2003). *India: Revitalising Punjab's Agriculture*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/14433

World Commission on Environment and Development (1987). *Our Common Future*. New York: Oxford University Press. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

Yin, R. K. (2003). *Case Study Research: Design and Methods*. Thousand Oaks, CA: Sage.

Zaralis, K. & Padel, S. (2019). Effects of High Stocking Grazing Density of Diverse Swards on Forage Production, Animal Performance and Soil Organic Matter: A Case Study. In Theodoridis, A., Ragkos, A. & Salampasis, M. (Eds.), *Innovative Approaches and Applications for Sustainable Rural Development,* HAICTA: International Conference on Information and Communication Technologies in Agriculture, Food & Environment 2017, Springer Earth System Sciences, Cham, Switzerland: Springer. http://10.1007/978-3-030-02312-6_8

ANNEXURE A

Survey Questionnaire

Sustainability of Farming in the State of Punjab: The Economic, Social and Ecological Analysis

About the Project

Panjab University is partnering on an inter-disciplinary project, *'Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies (TIGR2ESS)'*, as a part of the Global Challenges Research Fund award by the UK-India Research Councils. The project is led by the University of Cambridge, U.K., with multiple partner institutions in India and the U.K. The present research primarily aims to evaluate the sustainability of organic and conventional farming in Punjab.

ਯੂਕੇ-ਇੰਡੀਆ ਰਿਸਰਚ ਕੌਂਸਲਾਂ ਦੁਆਰਾ ਗਲੋਬਲ ਚੈਲੇਂਜਸ ਰਿਸਰਚ ਫੰਡ ਅਵਾਰਡ ਦੇ ਹਿੱਸੇ ਵਜੋਂ, ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ ਇੱਕ ਅੰਤਰ-ਅਨੁਸ਼ਾਸਨੀ ਪ੍ਰੋਜੈਕਟ, *'ਟ੍ਰਾਂਸਫਾਰਮਿੰਗ ਇੰਡੀਆਜ਼ ਗ੍ਰੀਨ ਰੈਵੋਲਿਸ਼ਨ ਰਿਸਰਚ ਐਂਡ ਐਮਪਾਵਰਮੈਂਟ ਫਾਰ ਸਸਟੇਨੇਬਲ ਫੂਡ ਸਪਲਾਈਜ਼ (TIGR2ESS)'* ਤੇ ਭਾਈਵਾਲੀ ਕਰ ਰਹੀ ਹੈ। ਇਸ ਪ੍ਰੋਜੈਕਟ ਦੀ ਅਗਵਾਈ ਯੂਕੇ ਦੀ ਕੈਂਬਰਿਜ ਯੂਨੀਵਰਸਿਟੀ ਕਰਦੀ ਹੈ, ਜਿਸ ਵਿੱਚ ਭਾਰਤ ਅਤੇ ਯੂਕੇ ਦੀਆਂ ਕਈ ਸਹਿਭਾਗੀ ਸੰਸਥਾਵਾਂ ਹਨ । ਮੌਜੂਦਾ ਖੋਜ ਦਾ ਮੁੱਖ ਉਦੇਸ਼ ਪੰਜਾਬ ਵਿੱਚ ਜੈਵਿਕ ਅਤੇ ਰਵਾਇਤੀ ਖੇਤੀ ਦੀ ਸਥਿਰਤਾ ਦਾ ਮੁਲਾਂਕਣ ਕਰਨਾ ਹੈ ।

Consent and Confidentiality Statement

Your participation is entirely voluntary, and all responses will be kept completely confidential. Individual respondents will not be identified, and results will only be presented in an aggregated or anonymous form. Thank you in advance, and we hope you will agree to participate in this survey to help us understand your farming practices.

I consent to be part of this PU Organic Farming Survey and to be interviewed and photographed.

ਤੁਹਾਡੀ ਭਾਗੀਦਾਰੀ ਪੂਰੀ ਤਰ੍ਹਾਂ ਸਵੈਇੱਛਤ ਹੈ, ਅਤੇ ਸਾਰੇ ਜਵਾਬ ਪੂਰੀ ਤਰ੍ਹਾਂ ਗੁਪਤ ਰੱਖੇ ਜਾਣਗੇ। ਵਿਅਕਤੀਗਤ ਉੱਤਰਦਾਤਾਵਾਂ ਦੀ ਪਛਾਣ ਨਹੀਂ ਕੀਤੀ ਜਾਏਗੀ, ਅਤੇ ਨਤੀਜੇ ਸਿਰਫ ਸਮੂਹਿਕ ਜਾਂ ਅਗਿਆਤ ਰੂਪ ਵਿੱਚ ਪੇਸ਼ ਕੀਤੇ ਜਾਣਗੇ। ਅਗਾ ਧੰਨਵਾਦ, ਅਤੇ ਅਸੀਂ ਉਮੀਦ ਕਰਦੇ ਹਾਂ ਕਿ ਤੁਸੀਂ ਇਸ ਸਰਵੇਖਣ ਵਿੱਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਸਹਿਮਤ ਹੋਵੋਗੇ ਤਾਂ ਜੋ ਤੁਹਾਡੀ ਖੇਤੀ ਦੇ ਤਰੀਕਿਆਂ ਨੂੰ ਸਮਝਣ ਵਿੱਚ ਸਾਡੀ ਮਦਦ ਕੀਤੀ ਜਾ ਸਕੇ।

ਮੈਂ ਇਸ ਪੀ. ਯੂ. ਆਰਗੈਨਿਕ ਫਾਰਮਿੰਗ ਸਰਵੇ ਦਾ ਹਿੱਸਾ ਬਣਨ ਅਤੇ ਇੰਟਰਵਿ ਅਤੇ ਫੋਟੋ ਖਿੱਚਣ ਲਈ ਸਹਿਮਤ ਹਾਂ।

Signature: ਦਸਤਖਤ

Date: ਤਾਰੀਖ਼

THE FARM ASSESSMENT INDEX SURVEY
(ਫਾਰਮ ਅਸੈਸਮੈਂਟ ਇੰਡੈਕਸ ਸਰਵੇਖਣ)

Date of the Survey: _____ **Name of the Interviewer:** _____

Name of the Farmer: _____ **Farmer Code:** _____

Year/Season/Date of Sowing: _____ **Harvest Time for Kharif /Rabi Crop (month/week):** _____

1. BASIC DETAILS **ਬੁਨਿਆਦੀ** ਵੇਰਵੇ

1.1. State ਰਾਜ	**Punjab**	1.2. District ਜ਼ਿਲ੍ਹਾ		1.3 Tehsil ਤਹਿਸੀਲ		1.4. Block/Village ਲਾਕ/ਪਿੰਡ	
1.5. Full name of the cultivator/decision-maker ਕਾਸ਼ਤਕਾਰ/ਫੈਸਲਾ ਲੈਣ ਵਾਲੇ ਦਾ ਪੂਰਾ ਨਾਂ				1.6. Gender (✓): Male ☐ Female ☐ ਲਿੰਗ: ਮਰਦ ☐ ਔਰਤ ☐		1.7. Age (in years): ਸਾਲਾਂ ਵਿੱਚ ਉਮਰ	
1.8. Name of the respondent and relationship with the cultivator ਉੱਤਰਦਾਤਾ ਦਾ ਨਾਮ ਅਤੇ ਕਾਸ਼ਤਕਾਰ ਨਾਲ ਸੰਬੰਧ							
1.9. Total number of members in the family ਪਰਿਵਾਰ ਵਿੱਚ ਮੈਂਬਰਾਂ ਦੀ ਕੁੱਲ ਸੰਖਿਆ	Adults ਬਾਲਗ: Children ਬੱਚੇ:	1.10. No. of family members involved in agriculture ਕੰਮ ਕਰਨ ਵਾਲੇ ਮੇਮ੍ਬਰ ਦੀ ਸੰਖਿਆ ਖੇਤੀਬਾੜੀ				Male ਮਰਦ: Female ਔਰਤ:	
1.11. Complete postal address ਡਾਕ ਪਤਾ				1.12. Mobile/Phone/Email ਫੋਨ/ਮੋਬਾਈਲ/ਈਮੇਲ			
1.13. Primary occupation ਮੁੱਖ ਕਿੱਤਾ				1.14. Secondary occupation ਸਹਾਇਕ ਕਿੱਤੇ			
1.15. Alternate source of household income (Yes/No) ਘਰੇਲੂ ਆਮਦਨੀ ਦਾ ਵਿਕਲਪਿਕ ਸਰੋਤ (ਹਾਂ/ਨਹੀਂ)		1.16. Details, if yes: ਵੇਰਵੇ, ਜੇ ਹਾਂ					
1.17. Farmer's Education ਸਿੱਖਿਆ (✓)	A. No formal education ☐ A. ਅਨਪੜ੍ਹ ☐	B. Primary ☐ B. ਪ੍ਰਾਇਮਰੀ ☐	C. Secondary ☐ C. ਸੈਕੰਡਰੀ ☐	D. Higher-secondary ☐ D. ਉੱਚ-ਸੈਕੰਡਰੀ ☐	E. Graduate ☐ E. ਗ੍ਰੈਜੂਏਟ ☐	F. Post-graduate ☐ F. ਪੋਸਟ-ਗ੍ਰੈਜੂਏਟ ☐	
1.18. Education distribution of household (no.) No. of males with respective age: No. of females with respective age: ਘਰ ਦੀ ਸਿੱਖਿਆ ਵੰਡ (ਸੰ.) ਸੰਬੰਧਤ ਉਮਰ ਵਾਲੇ ਪੁਰਸ਼ਾਂ ਦੀ ਸੰਖਿਆ: ਸੰਬੰਧਤ ਉਮਰ ਵਾਲੀਆਂ ਰਤਾਂ ਦੀ ਸੰਖਿਆ:	A. No formal education ___ D. Higher-secondary ___ A. ਅਨਪੜ੍ਹ _____ D. ਉੱਚ-ਸੈਕੰਡਰੀ ____	B. Primary ___ E. Graduate ____ B. ਪ੍ਰਾਇਮਰੀ _____ E. ਗ੍ਰੈਜੂਏਟ _____	C. Secondary ___ F. Post-graduate _____ C. ਸੈਕੰਡਰੀ _____ F. ਪੋਸਟ-ਗ੍ਰੈਜੂਏਟ _____				
1.19. How long have you been into farming? (experience in years) ਤੁਸੀਂ ਖੇਤੀਬਾੜੀ ਵਿੱਚ ਕਿੰਨੇ ਸਮੇਂ ਤੋਂ ਹੋ? (ਸਾਲਾਂ ਵਿੱਚ ਅਨੁਭਵ)				Total: ਕੁੱਲ:	Conventional: ਰਸਾਇਣਕ:	Organic: ਜੈਵਿਕ:	

1.20. Who in the household takes farm-related decisions like crop/ nutrient/harvest? ਘਰ ਵਿੱਚ ਕੌਣ ਖੇਤੀ ਨਾਲ ਸੰਬੰਧਤ ਫੈਸਲੇ ਲੈਂਦਾ ਹੈ ਜਿਵੇਂ ਫਸਲ/ਪੌਸ਼ਟਿਕ ਤੱਤ/ ਵਾਢੀ	

2. ASSET DETAILS (to the extent relevant) **ਸੰਪਤੀ ਦੇ ਵੇਰਵੇ** (ਸੰਬੰਧਤ ਹੱਦ ਤੱਕ)

S. No.	Particulars ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ	Number ਗਿਣਤੀ	Year of Purchase/Building ਖਰੀਦ/ਇਮਾਰਤ ਦਾ ਸਾਲ	Leased/Rented ਕਿਰਾਏ 'ਤੇ	Source ਸਰੋਤ
2.1.	Tractor ਟਰੈਕਟਰ				
2.2.	Trolley ਟਰਾਲੀ				
2.3.	Diesel engine ਡੀਜ਼ਲ ਇੰਜਣ				
2.4.	Submersible pump ਸਬਮਰਸੀਬਲ ਪੰਪ				
2.5.	Spray pump ਸਪਰੇਅ ਪੰਪ				
2.6.	Electric motor ਇਲੈਕਟ੍ਰਿਕ ਮੋਟਰ				
2.7.	Generator ਜਨਰੇਟਰ				
2.8.	Leveller ਲੇਵਲਰ				
2.9.	Rotavator ਰੋਟਾਵੇਟਰ				
2.10.	Disc harrow ਡਿਸਕ ਹੈਰੋ				
2.11.	Cultivator ਕਾਸ਼ਤਕਾਰ				
2.12.	Seed drill ਬੀਜ ਦੀ ਮਸ਼ਕ				
2.13.	Thresher ਥ੍ਰੈਸ਼ਰ				
2.14.	Combine ਕੰਬਾਈਨ				
2.15.	Store drum ਸਟੋਰ ਡ੍ਰਮ				
2.16.	Happy seeder ਹੈਪੀ ਸੀਡਰ				
2.17.	Others* ਹੋਰ*				
2.18.	Cattle shed ਪਸ਼ੂ ਬਸੇਰਾ				
2.19.	Implement shed ਇਮਪਲੇਮੈਂਟ ਸ਼ੇਡ				
2.20.	Storage shed ਸਟੋਰੇਜ ਸ਼ੈੱਡ				

Note: *Includes reaper, ranger, chopper, planter, harvester, etc. *ਰੀਪਰ, ਰੇਂਜਰ, ਹੈਲੀਕਾਪਟਰ, ਪਲਾਂਟਰ, ਹਾਰਵੈਸਟਰ, ਆਦਿ ਸ਼ਾਮਲ ਹਨ

3. LANDHOLDING DETAILS ਜ਼ਮੀਨ ਦੇ ਵੇਰਵੇ

3.1 What is the total landholding of the farmer (in acres)? ਕਿਸਾਨ ਦੀ ਕੁੱਲ ਜ਼ਮੀਨ (ਏਕੜ ਵਿੱਚ) ਕੀ ਹੈ? _____

Description	Plot 1	Plot 2	Plot 3
3.2. Plot size (in acres) ਪਲਾਟ ਦਾ ਆਕਾਰ (ਏਕੜ ਵਿੱਚ)			
3.3. Plot type ਪਲਾਟ ਦੀ ਕਿਸਮ: i. Owned ਮਲਕੀਅਤ ਹੈ ii. Leased-in (with rent in Rs./annum) ਠੇਕੇ ਤੇ ਲਿੱਤਾ (ਕਿਰਾਏ ਦੇ ਨਾਲ/ਰੁਪਏ ਵਿੱਚ) iii. Leased-out (with rent in Rs./annum) ਠੇਕੇ ਤੇ ਦਿੱਤਾ (ਕਿਰਾਏ ਦੇ ਨਾਲ/ਸਾਲਾਨਾ ਵਿੱਚ)			
3.4. Irrigated area (in acres) ਏਕੜ ਵਿੱਚ ਸਿੰਚਾਈ ਵਾਲਾ ਖੇਤਰ			
3.5. Source of irrigation (e.g., tube well, main canal, branch canal/other) ਸਿੰਚਾਈ ਦਾ ਸਰੋਤ (ਉਦਾਹਰਨ ਲਈ, ਟਿਬਵੈੱਲ, ਮੁੱਖ ਨਹਿਰ, ਸ਼ਾਖਾ ਨਹਿਰ/ਹੋਰ)			
3.6. Rainfed area (in acres) ਏਕੜ ਵਿੱਚ ਮੀਂਹ ਵਾਲਾ ਖੇਤਰ			
3.7. Land under ecological/organic farming (in acres) ਵਾਤਾਵਰਣਕ/ਜੈਵਿਕ ਖੇਤੀ ਅਧੀਨ ਜ਼ਮੀਨ ਦੀ ਹੱਦ (ਏਕੜ ਵਿੱਚ)			
3.8. If organic, is it certified? (Yes/No) ਜੇ ਜੈਵਿਕ, ਕੀ ਇਹ ਪ੍ਰਮਾਣਤ ਹੈ? (ਹਾਂ ਜਾਂ ਨਹੀਂ)			
3.9. If certified, what is the source (name of the agency/group) and cost? ਜੇ ਪ੍ਰਮਾਣਤ ਹੈ, ਸਰੋਤ ਕੀ ਹੈ (ਏਜੰਸੀ/ਸਮੂਹ ਦਾ ਨਾਮ) ਅਤੇ ਲਾਗਤ?			
3.10. Soil type (coarse loamy, coarse & fine loamy, fine loamy, other) ਮਿੱਟੀ ਦੀ ਕਿਸਮ (ਸੈਂਡੀ, ਸੈਂਡੀ ਲੋਮ, ਲੋਮੀ, ਲਾਲ, ਕਾਲਾ, ਹੋਰ)			
3.11. Main crop (variety) ਮੁੱਖ ਫਸਲ (ਕਿਸਮ)			
3.12. Previous harvest crop (variety) ਪਿਛਲੀ ਵਾਢੀ ਦੀ ਫਸਲ (ਕਿਸਮ)			
3.13. Do you have a Soil Health Card? (Yes/No) (Click photo, if handy) ਕੀ ਤੁਹਾਡੇ ਕੋਲ ਸੋਇਲ ਹੈਲਥ ਕਾਰਡ ਹੈ? (ਹਾਂ/ਨਹੀਂ) (ਫੋਟੋ 'ਤੇ ਕਲਿਕ ਕਰੋ, ਜੇ ਸੌਖਾ ਹੋਵੇ)			
3.14. If yes, then specify ਜੇ ਹਾਂ, ਤਾਂ ਨਿਰਧਾਰਤ ਕਰੋ: i. Soil Organic (micro-nutrients) ਮਿੱਟੀ ਜੈਵਿਕ (ਸੂਖਮ-ਪੌਸ਼ਟਿਕ ਤੱਤ) ii. Nitrogen (N) ਨਾਈਟ੍ਰੋਜਨ (ਐਨ) iii. Phosphorus (P) ਫਾਸਫੋਰਸ (ਪੀ) iv. Potassium (K) ਪੋਟਾਸ਼ੀਅਮ (ਕੇ) v. Soil pH ਮਿੱਟੀ pH vi. Soil salinity ਮਿੱਟੀ ਦੀ ਲੂਣਤਾ			

4. LAND PREPARATION PROCESSES **ਜ਼ਮੀਨ ਤਿਆਰੀ ਪ੍ਰਕਿਰਿਆਵਾਂ**

Wage Rate for Men: ₹……/day
ਪੁਰਸ਼ਾਂ ਲਈ ਤਨਖਾਹ ਦਰ: ₹……/ ਦਿਨ

Wage Rate for Women: ₹……/day
ਔਰਤ ਲਈ ਉਜਰਤਾਂ ਦੀ ਦਰ: ₹……/ਦਿਨ

Machine hire cost: ₹……/hour
ਮਸ਼ੀਨ ਕਿਰਾਏ ਦੀ ਲਾਗਤ:……/ਘੰਟਾ

Description	Plot 1	Plot 2	Plot 3
NOP 1: Ploughing **ਹਲਣਾ**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			
NOP 2: Harrowing **ਤਰਿਆਂ**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			
NOP 3: Puddling **ਕੱਦੂ ਕਰਨਾ**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			
NOP 4: Other (Name: _____) **ਹੋਰ** (ਨਾਮ: _____)	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**

Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			

5. BASAL MANURE APPLICATION ਬੇਸਲ ਰੂੜੀ ਦੀ ਵਰਤੋਂ

Wage Rate for Men: ₹……/day
ਪੁਰਸ਼ਾਂ ਲਈ ਤਨਖਾਹ ਦਰ: ₹……/ ਦਿਨ

Wage Rate for Women: ₹……/day
ਔਰਤ ਲਈ ਉਜਰਤਾਂ ਦੀ ਦਰ: ₹……/ਦਿਨ

Machine hire cost: ₹……/hour
ਮਸ਼ੀਨ ਕਿਰਾਏ ਦੀ ਲਾਗਤ:……/ਘੰਟਾ

Description	Plot 1	Plot 2	Plot 3
Fertilizer/Manure 1: Broadcasting/ Placement/Fertigation/ Mulching/Tilling (✓) **ਖਾਦ/ਖਾਦ 4: ਪ੍ਰਸਾਰਣ/ਪਲੇਸਮੈਂਟ/ਫਰਟੀਗੇਸ਼ਨ/ਟਿਲਿੰਗ**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Source (home-made/market/govt.) ਸਰੋਤ (ਘਰੇਲੂ ਉਪਯੋਗ/ਮਾਰਕੀਟ/ਸਰਕਾਰ)			
Total quantity (with unit) ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Unit description (in kg.) ਕਿੱਲੋ ਵਿੱਚ ਇਕਾਈ ਦਾ ਵਰਣਨ			
Cost per unit ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨਰੀ (diesel and hours)			
Fertilizer/Manure 2: Broadcasting/ Placement/Fertigation/ Mulching/Tilling (✓) **ਖਾਦ/ਖਾਦ 4: ਪ੍ਰਸਾਰਣ/ਪਲੇਸਮੈਂਟ/ਫਰਟੀਗੇਸ਼ਨ/ਟਿਲਿੰਗ**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Source (home-made/market/govt.) ਸਰੋਤ (ਘਰੇਲੂ ਉਪਯੋਗ/ਮਾਰਕੀਟ/ਸਰਕਾਰ)			
Total quantity (with unit) ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Unit description (in kg.)			

ਕਿੱਲੋ ਵਿੱਚ ਇਕਾਈ ਦਾ ਵਰਣਨ			
Cost per unit ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨਰੀ (diesel and hours)			
Fertilizer/Manure 3: Broadcasting/ Placement/Fertigation/ Mulching/Tilling (✓) **ਖਾਦ/ਖਾਦ 4: ਪ੍ਰਸਾਰਣ/ਪਲੇਸਮੈਂਟ/ਫਰਟੀਗੇਸ਼ਨ/ਟਿਲਿੰਗ**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Source (home-made/market/govt.) ਸਰੋਤ (ਘਰੇਲੂ ਉਪਯੋਗ/ਮਾਰਕੀਟ/ਸਰਕਾਰ)			
Total quantity (with unit) ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Unit description (in kg.) ਕਿੱਲੋ ਵਿੱਚ ਇਕਾਈ ਦਾ ਵਰਣਨ			
Cost per unit ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨਰੀ (diesel and hours)			
Fertilizer/Manure 4: Broadcasting/ Placement/Fertigation/ Mulching/Tilling (✓) **ਖਾਦ/ਖਾਦ 4: ਪ੍ਰਸਾਰਣ/ਪਲੇਸਮੈਂਟ/ਫਰਟੀਗੇਸ਼ਨ/ਟਿਲਿੰਗ**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Source (home-made/market/govt.) ਸਰੋਤ (ਘਰੇਲੂ ਉਪਯੋਗ/ਮਾਰਕੀਟ/ਸਰਕਾਰ)			
Total quantity (with unit) ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Unit description (in kg.) ਕਿੱਲੋ ਵਿੱਚ ਇਕਾਈ ਦਾ ਵਰਣਨ			
Cost per unit ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			

Machine ਮਸ਼ੀਨਰੀ (diesel and hours)			

6. SOWING, RESOWING, TRANSPLANTING etc. **ਬਿਜਾਈ, ਮੁੜ ਬੀਜਾਈ, ਟ੍ਰਾਂਸਪਲਾਂਟਿੰਗ ਆਦਿ (All three activities combined)**

Wage Rate for Men: ₹……/day
ਪੁਰਸ਼ਾਂ ਲਈ ਤਨਖਾਹ ਦਰ: ₹……/ ਦਿਨ

Wage Rate for Women: ₹……/day
ਔਰਤ ਲਈ ਉਜਰਤਾਂ ਦੀ ਦਰ: ₹……/ਦਿਨ

Machine hire cost: ₹……/hour
ਮਸ਼ੀਨ ਕਿਰਾਏ ਦੀ ਲਾਗਤ:……/ਘੰਟਾ

Description	Main crop ਮੁੱਖ ਫਸਲ	Inter crop 1 ਅੰਤਰ ਫ਼ਸਲ 1	Inter crop 2 ਅੰਤਰ ਫ਼ਸਲ 2	Inter crop 3 ਅੰਤਰ ਫ਼ਸਲ 3	Inter crop 4 ਅੰਤਰ ਫ਼ਸਲ 4
Plot 1: Seed Broadcasting/Transplanting/ Seed Planting ਬੀਜ ਪ੍ਰਸਾਰਣ/ਟ੍ਰਾਂਸਪਲਾਂਟਿੰਗ/ ਬੀਜ ਲਾਉਣਾ (✓)	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Name of the crop ਫਸਲ ਦਾ ਨਾਮ					
Seed variety name ਬੀਜ ਦੀਆਂ ਕਿਸਮਾਂ ਦਾ ਨਾਮ					
Seed type (Bt/hybrid/improved/traditional) ਬੀਜ ਦੀ ਕਿਸਮ (ਬੀਟੀ/ਹਾਈਬ੍ਰਿਡ/ਸੁਧਾਰੀ/ਰਵਾਇਤੀ)					
Source (home/govt./pvt/fellow farmers) ਸਰੋਤ (ਘਰ/ਸਰਕਾਰ/ਪ੍ਰਾਈਵੇਟ/ਸਾਥੀ ਕਿਸਾਨ)					
Seed quantity ਬੀਜ ਦੀ ਮਾਤਰਾ (no. of kgs/acre)					
Seed cost per unit ਬੀਜ ਦੀ ਦਰ (Rs./per kg.)					
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)					
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)					
Machinery ਮਸ਼ੀਨਰੀ (diesel and hours)					
For commercial/personal consumption ਵਪਾਰਕ/ਨਿੱਜੀ ਖਪਤ ਲਈ					
Plot 2: Seed Broadcasting/Transplanting/ Seed Planting ਬੀਜ ਪ੍ਰਸਾਰਣ/ਟ੍ਰਾਂਸਪਲਾਂਟਿੰਗ/ ਬੀਜ ਲਾਉਣਾ (✓)	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Name of the crop ਫਸਲ ਦਾ ਨਾਮ					
Seed variety name ਬੀਜ ਦੀਆਂ ਕਿਸਮਾਂ ਦਾ ਨਾਮ					
Seed type (Bt/hybrid/improved/traditional) ਬੀਜ ਦੀ ਕਿਸਮ (ਬੀਟੀ/ਹਾਈਬ੍ਰਿਡ/ਸੁਧਾਰੀ/ਰਵਾਇਤੀ)					
Source (home/govt./pvt/fellow farmers)					

ਸਰੋਤ (ਘਰ/ਸਰਕਾਰ/ਪ੍ਰਾਈਵੇਟ/ਸਾਥੀ ਕਿਸਾਨ)					
Seed quantity ਬੀਜ ਦੀ ਮਾਤਰਾ (no. of kgs/acre)					
Seed cost per unit ਬੀਜ ਦੀ ਦਰ (Rs./per kg.)					
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)					
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)					
Machinery ਮਸ਼ੀਨਰੀ (diesel and hours)					
For commercial/personal consumption ਵਪਾਰਕ/ਨਿੱਜੀ ਖਪਤ ਲਈ					

7. TOP DRESSING ਚੋਟੀ ਦੇ ਡਰੈਸਿੰਗ

Wage Rate for Men: ₹……/day
ਪੁਰਸ਼ਾਂ ਲਈ ਤਨਖਾਹ ਦਰ: ₹……/ ਦਿਨ

Wage Rate for Women: ₹……/day
ਔਰਤ ਲਈ ਉਜਰਤਾਂ ਦੀ ਦਰ: ₹……/ਦਿਨ

Machine hire cost: ₹……/hour
ਮਸ਼ੀਨ ਕਿਰਾਏ ਦੀ ਲਾਗਤ:……/ਘੰਟਾ

Description	Plot 1	Plot 2	Plot 3
Fertilizer ਖਾਦ 1 (Name): _____	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Source (home/govt./pvt. trader) ਸਰੋਤ (ਸਰਕਾਰ/ਘਰ/ਪ੍ਰਾਈਵੇਟ ਵਪਾਰੀ)			
Total quantity with unit ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Unit description (in kg.) ਕਿੱਲੋ ਵਿੱਚ ਇਕਾਈ ਦਾ ਵਰਣਨ			
Cost per unit (ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ)			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type) (if any)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			
Fertilizer ਖਾਦ 2 (Name): _____	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**

Source (home/govt./pvt. trader) ਸਰੋਤ (ਸਰਕਾਰ/ਘਰ/ਪ੍ਰਾਈਵੇਟ ਵਪਾਰੀ)			
Total quantity with unit ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Unit description (in kg.) ਕਿੱਲੋ ਵਿੱਚ ਇਕਾਈ ਦਾ ਵਰਣਨ			
Cost per unit (ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ)			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type) (if any)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			
Fertilizer ਖਾਦ 3 (Name): _____	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**	**Self ਸਵੈ (No.):** **Hired ਕਿਰਾਏ ਤੇ (No.):**
Source (home/govt./pvt. trader) ਸਰੋਤ (ਸਰਕਾਰ/ਘਰ/ਪ੍ਰਾਈਵੇਟ ਵਪਾਰੀ)			
Total quantity with unit ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Unit description (in kg.) ਕਿੱਲੋ ਵਿੱਚ ਇਕਾਈ ਦਾ ਵਰਣਨ			
Cost per unit (ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ)			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type) (if any)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			

8. WEEDING/INTER-CULTIVATION ਬੂਟੀ/ਅੰਤਰ-ਉਪਜ

Wage Rate for Men: ₹……/day
ਪੁਰਸ਼ਾਂ ਲਈ ਤਨਖਾਹ ਦਰ: ₹……/ ਦਿਨ

Wage Rate for Women: ₹……/day
ਔਰਤ ਲਈ ਉਜਰਤਾਂ ਦੀ ਦਰ: ₹……/ਦਿਨ

Machine hire cost: ₹……/hour
ਮਸ਼ੀਨ ਕਿਰਾਏ ਦੀ ਲਾਗਤ:……/ਘੰਟਾ

Description	Plot 1	Plot 2	Plot 3
Weeding Round 1: Manual De-Weeding /Herbicide/Inter-Cultivation (✓) ਨਦੀਨਾਂ ਦਾ ਰਾਡ 1: ਮੈਨੁਅਲ ਡੀ-ਵੈਡਿੰਗ ਜਾਂ ਜੜੀ-ਬੂਟੀਆਂ ਜਾਂ ਅੰਤਰ-ਕਾਸ਼ਤ			
Crop name ਫਸਲ ਦਾ ਨਾਮ (if particular)			
Name of the agro-chemical, if herbicide ਐਗਰੋ-ਕੈਮੀਕਲ ਦਾ ਨਾਂ, ਜੇਕਰ ਜੜੀ-ਬੂਟੀਆਂ ਦਾ ਖਾਤਮਾ ਹੋਵੇ			
Source (Home/Govt/Pvt/Fellow farmers) ਸਰੋਤ (ਘਰ/ਸਰਕਾਰ/ਪ੍ਰਾਈਵੇਟ/ਸਾਥੀ ਕਿਸਾਨ)			
Total quantity (with unit) ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Cost per unit ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type) (if any)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			
Weeding Round 2: Manual De-Weeding /Herbicide/Inter-Cultivation (✓) ਨਦੀਨਾਂ ਦਾ ਰਾਡ 2: ਮੈਨੁਅਲ ਡੀ-ਵੈਡਿੰਗ ਜਾਂ ਜੜੀ-ਬੂਟੀਆਂ ਜਾਂ ਅੰਤਰ-ਕਾਸ਼ਤ			
Crop name ਫਸਲ ਦਾ ਨਾਮ (if particular)			
Name of the agro-chemical, if herbicide ਐਗਰੋ-ਕੈਮੀਕਲ ਦਾ ਨਾਂ, ਜੇਕਰ ਜੜੀ-ਬੂਟੀਆਂ ਦਾ ਖਾਤਮਾ ਹੋਵੇ			
Source (Home/Govt/Pvt/Fellow farmers) ਸਰੋਤ (ਘਰ/ਸਰਕਾਰ/ਪ੍ਰਾਈਵੇਟ/ਸਾਥੀ ਕਿਸਾਨ)			

Total quantity (with unit) ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Cost per unit ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type) (if any)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			

9. DETAILS OF IRRIGATION (ਸਿੰਜਾਈ ਦੇ ਵੇਰਵੇ)

Description	Plot 1	Plot 2	Plot 3
No. of irrigations/watering applied ਸਿੰਚਾਈ/ਸਿੰਚਾਈ ਦੀ ਸੰਖਿਆ ਲਾਗੂ ਕੀਤੀ ਗਈ			
Method of irrigation (Flood/Sprinklers/Drip/Piped) ਸਿੰਚਾਈ ਦੀ ਵਿਧੀ (ਹੜ੍ਹ/ਛਿੜਕਾਅ/ਡ੍ਰਿਪ/ਪਾਈਪਡ)			
If by pump, horsepower (HP) of pump used ਜੇ ਪੰਪ ਦੁਆਰਾ, ਪੰਪ ਦਾ ਐਚਪੀ ਵਰਤਿਆ ਜਾਂਦਾ ਹੈ			
If by pump, inch diameter of the pipe used ਜੇ ਪੰਪ ਦੁਆਰਾ, ਪਾਈਪ ਦਾ ਇੰਚ ਵਿਆਸ ਵਰਤਿਆ ਜਾਂਦਾ ਹੈ			
Depth of the tubewell ਟਿਯੂਬਵੈੱਲ ਦੀ ਗਹਰਾਹੀ			
Tubewell Age (how old is the tubewell?) ਟਿਯੂਬਵੈੱਲ ਦੀ ਉਮਰ ਕਿੰਨੀ ਹੈ?			
Estimated time in minutes to irrigate field each time ਰ ਵਾਰ ਖੇਤ ਦੀ ਸਿੰਚਾਈ ਲਈ ਮਿੰਟਾਂ ਵਿੱਚ ਅਨੁਮਾਨਤ ਸਮਾਂ			
Estimated quantity of water for each irrigation (in litres) ਲਿਟ ਵਿੱਚ ਹਰੇਕ ਸਿੰਚਾਈ ਲਈ ਪਾਣੀ ਦੀ ਅਨੁਮਾਨਤ ਮਾਤਰਾ			
Cost of water/irrigation ਪਾਣੀ/ਸਿੰਚਾਈ ਦੀ ਲਾਗਤ			

10. PESTS AND DISEASES ਕੀੜੇ ਅਤੇ ਬਿਮਾਰੀਆਂ

Wage Rate for Men: ₹……/day
ਪੁਰਸ਼ਾਂ ਲਈ ਤਨਖਾਹ ਦਰ: ₹……/ ਦਿਨ

Wage Rate for Women: ₹……/day
ਔਰਤ ਲਈ ਉਜਰਤਾਂ ਦੀ ਦਰ: ₹……/ਦਿਨ

Machine hire cost: ₹……/hour
ਮਸ਼ੀਨ ਕਿਰਾਏ ਦੀ ਲਾਗਤ:……/ਘੰਟਾ

Description	Plot 1	Plot 2	Plot 3
Kind of Pest ਕੀੜਿਆਂ/Disease ਬਿਮਾਰੀਆਂ 1: _____ **Spraying ਛਿੜਕਾਅ/Drenching ਡ੍ਰੈਂਚਿੰਗ (✓)**			
Severity (High/Medium/Low) ਗੰਭੀਰਤਾ (ਉੱਚ/ਮੱਧਮ/ਘੱਟ)			
Crop name (if particular) ਫਸਲ ਦਾ ਨਾਮ (ਜੇ ਖਾਸ ਹੋਵੇ))			
Name of the agro-chemical ਐਗਰੋ-ਕੈਮੀਕਲ ਦਾ ਨਾਮ			
Source ਸਰੋਤ			
Total quantity with unit ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Cost per unit ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type) (if any)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			
Kind of Pest ਕੀੜਿਆਂ/Disease ਬਿਮਾਰੀਆਂ 2: _____ **Spraying ਛਿੜਕਾਅ/Drenching ਡ੍ਰੈਂਚਿੰਗ (✓)**			
Severity (High/Medium/Low) ਗੰਭੀਰਤਾ (ਉੱਚ/ਮੱਧਮ/ਘੱਟ)			
Crop name (if particular) ਫਸਲ ਦਾ ਨਾਮ (ਜੇ ਖਾਸ ਹੋਵੇ))			
Name of the agro-chemical ਐਗਰੋ-ਕੈਮੀਕਲ ਦਾ ਨਾਮ			
Source ਸਰੋਤ			
Total quantity with unit ਯੂਨਿਟ ਦੇ ਨਾਲ ਕੁੱਲ ਮਾਤਰਾ			
Cost per unit ਲਾਗਤ ਪ੍ਰਤੀ ਯੂਨਿਟ			
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)			

Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)			
Machine ਮਸ਼ੀਨ (type) (if any)			
Hours ਘੰਟੇ			
Diesel consumed ਡੀਜ਼ਲ ਦੀ ਖਪਤ			

11. HARVESTING AND MARKETING ਵਾਢੀ ਵੇਚਣਾ ਅਤੇ ਮਾਰਕੇਟਿੰਗ

Wage Rate for Men: ₹……/day
ਪੁਰਸ਼ਾਂ ਲਈ ਤਨਖਾਹ ਦਰ: ₹……/ ਦਿਨ

Wage Rate for Women: ₹……/day
ਔਰਤ ਲਈ ਉਜਰਤਾਂ ਦੀ ਦਰ: ₹……/ਦਿਨ

Machine hire cost: ₹……/hour
ਮਸ਼ੀਨ ਕਿਰਾਏ ਦੀ ਲਾਗਤ:……/ਘੰਟਾ

Plot 1	**Main crop** **ਮੁੱਖ ਫਸਲ**	**Inter crop 1** **ਅੰਤਰ ਫ਼ਸਲ 1**	**Inter crop 2** **ਅੰਤਰ ਫ਼ਸਲ 2**	**Inter crop 3** **ਅੰਤਰ ਫ਼ਸਲ 3**	**Inter crop 4** **ਅੰਤਰ ਫ਼ਸਲ 4**
Harvesting Process Machine/Manual ਕਟਾਈ ਪ੍ਰਕਿਰਿਆ (ਮਸ਼ੀਨ/ ਮੈਨੁਅਲ) (✓)					
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)					
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)					
Machine hours ਮਸ਼ੀਨ ਦੇ ਘੰਟੇ					
If machine, diesel consumed in litres ਜੇ ਮਸ਼ੀਨ, ਡੀਜ਼ਲ ਲੀਟਰ ਦੀ ਖਪਤ ਹੁੰਦੀ ਹੈ					
Post-Harvesting Process ਕਟਾਈ ਤੋਂ ਬਾਅਦ ਦੀ ਪ੍ਰਕਿਰਿਆ **Threshing/Drying/Milling** **ਥਰੈਸ਼ਿੰਗ/ਸੁਕਾਉਣਾ/ਮਿਲਿੰਗ (✓)**					
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)					
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)					
Machine/livestock (ਮਸ਼ੀਨ/ਪਸ਼ੂਧਨ)					
Hours (ਘੰਟੇ)					
Diesel consumed (ਡੀਜ਼ਲ ਦੀ ਖਪਤ)					
Sales & Transportation					

ਵਿਕਰੀ ਅਤੇ ਆਵਾਜਾਈ					
Sources of information on price trends (PY/local market/traders/ Neighbours/ internet/mobile) ਕੀਮਤ ਦੇ ਰੁਝਾਨਾਂ ਬਾਰੇ ਜਾਣਕਾਰੀ ਦੇ ਸਰੋਤ (ਪੀਵਾਈ/ ਸਥਾਨਕ ਬਾਜ਼ਾਰ/ਵਪਾਰੀ/ ਗੁਆਂਢੀ /ਇੰਟਰਨੈਟ/ਮੋਬਾਈਲ)					
Place of sale (Mandi/Farmgate - direct or contract/FCI/Other) ਵਿਕਰੀ ਦਾ ਸਥਾਨ (ਮੰਡੀ/ਫਾਰਮਗੇਟ- ਸਿੱਧਾ ਜਾਂ ਇਕਰਾਰਨਾਮਾ/ਐਫਸੀਆਈ/ਹੋਰ)					
Mode of travel ਯਾਤਰਾ ਦੇ ਸਾਧਨ					
Distance travelled (in kms.) ਯਾਤਰਾ ਕੀਤੀ ਦੂਰੀ (ਕਿਲੋਮੀਟਰ ਵਿੱਚ)					
Diesel consumption ਡੀਜ਼ਲ ਦੀ ਖਪਤ					
Total cost ਕੁੱਲ ਲਾਗਤ					
Plot 2					
Harvesting Process Machine/Manual **ਕਟਾਈ ਪ੍ਰਕਿਰਿਆ (ਮਸ਼ੀਨ/ ਮੈਨੁਅਲ) (✓)**					
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)					
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)					
Machine hours ਮਸ਼ੀਨ ਦੇ ਘੰਟੇ					
If machine, diesel litres consumed ਜੇ ਮਸ਼ੀਨ, ਡੀਜ਼ਲ ਲੀਟਰ ਦੀ ਖਪਤ ਹੁੰਦੀ ਹੈ					
Post-Harvesting Process ਕਟਾਈ ਤੋਂ ਬਾਅਦ ਦੀ ਪ੍ਰਕਿਰਿਆ **Threshing/Drying/Milling**					

ਥਰੈਸ਼ਿੰਗ/ਸੁਕਾਉਣਾ/ਮਿਲਿੰਗ (✓)					
Man power ਮਨੁੱਖ ਸ਼ਕਤੀ (number × days)					
Women power ਔਰਤ ਸ਼ਕਤੀ (number × days)					
Machine/livestock (ਮਸ਼ੀਨ/ਪਸ਼ੂਧਨ)					
Hours (ਘੰਟੇ)					
Diesel consumed (ਡੀਜ਼ਲ ਦੀ ਖਪਤ)					
Sales & Transportation **ਵਿਕਰੀ ਅਤੇ ਆਵਾਜਾਈ**					
Sources of information on price trends (PY/local market/traders/ Neighbours/ internet/mobile) ਕੀਮਤ ਦੇ ਰੁਝਾਨਾਂ ਬਾਰੇ ਜਾਣਕਾਰੀ ਦੇ ਸਰੋਤ (ਪੀਵਾਈ/ਸਥਾਨਕ ਬਾਜ਼ਾਰ/ਵਪਾਰੀ/ ਗੁਆਂਢੀ /ਇੰਟਰਨੈਟ/ਮੋਬਾਈਲ)					
Place of sale (Mandi/Farmgate- direct or contract/FCI/Other) ਵਿਕਰੀ ਦਾ ਸਥਾਨ (ਮੰਡੀ/ਫਾਰਮਗੇਟ- ਸਿੱਧਾ ਜਾਂ ਇਕਰਾਰਨਾਮਾ/ਐਫਸੀਆਈ/ਹੋਰ)					
Mode of travel ਯਾਤਰਾ ਦੇ ਸਾਧਨ					
Distance travelled (in kms.) ਯਾਤਰਾ ਕੀਤੀ ਦੂਰੀ (ਕਿਲੋਮੀਟਰ ਵਿੱਚ)					
Diesel consumption ਡੀਜ਼ਲ ਦੀ ਖਪਤ					
Total cost ਕੁੱਲ ਲਾਗਤ					

12. YIELD DETAILS (ਉਪਜ ਵੇਰਵੇ)

Plot 1	Main crop ਮੁੱਖ ਫਸਲ	Inter crop 1 ਅੰਤਰ ਫ਼ਸਲ 1	Inter crop 2 ਅੰਤਰ ਫ਼ਸਲ 2	Inter crop 3 ਅੰਤਰ ਫ਼ਸਲ 3	Inter crop 4 ਅੰਤਰ ਫ਼ਸਲ 4
Main product quantity produced (in kg.) ਮੁੱਖ ਉਤਪਾਦ ਮਾਤਰਾ ਦਾ ਉਤਪਾਦਨ ਕੀਤਾ ਗਿਆ ਹੈ, ਜਿਸਦਾ ਜ਼ਿਕਰ ਇਕਾਈਆਂ ਨਾਲ ਕੀਤਾ ਗਿਆ ਹੈ					
Description of unit ਯੂਨਿਟ ਦਾ ਵੇਰਵਾ					
Quantity sold ਮਾਤਰਾ, ਜੇ ਵੇਚੀ ਜਾਵੇ (in kg.)					
Selling price per unit ਪ੍ਰਤੀ ਯੂਨਿਟ ਕੀਮਤ ਵੇਚੀ ਗਈ					
Market price ਮਾਰਕੀਟ ਕੀਮਤ					
Byproduct ਉਪ -ਉਤਪਾਦ **1**: _____					
Quantity produced ਪੈਦਾ ਕੀਤੀ ਮਾਤਰਾ (in kg.)					
Description of unit ਯੂਨਿਟ ਦਾ ਵੇਰਵਾ					
Removed/Burned/Mixed in the soil ਹਟਾਇਆ/ਸਾੜਿਆ ਗਿਆ/ਮਿੱਟੀ ਵਿੱਚ ਮਿਲਾਇਆ ਗਿਆ (✓)					
Quantity, if sold ਮਾਤਰਾ, ਜੇ ਵੇਚੀ ਜਾਵੇ (in kg.)					
Selling price per unit ਪ੍ਰਤੀ ਯੂਨਿਟ ਕੀਮਤ ਵੇਚੀ ਗਈ					
Byproduct ਉਪ -ਉਤਪਾਦ **2**: _____					
Quantity produced ਪੈਦਾ ਕੀਤੀ ਮਾਤਰਾ (in kg.)					
Description of unit ਯੂਨਿਟ ਦਾ ਵੇਰਵਾ					
Removed/Burned/Mixed in the soil ਹਟਾਇਆ/ਸਾੜਿਆ ਗਿਆ/ਮਿੱਟੀ ਵਿੱਚ ਮਿਲਾਇਆ ਗਿਆ (✓)					
Quantity, if sold ਮਾਤਰਾ, ਜੇ ਵੇਚੀ ਜਾਵੇ (in kg.)					
Selling price per unit ਪ੍ਰਤੀ ਯੂਨਿਟ ਕੀਮਤ ਵੇਚੀ ਗਈ					
Plot 2					
Main product quantity produced (in kg.) ਮੁੱਖ ਉਤਪਾਦ ਮਾਤਰਾ ਦਾ ਉਤਪਾਦਨ ਕੀਤਾ ਗਿਆ ਹੈ, ਜਿਸਦਾ ਜ਼ਿਕਰ ਇਕਾਈਆਂ ਨਾਲ ਕੀਤਾ ਗਿਆ ਹੈ					

Description of unit ਯੂਨਿਟ ਦਾ ਵੇਰਵਾ					
Quantity sold ਮਾਤਰਾ, ਜੇ ਵੇਚੀ ਜਾਵੇ (in kg.)					
Selling price per unit ਪ੍ਰਤੀ ਯੂਨਿਟ ਕੀਮਤ ਵੇਚੀ ਗਈ					
Market price ਮਾਰਕੀਟ ਕੀਮਤ					
Byproduct ਉਪ -ਉਤਪਾਦ **1**: _____					
Quantity produced ਪੈਦਾ ਕੀਤੀ ਮਾਤਰਾ (in kg.)					
Description of unit ਯੂਨਿਟ ਦਾ ਵੇਰਵਾ					
Removed/Burned/Mixed in the soil ਹਟਾਇਆ/ਸਾੜਿਆ ਗਿਆ/ਮਿੱਟੀ ਵਿੱਚ ਮਿਲਾਇਆ ਗਿਆ (✓)					
Quantity, if sold ਮਾਤਰਾ, ਜੇ ਵੇਚੀ ਜਾਵੇ (in kg.)					
Selling price per unit ਪ੍ਰਤੀ ਯੂਨਿਟ ਕੀਮਤ ਵੇਚੀ ਗਈ					
Byproduct ਉਪ -ਉਤਪਾਦ **2**: _____					
Quantity produced ਪੈਦਾ ਕੀਤੀ ਮਾਤਰਾ (in kg.)					
Description of unit ਯੂਨਿਟ ਦਾ ਵੇਰਵਾ					
Removed/Burned/Mixed in the soil ਹਟਾਇਆ/ਸਾੜਿਆ ਗਿਆ/ਮਿੱਟੀ ਵਿੱਚ ਮਿਲਾਇਆ ਗਿਆ (✓)					
Quantity, if sold ਮਾਤਰਾ, ਜੇ ਵੇਚੀ ਜਾਵੇ (in kg.)					
Selling price per unit ਪ੍ਰਤੀ ਯੂਨਿਟ ਕੀਮਤ ਵੇਚੀ ਗਈ					

13. **MISCELLANEOUS OUTPUTS (Peripheral trees, like poplars, eucalyptus, etc.) ਅਨੇਕ ਉਤਪਾਦ: ਕੀ ਫਾਰਮ ਵਿੱਚ ਪੈਰੀਫਿਰਲ ਰੁੱਖ ਹਨ (ਜਿਵੇਂ ਪੋਪਲਰ, ਯੂਕੇਲਿਪਟਸ)**

S. No.	Tree/plant name	Number	Cost incurred (in ₹)	Product name	Quantity produced, with unit mentioned	Quantity sold	Sale Price per unit	Unit description

14. **EXPENSES ON LIVESTOCK** ਪਸ਼ੂਧਨ ਤੇ ਖਰਚਾ

Type of Animal/Bird ਪਸ਼ੂ ਜਾਂ ਪੰਛੀ ਦੀ ਕਿਸਮ	Type ਕਿਸਮ 1: Number (ਗਿਣਤੀ) : Breed (ਨਸਲ):			Type ਕਿਸਮ 2: Number (ਗਿਣਤੀ) : Breed (ਨਸਲ):			Type ਕਿਸਮ 3: Number (ਗਿਣਤੀ) : Breed (ਨਸਲ):		
Cost	**Number**	**Calculation**	**Amount (₹)**	**Number**	**Calculation**	**Amount (₹)**	**Number**	**Calculation**	**Amount (₹)**
Infrastructure annual maintenance cost ਬੁਨਿਆਦੀ ਢਾਂਚਾ ਕਾਇਮ ਰੱਖਣ ਦੀ ਕੀਮਤ									
Cost of feed/fodder purchased ਖਰੀਦੇ ਗਏ ਫੀਡ/ਚਾਰੇ ਦੀ ਲਾਗਤ									
Imputed Labour cost (own) ਬਾਹਰੀ ਲੇਬਰ ਦੀ ਲਾਗਤ (ਆਪਣਾ)									

Labour cost (hired) ਬਾਹਰੀ ਲੇਬਰ ਦੀ ਲਾਗਤ (ਕਿਰਾਏ 'ਤੇ)									
Veterinary cost ਵੈਟਰਨਰੀ ਲਾਗਤ									
Cost of marketing produce ਮਾਰਕੀਟਿੰਗ ਉਤਪਾਦਾਂ ਦੀ ਲਾਗਤ									
Total Cost ਕੁੱਲ ਲਾਗਤ									

15. **INCOME FROM LIVESTOCK ਪਸ਼ੂਧਨ ਤੋਂ ਆਮਦਨੀ**

Type of Animal/Bird ਪਸ਼ੂ ਜਾਂ ਪੰਛੀ ਦੀ ਕਿਸਮ	**Type ਕਿਸਮ 1**: **Number (ਗਿਣਤੀ) :** **Breed (ਨਸਲ):**			**Type ਕਿਸਮ 2**: **Number (ਗਿਣਤੀ) :** **Breed (ਨਸਲ):**			**Type ਕਿਸਮ 3**: **Number (ਗਿਣਤੀ) :** **Breed (ਨਸਲ):**		
Product Type ਉਤਪਾਦ ਦੀ ਕਿਸਮ									
Income ਆਮਦਨ	**Number**	**Calculation**	**Amount (₹)**	**Number**	**Calculation**	**Amount (₹)**	**Number**	**Calculation**	**Amount (₹)**
Yearly yield (total with unit) ਇਕਾਈ ਦੇ ਨਾਲ ਸਾਲਾਨਾ ਉਪਜ (ਕੁੱਲ)									
Sales price of unit produce ਇਕਾਈ ਉਤਪਾਦਾਂ ਦੀ ਵਿਕਰੀ ਕੀਮਤ									
Total Income ਕੁੱਲ ਆਮਦਨ									

16. **INDEBTEDNESS, IF ANY** (only for crop investment, and not for capital investments)
ਕਰਜ਼ਾ ਨਿਵੇਸ਼, ਜੇ ਕੋਈ (ਸਿਰਫ ਫਸਲੀ ਨਿਵੇਸ਼ ਲਈ, ਅਤੇ ਰਾਜਧਾਨੀ ਨਿਵੇਸ਼ ਲਈ ਨਹੀਂ)

1. Did you borrow any money for agricultural investment for your farming this season (This includes credit for the purchase of external inputs)
ਕੀ ਤੁਸੀਂ ਇਸ ਸੀਜ਼ਨ ਵਿੱਚ ਆਪਣੀ ਖੇਤੀ ਲਈ ਖੇਤੀਬਾੜੀ ਨਿਵੇਸ਼ ਲਈ ਕੋਈ ਪੈਸਾ ਉਧਾਰ ਲਿਆ ਸੀ(ਇਸ ਵਿੱਚ ਬਾਹਰੀ ਇਨਪੁਟਸ ਦੀ ਖਰੀਦ ਲਈ ਕ੍ਰੈਡਿਟ ਸ਼ਾਮਲ ਹੈ)?: **Yes** □/**No** □
2. If yes, what is it for? (mention details) ਜੇ ਹਾਂ, ਤਾਂ ਇਹ ਕਿਸ ਲਈ ਹੈ? (ਵੇਰਵਿਆਂ ਦਾ ਜ਼ਿਕਰ ਕਰੋ)
_____
3. If yes, what is the total amount borrowed ਜੇ ਹਾਂ, ਤਾਂ ਉਧਾਰ ਲਈ ਗਈ ਕੁੱਲ ਰਕਮ ਕੀ ਹੈ?
ਰੁਪਏ?:_____
4. Source of Credit ਕ੍ਰੈਡਿਟ ਦਾ ਸਰੋਤ: (A) Friend □ (B) Relative □ (C) Moneylender □ (D) Input Dealer □ (E) Bank □ (F) Coop Society □ (G) Others □ _____
5. Interest Rate (%) (ਵਿਆਜ ਦਰ): .....%

17. **INSURANCE, IF ANY** (only for crop investment, and not for capital investments)
ਬੀਮਾ, ਜੇ ਕੋਈ ਹੋਵੇ (ਸਿਰਫ ਫਸਲੀ ਨਿਵੇਸ਼ ਲਈ, ਅਤੇ ਰਾਜਧਾਨੀ ਨਿਵੇਸ਼ ਲਈ ਨਹੀਂ)

1. Did you take any insurance on crops ਕੀ ਤੁਸੀਂ ਫਸਲਾਂ ਦਾ ਕੋਈ ਬੀਮਾ ਲਿਆ ਸੀ? **Yes** □ **No** □
2. If yes, what is the insured amount and premium ਜੇ ਹਾਂ, ਤਾਂ ਬੀਮਾ ਰਕਮ ਅਤੇ ਪ੍ਰੀਮੀਅਮ ਕੀ ਹੈ?

_____

18. **SUBSIDIES** availed ਸਬਸਿਡੀਆਂ ਦਾ ਲਾਭ (only for the current crop)

Name	Source	Amount (₹)
i. Fertilizer ਖਾਦ		
ii. Power ਬਿਜਲੀ		
iii. Irrigation ਸਿੰਚਾਈ		
iv. Other (name) ਹੋਰ (ਨਾਮ)		

19. **FARM MANAGEMENT AND RESOURCES** **ਖੇਤ ਪ੍ਰਬੰਧਨ ਅਤੇ ਸਰੋਤ**

19.1	What is the reason for selecting a crop ਫਸਲ ਦੀ ਚੋਣ ਕਰਨ ਦਾ ਕੀ ਕਾਰਨ ਹੈ? (✓)	
	i. Conventional/habit ਰਵਾਇਤੀ/ਆਦਤ	
	ii. Experienced ਤਜਰਬੇਕਾਰ	
	iii. Lead farmers ਕਿਸਾਨਾਂ ਦੀ ਅਗਵਾਈ	
	iv. Based on market trend ਬਾਜ਼ਾਰ ਦੇ ਰੁਝਾਨ ਦੇ ਅਧਾਰ ਤੇ	
	v. Based on various knowledge from groups/institutions ਸਮੂਹਾਂ/ਸੰਸਥਾਵਾਂ ਦੇ ਵੱਖੋ ਵੱਖਰੇ ਗਿਆਨ ਦੇ ਅਧਾਰ ਤੇ	
	vi. Minimum Support Price (MSP) (ਐਮ.ਐਸ.ਪੀ)	
19.2	How willing is the farmer to learn about new agricultural practices and information? ਕਿਸਾਨ ਖੇਤੀ ਦੇ ਨਵੇਂ ਤਰੀਕਿਆਂ ਅਤੇ ਜਾਣਕਾਰੀ ਬਾਰੇ ਸਿੱਖਣ ਲਈ ਕਿੰਨਾ ਤਿਆਰ ਹੈ? (✓)	
	i. Not willing ਇੱਛੁਕ ਨਹੀਂ	
	ii. Willing but apprehensive ਇੱਛੁਕ ਪਰ ਚਿੰਤਤ	

	iii. Willing to try once ਇੱਕ ਵਾਰ ਕੋਸ਼ਿਸ਼ ਕਰਨ ਲਈ ਤਿਆਰ	
	iv. Willing to try always ਹਮੇਸ਼ਾਂ ਕੋਸ਼ਿਸ਼ ਕਰਨ ਲਈ ਤਿਆਰ	
19.3.	What is the basis for a decision to apply fertiliser ਖਾਦ ਲਾਗੂ ਕਰਨ ਦੇ ਫੈਸਲੇ ਦਾ ਆਧਾਰ ਕੀ ਹੈ? (✓)	
	i. Based on personal conjecture ਵਿਅਕਤੀਗਤ ਅਨੁਮਾਨ ਦੇ ਅਧਾਰ ਤੇ	
	ii. Advise by shop keeper ਦੁਕਾਨਦਾਰ ਦੁਆਰਾ ਸਲਾਹ	
	iii. Based on experience ਤਜ਼ਰਬੇ ਦੇ ਅਧਾਰ ਤੇ	
	iv. Based on expert recommendation ਮਾਹਰ ਦੀ ਸਿਫਾਰਸ਼ ਦੇ ਅਧਾਰ ਤੇ	
	v. Based on soil testing and advise ਮਿੱਟੀ ਪਰਖ ਅਤੇ ਸਲਾਹ ਦੇ ਅਧਾਰ ਤੇ	
	vi. Based on yield and profitability ਉਪਜ ਅਤੇ ਮੁਨਾਫੇ ਦੇ ਅਧਾਰ ਤੇ	
19.4.	What is the basis for deciding which pesticide to apply? ਕਿਹੜੀ ਕੀਟਨਾਸ਼ਕ ਦਵਾਈ ਨੂੰ ਲਾਗੂ ਕਰਨਾ ਹੈ, ਇਸਦਾ ਅਧਾਰ ਕੀ ਹੈ? (✓)	
	i. Based on personal estimation ਵਿਅਕਤੀਗਤ ਅਨੁਮਾਨ ਦੇ ਅਧਾਰ ਤੇ	
	ii. Based on experience ਤਜ਼ਰਬੇ ਦੇ ਅਧਾਰ ਤੇ	
	iii. Based on shopkeeper ਦੁਕਾਨਦਾਰ 'ਤੇ ਅਧਾਰਤ	
	iv. Based on expert suggestion or training ਮਾਹਰ ਦੇ ਸੁਝਾਅ ਜਾਂ ਸਿਖਲਾਈ ਦੇ ਅਧਾਰ ਤੇ	
19.5.	When do you decide to apply pesticides? ਤੁਸੀਂ ਕੀਟਨਾਸ਼ਕਾਂ ਨੂੰ ਲਾਗੂ ਕਰਨ ਦਾ ਫੈਸਲਾ ਕਦੋਂ ਕਰਦੇ ਹੋ? (✓)	
	i. At regular interval/stage of the crop ਫਸਲ ਦੇ ਨਿਯਮਤ ਅੰਤਰਾਲ/ਪੜਾਅ' ਤੇ	
	ii. At first sighting of the pest ਕੀੜੇ ਦੇ ਪਹਿਲੀ ਨਜ਼ਰ ਤੇ	
	iii. After visible symptoms of infestation ਲਾਗ ਦੇ ਦਿਖਾਈ ਦੇਣ ਵਾਲੇ ਲੱਛਣਾਂ ਦੇ ਬਾਅਦ	
	iv. Only if it appears to get severe and create significant loss ਸਿਰਫ ਤਾਂ ਹੀ ਜੇ ਇਹ ਗੰਭੀਰ ਹੁੰਦਾ ਜਾਪਦਾ ਹੈ ਅਤੇ ਮਹੱਤਵਪੂਰਣ ਨੁਕਸਾਨ ਪੈਦਾ ਕਰਦਾ ਹੈ	
	v. Never or very rarely ਕਦੇ ਜਾਂ ਬਹੁਤ ਘੱਟ	
19.6.	What can help farmers improve their handling of pesticides? ਕੀਟਨਾਸ਼ਕਾਂ ਦੇ ਪ੍ਰਬੰਧਨ ਨੂੰ ਬਿਹਤਰ ਬਣਾਉਣ ਵਿੱਚ ਕਿਸਾਨਾਂ ਦੀ ਕੀ ਮਦਦ ਹੋ ਸਕਦੀ ਹੈ? (✓) (can select more than one option)	
	i. Knowledge support ਗਿਆਨ ਦਾ ਸਮਰਥਨ	
	ii. Equipment support ਉਪਕਰਣ ਸਹਾਇਤਾ	
	iii. Skilled labour ਹੁਨਰਮੰਦ ਕਿਰਤ	
	iv. Market incentives ਮਾਰਕੀਟ ਪ੍ਰੋਤਸਾਹਨ	
	v. Subsidies ਸਬਸਿਡੀਆਂ	
19.7.	What is the level of knowledge about different methods like drip/sprinkler ਡਰਿਪ/ਸਪ੍ਰਿੰਕਲਰ ਵਰਗੇ ਵੱਖੋ ਵੱਖਰੇ ਤਰੀਕਿਆਂ ਬਾਰੇ ਗਿਆਨ ਦਾ ਪੱਧਰ ਕੀ ਹੈ? (✓)	
	i. None ਕੋਈ ਨਹੀਂ	
	ii. Some knowledge ਕੁਝ ਗਿਆਨ	
	iii. Good knowledge ਚੰਗਾ ਗਿਆਨ	
	iv. Good knowledge and practice ਚੰਗਾ ਗਿਆਨ ਅਤੇ ਅਭਿਆਸ	
19.8.	What is the usual irrigation timing ਆਮ ਸਿੰਚਾਈ ਦਾ ਸਮਾਂ ਕੀ ਹੈ? (✓)	
	i. Irrigate during evening ਸ਼ਾਮ ਨੂੰ ਸਿੰਚਾਈ ਕਰੋ	
	ii. Irrigate early morning ਸਵੇਰੇ ਜਲਦੀ ਸਿੰਜਾਈ ਕਰੋ	
	iii. Depends on power supply ਬਿਜਲੀ ਸਪਲਾਈ 'ਤੇ ਨਿਰਭਰ ਕਰਦਾ ਹੈ	

	iv. Irrigate in daytime ਦਿਨ ਵੇਲੇ ਸਿੰਚਾਈ ਕਰੋ	
19.9.	What are the sources of information on price trends ਕੀਮਤ ਦੇ ਰੁਝਾਨਾਂ ਬਾਰੇ ਜਾਣਕਾਰੀ ਦੇ ਸਰੋਤ ਕੀ ਹਨ? (✓) (can select more than one option)	
	i. Previous year trend ਪਿਛਲੇ ਸਾਲ ਦਾ ਰੁਝਾਨ	
	ii. Local market scenario ਸਥਾਨਕ ਬਾਜ਼ਾਰ ਦਾ ਦ੍ਰਿਸ਼	
	iii. Neighbours ਗੁਆਂਢੀ	
	iv. Traders ਵਪਾਰੀ	
	v. Media ਮੀਡੀਆ	
	vi. Internet/mobile ਇੰਟਰਨੈਟ/ਮੋਬਾਈਲ	
19.10.	Does the farmer face any issue in getting labour for the farm work? ਕੀ ਕਿਸਾਨ ਨੂੰ ਖੇਤ ਦੇ ਕੰਮ ਲਈ ਲੇਬਰ ਪ੍ਰਾਪਤ ਕਰਨ ਵਿੱਚ ਕਿਸੇ ਸਮੱਸਿਆ ਦਾ ਸਾਹਮਣਾ ਕਰਨਾ ਪੈਂਦਾ ਹੈ? (✓)	
	i. Mostly self-labour ਜਿਆਦਾਤਰ ਸਵੈ-ਕਿਰਤ	
	ii. Sufficient supply ਲੋੜੀਂਦੀ ਸਪਲਾਈ	
	iii. Seasonal ਮੌਸਮੀ	
	iv. Poor labour supply ਖਰਾਬ ਲੇਬਰ ਸਪਲਾਈ	

20. **SOCIAL INTERFACE ਸਮਾਜਿਕ ਇੰਟਰਫੇਸ**

20.1.	Are you associated with any community or producers' group? ਕੀ ਤੁਸੀਂ ਕਿਸੇ ਭਾਈਚਾਰੇ ਜਾਂ ਉਤਪਾਦਕਾਂ ਦੇ ਸਮੂਹ ਨਾਲ ਜੁੜੇ ਹੋਏ ਹੋ? (✓) (can select more than one option)	
	i. Good rapport with adjacent/neighbouring farmers ਨੇੜਲੇ/ ਗੁਆਂਢੀ ਕਿਸਾਨਾਂ ਨਾਲ ਚੰਗਾ ਸੰਬੰਧ	
	ii. Part of SHGs/NGO	
	iii. Part of farmer association/co-operative/farmer producer organisations ਕਿਸਾਨ ਐਸੋਸੀਏਸ਼ਨ/ਸਹਿਕਾਰੀ/ਕਿਸਾਨ ਉਤਪਾਦਕ ਸੰਸਥਾਵਾਂ ਦਾ ਹਿੱਸਾ	
	iv. Others (name):	
	v. None	
20.2.	What is the benefits farmer gain from the groups he belongs to? ਕਿਸਾਨ ਉਨ੍ਹਾਂ ਸਮੂਹਾਂ ਤੋਂ ਕੀ ਲਾਭ ਪ੍ਰਾਪਤ ਕਰਦਾ ਹੈ ਜਿਨ੍ਹਾਂ ਨਾਲ ਉਹ ਸੰਬੰਧਤ ਹਨ? (✓) (can select more than one option)	
	i. Knowledge like crop selection, weather, etc. ਗਿਆਨ ਜਿਵੇਂ ਫਸਲ ਦੀ ਚੋਣ, ਮੌਸਮ, ਆਦਿ.	
	ii. Input support ਇਨਪੁਟ ਸਹਾਇਤਾ	
	iii. Market support like access, transport etc. ਮਾਰਕੀਟ ਸਹਾਇਤਾ ਜਿਵੇਂ ਪਹੁੰਚ, ਆਵਾਜਾਈ ਆਦਿ.	
	iv. Capacity building activities ਸਮਰੱਥਾ ਨਿਰਮਾਣ ਗਤੀਵਿਧੀਆਂ	
20.3.	What is the strength and composition of the group ਸਮੂਹ ਦੀ ਤਾਕਤ ਅਤੇ ਰਚਨਾ ਕੀ ਹੈ? (✓) (can select more than one option)	
	i. Very good or equal participation from women ਔਰਤਾਂ ਦੀ ਬਹੁਤ ਚੰਗੀ ਜਾਂ ਬਰਾਬਰ ਭਾਗੀਦਾਰੀ	
	ii. Equivalent voice and participation from majority of members ਬਹੁਗਿਣਤੀ ਮੈਂਬਰਾਂ ਦੀ ਸਮਾਨ ਆਵਾਜ਼ ਅਤੇ ਭਾਗੀਦਾਰੀ	
	iii. Different caste ਵੱਖਰੀ ਜਾਤ	
	iv. Different religion ਵੱਖਰਾ ਧਰਮ	

21. **DETAILS OF EXTENSION SUPPORT RECEIVED DURING THE PAST SEASON ਪਿਛਲੇ ਸੀਜ਼ਨ ਦੌਰਾਨ ਪ੍ਰਾਪਤ ਹੋਏ ਐਕਸਟੈਂਸ਼ਨ ਸਪੋਰਟ ਦੇ ਵੇਰਵੇ**

21.1.	What are the sources of information and knowledge on farming? ਖੇਤੀ ਬਾਰੇ ਜਾਣਕਾਰੀ ਅਤੇ ਗਿਆਨ ਦੇ ਸਰੋਤ ਕੀ ਹਨ? (✓)	
	i. Family knowledge/experience ਪਰਿਵਾਰਕ ਗਿਆਨ/ਅਨੁਭਵ	
	ii. Formal education ਰਸਮੀ ਸਿੱਖਿਆ	
	iii. Neighbouring farmers ਗੁਆਂਢੀ ਕਿਸਾਨ	
	iv. State extension services ਰਾਜ ਵਿਸਥਾਰ ਸੇਵਾਵਾਂ	
	v. Television/Radio ਟੈਲੀਵਿਜ਼ਨ/ਰੇਡੀਓ	
	vi. Newspaper/Magazines ਅਖ਼ਬਾਰ/ਮੈਗਜ਼ੀਨ	
	vii. Mobile/internet ਮੋਬਾਈਲ/ਇੰਟਰਨੈਟ	
21.2.	Have you ever taken advice regarding the farming practice from any institution ਕੀ ਤੁਸੀਂ ਕਦੇ ਕਿਸੇ ਸੰਸਥਾ ਤੋਂ ਖੇਤੀ ਦੇ ਅਭਿਆਸ ਬਾਰੇ ਸਲਾਹ ਲਈ ਹੈ? (✓)	
	i. Not willing (No trust) ਤਿਆਰ ਨਹੀਂ (ਕੋਈ ਭਰੋਸਾ ਨਹੀਂ)	
	ii. Not aware ਪਤਾ ਨਹੀਂ	
	iii. Rarely ਬਹੁਤ ਘੱਟ	
	iv. Sometimes ਕਈ ਵਾਰ	
	v. Regularly ਬਾਕਾਇਦਾ	

21.3.	**Type of Support**	**Received (Yes/No)**	**Who provided support? (A) NGO/SHG (B) Govt organisation (C) PAU (D) Farmers Association/Co-operative (E) Others (mention):……**
	i. Training ਸਿਖਲਾਈ		
	ii. Exposure visits ਐਕਸਪੋਜ਼ਰ ਦੌਰੇ		
	iii. Input support ਇਨਪੁਟ ਸਹਾਇਤਾ		
	iv. Marketing support ਮਾਰਕੀਟਿੰਗ ਸਹਾਇਤਾ		
	v. Any other support ਕੋਈ ਹੋਰ ਸਹਾਇਤਾ: _____		

22. **EXPERIENCE, CHALLENGES, AND SUGGESTIONS (ਅਨੁਭਵ, ਚੁਣੌਤੀਆਂ, ਅਤੇ ਸੁਝਾਅ)**

22.1 Experience of farmers in this cropping season *vis-à-vis* previous crop (ਪਿਛਲੀ ਫਸਲ ਦੇ ਮੁਕਾਬਲੇ ਇਸ ਫਸਲ ਦੇ ਸੀਜ਼ਨ ਵਿੱਚ ਕਿਸਾਨਾਂ ਦਾ ਤਜਰਬਾ (✓)

Parameters	Significant decrease	Marginal decrease	No change	Marginal increase	Significant increase	Don't know
i. Cost of cultivation ਕਾਸ਼ਤ ਦੀ ਲਾਗਤ						
ii. Labour requirement ਕਿਰਤ ਦੀ ਲੋੜ						
iii. Drudgery ਸਖਤ ਕੰਮ ਜਾਂ ਥਕਾਵਟ ਵਾਲਾ ਕੰਮ						
iv. Crop yield ਫਸਲ ਦੀ ਪੈਦਾਵਾਰ						
v. Net farm income ਸ਼ੁੱਧ ਖੇਤੀ ਆਮਦਨ						
vi. Number of crops cultivated ਕਾਸ਼ਤ ਕੀਤੀਆਂ ਫਸਲਾਂ ਦੀ ਸੰਖਿਆ						
vii. Number of saleable produces ਵੇਚਣਯੋਗ ਉਤਪਾਦਾਂ ਦੀ ਸੰਖਿਆ						
viii. Price received for the produce ਉਪਜ ਲਈ ਪ੍ਰਾਪਤ ਕੀਮਤ						
ix. Crop duration ਫਸਲ ਦੀ ਮਿਆਦ						
x. Any Other:_____						

22.2 Contribution of women in different agricultural operations ਵੱਖ -ਵੱਖ ਖੇਤੀ ਕਾਰਜਾਂ ਵਿੱਚ ਔਰਤਾਂ ਦਾ ਯੋਗਦਾਨ (✓)

Operation	All	Maximum	Equal	Minimum	Nil	Don't Know
i. Land preparation ਜ਼ਮੀਨ ਦੀ ਤਿਆਰੀ						
ii. Sowing (nursery, transplantation) ਬਿਜਾਈ (ਨਰਸਰੀ, ਟ੍ਰਾਂਸਪਲਾਂਟੇਸ਼ਨ)						
iii. Fertilizer application ਖਾਦ ਦੀ ਅਰਜ਼ੀ						
iv. Weeding ਬੂਟੀ						
v. Pest control ਕੀੜਿਆਂ ਦਾ ਨਿਯੰਤਰਣ						
vi. Irrigation ਸਿੰਚਾਈ						
vii. Harvesting ਕਟਾਈ						
viii. Post harvesting operations ਕਟਾਈ ਤੋਂ ਬਾਅਦ ਦੇ ਕੰਮ						
ix. Marketing ਮਾਰਕੀਟਿੰਗ						
x. Any Other:_____						

22.3 Challenges faced by farmers ਕਿਸਾਨਾਂ ਨੂੰ ਦਰਪੇਸ਼ ਚੁਣੌਤੀਆਂ (✓)

Parameters	Stressed	Yes	No	Don't Know
i. Low yield ਘੱਟ ਉਪਜ				
ii. Pest and disease ਗ ਅਤੇ ਕੀੜੇ				
iii. Weed management ਬੂਟੀ ਪ੍ਰਬੰਧਨ				
iv Access to organic inputs ਜੈਵਿਕ ਇਨਪੁਟਸ ਤੱਕ ਪਹੁੰਚ				
v. Lack of knowledge ਗਿਆਨ ਦੀ ਘਾਟ				

vi. Higher labour requirement ਵਧੇਰੇ ਕਿਰਤ ਦੀ ਲੋੜ				
vii. Drudgery ਸਖਤ ਕੰਮ ਜਾਂ ਥਕਾਵਟ ਵਾਲਾ ਕੰਮ				
viii. Marketing challenges ਮਾਰਕੀਟਿੰਗ ਚੁਣੌਤੀਆਂ				
ix. Price realization ਕੀਮਤ ਦੀ ਪ੍ਰਾਪਤੀ				
x. Credit requirements ਕ੍ਰੈਡਿਟ ਲੋੜਾਂ				
xi. Net income ਸ਼ੁਧ ਆਮਦਨੀ				
xii. Difficulty in livestock management ਸ਼ੂਧਨ ਪ੍ਰਬੰਧਨ ਵਿੱਚ ਮੁਸ਼ਕਲ				
xiii. Lack of institutional support ਸੰਸਥਾਗਤ ਸਹਾਇਤਾ ਦੀ ਘਾਟ				
xiv. Irrigation constraints ਸਿੰਚਾਈ ਦੀਆਂ ਕਮੀਆਂ				
xv. Rented land ਕਿਰਾਏ ਦੀ ਜ਼ਮੀਨ				
xvi. Any Other:_____				

22.4 Suggestions to resolve the constraints faced by farmers (ਕਿਸਾਨਾਂ ਨੂੰ ਦਰਪੇਸ਼ ਮੁਸ਼ਕਿਲਾਂ ਦੇ ਹੱਲ ਲਈ ਸੁਝਾਅ) (✓)

Constraints (ਪਾਬੰਦੀਆਂ)	**Suggestions (ਸੁਝਾਅ)**
i. Production ਉਤਪਾਦਨ	
ii. Input ਇਨਪੁਟ	
iii. Technology and Process ਤਕਨਾਲੋਜੀ ਅਤੇ ਪ੍ਰਕਿਰਿਆ	
iv. Marketing ਮਾਰਕੀਟਿੰਗ	
v. Certification ਸਰਟੀਫਿਕੇਸ਼ਨ	
vi. Institutional ਸੰਸਥਾਗਤ	
vii. Any Other:_____	

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